Opportunities for Success and CO_2 Savings from Appliance Energy Efficiency Harmonisation

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in Partnership with CLASP,
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CONTENTS

ACRONYMS AND ABBREVIATIONS

4E	IEA Implementing Agreement: Efficient Electrical End-Use Equipment (www.iea-4e.org)
AC	Alternating Current
AC	Air conditioning
ACEEE	American Council for Energy Efficient Economy
ANOPR	Advance Notice of Proposed Rulemaking
ANSI	American National Standards Institute
AP	Acidification Potential
APEC	Asia Pacific Economic Cooperation
ASD	Adjustable Speed Drive (general term for adapting to partial load)
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BEE	Bureau of Energy Efficiency, India
Btu	British Thermal Unit
CCT	Correlated Colour Temperature
CDM	Clean Development Mechanism
CECED	European Home Appliance Manufacturers Association
CEMEP	European Committee of Manufacturers of Electrical Machines and Power Electronics
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardisation
CFL	Compact Fluorescent Lamp
CFLi	Compact Fluorescent Lamp with integrated ballast
CFLn	Compact Fluorescent Lamp without integrated ballast
CFR	Code of Federal Regulations
CHP	Combined Heat and Power
CIE	International Commission on Lighting
CMH	Ceramic Metal Halide
CNCA	Certification and Accreditation Commission of China
CNIS	China National Institute of Standardisation
CRI	Colour Rendering Index
CSA	Canadian Standards Association
CSCC	China Standards Certification Centre (formerly the China Certification Centre for Energy Conservation Products, CECP)
CW	Constant Wattage isolated transformer (HID magnetic ballast)
CWA	Constant Wattage Autotransformer (HID magnetic ballast)
DALI	Digital Addressable Lighting Interface
DC	Direct Current
DG TREN	European Commission, Directorate General Transport and Energy

DG-ENTI	Directorate General for Enterprise and Industry
DG-ENV	Directorate General for Environment
DG-TREN	Directorate General for Energy and Transport
DOE	Department of Energy (United States of America)
DOE	USA Department of Energy
EACI	Executive Agency on Competitiveness and Innovation
EC	European Commission
EC	European Commission
Ecodesign	EC Directive for Energy-using Products 2005/32/EC
EEAP	Energy Efficiency Action Plan
EERE	DOE Energy Efficiency and Renewable Energy program
EERE	Office of Energy Efficiency and Renewable Energy (DOE)
Eff	CEMEP motor classification (Eff 1, Eff 2, Eff 3)
EIA	Energy Information Administration (DOE)
EISA	Energy Independence and Security Act (2007)
ELC	European Lamp Companies Federation
EMAS	Eco-Management and Audit Scheme
EMSA	Electric Motor Systems Annex 4E (www.motorsystems.org)
EMSA	IEA 4E Motor Systems Annex
EN	European Standard (Européenne Norme)
EPA	Environmental Protection Agency
EPA	USA Environmental Protection Agency
EPACT	Energy Policy Act (1992 and 2005)
EPAct	Energy Policy Act, 1992 MEPS for electric motors
EPCA	Energy Policy and Conservation Act (1975)
ETAP	Environmental Technologies Action Plan
EU	European Union
EU	European Union (the number like "EU-27" refers to the countries included
EU SDS	European Union's Sustainable Development Strategy
EuP	Energy-Using Products
EuP	Ecodesign Directive for Energy-using Products 2005/32/EC
FCC	Federal Communications Commission (US)
FEMP	Federal Energy Management Program
FR	Federal Register
FTC	Federal Trade Commission
GDP	Gross Domestic Product
GDP	Gross domestic product
GEF	Global Environment Facility
GHG	Green House Gases
GLS	General Lighting Service
GPP	Green Public Procurement

GW	Gigawatt (109 W)
GWP	Global Warming Potential
HEM	Higher efficiency motor (e.g. IE3 or NEMA Premium efficiency class)
HEP	High Efficiency Plasma
HID	High Intensity Discharge
HP	Horsepower (US motors equivalent to kW)
HPS	High Pressure Sodium
HVAC	Heating, ventilating and air conditioning
HX	High Reactance Autotransformer (HID magnetic ballast)
Hz	Hertz
ICT	Information and Communication Technology
IE1	New IEC 60034-30 Energy Efficiency Classes for electric motors (roughly equivalent to Eff 2)
IE2	New IEC 60034-30 Energy Efficiency Classes for electric motors (roughly equivalent to Eff1 and EPAct)
IE3	New IEC 60034-30 Energy Efficiency Classes for electric motors (roughly equivalent to NEMA Premium)
IEA	International Energy Agency, Paris France
IEC	International Electrotechnical Committee
IEC	International Electrotechnical Commission, Geneva Switzerland
IEEE	Institute of Electrical and Electronics Engineers
INPV	Industry Net Present Value
IP	Intellectual Property
IPP	Integrated Product Policy
IPPC	
BREFs	Integrated Pollution Prevention and Control, Best Available Techniques
IRR	Internal rate of return
IS	Indian Standard
ISO	International Organisation for Standardisation
JIS	Japan Industrial Standard
JRA	Japan Refrigeration and Air Conditioning Industry Association
kW	Kilowatt (EU motors equivalent to HP)
kW	Kilowatt (103 W)
LCC	Life Cycle Cost
LCC	Life Cycle Cost
LED	Light Emitting Diode
LLD	Lamp Lumen Depreciation
LLF	Light Loss Factor
LNG	Liquefied natural gas
LPS	Low Pressure Sodium
LPW	Lumens Per Watt

MEEUP	Methodology study for Ecodesign of Energy-Using Products
MEPS	Minimum Energy Performance Standard
MEPR	Minimum Energy Performance Regulation (includes MEPS and Top Runner)
MFD	Multi-Function Devices (e.g., all-in-one: printer, copier, scanner, phone.)
MH	Metal Halide
MIA	Manufacturer Impact Analysis
MV	Mercury Vapour
MW	Megawatt (106 W)
NABL	National Accreditation Board for Testing and Calibration Laboratories, India
NEMA	National Electrical Manufacturers Association, USA
NGO	Non-Governmental Organisation
NOPR	Notice of Proposed Rulemaking
NPV	Net Present Value
OEM	Original Equipment Manufacturer
OLED	Organic Light Emitting Diode
PBP	Payback Period
PMH	Pulse-start Metal Halide
rpm	Revolutions per minute
SAC	Standardisation Administration of China
SCP/SIP	Sustainable Consumption and Production / Sustainable Industrial Policy
SEPA	State Environmental Protection Administration (China)
SI	le Système International d'unités
STB	Set Top Box
TCO	Total cost of ownership
TSD	Technical Support Document
TWh	Tera Watt Hour (1012 Wh)
UL	Underwriters Laboratory
US	United States
USC	United States Code (i.e., Congressional Statute)
VA	Voluntary Agreement
VFD	Variable Frequency Drive (specific technology to adapt to variable load)
VSD	Variable Speed Drive (see ASD)
WEEE	Waste Electrical and Electronic Equipment (EU Directive)

EXECUTIVE SUMMARY

Efficiency standards and labelling schemes are currently in place for a variety of end-use equipment types in countries that account for about 80% of the world's population and a higher share of its GDP, energy use and CO_2 emissions. Policymakers in the major economies are increasingly paying heed to developments in the other economies and this raises the prospect for increased international cooperation and enhanced alignment of policy settings. Were equipment energy using test procedures and energy performance metrics to be more closely internationally aligned it would facilitate trade, conformity assessment and comparison of policy settings across the major economies. But what might it do to facilitate energy savings?

This report presents findings of an extensive investigation of the energy efficiency standards and labelling programs in place in China, the EU, India, Japan and the USA. The broad aim of this research is to identify what might be gained through closer coordination and alignment of technical requirements and policy settings among the major economies and to explore what additional savings could be realised were economies to extend the coverage and stringency of their programs to align with international best practice. It is found that were the current most broadly based and stringent equipment energy efficiency regulations to be adopted world-wide by 2030 it would save

- 4000 TWh of final electricity demand (12% of the total) and 4% of oil and gas demand in the residential, commercial and industrial sectors excluding energy used for transport and industrial process heat
- 2600 Mt of CO_2 emissions (11% of emissions from the sectors addressed)

These savings arise because existing policy coverage is incomplete (ranging between 0% and about 70% of the energy use in the sectors considered and because the stringency and manner in which permissible energy per unit service is determined leaves some large unexploited opportunities, even in the most advanced programmes. Policy coverage is particularly incomplete for the commercial and industrial sectors and large cost-effective energy savings remain untapped in each. Lack of ambition in stringency is also a constraint. Increased stringency in line with current world best practice would lead to especially substantial energy savings for the broad end uses of: lighting, HVAC, industrial electric motors, consumer electronics and white goods.

Important as these savings are they amount to only slightly over 40% of what could be achieved from the universal adoption of today's most energy efficient technologies by 2030. Energy demand savings of 28% and 6700 Mt CO_2 emissions reductions are theoretically possible were such technologies to be universally adopted. This implies that there is plenty of scope to increase the ambition of the most demanding policy settings in place today and that sustainable energy technology policy still has some way to go before it is treating the demand side options on the same basis as supply side options. Elucidating the advantages of efficient demand side

technologies is an essential factor if even handed treatment is to be established and a key factor in achieving that is developing a sophisticated understanding of the relative efficiency of other economies energy service technologies. Greater international harmonisation in testing, efficiency metrics and regulatory energy service classifications will greatly facilitate this.

The report presents key findings regarding the degree of alignment of test procedures and efficiency metrics for the 24 most significant electrical end-uses in the residential, commercial and industrial sectors. It further provides an assessment of the prospects to increase harmonisation of test procedures, efficiency metrics and regulatory measures for each of the products and discusses the issues related to this. The key institutions involved in equipment energy efficiency regulatory settings are described and the regulatory and energy performance standards setting processes followed in each economy are outlined. In addition the report provides detailed information on most of the equipment regulatory measures in place in the five economies today and a presents a full listing of the products which are currently subject to MEPRS and energy labelling.

Were there to be accelerated adoption of leading international energy efficiency policy requirements it would produce significant savings even within economies that currently have many of the highest energy efficiency policy settings. For economies that currently have only limited efficiency requirements the savings from accelerated adoption of world's best requirements would stimulate much larger savings. There are clear signs that all major economies are becoming more receptive to dialogue and information exchange on the policies in place and in all cases there is increasing pressure to adopt international best practice, or at least to not be too far behind it. The most viable route towards greater harmonisation is therefore is one that takes a soft path and aims to strengthen awareness and cooperative actions while illustrating what is achievable through broad-based and suitably ambitious policy settings. The key will be in ensuring the right information is available and presented at the pertinent decision making forum at the right time. Regulatory processes are unlikely to wait while others responsible for a different jurisdiction deliberate, thus ensuring decision makers are aware of relevant regulatory processes ahead of time is essential if alignment is to occur. When alignment has already occurred (e.g. for external power supplies or for industrial electric motors) this is exactly what has happened and these are the models that need to be replicated if greater, meaningful harmonisation is to occur in the future.

INTRODUCTION

Efficiency standards (MEPS) and labelling schemes are currently in place for a variety of end-use equipment types in countries that account for about 80% of the world's population and a higher share of its GDP, energy use and CO_2 emissions. While these programs have saved significant amounts of energy and CO_2 emissions and are generally highly cost effective, there is still scope for improvement in all economies. In the past there was only limited cooperation between these programs but in the last two years there are signs of more international engagement. Major economies including China, the EU, India, Japan and the USA have recently established the International Partnership for Energy Efficiency Cooperation (IPEEC), which is a high-level forum to facilitate the exchange of information and cooperation on energy efficiency policy. The IEA's 4E Implementing Agreement brings together some of the major economies in a common cooperative framework addressing energy efficiency in electric equipment; the EU and USA have established a regular cooperative forum where senior program managers exchange information on their standards and labelling programs and numerous other bilateral efforts are accelerating the rapidity of knowledge transfer between the principal policy makers.

Given the high degree of international activity with respect to energy efficiency standards and labelling schemes it seems appropriate to consider what lessons may be derived from a better understanding of current practices among the major economies and when might it be appropriate to consider greater alignment, or harmonisation, of practices and requirements.

In principle the existing programs have much to learn from each other, notably because:

The share of energy using products subject to energy efficiency policy requirements such as minimum energy performance standards or fleet-average efficiency targets varies significantly and there is no economy where all end-uses are currently subject to requirements and in most there are still significant gaps

- The stringency of requirements varies appreciably, suggesting there is on-going scope for ambition to be increased
- The degree to which requirements encourage system-level, as opposed to component level, efficiency improvement are markedly different
- The apparent effectiveness of product energy labelling varies significantly
- Compliance with requirements is often poorly assessed and sometimes weakly enforced
- The energy test procedures and energy efficiency metrics frequently vary among economies, thereby making performance comparison difficult. In some cases, the test procedures are inadequate for public policy purposes and in others energy performance test procedures have not been developed

- The degree to which complementary policies to stimulate energy savings in products operated within energy using systems are applied varies even more greatly and may have even larger savings potential.

At present it is a relatively complex matter to compare requirements across the globe because product definitions can differ, energy test procedures are not fully aligned, efficiency metrics diverge and policy terms of reference differ. Nonetheless, in many cases there is a sufficient degree of alignment in these factors that it is possible to make more informed comparisons and in some other cases full alignment renders direct comparison possible. Such comparisons can greatly assist the policy making process because they remove uncertainty about the feasibility of reaching certain efficiency levels and facilitate fast-tracking of policy development through a "follow-my-leader" effect. Furthermore, harmonised testing and efficiency definitions can greatly facilitate industry in the design, production and diffusion of energy efficient equipment because they: enhance clarity over efficiency requirements in different jurisdictions, reduce testing and compliance costs and minimise the need for regionally distinct product platforms.

This analysis reports on findings, conducted by Navigant Consulting and Energy Efficient Strategies and commissioned by the Collaborative Labelling and Appliance Standards Program with support from Climate Works, that considers the situation applying in the five major economies of China, the EU, India, Japan and the USA. The study examines 24 major electric end-uses in each of the economies and assesses:

- The characteristics and similarity of energy performance test procedures and the prospects for greater international alignment or harmonisation
- The characteristics and similarity of energy efficiency metrics used in standards and labelling schemes and the extent of comparability between them
- Similarities and differences in product classifications
- The extent of coverage of energy efficiency standards and labelling schemes
- The ambition and stringency of the schemes
- Initial estimates of the potential to increase savings through harmonisation of requirements aimed at today's most efficient level.

This paper reports a summary of the findings regarding test procedures and presents illustrations of the differences that product policy coverage and policy ambition have on savings. It begins by considering the conceptual issues underpinning harmonisation and the degree to which they may influence future cooperative thinking.

2. ISSUES AFFECTING HARMONISATION PROCESSES AND FEASIBILITY ANALYSIS

2.1 Conceptual issues surrounding of harmonisation

Greater international harmonisation is conceivable for all the different activities that underpin equipment energy efficiency programs but easily the largest potential to stimulate energy savings is via greater policy-level harmonisation. The key determinants of policy induced savings are the range, ambition and rigor of the energy efficiency policy portfolios. These can directly apply to the products, as do standards and labels, or they can apply to energy using systems, as do system energy performance requirements applied through building codes or other mechanisms. In theory policy harmonisation will only lead to energy savings if the parties concerned agree to harmonise at more ambitious policy levels than are the current norm. For example, were there to be agreement to harmonise at the highest international requirements currently in force it would generate appreciable energy savings with the amount varying depending on the degree of harmonisation as follows:

- Large energy savings would accrue were each economy that currently has specific product energy efficiency requirements to harmonise those at the level of the most stringent requirement currently applied in any economy
- Larger savings would accrue were every economy to adopt the most stringent product energy efficiency requirements in place for all end-uses, regardless of whether they currently have requirements or not
- Greater savings again would accrue were there also to be international harmonisation of end-use systems efficiency requirements to the highest current level

Thus conceptually very significant savings could accrue were there to be an upwards harmonisation that served to increase the coverage, scope and ambition of end-use energy efficiency policy settings above base-case levels. Furthermore, in principle the highest level is not a static requirement. Technologies improve and manufacturing costs decline as better manufacturing techniques are developed and economies of scale are achieved. Therefore if harmonisation were to be based on regular revision to new highest justifiable levels, in principle it would save more energy again.

2.2 Energy using test procedures

Energy performance test procedures underpin all equipment standards and labelling programs because they are the means by which equipment energy performance is measured and compared. There are many institutions involved in developing, issuing and adopting equipment energy performance test procedures but only a few which operate at the fully international level. The principal international standards bodies dealing with equipment energy performance test standards are: the International organisation for Standardisation (ISO) and the International Electro technical Commission (IEC). The membership of both bodies is made up of national standards institutes and it is these which arrange for nationally designated experts to participate in the standards development committees and which vote to adopt standards which are developed by the technical committees. Many economies use ISO or IEC energy performance standards directly in their standards and labelling programs, other adopt national versions of the international standards, which may or may not have some variations, others adopt them on a piecemeal basis and also make use of other preferred national or international standards (e.g. in use in another international economy but not necessarily adopted by ISO or IEC). Figure 1 shows an example of this for China, where just under half (25) of the 51 energy performance test procedures used in their 47 distinct equipment energy efficiency standards and labelling regulations are of ISO or IEC origins, five are from other international standards bodies (ITU, IEEE, International Energy Star), eleven are of purely national origin, eight are of US origin and two are Japanese.

Even those economies which have the highest use of ISO and IEC standards do not exclusively use those standards and thus of the five major economies the degree of usage of unadulterated ISO and IEC standards is found to vary from highest to lowest in the following order:

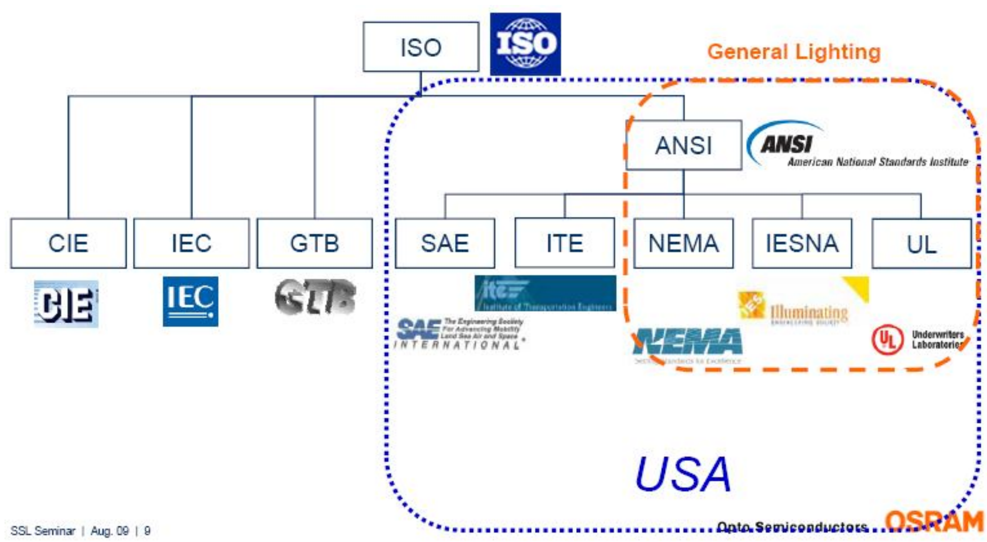
- the European Union
- China
- India
- Japan
- the USA

As part of the establishment of the single European market the EU created their own EU-level shadow standards bodies to the ISO and IEC called CEN and CENELEC respectively. These bodies frequently adopt ISO and IEC standards, but also sometimes modify them or less commonly adopt wholly different standards. ISO and IEC sometimes adopt or adapt CEN or CENELEC standards too.

The Standardisation Administration of China, the national body which develops test standards, is a member of ISO and IEC and votes in their standardisation committees. The same is true of the Indian Standards institute and the Japanese Industrial Standards (JIS) body. The USA is represented by NIST but depending on the equipment type US standards experts participate in ISO and IEC standards development institutes from numerous dedicated industry standardisation bodies such as ARI for air conditioning, AHAM for household appliances, NEMA for electric motors and lighting, etc. Thus there is a considerable degree of interconnection between the principal technical bodies charged with developing standards at the national or economy-wide level and there is a lot of commonality in the methodologies used internationally.

The example of lighting illustrates these institutional interconnections. The figure below shows how the American National Standards Institute (ANSI) links into ISO, but is linked at the US national level to NEMA, IESNA and UL in the domain of lighting standards development. ISO lighting standards are also informed by the activities of the CIE, IEC and GTB not to mention numerous other national standards bodies who are the equivalents of ANSI. ISO publishes non-electrical product related standards for lighting but all international lighting standards concerned with electrical products (e.g. lamps and ballasts) are issued by IEC.

Figure 2.1 International and US lighting standardisation bodies



Nonetheless, while these bodies may create or assist in the creation of voluntary energy performance test standards, the decision about which test standard will be adopted for use in national energy efficiency requirements usually resides with regulatory bodies such as the DOE and EPA in the USA, the European Commission in Europe, CNIS in China, BEE in India and METI in Japan. These agencies sometimes issue their own technical standards or adapt existing ones developed by technical standards bodies, but most commonly they simply adopt an existing standard. The EPA is the main exception to this as they have developed many wholly new test standards to determine the energy performance of products subject to Energy Star requirements.

Harmonisation of energy performance test procedures is not an end in its own right but is potentially a means of facilitating common energy policy, technology diffusion and trade objectives. In principle greater harmonisation facilitates trade, conformity assessment, comparison of performance levels, technology transfer and the accelerated adoption of best practice policy settings; however, it is important that this doesn't come at the expense of the fitness for purpose of the test procedure in the local context. The ideal test procedure is:

- repeatable (gives the same result each time the product is tested in the same lab);
- reproducible (gives the same result each time the product is tested in different labs);
- gives an accurate measure of energy consumption reflective of in-situ consumption;
- gives an accurate measure of energy efficiency reflective of the in-situ energy efficiency ranking;
- is not costly or overly time consuming.

In practice, any test procedure is a compromise between these objectives. Therefore when considering the merits of harmonising test procedures it is also important to consider whether a single international test procedure will be adequate for local usage and to consider the adequacy of the existing international test procedures for energy policy purposes.

2.2.1 Prospects for greater alignment of energy performance test procedures

The review of energy performance test procedures done in this study assesses the test procedures in use for each of the 24 energy using equipment types considered in the five economies against these criteria and assesses:

- the degree to which they are already aligned,
- the nature of the differences that exist between them and
- the fitness of use of the international test procedures.

The analysis then reviews test procedure development dynamics and assesses the status of discussions at the international level to determine what the prospects are for greater harmonisation at the international level.

The detailed discussion and results are presented in Part 2 of this report. This section of the report also reviews the energy performance metrics used in each economy and assesses the prospects for harmonisation from a technical and process orientated perspective for both by each product type.

The main findings of the test procedures comparisons are summarised by end-use in Table 3.1. For each product, a subjective assessment was made of the degree of international harmonisation based on analysis of the ongoing work on test procedures at regional and international level.

It was found that the degree of harmonisation for test procedures is relatively high for air conditioners and chillers, external power supplies, some of the lighting products (GLS, CFLs, and LFBs), electric motors and transformers. While for products like refrigerators, clothes washers and dryers, water heating appliances, space heating appliances the degree of harmonisation of test procedures is relatively low.

Not surprisingly, the greatest prospects for harmonisation occur when a new product is developed or when there are few existing national test procedures. This is the case for so called green-field products like LEDs, but can also be the case when test procedures or national efficiency requirements have not yet been set or have only been set in a single economy, such as for directional lamps. Appendix A of this report presents detailed information on directional lamps and LED testing developments internationally and considers the options for harmonisation. This analysis and discussion presents a specific product class case study of the types of issues that need to be addressed in considering harmonisation or alignment of testing and performance requirements for use in energy efficiency regulations.

Harmonisation efforts are not limited to green-field products; however, and it is also possible to harmonise test procedures for mature products. The recently revised IEC test procedure for asynchronous electric induction motors is an excellent example of this, wherein the adoption of the best elements of other widely used international test procedures has enabled a broad international consensus to be established around the adoption of the new test procedure. This standard is now being written into energy performance legislation in Europe, North America and China.

Table 3.1 Summary of test procedure harmonisation prospects by energy using equipment type

Product/end-use	Degree of harmonisation for energy test procedures	Regions with greatest difference from international standards	Potential for harmonisation of energy test procedures	Comments
Room air conditioners (Ducted)	High	Japan, USA	Fair	Treatment of split units in USA and variable capacity units everywhere are the main sources of difference. Japan and EU are moving to part-load testing approach
Central air conditioners (Non-ducted)	High/Moderate	USA	Fair	New ISO standard under consideration; US would need to re-categorise split AC systems
Chillers	High/Moderate		Good	No international test procedure; however, work on an ISO standard has been approved
Household refrigeration appliances	Moderate/Poor	India, Japan, USA	Moderate/Poor	New IEC standard expected in 2011 should help improve prospects
Household clothes washers	Low	Japan, USA	Moderate/Poor	New IEC standard will address all clothes washer types (horizontal and vertical) but local wash temperatures and cleaning requirements vary dramatically
Household clothes dryers	Low	All	Moderate/Poor	IEC61121 is under revision and should encourage greater harmonisation
Household dishwashers	Moderate	USA	Fair	New IEC standard could be made more attractive if prescriptive requirements were optional
Product/end-use	**Degree of harmonisation**	**Regions with greatest**	**Potential for harmonisation**	**Comments**

	for energy test procedures	difference from international standards	of energy test procedures	
Water heating appliances	Low	All	Moderate	New IEC standard under development could form the basis of a global standard
Televisions	Moderate	EU is first to adopt	Fair	IEC62087 Edition 2-2008 was specifically developed as a global energy measurement standard and should be adopted
Digital television decoders (set top boxes)	Moderate		Good	IEC62087 Edition 2-2008 was specifically developed as a global energy measurement standard and should be adopted
External power supplies	High		Very good	The draft international test method is broadly based on the approach used by Energy Star International; delay in issuance presents risk
Lighting: GLS and GLS lookalikes	High	Japan, USA	Fair	With the phase-out of GLS underway this is more relevant for advanced halogen GLS lookalikes
Lighting: CFLi	High		Good	New IEC standard likely to have broad support
Lighting: fluorescent ballasts	High/Moderate	Japan, USA	Moderate	No technical justification for differences in test standards
Lighting: directional lamps	Too soon to say		Good	Greenfield product: opportunity for new international standards to gain broad acceptance
Lighting: linear fluorescent lamps	High/Moderate	Japan, USA	Moderate	No technical justification for differences in test standards
Product/end-use	**Degree of harmonisation for energy test**	**Regions with greatest difference**	**Potential for harmonisation of energy test**	**Comments**

	procedures	from international standards	procedures	
Lighting: HID lamps	High/Moderate	Japan, USA	Moderate	No technical justification for differences in test standards
Lighting: LEDs	Too soon to say	None	Good	Greenfield product: opportunity for new international standards to gain broad acceptance
Space heating devices	Low	All	Poor except air to air heat pumps	Too much regional product diversity except for air-to-air heat pumps
Fans and ventilation	High/Moderate	USA	Good	IEC standards are adequate and widely used
Office Equipment, ICT, Standby power	High	None	Good	International Energy Star is the most common testing platform; broad support for IEC standby power standard
Electric motors	High	None	Very good	New IEC standard likely to have broad support
Cooking appliances	Low	All	Moderate/Poor	Cooking appliances are poor candidates for international harmonisation except microwaves and maybe ovens
Transformers	High	None	Good	Little variation in test procedures implies good potential for harmonisation
Comm. refrigeration equipment	Moderate		Uncertain	Some confusion at present, but the field is relatively open

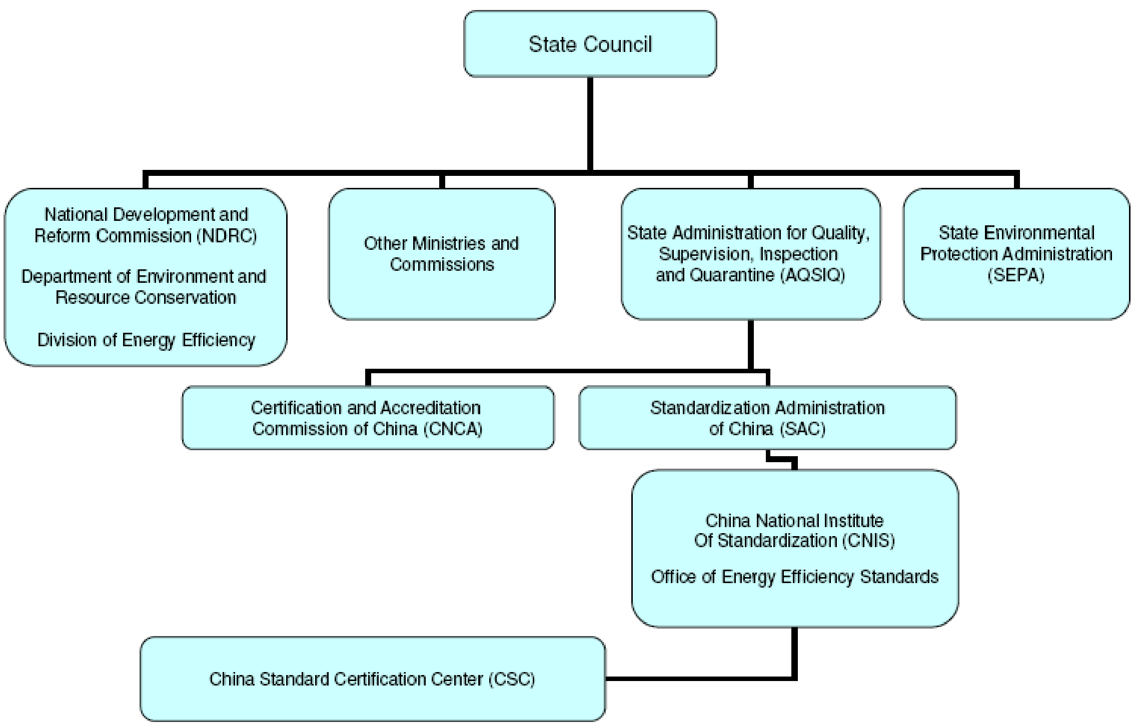
3. INTERNATIONAL STANDARDS AND LABELLING PROGRAMMES: A SUMMARY OF THE FIVE ECONOMIES

This section provides a summary of the current standards and labelling programmes applied in the five economies considered in this study: China, the European Union, India, Japan and the USA.

3.1 China

China first implemented minimum energy performance standards (MEPS) for energy using equipment in 1989 and now has some 39 standards in place. Mandatory energy labelling was first implemented in 2005 and currently applies to 19 products. In addition a voluntary endorsement labelling scheme is applied to over 40 products. China now has one of the most comprehensive energy efficiency standards and labelling schemes in the world. Figure 3.1 below provides the basic structure of the Chinese standards and labelling organisations. These organisations and some of the programmes they administer are discussed below.

Figure 3.1 Chinese Standards and Labelling Organisations



(source: Lawrence Berkeley National Laboratory)

The MEPS and mandatory energy labelling programmes in China are developed and administered by the China National Institute of Standardisation (CNIS), which reports to the Standardisation Administration of China (SAC) and is in turn part of the State Administration for Quality, Supervision, Inspection and Quarantine (AQSIQ).

Figure 3.2 Mandatory energy labelling in China (source: CNIS)

3.1.1 Voluntary labelling and certification

The China Quality Certification Centre (CQC) was formerly the China Standards Certification Centre, which was originally established by the State Economic and Trade Commission (SETC) and the China State Bureau of Quality and Technical Supervision (CSBTS) in 1998. At that time, it was called the China Certification Centre for Energy Conservation Product (CECP), but has now changed its name to the China Standards Certification Centre (CSCC) and more recently the China Quality Certification Centre (CQC). The centre was set up to promote advanced energy efficiency and conservation products.

The China Quality Certification Centre (CQC) is the largest professional certification body in China and is a professional certification body operating under the auspices of the China Certification & Inspection Group (CCIC), approved by the State General Administration for Quality Supervision and Inspection and Quarantine and Certification and Accreditation Administration of the People's Republic of China.

CQC evolved from the former China Commission for Conformity Certification of Electrical Equipment established in 1985. In April 2002, CQC was established by merging 6 institutions under 5 ministries (including former China National Import & Export Commodities Inspection Corporation Quality Certification Centre; the Secretariat, Electrical Equipment Subcommittee, Home Appliance Subcommittee, and Electronics Subcommittee of former China Commission for Conformity Certification of Electrical Equipment; and CCIB Beijing Review Office). In September 2007, a restructuring program was launched and CQC therefore became a dedicated certification platform of the newly-incorporated CCIC.

CQC develops and administers the voluntary endorsement energy labelling programme in China including overseeing the certification of products that apply to receive the label.

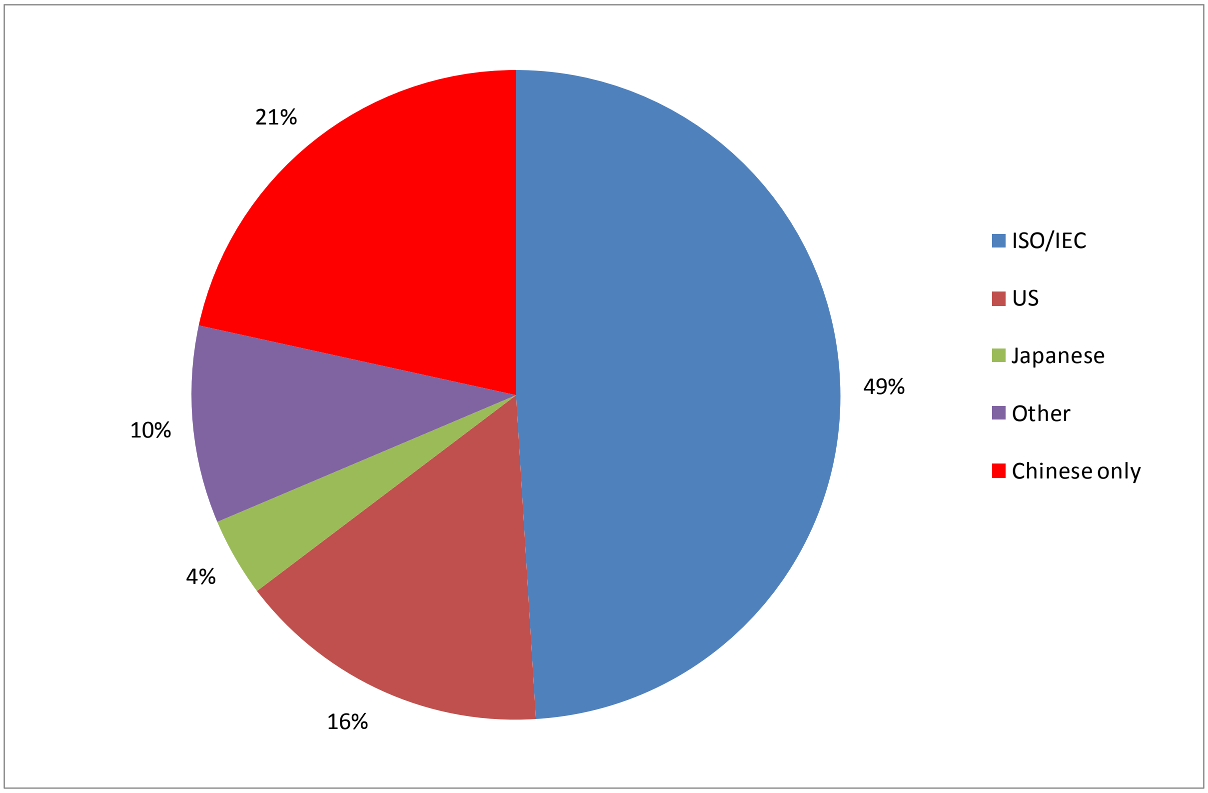
3.2.2 Procurement Policy for Energy Efficient Products

China's *Procurement Policy for Energy Efficient Products* scheme requires Chinese government agencies at all levels, as part of the procurement process, to give priority to energy-efficient certified products. To be considered eligible under this programme, products must be awarded the CQC endorsement label.

3.2.3 Summary of energy test procedures used in China

China's policy is to use international test procedures whenever they are available and deemed satisfactory for the purpose required. When international test procedures are not available or not suitable the authorities will consider using another country's national standard. If none of these are available or suitable they will develop a dedicated Chinese national standard. Some 53 energy performance test procedures are referenced within the regulations applying to the 39 products (excluding transportation and industrial processes) currently subject to MEPS in China. Of these 59% (29 are international test procedures, mostly deriving from ISO/IEC but also from the ITU and IEEE). Some 15% are derived from US standardisation bodies (ANSI, ARI, ASHRAE). Two are Japanese, one is Canadian (CAN/CSA) and one is from the International Energy Star programme. The remaining 25% are purely domestically produced Chinese standards and for the most part these are applied to the less significant energy using products such as irons and radios, Figure 3.3.

Figure 3.3 Origins of energy test procedures used in Chinese MEPS and Mandatory Energy Labelling



3.2 The European Union

The European Union first introduced a European Community-wide energy labelling scheme in 1992 and the first minimum energy efficiency standard was issued in 1994 (for domestic boilers). While some eight household appliance or lighting types are subject to mandatory comparative energy labelling in the EU only three products were subject to MEPs through the want of framework legislation. This changed in 2005 when the European Community adopted the Eco-design framework Directive. This Directive empowers the European Commission, in consultation with a regulatory group drawn from EU member state administrations, to set binding Eco-design requirements through the form of implementing regulations that are set specifically for each product group. The Directive itself only lays down the conditions and criteria for introducing implementing measures: they may be adopted for a particular product, provided it has a significant impact on the environment (energy consumption) coupled with a high volume of sales and trade on the internal market and with clear potential for improvement without entailing excessive costs (energy saving potential). The environmental priority for the adoption of implementing measures is the potential of energy-using products to combat climate change in a cost-effective manner.

Implementing measures are considered when no valid self-regulatory initiative has been taken by industry. Self-regulation by industry, including voluntary and unilateral commitments, may indeed produce quick progress, due to rapid and cost-effective implementation, and allows flexible and appropriate adaptation to technological solutions and market sensitivities.

Each implementing measure is preceded by preparatory studies and an impact assessment conducted by external experts and the Commission with the aim of identifying cost-effective solutions to improve the overall environmental performance of products and incorporates participatory and delegated decision-making processes. Implementing measures are eventually adopted by the Commission under the regulatory procedure with scrutiny. That means, there is a three-month veto right by the European Parliament and Council.

Since the passage of the Directive some 29 energy using product studies have been initiated of which 19 are completed and 10 are currently on-going. Implementing regulations imposing MEPS have been passed for eight product types and more are under active consideration.

1. Minimum requirements: The implementing measures under the Eco-design Directive set specific or generic requirements for products to be placed on the EU internal market. The nine implementing measures adopted by the Commission in 2008 / 2009 set specific minimum requirements on energy efficiency (MEPS) and are mandatory Regulations, binding in their entirety and directly applicable in all EU Member States.
2. Test procedures: The mandatory Regulations contain the main principles on energy efficiency measurements. For detailed test standards the Commission mandates the European Standardisation Organisations (ESO) to elaborate voluntary, harmonised standards for each product group. In the light of Member States' opinion, the Commission decide to publish, to publish with restrictions or not to publish the references to the harmonised standards concerned in the Official Journal of the European Union.
3. Labelling: Complementary to minimum energy-efficiency requirements, the EU energy label informs the consumer about the energy consumption of the products they buy. The existing A-G labels are based on implementing Directives under the Energy Labelling framework Directive from 1992.

3.2.1 Summary of energy test procedures used in the EU

The EU's policy is to use international test procedures whenever they are available and deemed satisfactory for the purpose required. When international test procedures are not available or not suitable the authorities will consider using another country's national standard. If none of these are available or suitable they will develop a dedicated European national standard.

Of the eight products subject to energy labelling in the EU, seven use European test procedures that are practically equivalent (in terms of how they measure energy use) to the corresponding international (ISO/IEC) test procedures and one is a purely European test procedure because no international test procedure was eligible. Of the eight products subject to MEPS under the Eco-design directive at least seven are using internationally aligned energy test procedures.

3.2.2 Covered Products and Schedule

Following the publication of the Directive in July 2005, the European Commission has contracted 30 'preparatory studies', systematically providing scientific background information on individual product groups or horizontal matters. Further studies are expected to be carried out within the forthcoming years. These studies are part of the overall 'EuP process' and will recommend ways to improve the environmental performance of the products by assessing the environmental aspects over the entire life cycle of the relevant energy-using product.

As discussed in Appendix A of this report, each preparatory study is divided into eight tasks:

- Definition
- Economic and market analysis
- Consumer behavior
- Technical analysis of existing products
- Definition of base-case
- Technical analysis – Best Available Technology
- Improvement potential
- Policy, impact and sensitivity analysis.

During the studies, stakeholders have the possibility to comment on draft reports and to give input at stakeholder workshops organised by the contractors. Members of the project consortium participate in the interim and final stakeholder workshops.

Table 3.1. Preparatory Studies in the Energy Using Products Process

Product	Website	Timing	Description
Lot 1. Boilers and combi-boilers	http://www.ecoboilers.org	2006.02-2007.10	Gas/oil/electric
Lot 2. Water Heaters	http://www.ecohotwater.org	2006.02 – 2007.10	Gas-fired, oil-fired and electric water heaters

Product	Website	Timing	Description
Lot 3. Personal Computers and Computer Monitors	http://www.ecocompouter.org	2007.09	Desktops, notebook computers, thin clients and workstations (but not servers)
Lot 4. Imaging Equipment	http://www.ecoimaging.org	2007.12 – 2008.05	copiers, faxes, printers, scanners, MFD
Lot 5. Consumer electronics: Televisions	http://www.ecotelevision.org	2006.09 – 2007.08	Televisions
Lot 6. Stand-by and off-mode losses of EuPs	http://www.ecostandby.org/documents.php	2007.10	On/off products, on/standby products, job based products
Lot 7. Battery Chargers and External Power Supplies	http://www.ecocharger.org	2006.02-2007.01	**BC**: A device intended to replenish the charge in a rechargeable battery, the charger may be comprised of multiple components, in more than one enclosure, and may be all or partially contained in the end-use product. **EPS**: A single voltage external ac-dc / ac-ac power supply.
Lot 8. Office Lighting	http://www.eup4light.net	2006.04-2007.05	Lamp, ballast, luminaire
Lot 9. Street Lighting	http://www.eup4light.net	2006.04-2007.01	Fixed lighting installation containing a lamp, ballast, luminaire
Lot 10. Residential Room Conditioning	http://www.ecoaircon.eu	2006.09-2008.04	Room air conditioning, residential ventilation, comfort fans

Product	Website	Timing	Description
Lot 11. Electric Motors 1-150Kw	http://www.ecomotors.org	2006.03-2007.10	Electric motors, Water pumps, circulators in buildings, ventilation fans
Lot 12. Commercial Refrigerators and Freezers	http://www.ecofreezercom.org	2006-2007.12	Commercial plug-in and remote refrigerated display cabinets, and refrigerated vending machines
Lot 13. Domestic Refrigerators and Freezers	http://www.ecocold-domestic.org	2006.06-2007.12	Domestic Refrigerators and Freezers
Lot 14. Dishwashers/ washing machines	http://www.ecowet-domestic.org/	2006.07-2007.12	Dishwashers and washing machines
Lot 15. Solid fuel small combustion machines	http://www.ecosolidfuel.org/	2007.09-2009.09	Central heating boilers, fireplaces, stoves, cookers using mineral raw or manufactured fuels; biomass, raw or manufactured; or peat
Lot 16. Laundry dryers	http://www.ecodryers.org	2007.12-2009.03	Clothes dryer
Lot 17. Vacuum cleaners	http://www.ecovacuum.org/	2007.10-2008.11	Vacuum cleaners
Lot 18a. Complex set top boxes	http://www.ecocomplexstb.org/	2007.09-2008.12	STB's that operate in an interconnected environment such as exists in subscription services and networked home entertainment systems

Product	Website	Timing	Description
Lot 18b. Simple set top boxes	http://www.ecostb.com	2007.12	STB's that decode digital signals for analogue televisions
Lot 19. Domestic lighting (part 2)	http://www.eup4light.net	2008.10	Lamps typically used in households (incandescent lamps, halogen lamps and compact fluorescent lamps)
Lot 20. Local room heating products	http://www.ecoheater.org/lot20/	2009.06 – 2010.12	Domestic heaters
Lot 21. Central heating products	http://www.ecoheater.org/lot21/	2009.06-2010.12	Central heating products using hot air to distribute heat (other than CHP)
Lot 22. Domestic & commercial ovens	http://www.ecocooking.org/lot22/	2009.06-2010.12	Electric, gas & microwave ovens
Lot 23. Domestic & commercial hobs & grills	http://www.ecocooking.org/lot23/	2009.06-2010.12	Domestic & commercial hobs & grills
Lot 24. Professional washing machines, dryers and dishwashers	http://www.ecowet-commercial.org/	2009.06-2011.02	Professional washing machines, dryers and dishwashers
Lot 25. Non-tertiary coffee machines	http://www.ecocoffeemachine.org/	2009.06-2010.08	Coffee machines

Product	Website	Timing	Description
Lot 26. Networked Standby	http://www.ecostandby.org/	2009.06 – 2011.02	Computer Network Equipment in standby mode
ENTR Lot 1. Refrigerating and freezing equipment	http://www.ecofreezercom.org	2009.01-2010.11	Service cabinets, blast cabinets, walk-in cold rooms, chillers, ice makers, ice cream and milk-shake machines
ENTR Lot 2. Transformers	http://www.ecotransformer.org/	2009.01-2010.11	Distribution transformers, power transformers
ENTR Lot 3. Sound and imaging equipment	http://www.ecomultimedia.org	2009.01-2010.09	DVD/video players and recorders, video projectors, game consoles, digital picture frames

3.2.3 Schedule of Forthcoming Actions

Product	Scope	Program	Regulation	Energy Efficiency Metric	Future Directions
Household refrigerators	Household and similar use, does not cover beer/wine storage cabinets (these may be labelled voluntarily)	Mandatory labelling (1995) and MEPs, Revised labelling currently under discussion, MEPS adopted.	EU Directives: 94/2/EEC 2003/66/EC (currently under revision), EU Directive: 2005/32/EC and implementing Regulation 643/2009	Adjusted volume, energy consumption for labelling, must pass performance tests	Revision to labelling requirements expected in 2010. Introduction of MEPs in 2010. Working on IEC global test method.

Product	**Scope**	**Program**	**Regulation**	**Energy Efficiency Metric**	**Future Directions**
Clothes washers	Household and similar use	Mandatory energy labelling (1995), MEPS (EUP) and revised labelling currently under discussion	EU Directive: 95/12/EC, 96/89/EC (Currently under revision)	Energy consumption on 60°C washes. Declaration of wash performance on label	Revision to labelling requirements and introduction of MEPs expected in 2010
Clothes dryers	Household and similar use	Mandatory energy labelling (1995)	EU Directive: 95/13/EC	Energy consumption per kg moisture removed. Must dry in a single setting.	EU likely to look to adoption of revised IEC61121
Combined washer-driers	Household and similar use	Mandatory energy labelling (1996)	EU Directive: 96/60/EC	Energy metrics for washing and drying	None at present
Dishwashers	Household and similar use	Mandatory energy labelling (1997), MEPS (EUP) and revised labelling currently under discussion	EU Directives: 97/17/EC, 99/9/EC (Currently under revision)	Energy consumption per place setting. Energy, washing and drying performance declared on label	Revision to labelling requirements and introduction of MEPs expected in 2010
Cooking (food-preparing equipment)	Household and similar use	Mandatory energy labelling (2002)	EU Directive: 2002/40/EC	Energy consumption under standard test procedure, oven cavity volumes	Ongoing preparatory studies lot 22 and 23.

Product	Scope	Program	Regulation	Energy Efficiency Metric	Future Directions
Air conditioner s	Household and similar use under 12kW cooling output	Mandatory energy labelling (2002)	EU Directive: 2002/31/EC (Currently under revision)	Cooling output and energy efficiency ratio	Revision to labelling requirements and introduction of MEPs expected in 2010.
Chillers	See entry for commercial refrigerators				Ongoing preparatory study ENTR lot 1.
Gas and oil water heaters	Water heaters with outputs in the range 4 to 400 kW.	MEPS (1992)	EU Directive: 92/42/EEC	Full and part-load efficiency	Revisions to MEPS and possible other measures expected in 2010
Electric and fossil-fuelled heating equipment	Local room heating and central heating products				Ongoing preparatory studies lot 20 and 21.
Fluorescent Lamp Ballasts	Ballasts to drive fluorescent lamps (some exceptions) without integrated ballasts, HID lamps	MEPS (2009)	EU Directive: 2005/32/EC and implementing Regulation 245/2009	Energy Efficiency Index	Detailed new regulation is applicable from 2010
Fluorescent lamps	Fluorescent lamps (some exceptions) without integrated ballasts, HID lamps	MEPS (2009)	EU Directive: 2005/32/EC and implementing Regulation 245/2009	Energy Efficiency Index	Detailed new regulation is applicable from 2010

Product	Scope	Program	Regulation	Energy Efficiency Metric	Future Directions
Non-directional household lamps	Wide range of non-directional household lamps including GLS, CFLs and LEDs (with exceptions)	Energy labelling (1998). Staged withdrawal of GLS lamps, introduction of MEPS for others (2009)	EU Directive: 98/11/EEC, EU Directive: 2005/32/EC and implementing Regulation 244/2009	14 metrics variously apply	6 staged approach: 2009, 2010, 2011, 2012, 2013, 2016
Directional household lamps	Directional household lamps	Currently under review in EU			
Transformers	Distribution transformers, power transformers				Ongoing preparatory studies ENTR lot 2.
Three Phase Electric Motors	Three Phase Electric Motors 0.75kW to 375kW	MEPS (2011)	EU Directive: 2005/32/EC and implementing Regulation 640/2009	IE2 (from June 2011)	MEPS change to IE3 in 2015 with relaxations if VSD fitted
Electric Fans	125W-500kW	MEPS (expected 2010)	EU Directive: 2005/32/EC and implementing measure (currently under discussion)	MEL defined by formulae for 8 categories of fans	Further change in MEPS expected 2012, 2020 (all requirements currently under discussion in EU)

Product	Scope	Program	Regulation	Energy Efficiency Metric	Future Directions
Electric pumps	Electric pumps used for clean water duty	MEPS (expected 2010)	EU Directive: 2005/32/EC and implementing measure (currently under discussion)	Defined by formulae	Best in class efficiency label under consideration, Further change in MEPS expected 4 years after introduction (all requirements currently under discussion in EU)
Circulators	Impeller pump 1W-2500W for use in heating or cooling systems	MEPS (2009)	EU Directive: 2005/32/EC and implementing Regulation 641/2009	EEI from 2013, Fully detailed in the Regulation	Revised MEPS in 2015, covering also circulators integrated in boilers
Commercial refrigerator s etc	Commercial refrigerators and freezers, including chillers, display/service /blast cabinets, walk-in cold rooms, ice makers and vending machines	Currently under review in EU			Ongoing preparatory study ENTR lot 1.

Product	Scope	Program	Regulation	Energy Efficiency Metric	Future Directions
Standby	Horizontal requirements applicable to electrical and electronic household and office equipment.	MEPS (2008)	EU Directive: 2005/32/EC and implementing Regulation 1275/2008	1W (reactivation function), 2W (information/status display (can be combined with reactivation function)). Off or standby mode must be provided	MEPs change in 2013 and power management requirements introduced
Televisions	Products designed primarily for the display and reception of Audio visual signals. May include additional components for data storage and/or display	MEPS (202009), Labelling currently under discussion	EU Directive: 2005/32/EC and implementing Regulation 642/2009	EEI based on energy per screen area (2010)	MEPs change in 2012
Digital set top boxes	Digital conversion (simple and complex set-top-boxes)	Simple set-top-boxes: MEPS (2009), Complex set-top-boxes: Voluntary agreement under discussion	EU Directive: 2005/32/EC and implementing Regulation 107/2009	Power consumption by standby and active modes (MEPS 2010)	Auto power down from 2010, MEPs change in 2012, complex boxes to be covered by voluntary agreement (under discussion)

Product	Scope	Program	Regulation	Energy Efficiency Metric	Future Directions
Imaging equipment	Copiers, faxes, printers, scanners, multifunctional devices	Voluntary agreement under discussion			
Computers	Personal computers (desktops and laptops) and computer monitors	MEPS (expected 2010)	EU Directive: 2005/32/EC and implementing measure (currently under discussion)	Energy Star under discussion	
External power supplies	Single output (AC or DC) external power supplies with an output power up to 250 W (@<6v, >550ma)	MEPS (2009) corresponding to US Federal Regs (2008)	EU Directive: 2005/32/EC and implementing Regulation 278/2009	Measure no load then efficiency at 25%, 50%, 75% and 100% rated output	2nd stage corresponding to Energy Star Version 2 in 2011
Industrial and laboratory furnaces and ovens					Preparatory study scheduled for 2010
Machine tools					Preparatory study scheduled for 2010
Network, data processing and data storing equipment	Network standby losses of energy-using products	*Further products currently on EU indicative list working plan			Ongoing preparatory study lot 26.

Product	Scope	Program	Regulation	Energy Efficiency Metric	Future Directions
Sound and imaging equipment	DVD/video players and recorders, video projectors, game consoles, digital picture frames				Ongoing preparatory study ENTR lot 1.
Water-using equipment.	Possibly shower heads, taps, water cleaning equipment, agriculture equipment (under discussion)				Preparatory study scheduled for 2010

3.3 India

India has no MEPS at present but has a mandatory energy labelling scheme applying to two products and a voluntary energy labelling scheme applying to nine products.

3.3.1 Summary of energy test procedures used in India

India's policy is to use international test procedures whenever they are available and deemed satisfactory for the purpose required. When international test procedures are not available or not suitable the authorities will consider using another country's national standard. If none of these are available or suitable they will develop a dedicated Indian national standard. In practice all three cases are found in the energy test procedures used in India.

3.4 Japan

Strictly speaking Japan does not operate MEPS in the way China, the EU or the USA does but rather has the Top Runner programme which imposes minimum fleet-average efficiency requirements that producers or importers have to satisfy for regulated products. In recognition of this distinction the term Minimum Energy Performance Regulations (MEPR) is used in this report to signify MEPS or Top Runner standards and the term MEPS is used for the specific case when a regulation prohibits the sale or production of a product less than a specified efficiency level.

Excluding transportation some 19 categories of products are subject to Top Runner requirements in Japan. In addition 17 of the products subject to Top Runner requirements are also required to display an energy label called the Energy Saving Label and another three are required to be labelled with a so called "uniform energy label" which is applied directly by retailers. The details in this section are taken from the Top Runner Program report by METI[1].

The Top Runner programme is covered by Japanese law referring to the rational use of energy "Energy Conservation Law – Section 6: Measures Related to Machinery and Equipment". This law requires all parties actively involved in the manufacture and/or import of machinery and equipment to improve the energy consumption efficiency of their products. The Top Runner programme is implemented through a combination of different channels including, Enforcement Regulations – set exclusion ranges, Government Ordinance – specified equipment production and import volumes and Notifications – standardised values and measurement methods.

3.4.1 Summary of energy test procedures used in Japan

Japan's stated policy is to use international test procedures whenever they are available and deemed satisfactory for the purpose required. When international test procedures are not available or not suitable the authorities will either develop a national test procedure, or they may consider using another country's national standard. In practice energy test procedures used in Japan are a mix of national and international test procedures, although even when there are material differences between them, many aspects of the national test procedures are likely to correspond to elements found in international test procedures, unless there were no relevant international test procedures at the time the national test procedure was adopted. The summary document describing the Top Runner Programme issued by METI states:

"Principle10. Measurement methods should bear domestic and international harmonisation in mind. If a standard has been already established, the measurement method should harmonise with the standard to the extent possible. Where no measurement method standard exists, it is appropriate to adopt specific, objective, and quantitative measurement methods based on actual equipment usage."

and goes on to assert:

"Measurement methods should be based on specific equipment's actual usage. If a measurement method has been established through voluntary or compulsory standards, including International Standards and Japanese Industrial Standards (JIS), it is appropriate to adopt relevant measurement methods that ensure

domestic and international harmonisation. When no measurement method exists as described above, the measurement method should be objective and quantitative."

Thus, harmonisation with international test procedures is asserted as a specific objective albeit a non-binding one.

3.4.2 Impacts of the Top Runner programme

The impacts of the Top Runner programme circa 2007 as reported by METI are shown in Table 3.1. For all product categories marked with * the energy efficiency standard values are defined by an energy consumption efficiency metric (e.g. km/l), while the performance of those without an * are all specified in terms of annual energy consumption (e.g. kWh/year) based on a standard duty cycle. The values of the "Energy efficiency improvement" indicate the rate of improvement in the efficiency metric calculated according to each standard over the time period. For example: if the metric for fuel economy evolves from 10 km/l to 15km/l, the improvement rate is calculated to be 50% and if the average annual consumption of a product evolves from 10kWh/year to 5kWh/year, the improvement rate is deemed to be 50%.

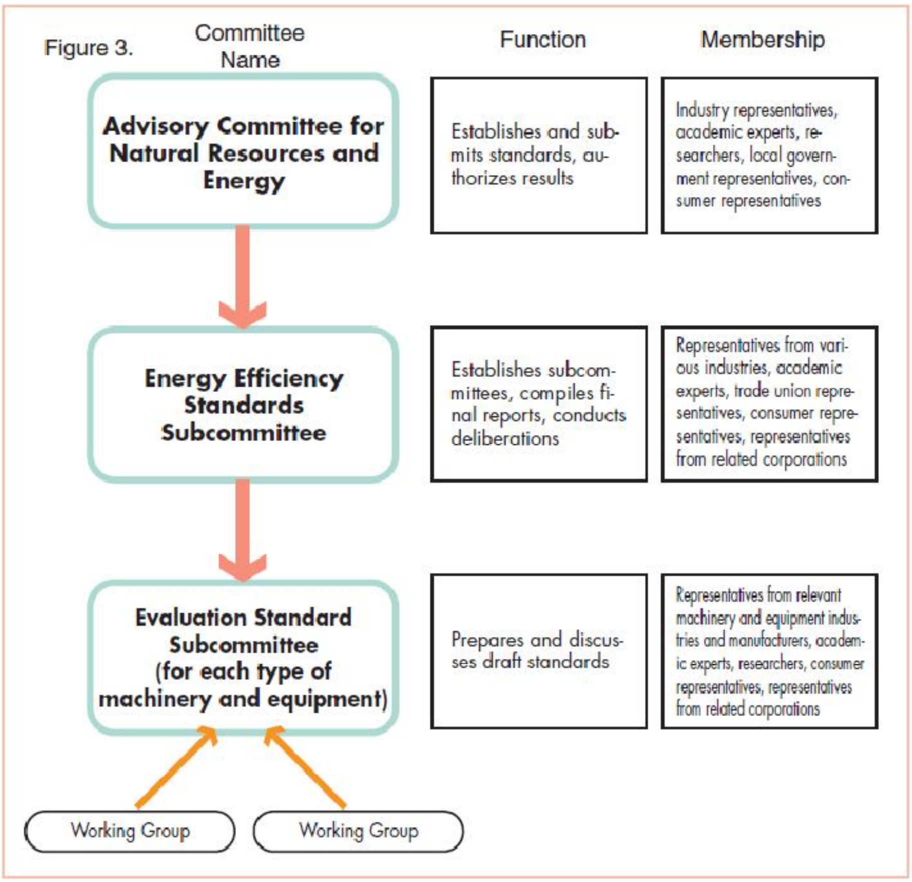
Table 3.1. Anticipated and actual market average efficiency improvements for products regulated under the Top Runner programme

Product category	Energy efficiency improvement (result)	Energy efficiency improvement (initial expectation)
TV receivers (TV sets using CRTs)	25.7% (FY 1997 →FY 2003)	16.4%
VCRs	73.6% (FY 1997 →FY 2003)	58.7%
Air conditioners * (Room air conditioners)	67.8% (FY 1997 →2004 freezing year)	66.1%
Electric refrigerators	55.2% (FY 1998 →FY 2004)	30.5%
Electric freezers	29.6% (FY 1998→FY 2004)	22.9%
Gasoline passenger vehicles *	22.8% (FY 1995→FY 2005)	22.8% (FY 1995→FY 2010)
Diesel freight vehicles *	21.7% (FY 1995→FY 2005)	6.5%
Vending machines	37.3% (FY 2000→FY 2005)	33.9%
Computers	99.1% (FY 1997 →FY 2005)	83.0%
Magnetic disk units	98.2% (FY 1997 →FY 2005)	78.0%
Fluorescent lights *	35.6% (FY 1997 →FY 2005)	16.6%

3.4.3 Institutions involved in establishing Top Runner regulations

Japan's policies for energy conservation are deliberated by the Minister of Economy, Trade and Industry "Advisory Committee for Natural Resources and Energy". The "Standard Values" are set by the "Energy Efficiency Standards Subcommittee" which is set-up by the "Advisory Committee for Natural Resources and Energy". The "Energy Efficiency Standards Subcommittee" has an "Evaluation Standard Subcommittee" for every product which supports the details of the stand for each product under evaluation. The role of the "Evaluation Standard Subcommittee" is to define the technical details for each of the products and then to present its outcomes to the "Energy Efficiency Standards Subcommittee" who finalise the product details. This collection of committees and supporting subcommittees are supported by the office responsible for the Agency for Natural Resources and Energy. It is often the case that before setting up the subcommittees that working groups are created to conduct studies evaluating the machinery and equipment being considered for the Top Runner Programme inclusion as well as studies which evaluate the energy efficiency consumption measurement methods. Figure 3.4 illustrates the set-up of the committees and provides a high-level overview of their roles and membership.

Figure 3.4 Committee structures in determining Top Runner requirements



The Agency for Natural Resources and Energy has a Division called the Energy Efficiency and Conservation Division which is responsible for preparing and delivering the studies selecting the potential types of machinery and equipment eligible for the Top Runner Programme inclusion. Any machinery or equipment which is deemed to meet the set requirements are put forward to the Energy Efficiency Standard Subcommittee. The set requirements which the machinery and equipment must meet include large scale use in Japan, high energy use during the in-use phase, and scope for energy efficiency improvement. The products selected for regulation are founded upon several other factors along with the "set requirements" and anticipated market trends for the products in question.

Once the Energy Efficiency Standards Subcommittee has received recommendations and the studies on suitable candidate products; then the "Evaluation Standard Subcommittee" is created to provide a more rigorous evaluation of the standard values. Where candidate products are complex and there are no well-established methodologies for measuring energy consumption efficiency studies are commissioned prior to the hand over to the Evaluation Standard Subcommittee discussions. Such studies are conducted by all relevant stakeholders with working groups established within relevant corporations and organisations seeking to develop a confirmation for the methodology used to evaluate the energy conservation performance, ultimately culminating in a proposed draft standard.

The Evaluation Standard Subcommittee has a defined agenda which dictates the discussions for setting the product standards. The agenda for setting the standards includes a discussion on the, equipment target scope as well as definition of the measurement methods of energy consumption efficiency. This is followed by measuring the energy consumption efficiency of all active market products yielding the maximum energy efficiency value on the market. The next step is to set the efficiency levels for target years by factoring the anticipated product technical development and manufacturer capacity amongst the key factors. This allows the Top Runner Standard values to be determined with target years defined.

Despite this Evaluation Standard Subcommittee being closed to public scrutiny in order to maintain industry data confidentiality, an interim report is made public on the web to allow for public commentary. The public input is then evaluated and where appropriate addressed and the final report is delivered. Upon the Energy Efficiency Standards Subcommittee approval, the draft standards are established.

Finally, the Draft Top Runner Standard Values are reported to the WTO/TBT in order to ensure trade barriers on imported products are avoided. Upon completion of the above defined procedures the government seeks to amend their regulation to add the draft Top Runner Standard Values to the target products. Naturally, the time lapse between the proposed target machinery and enforcing the legislation varies depending on the machinery and equipment type but such previous amendments have demonstrated that this can take from as little as a year up to two and a half years.

3.4.4 Energy labelling

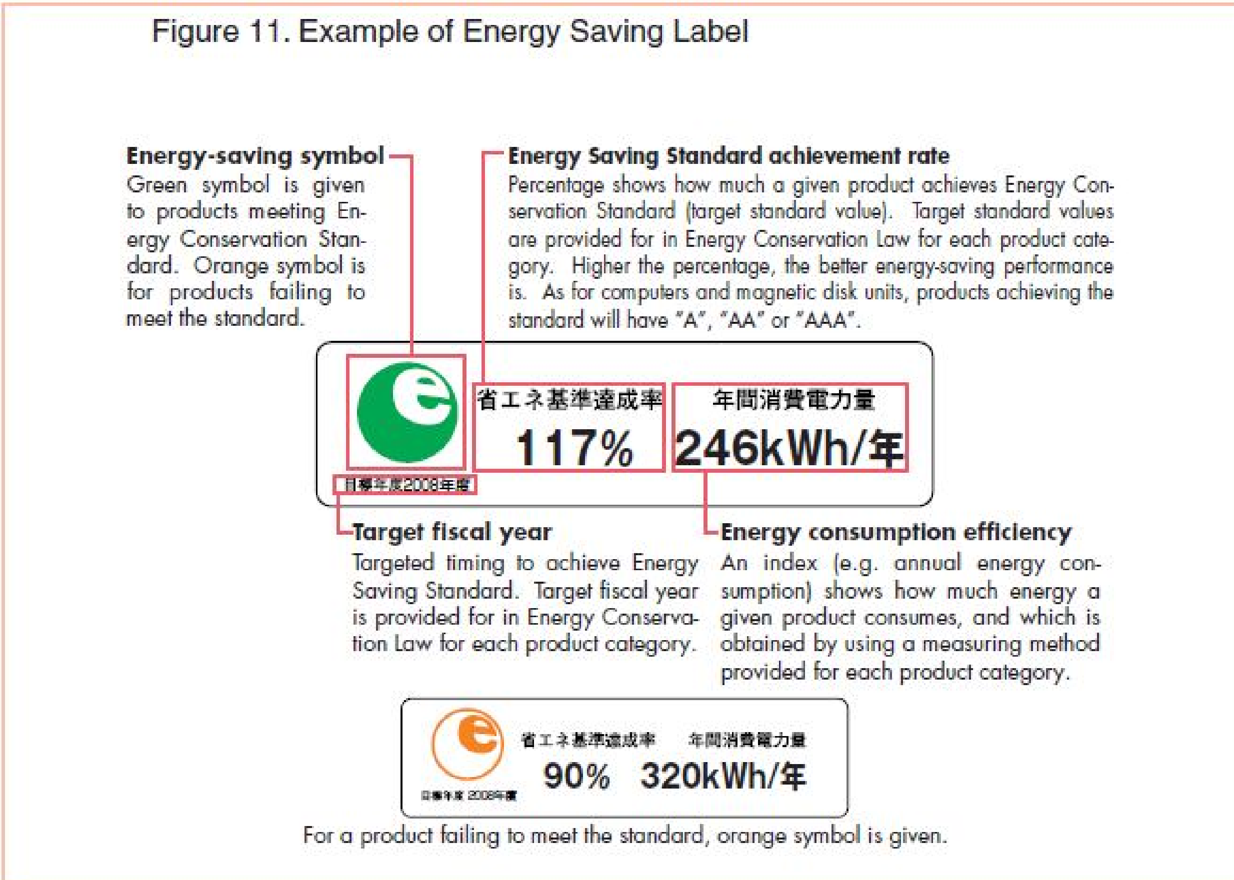
The Energy Conservation Law in Japan has set the requirement that machinery and equipment covered by the Top Runner Programme are required to conform to a display programme. The display programme was designed to provide consumers with greater information on factors such as the energy consumption efficiency of the products at the point of sale. In the event that a manufacturer selling a product covered by the Top Runner Programme does not display the correct labelling information as described by the "Notifications" then penalties will apply. The motivation behind the labelling requirements in conjunction to incentivising manufacturers to improve energy consumption efficiency, provide consumers with information to facilitate informed purchasing and promote energy efficient products is to drive manufacturers' efforts to develop more energy efficient products. The display and compliance items set out in a "Notification" which is defined for each of the products covered by the Top Runner Programme include: the name of the manufacturer responsible for the display, the product name and type, the energy consumption efficiency and other related items. The compliance items are pieces of information which must be present in a certain location, sise, units, etc at the time of display. In the event where machinery and equipment display requirements have already been set under the Household Goods Quality Labelling Law these items are required to abide by this law.

In the event a manufacture does not fulfil the display and compliance requirements then they are advised by the relevant Minister to make the necessary amendments. Further non-compliance leads to the non-conformance being made public with an order setting forth recommendations to be followed. As a final resort if the products in question are still non-compliant then penalties will be issued.

Furthermore, in order to raise the profile of high efficiency machinery and equipment which have attained the Top Runner Standard values driven by individual manufacturers the Energy Efficiency Standards Subcommittee operating under the Advisory Committee for Natural Resources and Energy established the best energy saving labelling programme for Japan. This programme resulted in having four items shown on the label including, a symbol to demonstrate the degree of energy savings standards achieved, the energy saving standard achievement rate, the energy consumption efficiency and finally the target fiscal year. A further outcome was to have the JIS developing the energy saving labelling programme.

Since this decision, the "JIS Energy Saving Labelling Committee" has developed a first draft which was approved by the Japanese Industrial Standards Committee's Committee on Electricity and Electronics and launched the energy saving label in August 2000. The initial program focus has grown from five product categories inducing, fluorescent lighting, electric refrigerators and freezers, Televisions and air conditioners to a total of sixteen items in December 2007. The labelling programme is developed as a voluntary labelling scheme, founded on JIS and displayed in product catalogues and products alike. The label requirements state that the labels may be displayed on the packaging, the product, the tags as well as the catalogues.

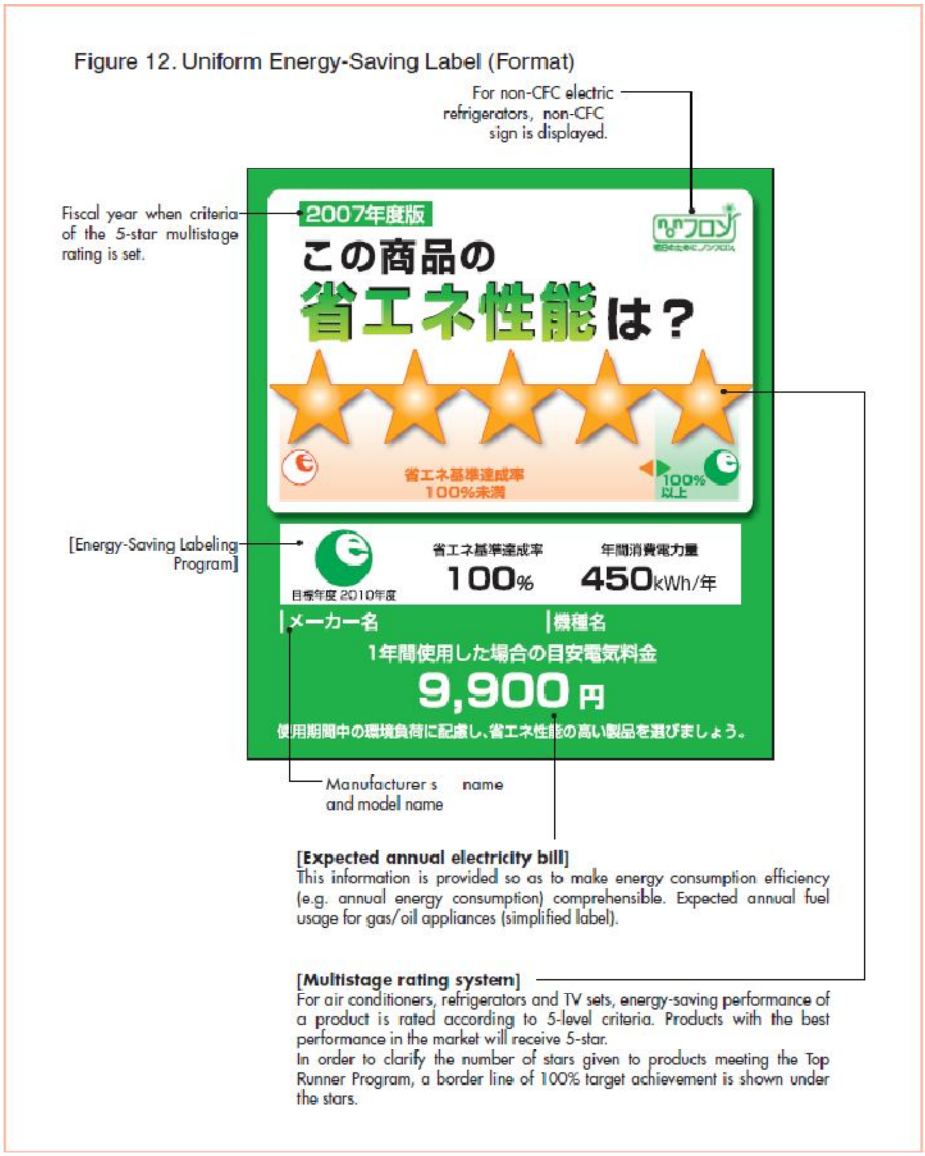
Figure 3.5 Japan's "Energy Saving Label"



The uniform energy label shown at the point of retail

Up until 2006 the energy savings labelling programme was the only scheme promoting energy savings. The value and importance of the retailer's function as the interface between manufacturers and consumers lead to the requirement that retailers are also included in the provision of information through the modification of the law relating to the Rational Use of Energy in April 2006. The Retailer Evaluation Standard Subcommittee which was created to operated under the Energy Efficiency Standards Subcommittee of Advisory for Natural Resources and Energy then proposed the display of energy-saving information and sought for public consultations. This resulted in a guideline which required retailers to provide product information at the point of sale through the medium of a "Uniform Energy-Saving Label" illustrating the following, multistage rating, expected electricity bill, amongst other information. The multistage rating uses a 5-star mark to represent a relative energy saving performance of the selected product in the market. The appearance of the uniform energy label is shown in Figure 3.6

Figure 3.6 Japan's "Uniform Energy-Saving Label"



Since October 2006, the "Uniform Energy-Saving Label" has been adopted to the following products, air conditioners, electric freezers and TV sets. For all other designated products the Energy-Savings Label described in section 3.4.4 are required. The products subject to energy labelling in Japan are shown in Table 3.2.

Table 3.2.Energy labelling by product type in Japan

Product	Energy-Saving Labeling Program	Expected annual electricity bill	Uniform Energy-Saving Label
Air conditioners	●	●	●
Electric refrigerators	●	●	●
Electric freezers	●	●	
Fluorescent lights	●	●	
Electric toilet seats	●	●	
TV sets	●	●	●
Computers	●		
Magnetic disk units	●		
Space heaters	●		
Gas cooking appliances	●	●(Fuel usage)	
Gas water heaters	●	●(Fuel usage)	
Oil water heaters	●	●(Fuel usage)	
Transformers	●		
Electric rice cookers	●	●	
Microwave ovens	●	●	
VCRs		●	
DVD recorders	●	●	

3.4.5 Actions in case of non-compliance

If the results obtained from the energy efficiency surveys mentioned in the previous paragraph appear to be remarkably low compared to judgment standards and a need to make suitable improvements in energy efficiency is recognised at the time, the Minister of Economy, Trade and Industry (in cases involving cars, the Minister of Economy, Trade and Industry and the Minister of Land, Infrastructure and Transportation) offer recommendations to the manufacturer in question as required. Further, if this advice is not followed, the recommendations are made public and the manufacturer may be ordered to follow the recommendations.

Manufacturers subject to these recommendations and advice should be limited to those whose improvements in manufacturing and imports of equipment are considered to have a substantial impact on energy consumption in Japan. Also, targets should be limited to manufacturers whose organisational capacity is economically and financially firm enough, that is, limited to manufacturers for which there will be no problems regarding social appropriateness. For each machinery or equipment product covered by the Top Runner Program, a cutback in shipping volume will be set according to production and import volume, as stipulated by government decree.

Moreover, if, there are categories that partially fail to achieve goals among the many items, it will not be appropriate to advise the manufacturer immediately. Instead, reasons why goals were not achieved, other companies' achievement records in the same field, achievement records in other categories of the company in question, and percentages of categories that have not achieved target standards in overall categories, and other factors will be comprehensively evaluated.

These measures are implemented for manufacturers that do not adhere to display rules. For displays, cutbacks based on manufacturers' production and import volume are not applied and all companies are subject to these measures in spite of small volume in production and import.

3.5 USA

The household appliance and commercial equipment energy conservation standards program is one of the U.S. Federal Government's most effective energy-saving programs. This is a large program covering a broad spectrum of consumer products and commercial equipment, and has had a significant positive impact on both the U.S. economy and the environment. The current national policy includes recommendations that higher standards be set for existing covered products where technologically feasible and economically justified, and that the program should be expanded to include additional appliances where technologically feasible and economically justified.[1] The details of this programme are summarised in Appendix B and short summaries are given in the text below.

[1] The household appliance and commercial equipment energy conservation standards program is one of the Federal Government's most effective energy-saving programs. According to ACEEE, to date the US energy-efficiency standards have already had a significant impact. They estimate that electricity use in 2000 was 88 terawatt-hours (TWh) lower than it would have been absent standards – a 2.5% reduction. By

Regulations are issued by executive branch agencies to carry out federal laws, including laws associated with energy conservation standards, and are available in the Code of Federal Regulations. For the regulations pertaining to appliance and equipment standards, see Title 10, Chapter II, Part 430—Energy Conservation Program for Consumer Products and Title 10, Chapter II, Part 431—Energy Efficiency Program for Certain Commercial and Industrial Equipment.

Some 23 product types are currently subject to MEPS in the USA of which seven are subject to an active rulemaking process. MEPS are also under development for many other products. All MEPS are developed and administered by the US DOE.

Some 18 products are subject to mandatory energy labelling, which is administered by the Federal Trade Commission (FTC).

Energy Star voluntary endorsement energy labelling and/or performance criteria have been developed for some 54 energy using products.

3.5.1 US DOE Activities

US DOE's programme primarily conducts work in three critical areas: labelling, test procedures, and mandatory energy conservation standards. These are discussed briefly below.

1. Labelling - the Federal Trade Commission (FTC) is required to prescribe labelling rules for residential appliances. DOE and FTC share responsibility for labelling commercial equipment.
2. Test Procedures – US DOE develops and establishes the test procedures that manufacturers must use to certify that their appliances and equipment to meet the minimum energy conservation standards. These test procedures measure the energy efficiency or energy use, and in some case, may provide an estimate of the annual operating cost of each appliance. For the most part, US DOE develops its test procedures based on standards developing organisations that are accredited by the American National Standards Institute (ANSI) or other international organisations (e.g., the International Electrotechnical Commission).
3. Mandatory Energy Conservation Standards – US DOE establishes federal minimum energy performance standards, through its rulemaking process, to maintain consistent,

2030, those savings will have grown to 563 TWh, or approximately 12% of projected consumption. ACEEE also looks at the many new products and updates to existing products that DOE regulates and found that these could yield over 1,900 TWh of electricity savings between 2009 and 2030. Projected annual savings from these new regulations in 2030 would be 180 TWh, or about 4% of the projected US electricity consumption in that year. The net present value benefits of standards amounts to over $123 billion (ACEEE, 2009).

national energy efficiency requirements for certain appliances and equipment. By law, DOE must upgrade standards to the maximum level of energy efficiency that is technically feasible and economically justified (see Appendix B). DOE strives to establish standards that maximise consumer benefits and minimise negative impacts on manufacturers and others.

3.5.2 U.S. Administration Direction

President Obama has made the energy and environment agenda a cornerstone of his Administration's energy policy. Speaking of draft energy legislation in consideration at Congress, President Obama said "after decades of dragging our feet, this plan will finally spark the creation of a clean energy industry that will create hundreds of thousands of jobs over the next few years, manufacturing wind turbines and solar cells for example, and millions more after that." He continued, "these jobs and these investments will double our capacity to generate renewable energy over the next few years."

The creation and distribution of renewable energy and capturing energy efficiency are focal points of Obama's national energy policy. To this end, President Obama emphasised the need for:

- Smart Grid Technology Adoption
- Greening Federal Buildings
- Modernizing Federal Vehicle Fleets
- Increasing Residential Energy Efficiency

"We'll also lead a revolution in energy efficiency, modernizing more than 75% of Federal buildings and improving the efficiency of more than 2 million American homes," said President Obama. "This will not only create jobs, it will cut the Federal energy bill by a third and save taxpayers $2 billion each year and save Americans billions of dollars more on their utility bills."

The President's February 5th Memo

President Barack Obama issued a memorandum for the Secretary of Energy on February 5, 2009 that directs the Secretary to comply with the deadlines for a range of covered products. This memo reflects the strong position of President Obama's Administration on appliance efficiency standards, and is provided below in its entirety.

February 5, 2009

MEMORANDUM FOR THE SECRETARY OF ENERGY

SUBJECT: Appliance Efficiency Standards

Under the Energy Policy and Conservation Act of 1975 (EPCA), the Department of Energy (DOE) is required to establish by certain dates energy efficiency standards for a broad class of residential and commercial products. These products are appliances and other equipment used in consumers' homes and in commercial establishments. In the Energy Policy Act of 2005 (EPACT), the Congress directed the DOE to develop a plan to issue expeditiously efficiency standards for those products with respect to which the Department had not yet met the deadlines specified in the EPCA.

In 2005, 14 States and various other entities brought suit alleging that the DOE had failed to comply with deadlines and other requirements in the EPCA. In November 2006, the DOE entered into a consent decree under which the DOE agreed to publish final rules regarding 22 product categories by specific deadlines, the latest of which is June 30, 2011. The consent decree includes target dates for the rulemaking processes and sets deadlines for issuance of final rules with respect to each product category. The Energy Independence and Security Act of 2007 (EISA) directed the DOE to establish energy standards for additional product categories.

The DOE remains subject to outstanding deadlines with respect to 15 of the 22 product categories covered by the consent decree, as well as statutory deadlines for a number of additional product categories. These efficiency standards, once implemented, will result in significant energy savings for the American people.

Therefore, I request that:

(a) the DOE take all necessary steps, consistent with the consent decree, EPACT, and EISA, to finalise legally required efficiency standards as expeditiously as possible and consistent with all applicable judicial and statutory deadlines. Such standards include, most immediately, those covered by the five energy efficiency rules with deadlines prior to and including August 8, 2009;

(b) with respect to standards subject to judicial and statutory deadlines later than August 8, 2009, the DOE work to complete prior to the applicable deadline those standards that will result in the greatest energy savings. To undertake this task, the DOE should quantify, to the extent feasible and consistent with statutory requirements, the expected annual energy savings from the relevant standards. The DOE must, however, ensure that it meets applicable deadlines for all standards.

This memorandum is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by a party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

You are hereby authorised and directed to publish this memorandum in the *Federal Register*.

BARACK OBAMA

3.5.3 Summary of energy test procedures used in the USA

US energy test procedures are developed under the auspices of the USDOE for products subject to MEPS and by either the USDOE or the USEPA for Energy Star requirements. In practice the MEPS regulations make use of test procedures developed by the relevant national standards or trade association, e.g. AHAM test procedures for home appliances, ARI and ASHRAE for air conditioning, NEMA for motors etc. ANSI standards are also widely used within these test procedures. Many of the ANSI test procedures are derived from international test procedures as are some of the others; however, the majority of US product energy test procedures are not internationally harmonised outside of North America.

4. INSTITUTIONS AND PROCESSES FOR TEST PROCEDURES, TEST REGIMES, REGULATIONS AND COMPLIANCE STRUCTURES

In addition to the main regulatory agencies discussed in Section 3 there are a number of international and national organisations that are involved in developing test procedures, test regimes, compliances structures and providing technical and policy level support to international coordination activities. This section reviews some of the principal institutions and discusses the process that could be followed to leverage their activities to support greater alignment and harmonisation of equipment energy performance specifications.

4.1 Voluntary Technical Standardisation Organisations

The two key international standardisation organisations who produce international energy measurement and energy efficiency performance definitions standards for energy usinmg equipment are the International Organisation for Standardisation (ISO) and the International Electrotechnical Commission (IEC). The IEC produces such standards for all the electrical end-uses and the ISO for all the other end-uses. The ISO also produces more general technical standards that often have an influence on the energy performance of electrical end-use equipment, e.g. illuminance recommendations in voluntary building codes. Details of both organisations are given below; however, they are not the only international standardisation institutions who issue standards relevant to energy using equipment energy performance. Some others are:

- The International Telecommunications Union (ITU)
- The Committee International de l'Eclairage (International Lighting Committee, CIE)
- The International Institute for Refrigeration (IRR)
- The Institute for Electrical and Electronic Engineers (IEEE)

each of which is active in their specific domains and each of which issue widely used technical standards. In addition to these bodies there are numerous national or regional technical standardisation bodies. Some of these are listed below.

4.1.1 Chinese standardisation bodies

- State Administration for Quality, Supervision, Inspection and Quarantine (AQSIQ)
- China National Institute of Standardisation (CNIS)
- Standardisation Administration of China (SAC)
- China Quality Certification Centre (CQC)

4.1.2 EU standardisation bodies

- CEN - European Committee for Standardisation
- CENELEC - European Committee for Electrotechnical Standardisation
- ETSI - European Telecommunications Standards Institute

The above bodies are federations of EU national standards bodies and have a roughly parallel structure to the ISO, IEC and ITU respectively.

4.1.3 Indian standardisation bodies

- Indian Bureau of Standards

4.1.4 Japanese standardisation bodies

- Japanese Industrial Standards

4.1.5 US standardisation bodies

- ANSI - American National Standards Institute
- ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers
- IESNA – Illuminating Engineering Society of North America

4.1.6 International Organisation for Standardisation (ISO)

http://www.iso.org/iso/home.html

ISO International Organization for Standardization

The ISO was founded in 1947 and is responsible for publishing international testing standards. It is the world's largest creator and publisher of standards, with a network of 162 national standards-making bodies. It is an non-governmental organisation, and links institutes in both the public and private sectors enabling it to offer resolutions that benefit commercial enterprises as well as society as a whole. The ISO has 159 members across the globe, for a list of participating countries, see the following link: www.iso.org/iso/about/iso_members.htm

The use of standards ensures the quality, safety, environmental awareness and efficiency of a product or service. The ISO has developed in excess of 18,000 international standards and documents and covers products in a range of sectors including agriculture, engineering, transport, medicine and IT. For a current list of International Standards, see the following link: www.iso.org/iso/iso_catalogue/catalogue_ics/catalogue_ics_browse.htm

Because the ISO is a NGO the Standards it develops are not mandatory, it is the responsibility of the country to enforce and regulate the ISO standard should they chose to adopt it.

Most standards are applied at a national level but some international standards exist. In order to achieve an international standard, stakeholders must agree on consistent specifications and criteria in all elements of production, testing, classification and supply of that product or service. By doing so, the product or service is easily transferable and tradable between countries by removing barriers and making them internationally acceptable. Other advantages of using ISO standards are: they provide Governments with benchmarks for quality, health & safety and the environment; they share technology and innovation between countries, particularly beneficial to developing countries; they protect consumers from using potentially dangerous products and provide assurance; they make the process of producing products and services more efficient, clean and safe; they give consumers more choice and bring them the benefits of competitive marketing; and standards relating to the environmental aspects of products can help protect and preserve the environment.

New standards are developed as a result of demand from a sector or stakeholder, the request generally comes through an ISO national member and is subsequently passed through a technical committee, of which there are 210, where it must be approved by a majority that it, amongst other criteria, is globally relevant.

Many organisations cooperate with the ISO and can be found listed here: www.iso.org/iso/about/organisations_in_liaison.htm. It's International Partners in international standardisation are the International Electrotechnical Commission (IEC) and the International Telecommunication Union (ITU), together they form the World Standards Cooperation (WSC) which brings a strategic focus to the promotion of international standardisation. The ISO also has a relationship with the World Trade Organisation (WTO) due to its work in trade barrier reduction. The ISO often collaborates with the United Nations (UN) and their agencies involved in regulation and policy harmonisation. In addition to these partnerships the ISO has formal ties to over 600 organisations to assist on their technical committees and to international organisations representing various stakeholder parties.

The ISO publishes a number of strategies and policies which can be downloaded for free from their website. The strategies include: a Code of Ethics; Strategic Plan; Action Plan for Developing Countries; Using and referencing ISO and IEC standards for technical regulations; and Global Relevance of ISO Technical Work and Publications. A full list can be found at:

www.iso.org/iso/about/iso_strategy_and_policies.htm

The ISO in collaboration with the IEC also maintain an Information Center which provides information on standardisation and related topics to stakeholders, to access the database follow the link below:

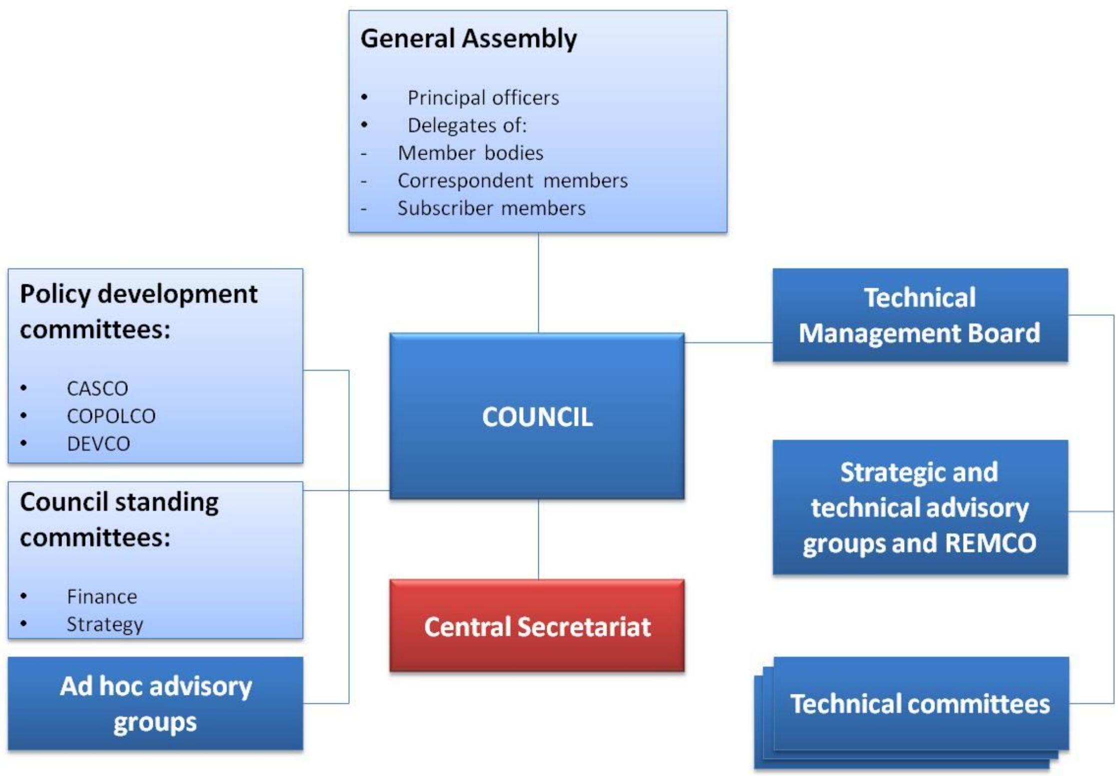
www.standardsinfo.net/info/livelink/fetch/2000/148478/6301438/index.html

ISO Organisation Chart

Strategic decisions are undertaken by ISO members during their General Assembly. The Council, chaired by the President, meets twice a year and its membership changes to reflect the ISO's broad membership.

The Central Secretariat (CS) is a permanently held position, and manages all operations of the ISO and reports to the Council. The CS has a team providing support to ISO members, developing programs and disseminating the outcomes of their work.

Figure 4.1 ISO organisation chart



4.1.7 International Electrotechnical Commission (IEC)

The IEC (http://www.iec.ch) was founded in 1906 and is a non-profit, international non-governmental standards organisation. The IEC is seen as a leading global organisation responsible for the preparation and publication of international standards for all electronics, magnetics, electromagnetics, electroacoustics, telecommunications and multimedia products as well as energy producing and distributing technologies. These and other associated technologies are referred to as "electrotechnology". These publications serve to form the basis of national standardisation as well as a point of reference when drafting international contracts and tenders.

The IEC currently accounts for 159 countries of which 76 are members and 83 participate in the affiliate country program - not an official membership but is developed to encourage the involvement from industrialised countries in the IEC. For a list of the IEC members see link: http://www.iec.ch/dyn/www/f?p=102:5:0::::FSP_LANG_ID:25

The IEC membership is formed by National Committee (NC) members that represent a nation's electrotechnical interests with respect to management and standardisation. The composition of a NC is determined by the range of interested stakeholders including but not limited to manufacturers, consumers, users, government agencies, associations and standard developers – the mix is determined by interested stakeholders in each country. NCs can be composed of a mix of public and private sector bodies and varies from country to country. Membership can take two forms, either full membership or associate members, which dictate the voting rights but not the participation in technical documents, technical committees and meetings, for further details, see the following link: http://www.iec.ch/about/members-e.htm.

The commission is located in Geneva and has regional headquarters in Singapore, Brazil (Sao Paulo) and the United States (Boston). The IEC uses its members to promote international cooperation on all issues relating to electrotechnical standardisation as well as managing three conformity assessments to standards in the field of electronics, electricity and associated technologies.

The primary objective of the IEC is to meet global efficiency requirements, ensure global coverage and dominance of its standards and conformity assessments, improve quality of the products/services under its remit, improve industrial process efficiency and seek to improve and protect health, safety and the environment. The IEC works closely with a range of international and regional partners. A sample of the International partners include: the International Organisation for Standardisation (ISO), the International Telecommunication Union (ITU), the World Health Organisation (WHO), the International Council on Large Electric Systems (CIGRE), the World Trade Organisation (WTO) and at a regional level the African electrotechnical standardisation commission (AFSEC), the European Committee for

Electrotechnical Standardisation (CENELEC) amongst others. For a more detailed listing and links to the partners, see the following link: http://www.iec.ch/about/partners/

The IEC's publications are written to be bilingual in both English and French with certain NCs preparing local language editions including Russian and Spanish. The IEC is in the process of streamlining its development process and thus time for its standards as it recognises the significance of developing international standards in accordance with market demand while accounting for rapid technological evolution and the shortening of product life cycle. The IEC publishes two categories of publications:

- **International consensus products:**
  - International Standards (full consensus);
  - Technical Specifications (full consensus not (yet) reached);
  - Technical Reports (information different from an IS or TS);
  - Publicly Available Specifications;
  - Guides (non-normative publications).

And

- **Limited consensus products:**
  - Industry Technical Agreement;
  - Technology Trend Assessment.

Further information on each of these publications, see the following link: http://www.iec.ch/ourwork/iecpub-e.htm

The IEC's conformity assessment and product certification schemes are:

- IECEE Scheme: conformity testing and certification for electrotechnical equipment and components. This provides a certification service for the Global Approval Program for Photovoltaics which enables it, through its members, to grant the PV GAP mark/seal. This has two branches the CB scheme for mutual recognition of test certificates for electrotechnical components and equipment and the second is the CB-FCS Scheme for mutual recognition of conformity assessment certificates for electrotechnical equipment and components;

- IECQ Scheme: quality assessment of electronic components and associated materials/processes;

- IECEx Scheme: certification to standards for equipment operating in explosive atmospheres.

For more detail on each of these conformity schemes, see the following link: http://www.iec.ch/helpline/sitetree/conformity/tree_conf.htm#websites

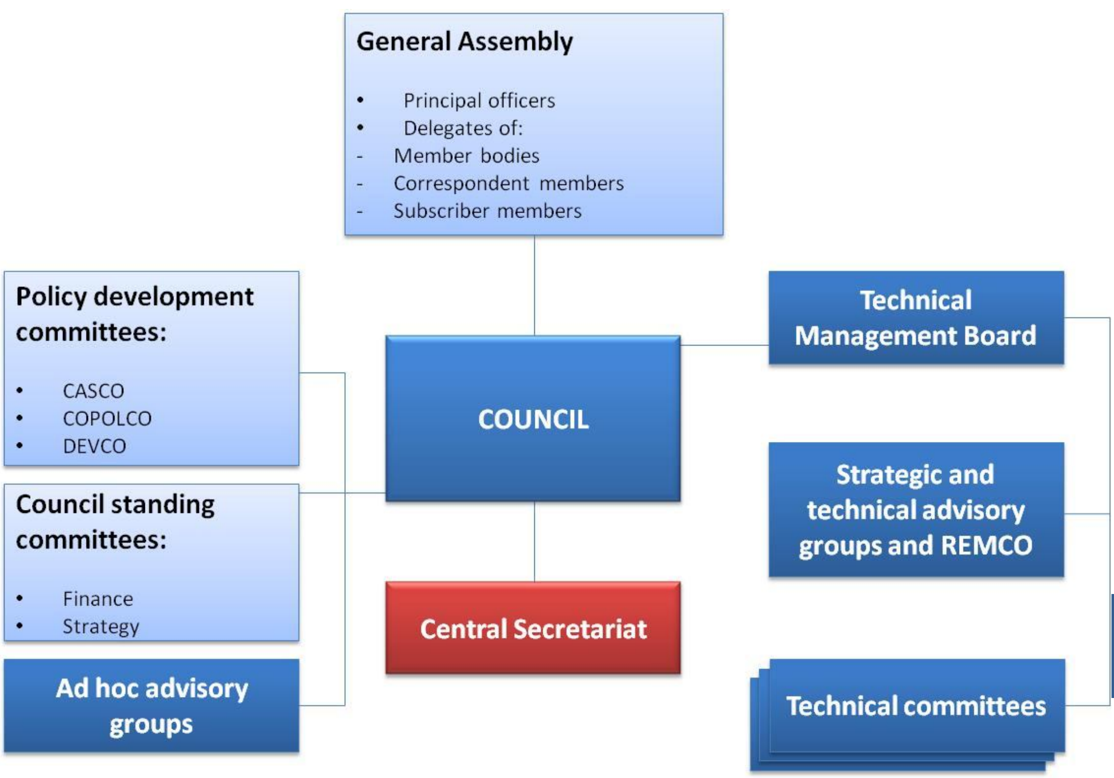
The IEC also examines terminology and symbols, electromagnetic compatibility, dependability, performance, measurement, design, development, safety and the environment. In 1938 the IEC published an international vocabulary guide unifying electrical terminology.

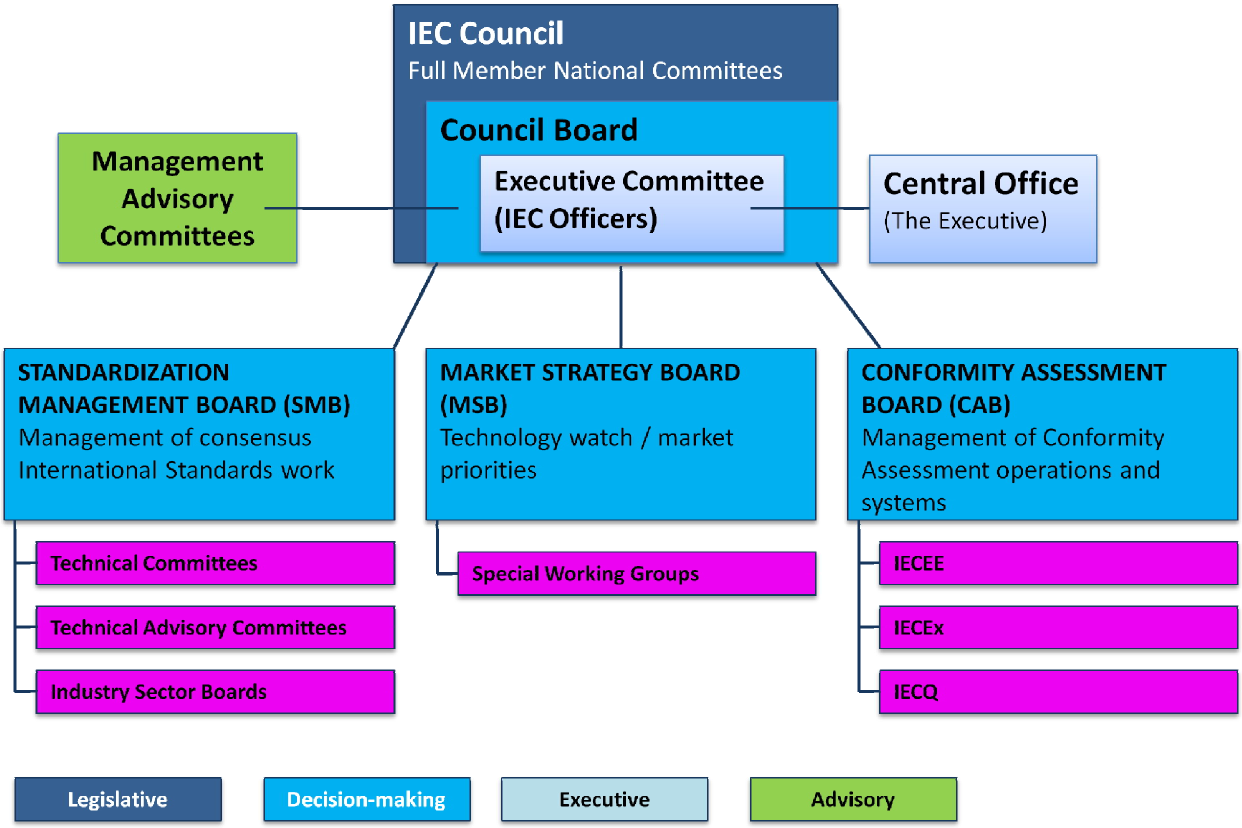
Each NC of the IEC selects the expert participants for its country. A combination of technical and sub committees (179), and project teams/maintenance teams (≈700) conduct the standards work for the IEC. This group is composed from an international expert electrotechnology panel originating from industry, commerce, government, test laboratories, research laboratories, academia and consumer groups. The technical committees prepare technical documents on specific subjects within their remit, which are submitted for voting by the IEC members with a view to their approval as international standards.

IEC Organisational Chart

The highest authority of the IEC is the Council, which is composed from the general assembly of the National Committees. The IEC also encompasses management, executive and advisory bodies and Officers. The Officers of the IEC are the President, Deputy President (Immediate Past-President or President-elect), Vice-Presidents, Treasurer, and General Secretary.

Figure 4.2 IEC organisation chart





4.2 Other Relevant International Organisations

Several other international bodies inform the equipment energy efficiency policy making and standardisation process or have specific roles that have an impact of the prospects for and process of increased harmonisation. This section gives details of some of the most important.

4.2.1 International Energy Agency (IEA) http://www.iea.org/

The IEA was founded in 1973 and gives policy advice to its 28 member countries as they strive to provide their populations with cleaner energy. The IEA's member countries are Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, The Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

The IEA is an intergovernmental organisation and their work is currently focused around policy concerning climate change; market transformation; collaboration efforts around technology development; and support and outreach in energy policy around the world with particular focus on the major energy consumers and producers such as India and China. The IEA undertakes research, data compilation activities, publishes good practice guides and writes policy analysis, all of which are distributed and promoted to assist the public and private sectors with their energy strategies.

The IEA run the following standing groups and committees which promote collaboration and knowledge sharing across its member countries in many fields, for full details see link: http://www.iea.org/about/stancom.htm:

- The Standing Group on Emergency Questions (SEQ) – Oil
- The Standing Group on the Oil Market (SOM) – Oil
- The Standing Group on Long-Term Co-operation (SLT) – Promotes cooperation between member countries
- The Standing Group for Global Energy Dialogue (SGD) – Work outside IEA member countries
- The Committee on Energy Research and Technology (CERT) – Technology development
  - Four expert bodies have been set up under CERT:
    - The Working Party on Fossil Fuels;
    - The Working Party on Renewable Energy Technologies;
    - The Working Party Energy End-Use Technologies; and
    - The Fusion Power Coordinating Committee.

The IEA have set up numerous technology based implementing agreements which are signed up to by participating countries with the aim of achieving a goal in a particular field. The agreement sets out the tasks required to achieve the goal and those tasks are shared across the countries including the level of effort required per country in order to achieve the goal. Further details can be found using the following link: http://www.iea.org/techno/ia.asp

The IEA organise events, workshops, speeches and presentations all over the world, a list of which can be found here: http://www.iea.org/events/index.asp. The workshops take place at least once a month and include wide reaching collaborative efforts and a selection of 2010 titles include: Transforming Innovation into Realistic Market Implementation Programmes; 2nd International CCS Regulators' Network meeting; and Renewables, from Cinderella options to mainstream energy solution.

The IEA publish many papers and guides and collect data on the energy policy status of their member countries. They also publish the World Energy Outlook which presents recommendations and advice over how the future of energy use across the world can be more sustainable. For a full list of publications please follow this link: http://www.iea.org/journalists/publications.asp. These guides make for excellent reference guides when compiling reports and contain data from across the world.

The IEA organised the G8 Summits, starting in Gleneagles in 2005, the follow on work and preceding G8 summits produced the following list of specific high-impact energy efficiency policy recommendations, the recommendations cover 25 fields of action across seven priority areas. The 25 fields are summarised below:

1. The IEA recommends action on energy efficiency across sectors. In particular, the IEA calls for action on:
   1.1 Measures for increasing investment in energy efficiency;
   1.2 National energy efficiency strategies and goals;
   1.3 Compliance, monitoring, enforcement and evaluation of energy efficiency measures;
   1.4 Energy efficiency indicators;
   1.5 Monitoring and reporting progress with the IEA energy efficiency recommendations themselves.
2. Buildings account for about 40% of energy used in most countries. To save a significant portion of this energy, the IEA recommends action on:
   2.1 Building codes for new buildings;
   2.2 Passive Energy Houses and Zero Energy Buildings;
   2.3 Policy packages to promote energy efficiency in existing buildings;
   2.4 Building certification schemes;
   2.5 Energy efficiency improvements in glazed areas.
3. Appliances and equipment represent one of the fastest growing energy loads in most countries. The IEA recommends action on:
   3.1 Mandatory energy performance requirements or labels;
   3.2 Low-power modes, including standby power, for electronic and networked equipment;
   3.3 Televisions and "set-top" boxes;
   3.4 Energy performance test standards and measurement protocols.
4. Saving energy by adopting efficient lighting technology is very cost-effective. The IEA recommends action on:
   4.1 Best practice lighting and the phase-out of incandescent bulbs;
   4.2 Ensuring least-cost lighting in non-residential buildings and the phase-out of inefficient fuel-based lighting.

5. About 60% of world oil is consumed in the transport sector. To achieve significant savings in this sector, the IEA recommends action on:
   5.1 Fuel-efficient tyres;
   5.2 Mandatory fuel efficiency standards for light-duty vehicles;
   5.3 Fuel economy of heavy-duty vehicles;
   5.4 Eco-driving.
6. In order to improve energy efficiency in industry, action is needed on:
   6.1 Collection of high quality energy efficiency data for industry;
   6.2 Energy performance of electric motors;
   6.3 Assistance in developing energy management capability;
   6.4 Policy packages to promote energy efficiency in small and medium-sised enterprises.
7. Energy utilities can play an important role in promoting energy efficiency. Action is needed to promote:
   7.1 Utility end-use energy efficiency schemes

http://www.iea.org/papers/2008/cd_energy_efficiency_policy/1-Croos-sectoral/1-G8_EE_2008.pdf

Figure 4.3 IEA organisation chart

As the diagram above shows, the IEA is made up of three offices and each office contains a number of divisions, the offices and divisions have been outlined below:

Office: Directorate of Energy Markets and Security (EMS)

Divisions: Oil Industry and Markets Division (OIMD)

Emergency Policy Division (EPD)

Energy Diversification Division (EDD)

Renewable Energy Division (RED)

Office: Directorate of Global Energy Dialogue (GED)

Divisions: DALSA works with dialogue countries in Asia Pacific, Latin America and sub-Saharan Africa

DEMA similarly works with dialogue countries in Europe, the Middle East, and North Africa

Country Studies Division (CSD) co-ordinates In-Depth Reviews

Office: Directorate of Sustainable Energy Policy and Technology (SPT)

Divisions: Energy Efficiency and Environment Division (EED)

Energy Technology Policy Division (ETP), Technology Network Unit (NET)

The EED has responsibility for the design and assessment of policy for CO_2 emissions related to the production of energy, and on the development of policies to progress and advance energy efficiency. They also maintain an Energy Efficiency website:

http://www.iea.org/efficiency/index.asp.

Further details on the EED can be found here: http://www.iea.org/about/spt.asp#eed

The IEA runs a number of energy efficiency related programs which consist of publications and papers; workshops; speeches; and additional information. The subject heading and link to the webpage can be found below.

- Buildings — http://www.iea.org/subjectqueries/buildings.asp
- Cross Sectoral Policy — http://www.iea.org/subjectqueries/crosssectoral.asp
- Energy Efficiency Database — http://www.iea.org/Textbase/pm/index_effi.asp
- Finance and Clean Energy — http://www.iea.org/finance/index.asp
- Standby Power Use and the IEA "1-Watt Plan" — http://www.iea.org/subjectqueries/standby.asp
- The International CHP/DHC Collaborative — http://www.iea.org/G8/CHP/chp.asp
- International Partnership for Energy Efficiency Cooperation (IPEEC) — http://ipeecshare.org/
- Implementing Agreement for Efficient Electrical End-use Equipment (4E) — http://www.iea-4e.org/

WORLD TRADE ORGANIZATION

4.2.2 World Trade Organisation (WTO)

The WTO (http://www.wto.org/) replaced the Global Agreement on Tariffs and Trade (GATT) in 1995, it currently has 153 members and observers, is led by the WTO Director-General, its head office is in Geneva, Switzerland and it officially operates in three languages, English, French and Spanish. For a full list of the WTO's members and observers please use the following link:

http://www.wto.org/english/thewto_e/whatis_e/tif_e/org6_e.htm

The WTO sets out and manages the rules of trade between countries across the globe, the rules are set out in trade agreements, currently consisting of 16 different multilateral and two different plurilateral agreements, that are signed up to by participating nations and agreed by the countries' parliaments. The WTO aims to reduce obstacles to trade thus making trade fairer across the world. The WTO enforces the rules through a legal and institutional framework.

WTO's activities

The WTO undertakes a number of activities to achieve fairer global trade, these include:

- Reducing trade barriers and negotiating rules for international trade conduct;
- Implementation and oversight of agreed trade rules;
- Analysis of the trade policies of WTO member countries including regional and bilateral agreements;
- Settling disagreements over the application of trade rules between countries;
- Capacity building in trade in developing countries;
- Encouraging remaining countries to join the WTO;
- Researching and collecting data on trade; and
- Raising public awareness about the work of the WTO and the benefits it brings.

Economic analyses and research: http://www.wto.org/english/res_e/reser_e/reser_e.htm

International trade and tariff data: http://www.wto.org/english/res_e/statis_e/statis_e.htm

Cooperation

The WTO works with a number of institutions and organisations, over 200 around the world, who assist them in data collection, research projects, technical support, training and the setting of standards.

WTO and the Environment http://www.wto.org/english/tratop_e/envir_e/envir_e.htm

The WTO's Marrakesh Agreement, which established the WTO, highlights environmental protection and sustainable development as a key goal of its trade agreements, however, a rule relating explicitly to the environment does not currently exist. Members can adopt measures aimed at environmental protection providing that they do not conflict with the WTO's broader goals and philosophy.

In general terms the WTO's trade transparency, enforcement tools and partnership with different organisations assist in the protection of the environment. It has also developed the Doha Development Agenda which focuses on the environment and assigns tasks to the Committee on Trade and Environment (CTE).

The CTE specifically considers how trade decisions impact the environment and vice versa, and takes the form of a forum for governments to discuss these matters. The CTE, amongst other items such as biodiversity and intellectual property agreements, has been tasked with considering the effects of labeling as a means of environmental protection. For further details on the CTE please follow the link below:

http://www.wto.org/english/tratop_e/envir_e/wrk_committee_e.htm

The CTE considers the link between a Government's requirement on products and their impact on the environment and the WTO agreements for trade. This also includes standards and technical legislation, materials used to package products and their ability to be recycled.

The WTO has not yet been able to reach a consensus on labeling for a number of reasons:

- Labels discourage and often eliminate developing countries, and small and medium sised firms from the market as they are unable to produce such products cheaply and efficiently;
- Labels, if misused, can create barriers and discriminate between countries by protecting the domestic/producing country;
- A challenge is faced when considering the process and production methods (PPM) of products and their impact on the final product. Some countries believe that if the PPM of the product has no effect on the appearance of the finished product (examples include sustainable wood, ability to be recycled) it is inconsistent with WTO agreements; and
- Within the WTO there is overlap between the remits of the CTE and the Technical Barriers to Trade Committee (TBT), who regularly discuss product standards and labeling.

The TBT Agreement's "Code of Good Practice for the Preparation, Adoption and Application of Standards" includes a section on voluntary labeling schemes which is encouraged in countries looking to develop a labeling scheme. For further details use the links below:

http://www.wto.org/english/docs_e/legal_e/17-tbt_e.htm#annexIII

http://www.wto.org/english/tratop_e/envir_e/labelling_e.htm

Organisation Chart

The Ministerial Conference meets every two years and the General Council conducts the WTO's general business between those intervals. Subsidiary bodies/councils/committees monitor the agreement's implementation by the WTO's various members. All the councils and committees are made from WTO members.

Figure 4.4 WTO organisation chart

4.2.3 Asia-Pacific Economic Cooperation (APEC)

APEC (http://www.apec.org/) was established in 1989 with the vision to facilitate economic growth, encourage cooperation, trade and investments in the Asia-Pacific region. APEC has twenty-one "Member Economies" which are, Australia; Brunei Darussalam; Canada; Chile; People's Republic of China; Hong Kong, China; Indonesia; Japan; Republic of Korea; Malaysia; Mexico; New Zealand; Papua New Guinea; Peru; The Republic of the Philippines; The Russian Federation; Singapore; Chinese Taipei; Thailand; United States of America; and Viet Nam. These member economies in 2008 accounted for 40.5% of the population, 54.2% of the world's GDP and 43.7% of global trade.

APEC is an intergovernmental group which operates as a cooperative economic and trade forum with a focus to further develop three key areas: economic and technical cooperation, trade and investment liberalisation, and business facilitation as well as human security, climate change, energy security and clean development in the region. The ultimate aim is the increase in exports, creation of more efficient member economies with more jobs and scope for international investment and trade. Further information on each of these areas can be found using the following link, and are summarised below:

http://www.apec.org/apec/about_apec/scope_of_work.html.

- **Trade and Investment Liberalisation:** aims to reduce and ultimately eliminate tariff and non-tariff barriers that inhibit trade and investment – outlined in APEC's "Regional Economic Integration" agenda;

- **Business Facilitation:** aims to reduce business transaction costs, align policy and business strategies, improve access and quality of trade information to encourage growth as well as open and free trade – outlined in APEC's "Structural Reform" agenda; and

- **Economic and Technical Cooperation (ECOTECH):** aims to provide training and cross-country cooperation in all APEC member states to facilitate capacity building at both personal and institutional level.

APEC operates on the principle of open dialogue and developing commitments are undertaken on a voluntary basis without any treaty obligations and binding commitments for its member economies.

In line with their three key development areas APEC runs four committees, several groups - working groups and special task groups, industry dialogues and other initiatives with involvement from each of the APEC member economies. The committees and groups are used to promote and enhance collaboration and knowledge sharing which are highlighted below. For full details see link: http://www.apec.org/apec/apec_group.html.

- Four committees – includes representation from each APEC member economy:
  - Budget and Management Committee;
  - Committee on Trade and Investment;
  - Economic Committee; and
  - SOM Committee on Economic and Technical Cooperation.
- CTI (Committee on Trade and Investment) groups – promotes reduction in obstacles to business activities:
  - Automotive dialogue;
  - Business mobility group;
  - Electronic commerce steering group; and more.
- Working groups – composed from experts from each APEC member economy:
  - Energy working group;
  - Industrial science and technology working group; and more.
- SOM (Senior Officials Meeting) special task groups – explore topical issues:
  - Task force for emergency preparedness;
  - Counter terrorism task force, and more.
- Industry dialogues – consultation with business communities in specific sectors:
  - Automotive dialogue;
  - Chemical dialogue.
- And other groups/initiatives:
  - Sustainable development;
  - Life sciences innovation forum, and more.

APEC also has a dedicated Policy Support Unit (PSU) that conducts research and analysis which is used to feed into the policy decision making of the member economies as well as to establish cross collaborative relationships with other international organisations in order to further their research and analysis. The PSU's mandate is broad and covers a range of activities, current work includes:

- Examining the impact and benefits of structural reform in the transport, energy and telecommunications sector;
- APEC voluntary review of institutional frameworks and process for reforms; and
- Statistical Database and key indicators of APEC member economies.

A full listing of current and completed work can be found through the following link: http://www.apec.org/apec/about_apec/psu/psu_sow.html

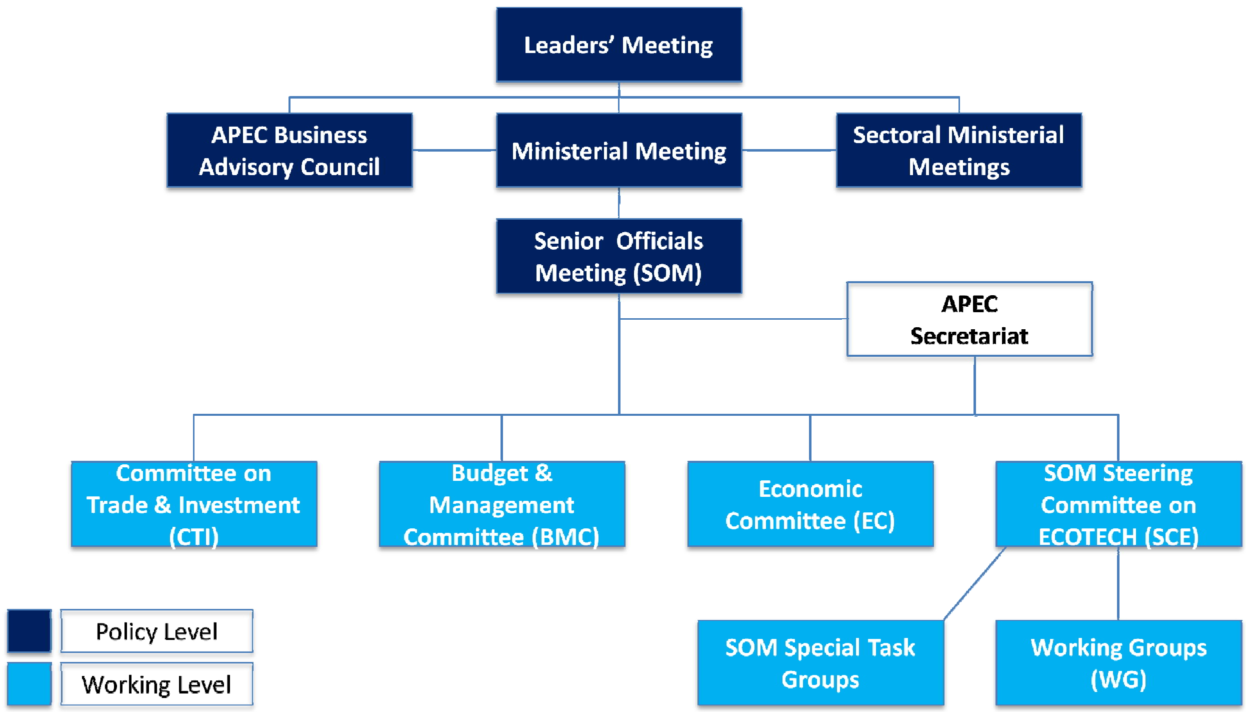
APEC's various committees, working groups and other fora have numerous publications which can be accessed using the following link: http://publications.apec.org/. APEC also publish the APEC Energy Handbook which was last published in January 2010, the APEC Energy Statistics publication of 2007, APEC Energy Demand and Supply Outlook as well as several other publications regarding energy, energy efficiency, standards and labeling – collectively they promote information sharing and contain information on energy supply and demand data, energy policy, energy efficiency improvement, infrastructure development, energy source diversification, regulatory reform, standards and labeling, upstream development and environmental protection.

Furthermore, APEC regularly organise events in the form of workshops, conferences, presentations and much more with a complete listing of future and past events accessed using the following link: http://www.apec.org/webapps/events_calendar/events_calendar_t.php.

An Organisational Chart of APEC

The diagram below demonstrates the organisation and management of APEC.

Figure 4.5 APEC organisation chart



4.2.4 International Partnership for Energy Efficiency Cooperation (IPEEC)

The declaration of the IPEEC can be found here:

http://www.enecho.meti.go.jp/topics/g8/ipeecsta_eng.pdf

The terms of reference for the IPEEC, signed in May 2009 can be found here: http://www.pi.energy.gov/documents/IPEEC_Terms_of_Reference.pdf

The IPEEC was established in June 2008 by Canada, the People's Republic of China, France, Germany, India, Italy, Japan, the Republic of Korea, the Russian Federation, the United Kingdom, the United States of America, and the European Community, represented by the European Commission. The decision was made at the Energy Ministerial meeting during the 2008 G8 Presidency. The IPEEC held its first executive committee meeting in Paris from the 17-18 September 2009.

The IPEEC provides a forum which generates actions to provide energy efficiency projects and programs across the participating countries. This involves knowledge sharing, developing new programs and partnerships, policy and best practice. The forum acknowledges and addresses the need for cooperation in the field of energy efficiency on a global scale. The IPEEC can also assist existing energy efficiency organisations by providing support and input and allow participating countries to get involved where they see value to their countries. The IPEEC will not however, develop goals or standards for energy efficiency for its member countries and all participation in activities are done on a voluntary basis without enforcement.

The IPEEC undertakes the following activities to achieve its goals:

- Support participating countries in their ongoing efforts in energy efficiency development through indicators, best practice and data collection;
- Sharing information on energy efficiency measures, examples include: standards and labeling; methodologies for energy measurement; financing tools; procurement policies; purchasing agreements; consumer awareness activities; best practice guidelines; cooperation between the private and publics sectors to promote technological developments; and methods to speed up information dissemination;
- The creation of public-private partnerships to target sectors with high levels of energy consumption and promote energy efficiency activities;
- Research and development into new energy efficient technologies, particularly for use in developing countries; and
- Organise the distribution of energy efficient products and services.

The IPEEC's current tasks include:

- **4E**: 4E is an International Energy Agency (IEA) led Implementing Agreement with a focus on the advancement of efficiency in appliances.
- **Sustainable Building Network** (SBN): SBN is a joint venture between the IEA and the German Government, its aim is promote methods to assist buildings achieve zero and/or low energy production through design solutions and linking building design to climate; and the development of policy on existing buildings.
- **Global EE Action Initiative (GEEAI)**: Provides support and advice and emerging economies to assist them in the development of a energy efficiency strategy.
- **Super-efficient Equipment and Appliances Deployment (SEAD)**: Helps advance the release of advanced energy efficient technologies
- **Energy Management Network (EMAK)**: Training program for energy managers in energy efficiency supported by Japan
- **Assessment of Financing Mechanisms**: Work to identify barriers, challenges and solution in financing energy efficiency initiatives, led by India.
- **Indicators, Improving Methods for Measuring and Verifying Energy Efficiency**: Assisting economies lacking expertise in this area and developing capability.

4.3 Accreditation and Certification Organisations

Testing of product energy performance compliance is managed in a variety of ways internationally but final decisions invariably require an independent test laboratory to do the testing in accordance with the accepted test procedure. In many cases energy performance test results are also subject to certification requirements meaning that the test result of products when in initially placed on the market is in some sense verified (certified) by a qualified third party (a certification body). The role of accreditation agencies is to establish if a testing agency is competent to conduct a given test and to accredit them as being so. All the major economies have at least one designated national accreditation agency whose job it is to accredit test labs to ensure they are competent to do the tests they conduct. The test labs they accredit can be government owned, industry owned or run by third parties such as consumer associations or private sector third party testing and certification bodies.

4.3.1 Accreditation bodies

All accreditation agencies in the major economies are members of the International Laboratory Accreditation Cooperation (ILAC) (www.ilac.org). This is an international cooperation of laboratory and inspection accreditation bodies formed more than 30 years ago to help remove technical barriers to trade. Accreditation is intended to allow people to make an informed decision when selecting a laboratory, as it demonstrates competence, impartiality and capability. It helps to underpin the credibility and performance of goods and services.

Accreditation bodies around the world, which have been evaluated by peers as competent, have signed an arrangement that enhances the acceptance of products and services across national borders. The purpose of this arrangement, the ILAC Arrangement, is to create an international framework to support international trade through the removal of technical barriers. ILAC members include laboratory and inspection accreditation bodies representing more than 70 economies and regional organisations.

The ultimate aim of the ILAC Arrangement is the increased use and acceptance by industry as well as regulators of the results from accredited laboratories and inspection bodies, including results from laboratories in other countries. In this way, the free-trade goal of 'product tested once and accepted everywhere' can be realised.

ILAC provides a focus for:

- Developing and harmonising laboratory and inspection accreditation practices
- Promoting laboratory and inspection accreditation to industry, governments, regulators and consumers
- Assisting and supporting developing accreditation systems
- Global recognition of laboratories and inspection facilities via the ILAC Arrangement, thus facilitating acceptance of test, inspection and calibration data accompanying goods across national borders

Among the five major economies the ILAC members are:

China

- China National Accreditation Service for Conformity Assessment (CNAS), People's Republic of China

- Hong Kong Accreditation Service (HKAS), Hong Kong, China

The EU

- Bundesministerium fur Wirtschaft, Familie und Jugend (BMWA), Austria
- BELAC (Belgian Accreditation Body), Belgium
- Croatian Accreditation Agency (HAA), Croatia
- Czech Accreditation Institute (CAI), Czech Republic
- Danish Accreditation (DANAK), Denmark
- Finnish Accreditation Service (FINAS), Finland
- Comite Francais d'Accreditation (COFRAC), France
- Deutsche Akkreditierungsstelle GmbH (DAkkS), Germany
- DAkkS was formed from a merger of DKD and DGA.
- Hellenic Accreditation System S.A. (ESYD), Greece
- Hungarian Accreditation Board (NAT), Hungary
- Irish National Accreditation Board (INAB), Ireland
- Sistema Italiano di Accreditamento (ACCREDIA), Italy
- Dutch Accreditation Council (RvA), Netherlands
- Norsk Akkreditering (NA), Norway
- Polish Centre for Accreditation (PCA), Poland
- Instituto Portugues de Acreditacao (IPAC), Portugal
- Romanian Accreditation Association (RENAR), Romania
- Slovak National Accreditation Service (SNAS), Slovakia
- Slovenian Accreditation (SA), Slovenia
- Entidad Nacional de Acreditacion (ENAC), Spain
- Swedish Board for Accreditation and Conformity Assessment (SWEDAC), Sweden
- United Kingdom Accreditation Service (UKAS), United Kingdom

India

- National Accreditation Board for Testing & Calibration Laboratories (NABL), India

Japan

- International Accreditation Japan (IA Japan), Japan
- Japan Accreditation Board for Conformity Assessment (JAB), Japan

- Voluntary EMC Laboratory Accreditation Center INC (VLAC), Japan

USA

- American Association for Lab Accreditation (A2LA), USA
- ANSI-ASQ National Accreditation Board doing business as ACLASS, USA
- International Accreditation Service, Inc (IAS), USA
- National Voluntary Laboratory Accreditation Program (NVLAP), USA
- Laboratory Accreditation Bureau (L-A-B), USA
- Perry Johnson Laboratory Accreditation, Inc. (PJLA), USA
- American Society of Crime Lab Directors/Laboratory Accreditation Board (ASCLD/LAB), USA

All these agencies are full members of ILAC, which means that meet the requirements for Associates (below) and have also been accepted as signatories to the ILAC Mutual Recognition Arrangement. Each accreditation body that is a signatory to the Arrangement agrees to abide by its terms and conditions and by the ILAC evaluation procedures. To do this, the signatory must:

- Maintain conformance with ISO/IEC 17011, related ILAC guidance documents, and a few, but important, supplementary requirements, and
- Ensure that all its accredited laboratories comply with ISO/IEC 17025 of ISO 15189 (for medical testing laboratories) and related ILAC guidance documents.

These signatories have, in turn, been peer-reviewed and shown to meet ILAC's criteria for competence.

Associate members are Accreditation bodies that, while not yet signatories to the ILAC Arrangement:

- operate accreditation schemes for testing laboratories, calibration laboratories, inspection bodies, and/or other services as decided from time to time by the ILAC General Assembly.
- can provide evidence that they are operational and committed to comply with:

  (a) the requirements set out in relevant standards established by appropriate international standards writing bodies such as the International Organization for

Standardization (ISO) and the International Electrotechnical Commission (IEC) and ILAC application documents; and

(b) the obligations of the ILAC Mutual Recognition Arrangement;

- are recognised in their economy as offering an accreditation service

In addition to this ILAC also recognises three regional cooperative accreditation bodies which comprise many of the same members and operate regional MRAs. These are set out below.

Recognised Regional Cooperation Bodies

Recognised Regional Cooperation Bodies are those whose regional Mutual Recognition Arrangements (MRA/MLA) have been successfully peer evaluated by ILAC as follows:

- Asia Pacific Laboratory Accreditation Cooperation (APLAC), Secretariat – Australia
- European co-operation for Accreditation (EA), Secretariat – France
- Inter American Accreditation Cooperation (IAAC), Secretariat – Mexico

4.3.2 Certification bodies

Certification bodies are often private sector third party agencies that operate certification programmes to improve confidence that product's meet specified performance levels. The way certification is used differs by economy and product and even within economies. For example, all products sold in the EU have to carry the CE mark to indicate that they comply with all relevant EU regulations. It is not mandatory for product suppliers to do third party testing and many operate their own testing facilities and make their own product performance declarations; however, many retailers and distributors demand that the products they retail are certified to be CE compliant by third party test agencies i.e. by a certification body. As a result a large private sector certification business exists. A similar situation applies in the USA where many retailers wish to see that product performance is verified by a third party. In some cases industry associations have set up a third party certification scheme which will verify product energy performance and ensure it complies with regulations, in other cases (where such schemes don't exist) a distributor or retailer may require this to be done a third party agency before they will stock a product. Certification agencies can also be administered by the state, as is the case for the China Quality Certification Centre (CQC) is the largest professional certification body in China and which develops and administers the voluntary endorsement energy labelling programme in China, including overseeing the certification of products that apply to receive the label.

The IEC operates the *Worldwide System for Conformity Testing and Certification of Electrotechnical Equipment and Components* (IECEE) (http://members.iecee.org/).

The purpose of this body is to facilitate international trade in electrical equipment, primarily intended for use in homes, offices, workshops, healthcare facilities and similar locations, for benefit of consumers, industries, authorities etc, and to provide convenience for manufacturers and other users of the services provided by various National Certification Bodies (NCBs), an international Scheme is operated by the IECEE (IEC System for Conformity testing and Certification of Electrotechnical Equipment and Components), known as the CB Scheme.

The Scheme is based on the principle of mutual recognition (reciprocal acceptance) by its members of test results for obtaining certification or approval at national level. It is intended to reduce obstacles to international trade which arise from having to meet different national certification or approval criteria. Participation of the various NCBs within the Scheme is intended to facilitate certification or approval according to IEC standards. Where national standards are not yet completely based on IEC standards, declared national differences are taken into account; however, successful operation of the Scheme presupposes that national standards are reasonably harmonized with the corresponding IEC standards.

Use of the Scheme to its fullest extent will promote the exchange of information necessary in assisting manufacturers around the world to obtain certification or approval at national level. The operating units of the Scheme are the NCBs accepted according to these Rules. Those NCBs employ testing laboratories also accepted according to the Rules, known as CB Testing Laboratories (CBTLs).

The CB Scheme is based on the use of CB Test Certificates which provide evidence that representative specimens of the product in question have successfully passed tests to show compliance with the requirements of the relevant IEC standard. A supplementary report providing evidence of compliance with declared national differences in order to obtain national certification or approval may also be attached to the CB Test Report. The first step for an NCB, intending to operate in the CB Scheme, is to be accepted as a Recognizing NCB. Such an NCB is prepared to recognize CB Test Certificates as a basis for certification or approval at national level for one or more categories of products. The second step for an NCB, which can be taken at the same time as the first step, is to be accepted as an Issuing and Recognizing NCB. Such an NCB is entitled to issue CB Test Certificates for the categories of equipment for which it recognizes CB Test Certificates. It should, however, be noted that an NCB may recognize CB Test Certificates for more categories of equipment than for which it is entitled to issue CB Test Certificates.

The members of the CB scheme in the five major economies are shown below.

China

- CNCA (Certification and Accreditation Administration of the People's Republic of China

The members of the CNCA include:

- NCB CQC China Quality Certification Centre
- CBTL Beijing Testing & Inspection Station for Household Electric Appliance (BTIHEA)
- CBTL China CEPREI Laboratory
- CBTL Guangzhou Electrical Safety Testing Institute (CEST)
- ACTL Guangzhou Electrical Safety Testing Institute (CEST-Dongguan)
- ACTL Guangzhou Electrical Safety Testing Institute-Shunde (CESTShunde)
- CBTL Guangzhou Vkan Certification & Testing Institute (CVC)
- CBTL Shanghai Institute of Quality Inspection and Technical Research Institute of Electronics & Household Appliances Quality Inspection (SQI_DZ)
- ACTL Shanghai Institute of Quality Inspection and Technical Research (SQI_ZM)
- CBTL Testing & Inspection Station for Cable and Wire (TICW)
- CBTL Testing & Inspection Station for Electric Tools (TIET)
- CBTL Shanghai Testing & Inspection Institute for Electrical Equipment (STIEE)
- CBTL Testing & Inspection Station for Radio and TV Products (TIRT)
- CBTL Safety & EMC testing Center of Electronics Industry (SEC)
- CBTL The Hong Kong Standards and Testing Center Ltd. (HKSTC)
- CBTL Shanghai Electrical Appliance Testing Laboratory (SEATL)
- CBTL Safety Test Laboratory for Electrical Appliances (STLEA)
- CBTL Guangzhou Electrical Safety Laboratory of Guangdong Entry-Exit Inspection & Quarantine Bureau (GZESL)
- CBTL Fujian Provincial Central Inspection Institute (FCII)

- CBTL Zhejiang test academy of quality and technical supervision

The EU (note: national representative bodies are indicated for all countries but national members are only shown for the four largest economies)

- OVE, Austria
- SGS Belgium NV, Belgium
- Croatian Standards Institute, Croatia
- CSNI, Czech Republic
- Dansk Standard, Denmark
- SGS Fimko Ltd, Finland
- LCIE by delegation from UTE, France
    - NCB LCIE
    - CBTL Bureau Veritas Consumer Products Services (previously Curtis Straus)
    - ACTL Bureau Veritas Consumer Products Services
    - CBTL Bureau Veritas Hong Kong Ltd - LCIE Electrical Division
    - CBTL LCIE CHINA Company limited
    - CBTL Bureau Veritas Consumer Product Services Limited, Taoyuan Branch (BV CPS Ltd, Taoyuan Branch)
    - CBTL Laboratoire Central des Industries Electriques (LCIE)
    - ACTL LCIE Sud Est
    - ACTL Low-voltage Apparatus Laboratory
    - CBTL European Solar Test Installation (ESTI)
    - CBTL BV CPS Shanghai
    - CBTL Foshan Supervision Testing Centre of Quality and Metrology
    - CBTL BV CPS Hamburg
    - CBTL Bureau Veritas Consumer Product Services Germany GmbH
    - NCB LNE - Laboratoire national de métrologie et d'essais

- Deutsches Komitee der IEC, Germany
    - NCB VDE Testing and Certification Institute
    - CBTL Institut "Prüffeld für elektrische Hochleistungs-technik" GmbH, (IPH)
    - CBTL CMA Industrial Development Foundation Limited
    - CBTL Electronics Testing Center, Taiwan (ETC)
    - CBTL VDE Testing and Certification Institute

- ACTL Institut “Prüffeld für elektrische Hochleistungstechnik” GmbH
- CBTL Fraunhofer - ISE, Institut für Solare Energiesysteme
- NCB TÜV Rheinland LGA Products GmbH
- CBTL TÜV Rheinland LGA Products GmbH Köln
- CBTL TÜV Rheinland Hong Kong Ltd.
- CBTL TÜV Rheinland Taiwan Ltd. Taichung Laboratory
- CBTL TÜV Rheinland (Shenzhen) Co., Ltd.
- CBTL LGA InterCert GmbH
- CBTL TÜV Rheinland LGA Products GmbH Nürnberg
- CBTL TÜV Rh Shanghai Co. Ltd
- CBTL TÜV Rh Guangdong Ltd
- CBTL TÜV Rheinland LGA Products GmbH Berlin
- CBTL TÜV Rheinland France SAS
- CBTL Industrial Technology Research Institute (ITRI)
- CBTL TUV Rheinland CCIC(Ningbo) Co., Ltd
- CBTL The Lighting Association
- NCB TÜV SÜD Product Service GmbH
- CBTL TÜV SÜD Product Service GmbH Munich
- ACTL TUV SUD Industrie Service GmbH
- CBTL TÜV SÜD Product Service GmbH Eschborn
- CBTL TÜV SÜD America Inc., Danvers MA
- ACTL Global Advantage International
- ACTL TÜV SÜD America Inc., New Brighton MN
- CBTL TÜV SÜD America Inc., San Diego CA
- CBTL TÜV Italia srl
- CBTL TÜV Product Services Ltd. Titchfield
- CBTL TÜV Product Service Limited Bearley
- CBTL CENTRE DE RECHERCHE INDUSTRIELLE DU QUÉBEC (CRIQ)
- CBTL GAI - Global Advantage International
- CBTL Specialized Technology Resources (Shanghai)Ltd.
- CBTL Laboratório Industrial da Qualidade (LIQ)
- CBTL PI Photovoltaik-Institut Berlin AG
- CBTL Eurotest Laboratori Srl
- CBTL TÜV SUD Korea Laboratory (TKL)
- ACTL TUV SUD PSB Pte Ltd
- CBTL TÜV SÜD Product Service GmbH Hannover
- NCB SLG Prüf- und Zertifizierungs GmbH
- CBTL SLG-CPC Testlaboratory Co., Ltd.
- CBTL SLG Prüf- und Zertifizierungs GmbH

- CBTL mikes-testingpartners gmbh
- NCB Eurofins Product Service GmbH
- CBTL Eurofins Product Service GmbH
- NCB TÜV NORD CERT GmbH
- CBTL TÜV NORD CERT GmbH
- NCB TÜV InterCert GmbH
- CBTL Eurotest Laboratori Srl
- NCB Bureau Veritas Consumer Product Services Germany GmbH

- ELOT, Greece
- MEEI Kft, Hungary
- Electro-technical Council of Ireland, Ireland
- IMQ SpA, Italy
  - NCB IMQ S.p.A
  - CBTL IMQ S.p.A
  - CBTL IMQ Primacontrol S.r.l.
  - NCB ICIM S.p.A.
- KEMA Quality BV by delegation from the Netherlands Electrotechnical Committee, Netherlands
- NEK, Norway
- PCBC, Poland
- CERTIF, Portugal
- Romanian Electrotechnical Committee, Romania
- Slovak Electrotechnical Committee, Slovakia
- SIQ by delegation form SIST, Slovenia
- AENOR, Spain
- SEK SVENSK ELSTANDARD, Sweden
- United Kingdom National Committee of the IECEE
  - NCB Intertek Testing & Certification Ltd.
  - CBTL ITS Testing & Certification Ltd. - ITS Leatherhead
  - ACTL Intertek Certification & Testing Ltd.
  - CBTL Testing & Certification Australia, Lane Cove Testing Station (TCA – LCTS)
  - NCB BSI
  - CBTL BSI Testing
  - NCB TraC EMC & Safety Ltd.

India

- Bureau of Indian Standards

The members of the BIS include:

- NCB STQC
- CBTL Electronics Test & Development Centre - ETDC (Bg.)
- CBTL Electronics Regional Test Laboratory (West) - ERTL (W)
- CBTL Electronics Regional Test Laboratory (East) - ERTL (E)
- CBTL Electronics Regional Test Laboratory (North) - ERTL (N)
- CBTL Electrical Regional Test Laboratory (South) - ERTL (S)

Japan

- Japanese Industrial Standards Committee

The members of the JISC include:

- NCB Japan Electrical Safety and Environment Technology Laboratories (JET)
- CBTL Japan Electrical Safety and Environment Technology Laboratories - JET Yokohama
- CBTL Japan Electrical Safety and Environment Technology Laboratories, Kansai Laboratory - JET Kansai
- CBTL Japan Electrical Safety and Environment Technology Laboratories - JET Tokyo
- NCB Japan Quality Assurance Organization (JQA)
- CBTL Japan Quality Assurance Organization,Safety & EMC Center - JQA Tokyo
- CBTL Japan Quality Assurance Organization, Kita-Kansai Testing Center - JQA Kita Kansai
- CBTL Japan Quality Assurance Organization (JQA) Safety & EMC Center, EMC Engineering Dept. TSURU EMC Branch
- NCB TÜV Rheinland Japan Ltd.
- CBTL Austest
- CBTL TÜV Rheinland Japan, Ltd. Yokohama Laboratory
- CBTL TÜV Rh Shanghai Co. Ltd
- CBTL TÜV Rh Guangdong Ltd
- CBTL TÜV Rheinland Japan, Ltd. Osaka Laboratory

- CBTL NATOM Corporation
- CBTL IPS Corporation
- CBTL JEL, Japan EMC Laboratory
- CBTL International Testing And Certification Services Pty. Ltd (ITACS)
- CBTL TÜV Rheinland Thailand Ltd
- CBTL Creative Safety & Consultant Co.
- CBTL TÜV Rheinland Korea Ltd.
- CBTL TÜV Rheinland Hong Kong Ltd.
- CBTL TÜV Rheinland Taiwan Ltd.
- CBTL TÜV Rheinland (Shenzhen) Co., Ltd.
- CBTL Compliance Certification Services Inc. (CCS)
- CBTL QuieTek Corporation
- CBTL PSE INC., TAIWAN
- CBTL TUV Rheinland CCIC(Ningbo) Co., Ltd
- CBTL TUV Rheinland (India) Pvt. Ltd.
- CBTL International Standards Laboratory (ISL)
- NCB UL Japan, Inc.
- CBTL UL Japan, Inc.
- CBTL UL Japan, Inc. Yokowa EMC lab

USA

- US National Committee of the IECEE

The members of the USNC IECEE include:

- NCB Underwriters Laboratories Inc.
- CBTL UL San Jose Office
- ACTL UL Brea
- ACTL UL Denver
- ACTL UL Northbrook Office
- ACTL Exova Canada Inc. (formerly Bodycote)
- CBTL UL RTP Office
- CBTL UL Melville Office
- CBTL UL Camas Office

- CBTL UL Chelmsford Office
- CBTL UL Northbrook Office
- ACTL UL Minneapolis LES
- ACTL UL LES Dallas
- ACTL Medical Equipment Compliance Associates, LLC (MECA)
- CBTL UL Japan, Inc.
- CBTL UL-CCIC
- NCB MET Laboratories, Inc.
- CBTL MET Laboratories Inc.
- NCB ITS - Intertek Testing Services, N.A.
- CBTL Intertek Testing Services, Boxborough
- CBTL Intertek Testing Services NA, Inc., Cortland
- CBTL Intertek Testing Services, Duluth
- CBTL Intertek Testing Services NA, Inc., Los Angeles
- ACTL Intertek Testing Services NA, Inc. Middleton
- CBTL Intertek Testing Services, Menlo Park
- CBTL Intertek Testing Services ETL SEMKO, Oakdale
- ACTL Intertek Testing Services NA, Inc. Plano
- CBTL Intertek Testing Services NA, Ltd. Coquitlam, B.C.
- NCB TUV Rheinland of North America, Inc.
- CBTL TÜV Rheinland of North America, Inc. Newtown
- CBTL TÜV Rheinland of North America, Inc. Pleasanton
- CBTL I.T.L. (PRODUCT TESTING) Ltd.

4.4 Conformity Assessment Processes in the Five Economies

The topic of conformity assessment is addressed in a separate study conducted for CLASP by Mark Ellis Associates to be issued as a CLASP *Guidebook on Best Practice for Monitoring, Verification and Enforcement*. This study, which has been prepared in parallel to the present document, summarises the current practices around the world including for the five major economies considered in this report. The authors of this report refer readers to that report.

4.5 Barriers to Harmonisation

The barriers to harmonisation are associated with lack of awareness of other regulatory and standardisation processes, the disconnections in the current regulatory and standardisation processes, in-built inertia and limited resources and time to engage in more broadly based international efforts.

4.5.1 Lack of awareness of the programmes in other economies

While all the regulators in the five economies are aware that the other major economies have standards and labelling schemes in place and are regularly setting new requirements they are often not aware of the relevant details. These include which products are regulated in the other economies, the test procedures and efficiency metrics, the type and use of equipment and the stringency of the regulations adopted. As a result they are usually insufficiently aware of the opportunities that may exist to:

- share regulatory development activities, information and costs
- emulate aspects of good regulations in place in other economies
- speed up the domestic regulatory processes by leveraging efforts made elsewhere
- compare the coverage, scope and stringency of the domestic regulations against those of peer economies

4. 5.2 Disconnections in the regulatory processes

The regulatory processes in each economy are based on domestic concerns and are managed through purely domestic processes. The only exception to this is the joint US-EU cooperation for Energy Star applied to IT and Office Equipment, which is managed through a joint regulatory structure staffed by representatives from both economies. In general the domestic regulatory processes are complex and demanding and thus most regulators are fully occupied in attempting to fulfil the requirements of these processes. The domestic regulatory schedules are set independently of those in other economies and are currently not informed by those in other economies as a result they have been completely disconnected from each other. Within the last year regulators at the European Commission and in the US Department of Energy have begun to exchange information on their regulatory programmes with a mind to consider potential cooperative opportunities and to be better informed of the nature of the regulations in place in each economy. This activity occurs at a relatively modest level and somewhat informally but does involve quite regular communication between the regulators in both economies. Despite this the cooperation is not yet so detailed as to compare the details of individual regulations and test procedures. The regulatory authorities in the other major economies do occasionally attend international fora (such as conferences and workshops) that discuss aspects of existing standards and labelling schemes but rarely engage in structured cooperation to exchange information on their programmes. That said, many have taken steps to document and publish details of their programmes in the public domain to facilitate transparency for those that are interested in understanding more about their programmes.

4.5.3 Disconnections in the standardisation processes

In some respects the test procedure standardisation processes are more interconnected among the major economies than the regulatory processes but in others they are less so. Where they are more interconnected is that all the national or regional standards bodies that issue test procedures which are used in the domestic regulatory programmes are also members of the international standardisation bodies such as ISO and IEC. These bodies send representatives to participate in international test standards development processes of interest to them and vote on the adoption of new or revised international test procedures. Even countries which make comparatively less use of international test procedures in their domestic regulations, such as the USA, will often participate in the development of new international standards through their nominated national representatives in specific technical committees. Where the disconnection is in some senses greater than for the regulatory processes is that the energy performance test procedures developed and adopted at the international level are frequently not used to measure energy performance in domestic energy efficiency regulations and rather test procedures issued and mandated by the domestic regulatory agency are used instead. As these test procedures need to be developed and adopted in a manner that works with the demands of the regulatory schedule it is difficult to synchronise international standardisation efforts with domestic regulatory needs.

4.5.4 Deficiencies in the local applicability of international test procedures

Another barrier that some regulatory authorities have reported is that the international test procedures are not always sufficiently representative of prevailing local conditions and usages patterns for them to be applicable in national regulations. The solution to this is for national authorities experiencing these problems to request and support the revision of the international test procedures to address the perceived deficiency but as this takes time and is an uncertain process as other standardisation bodies have to support proposed changes it is a barrier to more widespread adoption of international test procedures.

4.5.5 In-built inertia

All of the existing standards and labelling programmes are built upon a domestic history of product development, test procedure development, regulatory structures etc. that are only partially linked to the international processes. For the older programmes, such as that in place in the USA, the domestic test procedures were established without much regard for international test procedures and the same was true for product classifications and energy efficiency metrics. Once domestic procedures have been established they become entrenched and products tend to be designed to reflect their characteristics, thus everyone from the manufacturers, the standardisation bodies and the regulators has invested in the development and maintenance of a given structure with distinctive characteristics. The process of modification to better align such structures with their international equivalents thus necessarily requires local inertia to be overcome which requires that the benefits from harmonisation are perceived to be greater than the costs associated with modifying an established system.

4.5.6 Limited resources and time

Constraints in time and resources are undoubtedly one of the main barriers to greater harmonisation. Participation in international test procedure development processes is constrained by limited resources and in consequence many national standardisation bodies only review and vote on proposed standards rather than being actively involved in their development. Regulators in all the major economies are struggling to satisfy their existing regulatory development requirements and most are severely constrained by limited staff and resources. The perceived tax on time and resources of stronger engagement with international peers is thus likely to be one of the principal barriers to the broadening of harmonisation efforts.

4.6 Evidence of the benefits of harmonisation

Given the barriers to harmonisation already identified it's important to clearly express the benefits of harmonisation and to present evidence of how harmonisation has already assisted regulators in achieving improved outcomes.

4.6.1 General experiences of harmonisation

China has adopted energy efficiency regulations for numerous products and many of these have been assisted by previous international regulatory efforts. Through emulation of many aspects of existing regulatory requirements in the EU and the USA China was able to develop energy efficiency specifications for several end-uses faster and with less development effort than would have otherwise been the case. Furthermore, this partial emulation of international regulations has enabled the Chinese regulators to benchmark the performance of products on the domestic market and those produced for export to international markets with the regulatory specifications in place overseas and to use this to inform domestic regulatory settings in a manner that is consistent with the attainment of energy savings targets and industrial development policy. This approach was used to inform Chinese energy labelling and MEPRs regulations to the extent that test procedures, product categorisation and efficiency metrics were largely harmonised with existing international regulations for:

- refrigerators and freezers
- industrial electric motors
- clothes washers
- room air conditioners
- fluorescent lamp ballasts
- electric storage water heaters
- VCRs and DVDs
- Unitary air conditioners
- Multi-connected air conditioners
- Water heaters and combi-boilers
- Metal halide lamps
- High pressure sodium lamps
- Chillers

A larger range of Chinese regulations have made use of international test procedures including:

- CFLs
- TVs
- Transformers
- Set to boxes
- Range hoods and extractor fans
- Printers
- Fluorescent lamps
- Fax machines
- Centrifugal pumps
- Fans
- High pressure sodium lamp ballasts
- Metal halide lamp ballasts

In the case of the EU all the existing regulations use test procedures that are aligned with international energy performance test procedures and being able to adopt these test procedures within EU regulations has saved the European Commission and EU regulatory process a tremendous amount of time and expense compared to what would have been required to develop EU specific test procedures. In the few cases where deviations exist they are very minor.

Not many EU regulatory settings have been based upon those developed elsewhere; however, the exceptions to this are the EU's MEPs for electric motors and for external power supplies both of which were inspired by regulations developed in the USA. Both cases are summarised below.

Away from the motors domain other economies including the US and India have also benefitted from some aspects of harmonisation. The US MEPS for clothes washers were informed by consideration of horizontal axis clothes washer technology that was first pioneered in Europe and helps lower energy consumption by reducing the amount of hot water needed to clean clothes compared to vertical axis machines. When the advantages of this technology were analysed and it was further appreciated by US regulators that it's possible to have top loading horizontal axis machines the regulatory analysis and discussions became more ambitious and the resulting energy savings were increased. This was not an example of harmonisation in test procedures and efficiency metrics, however, but rather of the benefits that can be derived from information exchange between regulators and their consultants in different jurisdictions. Work is still on-going in the IEC Technical Committees to explore the options to increase the general applicability of the international text procedure to better meet the needs of the different clothes washing traditions around the world. India has adopted refrigerator energy labelling requirements that made use of the test procedures and product classifications developed in Australia, while most of their other labelling schemes use national test procedures that are mostly or largely harmonised with international test procedures. In both cases the availability of viable international test procedures, product classification and efficiency metric schemes has enabled the domestic programme to develop more rapidly and with less expense than would otherwise have been the case.

4.6.2 Harmonisation of electric motor testing and efficiency requirements

In the case of motors there was a coordinated international effort to harmonise test procedures and to establish common international efficiency thresholds led through the SEEEM program[2] and these were adopted in the latest IEC test procedures (IEC 60034-30 and IEC 60034-31). The

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[2] SEEEM (Standards for Energy Efficiency in electric Motors) was a informal initiative launched at the 2006 Conference on Energy Efficiency in Domestic Appliances and Lighting conference in London and brought together support from energy efficiency NGOs, national energy efficiency regulators, industry associations and representatives and experts to work cooperatively to develop harmonised global efficiency specifications to support a general market transformation. It was funded in an ad hoc manner by members of the above groups and has since been integrated into the IEA 4E implementing agreement. See www.seeem.org and www.motorsystems.org.

EU MEPS specify minimum levels that match the highest IEC energy efficiency class unless a variable speed drive is used in which case the second highest threshold can be used. The highest IEC threshold corresponds to the US NEMA Premium threshold, which is the MEPS level in place in the USA for many classes of motor. The benefits of this harmonisation effort are manifold. Motors are internationally traded products and now any manufacturer knows that they simply have to produce a motor to attain one of four efficiency classes, measured in a consistent way around the world, and it will be accepted for sale in any economy that permits that efficiency class to be sold. Prior to the broad agreement to adopt the revised international standard motors would have to be tested to more than one test procedure if they wanted to be sold in multiple economies thus testing and commercial transaction costs have been lowered. The regulators have benefitted because:

- they have effectively shared test procedure development costs and thus reduced the amount of time and expense required to develop such procedures through their own domestic processes. In the process they have also shared technical experience, which has resulted in an improved international test procedure that is sufficiently technically robust and practicable to be applied in all regulatory programmes.
- they can now directly compare the efficiency of products on their market with those in peer economies and respond appropriately in their steering of domestic markets
- they have been able to transpose analyses done in other economies to determine and justify the adoption of regulations subsequently set at specific efficiency levels and to apply or adapt them for their domestic regulatory process, thus saving costs, time and improving the robustness of their domestic process
- they have been able to borrow other economies performance thresholds and apply them as a starting point in their domestic regulatory negotiation. In particular, they have benefitted from the fact that other economies have already attained directly comparable efficiency levels to raise the bar in their domestic regulatory discussions of what are the techno-economic potentials of attaining higher efficiency levels are
- by adopting a common set of upper thresholds they have increased the market size open to the manufacturers of high efficiency motors and thus effectively created a larger market for higher efficiency products. By driving up volumes this lowers the cost per unit (through the industrial learning curve and economy of scale process) of higher efficiency products. Furthermore, as all producers know that the major economies are effectively applying linked efficiency thresholds in their regulations they know that the longer-term reward for pioneering even more advanced designs will be more certain because once a new higher efficiency technology is demonstrated and has inspired a single major economy to increase the thresholds applied in MEPRs and /or labelling and incentive schemes the diffusion of regulatory ambition via emulation is likely to occur

much more rapidly. The IEC standard specifically includes an aspirational higher efficiency level for that purpose.

Thus the experience of harmonisation of test procedures and associated regulatory thresholds for electric motors is an excellent example of the benefits of greater harmonisation. The outcome has been to accelerate regulatory processes, to reduce the costs entailed, to enhance the quality and ambition of the regulations, to increase energy savings, to lower industrial costs, to enhance transparency and to accelerate market learning and technology transfer toward higher efficiency products.

It is worth pointing out that in the case of motors the cooperative processes engaged in were non-binding and were not formally institutionalised. Instead an informal initiative was launched with the backing of a few governments to enhance the dialogue between regulators, experts, standardisation bodies, industry and other stakeholders to try and advance international cooperation in energy efficiency for industrial electric motors. The subsequent discussions and dialogues indentified the need to improve regional and international test procedures and to aim to harmonise them in line with an improved and revised international test procedure. A consensus obtained among key stakeholders led to broad agreement and a successful revision of the international test procedure plus the development of a set of recommended efficiency thresholds and a voluntary energy efficiency classification scheme within the IEC standard that was linked to existing regulatory settings in the major economies. The common experience allowed the EU regulatory authorities to adapt the US NEMA premium standard, which had been recently adopted in US MEPS, and apply it to the EU Ecodesign rulemaking process.

4.6.3 External power supplies

In the case of external power supplies the US EPA worked to define energy efficiency classes which following broad international consultation led to a common system of informative energy efficiency thresholds being developed and universally adopted by industry around the world. As a result all EPS carry a rating indicating if they are class I, II, III, IV, V or VI (higher is better). This international efficiency marking protocol provides a system for power supply manufacturers to designate the minimum efficiency performance of an external power supply, so that finished product manufacturers and government representatives can easily determine a unit's efficiency. This mark is not intended to serve as a consumer information label, but rather classifies the performance of an external power supply when tested to the internationally supported test method (this test method titled "Test Method for Calculating the Energy

Efficiency of Single-Voltage External AC-DC and AC-AC Power Supplies (August 11, 2004)" can be found at www.energystar.gov/powersupplies). California adopted MEPS based on these in 2004 (effective July 2006) and these same requirements were subsequently adopted as US national requirements through the Energy Policy Act of 2005, becoming effective on July 1, 2008 (set at the class IV level). A subsequent dialogue with the EU regulatory process resulted in the EU adopting requirements set at the class V level in 2009, which became effective in April 2010. The DOE is currently reviewing its EPS requirements and may adopt higher levels as a result. China is also developing MEPRs requirements for EPS that are likely to follow the international system and are expected to be announced in 2010 or 2011.

While there was no formal harmonisation process this is an excellent example of how informal harmonisation efforts can lead to a global market transformation and can greatly facilitate the work of regulators while simplifying product development platforms for industry. In parallel with the efforts to develop an EPS regulation for California, outreach to electronic product and power supply manufacturers and governments in Europe, China, and Australia from 2003 to 2005, resulted in all parties employing the same test procedure and marking protocols. EPS are truly globally traded products and the equipment types and usage conditions and patterns are the same everywhere, thus there is no logic in developing regionally fragmented testing requirements and divergent efficiency metrics. Key industrial and regulatory stakeholders appreciated this and thanks to cooperative efforts steered by Energy Star it became possible for a common agreement to be reached on a suite of efficiency metrics. This in turn facilitated the rapid adoption of MEPRs to preclude the less efficient classes.

4.6.4 De-harmonisation: refrigerators in Japan

While pointing out the benefits of harmonisation it is also important to be clear about some potential failings. Japan has a policy of harmonising national test procedures with international ones wherever it is deemed viable and in the early days of the Top Runner programme this led to the abandonment of national refrigerator test procedure in favour of the international test procedure. The national test procedure had many similar elements to the international one but also had some key differences. The international test procedure for non tropical climates specifies a single ambient test temperature of 25°C and does not include door openings. The older Japanese test procedure required testing at two ambient temperatures and applied a seasonally adjusted weighting to derive an annual average energy consumption figure. It also included door opening requirements with a relatively elevated and well controlled humidity level. Japan has a humid sub-tropical climate in many parts of the country and in addition central heating is rare so kitchens are often not heated in the winter months. The high humidity means that frost formation is rapid and thus no-frost appliances that include defrosting heaters dominate in the market. In these conditions door opening can have a significant impact on energy use because each time the door is opened moisture laden air is brought into the refrigerator and condenses and freezes on the evaporator. The heating device is then activated to defrost this. Furthermore the relatively large annual temperature swing within the kitchen increases the likelihood that the use of a single ambient temperature may result in an under or overestimate of real energy use.

Some years after adopting the international test procedure field energy measurements were conducted that found that the actual in situ consumption of refrigerators was much higher than recorded under the international test procedure. Furthermore and that the test procedure did not always reward the most efficient options under Japanese usage conditions in proportion to the real savings they produced compared to other designs. Therefore a decision was made to adopt a test procedure closer to the original test procedure and to once again diverge from the international test procedure. As a result the test results are now more representative of actual usage conditions in Japan but it is much more complicated to compare efficiency levels of Japanese products with those sold elsewhere. The Japanese authorities have not given up on international harmonisation, however, and now there are on-going efforts inspired by this and similar experiences in other economies to improve the general applicability of the international test procedure (which already works quite well for many usage conditions and refrigerator types). If it does become possible to produce a more universally applicable international refrigerator test procedure it would open the door to those economies which do not currently use it (including: Australia, Canada, Japan, Korea, New Zealand, and the USA) to bring their test procedures into line with the international one and to reap the benefits of greater performance comparability.

4.6.5 Lessons for future efforts

The conclusion of this experience is that greater international harmonisation can indeed facilitate accelerated and reduced cost development of equipment energy efficiency regulations in the major economies. Every economy stands to gain if it is done in an appropriate and timely manner. The harmonisation efforts which work best begin at the bottom of the regulatory pyramid with the establishment of viable and common test procedures. In the case of EPS this involved developing a globally applicable test procedure when there was no previously existing one and in the case of electric motors it involved collaborative efforts to improve the existent international test procedure to reflect best practice so it would become acceptable to all major stakeholders. Once such test procedures are agreed it then becomes possible to define a set of common efficiency thresholds that are sufficiently broad to encompass all current technologies and market circumstances but which also include aspirational efficiency thresholds as pointers for future market development. Following the establishment of such systems it is relatively straightforward for local regulatory processes to gather information on the domestic and international markets and to set MEPRs and/or labelling requirements in line with the common international framework, but which also reflect local concerns and realities. The key to this is that regulators and their representatives need to share an international vision and to become engaged in the standardisation process at the test procedure development level. Once this platform is agreed by the main stakeholders in the key economies the rest follows relatively naturally. The Japanese experience with refrigerators illustrates that care must be taken to avoid cutting corners in the development of adequate international test procedures and that demonstration of their viability should be a prerequisite of their adoption. This suggests that a viable strategy to facilitate long term harmonisation would be a more sustained and consistent effort to work on the development and maintenance of international test procedures and associated informative efficiency classifications to facilitate commonality in future regulatory developments.

4.7 What processes are needed to increase equipment energy efficiency harmonisation?

At the current time international harmonisation in equipment energy efficiency standardisation occurs through a number of more or less loosely connected processes. The following text discusses how this occurs for the specific cases of:

- energy performance measurement standards
- energy performance metrics
- energy performance product classifications
- energy labelling requirements
- minimum energy efficiency performance regulations
- energy performance conformity assessment

4.7.1 Energy performance measurement standards

In the case of energy performance measurement standards some countries adopt international standards as their de-facto measurement standard unless there is no international standard or the international standard is not deemed to be fit for purpose. The EU and Japan have institutionalised this to some extent. In the case of the EU all EU countries are required to use a Community wide accepted measurement standard for products which are regulated at the EU level (as is the case for energy labelling, Energy Star labelling and Ecodesign regulations). EU measurement standards are issued by CEN or CENELEC under the terms of the single market. These bodies undergo a standards development and issuance process that is very similar to those practiced by ISO and IEC, except the voting rights are held by the national standardisation bodies of each EU member state. CEN and CENELEC have an agreement with ISO and IEC such that each organisation fast-tracks the adoption of the other body's standard if they have not such standard themselves. Thus if IEC were to develop a new standard and there was no existing equivalent at CENELEC level, CENELEC would immediately put the IEC standard out to the vote for adoption as an official CENELEC standard. The same process happens in the reverse direction.

In Japan the process is similar but not so formalised. A priori the Japanese standardisation authorities consider the adoption of the international standards into Japanese technical standards and regulations and will only develop alternative standards if the international standards are not deemed to be adequate. Quite similar processes occur in China and India where there is a high degree of adoption of international standards; however, there is a tendency in both economies to continue using an older version of the international standard when new ones arise and thus overtime the national standards (based on the international measurement standards) can begin to diverge if they are not maintained at the same frequency. This phenomenon is true of all the economies considered here, as whatever the original origin of the technical measurement standard, once it has been incorporated into an energy efficiency regulation the same version of the standard will continue to be used even if the standard has since been revised unless there has also been a revision in the regulatory process. In some cases India and China will adopt national standards from other economies which are not international standards. This typically occurs when either the international standard is not deemed to be locally suitable or when there is no international standard to adopt. In many cases for all these economies, the international standard will be adopted but with modifications to better reflect local circumstances. Thus, national test procedures can be wholly or partly aligned with international test procedures.

In the case of the USA the process is a little different. US national standards bodies are often active in international standardisation committees and the US is an active member of ISO and IEC; however, the starting point for most national test procedures are standards produced at the national level oftentimes through the initial auspices of an industry association. These standards may or may not be informed or related to parallel international test procedures and often share many methodological aspects etc. In some cases such standards are submitted to ISO and IEC for potential adoption as international standards if there are not existing international standards in place and this can occur with minor or major modification. In recent months the DOE has begun to request that all new regulatory measurement standards considered for adoption in the US rulemakings should first consider the existing international standards, so there are prospects for greater harmonisation in the future.

Adoption of an energy performance measurement standard, whether its origin is local or international, by a national or local economy standards body does not guarantee that it will become the measurement standard used in national regulations. Regulatory bodies such as the DOE, METI, CNIS, BEE and the European Commission may modify the standards adopted or reject them outright or demand that the standardisation bodies revise the standards before they are adopted.

4.7.2 Energy performance metrics and product classifications standards

Adoption of efficiency metrics and product classifications is always determined by the energy efficiency regulatory agencies but is often informed by metrics and product classifications proposed in energy performance measurement standards. Thus if the measurement standards are internationally harmonised there is much greater probability that the efficiency metrics and product categories used in the regulations will be too. The product classifications used will often also be informed by local market considerations and the locally preferred product mix and usage profiles. There is also considerable amount of informal harmonisation wherein regulators or those that are informing the regulatory process will hear about what is done in another economy and may decide to adopt the same practice within the national/local regulations. This process used to be very non-systematic in all economies and some would pay almost no attention to activities in other parts of the world. In the last few years though the European Commission has begun to request that all Ecodesign studies review other international requirements and standards as an early activity and the US DOE has started to initiate the same process in the USA. The Chinese and Indian regulatory processes have always tended to investigate international practices as a part of their national regulatory deliberative process but not all the pertinent information is always delivered at the appropriate time. In recognition of the limitations that can exist even in asking national consultants to review the international scene the European Commission and the DOE have begun a regular review and meeting process to discuss each others' programmes and to consider what can be learnt from them.

None of the other economies are doing this on a systematic basis but all of them have informal information exchange processes that at least allow some of the relevant information on international practice to be on the table during the domestic regulatory deliberation process.

4.7.3 Energy regulations

The situation with regulations is very similar to that for the efficiency metrics and product classifications. Sometimes systematic or sometimes occasional information exchange occurs between the various local regulatory processes that results in a partial harmonisation of requirements. China for example partially harmonised some of their efficiency thresholds to those applied in the EU (e.g. for refrigerators where the Chinese Class 1 thresholds, metrics and product classifications are essentially the same as the EU Class A level, or for electric motors where the Chinese Class 1 level corresponds to the old EU Eff 1 voluntary efficiency classification, which has now been superseded by the recent Ecodesign adoption of the new IEC efficiency classification which is in itself largely based on the IEEE test procedure that has been used in the US for some years). Sometimes regulations are perfectly harmonised because they were informed by the same experts and direct dialogue occurred between the regulators; this is exactly what happened with the Californian and EU external power supply (EPS) regulations, which were subsequently also adopted by the DOE as US Federal requirements. Whenever, there are products which have not previously been regulated in any jurisdiction it becomes much easier to harmonise subsequent national regulations.

4.7.4 A process to increase future harmonisation

Whenever, there are products which have not previously been regulated in any jurisdiction it becomes much easier to harmonise subsequent national regulations. Currently this happens through a range of formal or informal exchanges; however, it is clear from past experience that whenever dialogue is present in a timely manner that greater information exchange and harmonisation occurs thus the key to enhancing harmonisation is to extend and support the dialogue among all the major regulatory and standardisation bodies. The institutions cited above all have a key role to play enhancing this process and much could be done to strengthen the existing level of dialogue and in increasing its pertinence and timeliness.

5. DETERMINATION AND RANKING OF VIABILITY OF ALIGNMENT OR HARMONISATION BY PRODUCT TYPE

This section presents an analysis of equipment efficiency regulations in place in each of the five economies. For each energy end-use it discusses issues such as:

- The differences in scope and stringency of current energy efficiency requirements
- The likely savings were the most stringent requirements and/or those with the broadest scope to be adopted
- Technical factors that complicate or prevent the comparison of efficiency levels
- On-going regulatory developments and opportunities for greater harmonisation
- The prospects for greater international alignment and factors that may influence this

From this evaluation and that presented in Part 2 on the prospects for greater harmonisation in test procedures a ranking of products in terms of their prospects and potential for harmonisation are given.

5.1 White goods and domestic cooking appliances

In general white good are some of the earliest products to be regulated for energy efficiency in the major markets and hence are those with the most established, and often the most local, approach to doing things. This means that as a general class they are comparatively difficult to align because regional differences in test procedures and to some extent product types have become enshrined.

5.1.1 Household refrigeration appliances

Domestic refrigerators and freezers are the first appliance to have been regulated in most economies and they are currently subject to minimum energy performance regulations in all the economies expect India. The MEPR in place can be directly compared in China and the EU because they use the same test procedure and the same energy efficiency metrics. In the other economies the test procedures and metrics differ to such an extent that it is extremely difficult to make accurate direct comparisons. Some simplistic comparisons can be made using crude adjustment factors but the results should be considered as purely indicative.

The EU MEPS from 1998 (set at an Energy Efficiency Index (EEI) of ~90%) were roughly 10% more stringent than the Chinese MEPS from 2005 (set at an EEI of 100%) but are about 39% (in very rough terms) less stringent than the US MEPS of 2004. This comparison gives a misleading comparison of the relative energy efficiency of the markets, however, as the labelling schemes in the EU and China have had a large impact on the refrigeration markets and brought market average efficiency up to levels substantially above the MEPS requirements. In the EU the average market efficiency level in 2007 was slightly better than the class A minimum threshold (EEI < 55%), which is roughly in line with the US MEPS level[ii]. The Chinese market in 2008 was at an average EEI of 60.3%[iii] i.e. about 11% less efficient than the EU market of 2007 (which has an EEI of 54.5%[iv]). The sales-weighted efficiency of the EU cold appliance market in 2007 was about 27% more efficient than the EU 1998 MEPS level, while in China the market in 2008 was about 40% more efficient than the Chinese 2005 MEPS requirement. Data showing the efficiency distribution of the US refrigerator market was not available for inclusion in this report but in the past the products on the US market have predominantly been near to the MEPS efficiency level with a certain share of the market at the Energy Star level (largely due to the influence of US utility programmes, which require Energy Star performance for eligible products). Thus it is likely that the US market average efficiency level is about 5% better than the US MEPS requirement.

Revisions to MEPS are planned in all three of these economies and new MEPS requirements are already published in the EU. From July 2010 the EU MEPS level becomes the current class A threshold (EEI<55%), from July 2012 they will require an EEI<44% and from July 2014 the requirement will match the current class A+ threshold (EEI<42%). Thus the EU 2014 MEPS are 58% more stringent than the Chinese 2005 MEPS and the Chinese market average efficiency would need to improve by about 39.5% compared with 2008 levels to satisfy them. The US MEPs of 2005 are very roughly 24% less demanding than the EU ones of 2014 but as mentioned previously these values have to be treated with considerable caution. The US has a rulemaking process underway and a final rulemaking is planned by the end of 2010. China is also reviewing their MEPS levels.

Unfortunately, there are no analytical tools or studies available that allow the Japanese MEPRs to be compared with those in place in other economies. The Top Runner requirements in Japan are harder to compare to the others because there are more significant differences in the test procedure, including door openings and two different ambient test temperatures.

Generally then, the prospects of harmonising refrigerator requirements are not good in the near term except amongst those economies already using the ISO test procedure; however, with a new ISO test procedure under development that holds the prospect of being more generally applicable there may be better prospects for universally comparable energy efficiency requirements in the future should economies choose to adopt it.

5.1.2 Household clothes washing machines

Clothes washer MEPRs are in place in China and the US and are under development in the EU. All three economies also apply mandatory energy labelling to clothes washers. Comparison of clothes washer energy performance requirements is far from straightforward due to significant differences in the test procedures, prevalent technology and clothes washing practice between the economies. As by far the main source of energy consumption in clothes washers is from water heating those economies that do ambient water temperature washing (e.g. Japan, some parts of China) tend to use very little energy for clothes washing in the machine although they may need to make use of stronger detergents with significant embodied energy. EU clothes washers are all horizontal axis machines that economise on water consumption and provide good cleaning performance (which is graded from A to G on the EU clothes washer energy label). Since the introduction of clothes washer energy labelling in 1996 the EU market has transformed such that 96.7% of the market was at class A or better in 2007[v]. Although no level above class A has been formally adopted industry refers to an A+ level which is 10.5% more demanding (a specific energy consumption of 0.17kWh/kg-cycle for a 60oC wash cycle, compared with 0.19kWh/kg-cycle for a class A product). So-called A+ products accounted for 39% of sales in 2007. MEPs for clothes washers are currently under consideration through the Ecodesign directive process in the EU and if implemented would supersede earlier industrial voluntary agreements.

In China clothes washers are similar to the impeller type top-loader machines commonly found in the US, or to the EU style horizontal axis machines. The existing MEPS thus apply different testing and minimum performance requirements based on the style of machine being considered, such that the energy performance requirements are directly comparable to those in the EU for the horizontal-axis machines. Unfortunately they are not comparable to those in the US for the impeller machines as the requirements are specified in kWh/kg/cycle whereas those in the US are specified in terms of energy use per unit machine storage volume per cycle. For the horizontal axis (drum type) machines the MEPs requirement is 0.35 kWh/kg/cycle which is

50% less efficient than the EU market average of 2007 and 46% less efficient than the EU class A or Chinese class 1 label requirement. The Chinese market weighted efficiency in 2008 appeared to be about 0.26kWh/kg/cycle i.e. about 36% less efficient than the EU market of 2007.

Japan does not have Top Runner requirements for clothes washers but as cold water washing is standard in Japan there are likely to only be negligible energy savings from introducing requirements. Cold washes are also thought to predominate in India in which case the savings from introducing MEPS are likely to be minimal.

5.1.3 Household clothes dryers

Among the five target economies clothes dryers are only commonly used in the USA and Europe. Both economies have mandatory energy labelling but only the US has MEPS (for both electric and gas-fired clothes dryers). Gas-fired dryers are very rare in Europe so in practice the only meaningful comparisons are between the electric clothes dryers. Another difference is that condenser dryers are common in Europe and vented dryers predominate in North America. A mixture of control types are used in both regions. There is no significant technical difference in the performance or testing requirements for these main dryer types or control types but some differences complicate direct performance comparisons. Nonetheless, the US MEPS requirements equate to an energy performance threshold of 0.73 kWh/kg, which is equivalent to an EU class-D labelled appliance. In practice all EU clothes dryers are rated class C or better, although the vast majority are class C, thus there would be no benefit from introducing the US MEPS in Europe. Class A clothes dryers, which use half the energy of a class C product, have been on the EU market for a decade but have previously always required the use of relatively expensive heat pumps and have only made limited headway. However, in recent times some cheaper class A products have entered the market and there may be a case for considering the introduction of MEPS that force the market to adopt more efficient technologies. In the US there are no EnergyStar labels for clothes dryers and hence there is no endorsement label to encourage the adoption of very efficient heat pump dryer technology. Were such a label to exist it is possible that utilities would wish to subsidise the first cost of heat pump clothes dryers.

5.1.4 Household dishwashers

Among the five target economies clothes dryers are only commonly used in the USA and Europe. Both economies have mandatory energy labelling but only the US has MEPS, although the EU has operated a voluntary industrial agreement for dishwashers for a number of years.

Revised dishwasher MEPS came into effect at the beginning of 2010 in the US such that all dishwashers manufactured on or after January 1, 2010 are required to meet the following standard:

(i) Standard size dishwashers shall not exceed 355 kWh/year and 6.5 gallons per cycle.

(ii) Compact size dishwashers shall not exceed 260 kWh/year and 4.5 gallons per cycle.

Considering that the EU stock average consumption for dishwashers was about 270kWh/year in 2005 and that 9-12 place setting machines dominate as in the US there is not likely to be any energy savings benefit from the EU adopting the current US MEPS levels. In 2007 93% of EU dishwasher sales were already energy label class A. The EU is currently considering whether to adopt MEPS for dishwashers and a report analysing the issues and opportunities has been prepared for DG-TREN under the Ecodesign framework.

5.1.5 Household cooking appliances

There are a myriad of household cooking appliances and the ones that predominate in a given economy vary significantly. In the EU and the USA most homes have ovens (electric or gas), cook-tops (ranges/hobs) (electric or gas) and microwave ovens (simple or combination types). Many also have cooker units with integrated gas or electric grills. In China gas cook tops (ranges) are common as are microwave ovens. Some homes have electric or gas cookers or ovens with an integrated cook-top. In Japan LPG gas cookers are common in households and microwaves while in India LPG stoves are most commonly used. There is also a plethora of smaller cooking appliances including: coffee makers, kettles, food mixers and processors, plus many less significant electric cooking appliances.

As a result the MEPRs that countries apply (if at all) is strongly influenced by the prevalent cooking practices and the prospects of significant energy savings. The US DOE issued the following MEPS for gas cooking appliances on April 2008:

- Requirement that gas cooking products with an electrical cord have no pilot light.
- Requirement that products without an electrical cord have no pilot light, effective April 2012.

and in the same process determined that standards for electric kitchen ranges and ovens were not needed.

Europe has no cooker/oven MEPS in place but as pilot lights have not been used in European ovens or cookers for many years there would be no tangible savings from adopting the US MEPS. The EU currently has two EUP studies underway on:

- Domestic and commercial ovens (electric, gas, and microwave)
- Domestic and commercial hobs and grills

both of which could lead to the future adoption of Ecodesign requirements for the products considered. Energy labelling for electric ovens has been in place in the EU since 2002 such that by 2007 class A appliances accounted for 58% and class B 30%.

The US currently has rulemaking processes underway for Microwave ovens with

- Microwave Oven MEPS March 2011
- Microwave Oven TP Standby and Off Mode, March 2011
- Kitchen ranges and ovens TP Standby and Off-Mode due March 2011
- Kitchen ranges and ovens MEPS due March 2017.

Note: it is not clear whether these will address the in-use mode as well as the standby mode. Standby for these products is covered under an all embracing regulation in the EU (see standby below).

China applies MEPS to:

- cooktops and ranges/ovens,
- household induction cookers and
- electric rice cookers;

and is in the process of developing MEPS for microwave ovens. The cooktops and ranges/ovens applies to:

- gas cooking appliances
- gas stoves
- built-in gas stoves
- gas electric combined stoves
- gas ovens

Details of these standards were not available or the test methods and metrics too diverse for them to be compared with the other countries specifications.

Japan has Top Runner requirements for:

- Electric rice cookers
- Microwave ovens and
- Gas cooking appliances

The gas cooking appliances include burners, gas burners with a grill and gas ranges but exclude: gas rice cookers, pure gas grills and portable gas stoves.

The requirements for rice cookers were expected to improve unit average efficiency by 11.3% from the time of introduction (2003) to the target year (2008). The microwave requirements were expected to improve their efficiency by 8.3% and the gas cooking appliances as follows:

- Burners: approximately 13.9% efficiency improvement was expected between 2002 and 2006
- Grills: approximately 27.4% efficiency improvement was expected between 2002 and 2008
- Oven section: approximately 20.3% efficiency improvement was expected between 2002 and 2008

India has energy labelling for LPG stoves for which the highest rated appliances must attain a thermal efficiency of over 74% and the lowest an efficiency of over 68%.

In general comparisons between cooking appliance regulatory requirements are difficult to make because of significant differences in the test procedures, efficiency metrics and technologies used; however energy savings of from 5-15% are likely from the adoption of the most advanced MEPS.

With so much current diversity the prospects of international harmonisation of requirements for most cooking appliances appear poor even though there is much technological overlap among several classes of cooking appliance. In principle gas ranges (cook-tops), gas ovens, electric ranges (cook-tops), electric ovens and microwave ovens around the world could all use the same test procedures and efficiency metrics as the local environmental conditions and usage profiles should not have a major impact on the method of test or the rated performance. As the most internationally traded and homogenous appliance among these microwave ovens would appear to present the best case for harmonised requirements.

5.2 Domestic HVAC and hot water

5.2.1 Space heating devices

There are a wide variety of space heating devices, both portable and fixed, which operate on different fuel types. The variety reflects the traditions of regional space heating practices and fuels and their associated usage patterns. Economies with significant heating loads such as Europe, the US, China and part of Japan have implemented MEPS or mandatory efficiency requirements for major space heating applications. Specifically, in Europe, oil, gas and combi-boilers are regulated; in the US, oil and gas furnaces and boilers; and in China, gas boilers and combi-boilers. Due to their temperate climate, India has not established any regulations, labels or test methods for space heating products.

In the US and Europe, whole-house heating systems are common, but the design of these systems varies substantially as the US commonly uses forced-air systems (that heat in the winter and provide air conditioning in the summer) and Europe uses more boiler/water-based systems. Thus the space heating systems are different, as are the efficiency metrics and test procedures. In China, if a whole-house heating system is used, it tends to be the boiler/water-based system, as is often found in Europe.

The efficiency rating for European Boilers is outlined in the Boiler Efficiency Directive 92/42/EC which distinguishes between three classes of boilers; condensing, low temperature and standard. These are defined by the boiler efficiency directive as:

- 'Standard boiler': a boiler for which the average water temperature can be restricted by design;

- 'Low temperature boiler': a boiler which can work continuously with a water supply temperature of 35-400°C, possibly producing condensation in certain circumstances, including condensing boilers using liquid fuel;
- 'Gas condensing boiler': a boiler designed to condense permanently a large part of the water vapour contained in the combustion gasses.

These three classes had a minimum efficiency specified boiler water temperature, within each class a star award system was given for every 3 percentage points that the efficiency was above the minimum – this no longer formally exists. The European standards for boilers are given in Net Calorific Values (NCV) and not reported in Gross Calorific Value (GCV) as in other directives (e.g. buildings)/parts of the world. These are defined as:

- NCV of gas: is the energy created by burning $1m^3$ of gas, which is approximately 10kWh. The boiler efficiencies founded on the NCV calculation do not factor the latent heat as does the GCV method and thus efficiencies greater than 100% may be achieved;
- GCV of gas: is the energy created by burning $1m^3$ of gas plus the latent heat of the water vapour produced by the combustion process. It has been estimated that this value is approximately 10% of the NCV of natural gas. This GCV method yields a theoretical boiler efficiency value of 100%.

Currently, the European Commission is working toward establishing new energy performance standards for space heating products through the Energy Using Products Directive. Lot 1 is focused on boilers and combi-boilers (gas/oil/electric) and Lot 2 is focusing on water heaters. Through this process, the Commission will establish minimum performance and labelling requirements for boilers and water heaters. The requirements for boilers include central heating boilers for gas, oil and electricity with a power of 3.6 to 350 kW. The primary function of a central heating boiler can be defined as to reach and maintain a desired level of comfort indoors while a central-heating combi has a dual function of both the central heating boiler and serving as a water heater. Some of the requirements for central heating boilers that are being considered include:

- Minimum performance of overall specific efficiency for boilers with an output power of less than 70 kW shall be 56 % from 2011 and 76% from 2013.
- For Boilers with an output power of more than 70 kW the requirement is 56% from 2011 and 96% from 2013.

- Maximum NO_x-emissions shall not exceed 20 parts per million from 2013.

This proposal was discussed at a consultation forum in June 2009 and is scheduled to be voted on by the regulatory committee in January 2011.

In Japan, regulations are established for space heaters using gas or oil for fuel, except for ones that are unvented, ones that use gases other than either those of City Gas 13A group or liquefied petroleum gas for fuel, vented gas space heaters, vented oil space heaters with maximum fuel consumption of over 4.0L/h, and direct vent type oil space heaters with maximum fuel consumption of over 2.75L/h. The Japanese regulatory metric is heat efficiency (%) measured according to the Japanese test procedures, JIS S2122 or JIS S3031. The requirement is that by the target fiscal year (FY2006) and each subsequent fiscal year, energy consumption efficiency in each category shall be at or greater than the target standard value. Efficiency targets are set for gas space heaters and oil space heaters, with the latter having five separate classes. Energy efficiency in the target fiscal year (FY 2006) is assumed to be improved by approximately 1.4% for the gas type and approximately 3.8% for the oil type from FY 2000. In addition, Japan requires a label that provides the product name or type, category (limited to oil space heaters), maximum fuel consumption (limited to non-radiation type vented oil space heaters whose maximum fuel consumption is over 1.5L/h), energy consumption efficiency, and manufacturer's name.

In China, the efficiency standard on space heating products covers domestic gas instantaneous water heater and condensing water heaters, and combi-boilers that provide both gas heating and hot water supply. The standard sets an energy efficiency requirement, including the evaluation of energy conservation values, energy efficiency grades, test methods and inspection rules for systems up to a capacity of 70 kW. The standard gas is referred to GB / T 13611 "City Gas classification" provisions of gas. These MEPS are tested under GB20665-2006, which in turn references JIS 2109-1997; JIS S2093-1996. The water heaters and combi-boilers are divided into three grades each of which has a minimum thermal efficiency (percentage).

In the United States, a wide range of space heating products are covered and regulated, including non-weatherized gas furnaces; weatherized gas furnaces; mobile home gas furnaces; oil-fired furnaces; gas boilers; and oil-fired boilers. These products are all regulated using an efficiency metric called "AFUE" for annual fuel utilization efficiency. The DOE completed a rulemaking establishing minimum efficiency regulations that take effect in 2015, which established AFUE requirements for these furnaces and boilers ranging from 80 to 83% efficient (noting that the "max tech" identified by DOE for these same six categories of furnaces and boilers ranges from 83 to 99%. Following DOE's Final Rule, the US Congress then acted to establish more stringent standards for furnaces and boilers, as part of the Energy Independence and Security Act of 2007. DOE adopted these levels in a subsequent Technical Amendment Final Rule in 2008.

5.2.2 Fans and ventilation

Ceiling fans are the most commonly regulated type of fan in the major economies, with all economies except for Japan having a regulation or draft regulation under development. The international test protocol for ceiling fans is: IEC 60879-1986 Ed.2 'Performance and construction of electric circulation fans and regulators'.

India has a voluntary energy labelling scheme for ceiling fans which specifies the requirements for participating in the energy efficiency standards and labelling for ceiling fans covering a 1200mm sweep. The referred Indian Standard is IS 374: 1979 (Specification for Ceiling Type fans and regulators) with all amendments, as applicable. The labelling scheme is based around a five star rating scheme, where more stars equate to higher efficiency. The standard IS 374:1979 is aligned with an earlier version of IEC 60879-1986 Ed.2.

China has MEPS and labelling for ceiling fans, through the standard GB/T 13380-2007, which is harmonised with IEC 60879-1986. The standard sets certain requirements in terms of (m^3/min-Watt) according to blade diameter, ranging from 0.2 to 1.8 meters. China also applies MEPS and energy labelling for industrial fans which are tested under GB/T 1236-2000; GB/T 10178-2000. These standards are harmonised with the ISO standards ISO 5801-1997 'Industrial fans -- Performance testing using standardized airways' and ISO 5802-2001 'Industrial fans -- Performance testing in situ'.

The United States has covered ceiling fans and established design requirements for those ceiling fans. It should be noted that these design requirements do not include a measure of efficiency, performance or other means of ensuring that the ceiling fan moves air efficiently within a room. The Energy Policy Act of 2005 established a regulation that applies to ceiling fans (as well as ceiling fan light kits, which are regulated separately). The Act requires that all ceiling fans manufactured on or after January 1, 2007, shall have the following features:

- Fan speed controls separate from any lighting controls;
- Adjustable speed controls (either more than 1 speed or variable speed);
- The capability of reversible fan action.

This regulation explicitly exempts fans sold for industrial applications; fans sold for outdoor applications; and cases in which safety standards would be violated by the use of the reversible mode.

The DOE was directed by the Energy Policy Act of 2005 to adopt a test procedure for ceiling fans, which measures performance. The test procedure is based on a methodology originally developed by Hunter Fan Company (called the "solid-state test method") and then adopted by the EPA's Energy Star program. This test method is only applicable on suspended ceiling fans, and is not able to accurately measure "hugger" (i.e., flush mounted) ceiling fans. This test procedure was incorporated into Appendix U to Subpart B of Part 430 of the Code of Federal Regulations. The US then adopted a labelling requirement based around this test procedure for all ceiling fans that became effective January 1, 2009, to label their product packages with: (1) the fan's airflow at high speed in cubic feet per minute (CFM); (2) the fan's power consumption in watts at high speed; (3) the fan's airflow efficiency in CFM per watt at high speed; and (4) a range of airflow efficiencies at high speed for standard-sized fans on the market as published by the Federal Trade Commission (FTC). This information on the label must be affixed to the product packaging and included in paper and online catalogues.

China has newly proposed MEPRS & labelling scheme in China, GB 12021.9 2008, which covers ceiling fans, table fans, rotary fans, wall fans, box fans, and floor-standing fans. The regulations have different requirements for shaded pole versus capacitive motors operating the fans, which also vary with fan diameter. In addition China has MEPS and energy labelling for range hoods & electric ventilation fans, which are tested under GB/T 14806-2003 which is harmonised with IEC 60665: 1980.

In Europe, a draft Eco-design implementing measure (MEPS) has been prepared which applies to fans that fall within the power range of 125 W to 500 kW. A fan is defined as a rotary bladed machine that is used to maintain a flow of a gas (typically air), and which is driven by an electric motor. The proposed MEPRS are specified in Annex I of the proposal, Eco-design requirements for fans driven by motors with an electric input power between 125 W and 500 kW. The proposal includes requirements for fans of different categories, and which take effect in 2012 and 2015. The draft Eco-design measure classifies fans into six categories - axial fans; centrifugal forward curved fan and centrifugal radial bladed fans; centrifugal backward curved fans without housing; centrifugal backward curved fans with housing; mixed flow fans; and cross flow fans. The measure also defines four "measurement categories" which represent measurement conditions or usage arrangements relating to the inlet and outlet conditions of the fan under test, including whether these conditions are free (i.e., open) or have a duct attached. Annex I then establishes efficiency requirements that become effective in 2012 and 2015 which are a function of the rated power of the motor. Comfort fans are a significant product in the European market - according to Prodcom, there are 20-40 million units sold annually, with tower fans, pedestal fans and table fans each accounting for about 30% of the EU comfort fan market, and ceiling, box and wall fans together accounting for about 10%.[3]

5.2.3 Room air conditioners (non ducted air conditioners)

All the economies except the EU and India have MEPRs for room air conditioners although there are important distinctions between them. All five economies have energy labelling for RACs and the EU is developing MEPS under the Ecodesign directive. Until recently all the economies applied steady state test conditions that were identical to or very close to the ISO5151 T1 test conditions to rate the cooling capacity and power consumption and from these to derive an energy efficiency ratio (EER) (for cooling only efficiency) or coefficient of performance (COP) (applied in the case of reversible air conditioners operating in the heating

[3] Table fan – means a propeller bladed appliance intended for a free inlet and a free outlet of air that can be put on a table or bracket mounted for wall or ceiling mounting. Desk fan; Propeller diameter: 250-400 mm; Air flow: 1300-3600 m3/h; Electrical supply: 35-60W; Pedestal fans - means a propeller bladed appliance intended for a free inlet and a free outlet of air that is mounted on a pedestal of fixed or variable height. Propeller diameter: 250-450 mm; Air flow: 2000-4500 m3/h; Electrical supply: 40-70W. Floor standing fans - Propeller diameter: 300-500 mm; Air flow: 3000-6000 m3/h; Electrical supply: 40-120W; Wall mounted fans - Propeller diameter: 250-400 mm; Air flow: 1300-3600 m3/h; Electrical supply: 35-60W; Ceiling fans - means a propeller bladed appliance that is provided with a device for suspension from the ceiling of a room so that the blades rotate in an horizontal plane. Propeller diameter: 900-2000 mm; Number of blades: 3-5; Electrical supply: 50-150W(without lights); Cool and warm Tower fans - means a tangential (or cross flow) appliance that can be put on a table or bracket mounted for wall or ceiling mounting. Height: 350-1400 mm; Air flow: 400-2200 m3/h; Electrical supply: 35-50W; Box fans - means a propeller bladed appliance with a parallel exterior envelope of air that can be put on a table or on any other horizontal surface. Propeller diameter: 250-400 mm; Electrical supply: 35-60W; Louvers available to orientate the flow.

mode). The exception to this was the US treatment of single split packaged air conditioners, which in the rest of the world are classed as room air conditioners but in NAFTA economies are categorised as central air conditioners. This is the main class of room air conditioner sold in the world and the group which attains the highest energy efficiency levels, thus its classification vis a vis other classes of room air conditioner is important. In the US, central air conditioners are tested at four part load conditions and a seasonal energy efficiency ratio is applied to derive an overall efficiency rating. For other room air conditioners (e.g. window-wall units) the testing is at a steady state condition very close to the ISO T1 condition.

A similar, but seasonally-weighted, approach has recently been adopted for the most recent Japanese Top Runner requirements, which from 2010 onwards are expressed in terms of a seasonal heating and cooling factor (Annual Performance Factor) that includes part-load performance testing at five different seasonal conditions weighted to give an overall annual average performance factor for reversible AC units (the most common type sold in Japan).

The stringency of the requirements differs but those applied in Japan are the highest for most categories of RAC, even allowing for some differences in the test procedure. Under the steady state test conditions applied in Japan for the older Top Runner requirements the most popular classes of reversible split room air conditioner (around 2.5 kW) had to attain an average steady state EER and COP of 5.27 W/W. Under the new requirements the APF limit is 5.8 W/W for those RAC with indoor units of less than 800mm wide and 295mm high and 6.5 for those of larger dimensions.

The EU's current class A energy labelling requirement for the same type of RAC is 3.4 W/W (the average of the heating and cooling-mode thresholds). India's highest labelling requirement is for 3.49 W/W in cooling mode only (the EU's cooling mode only is 3.6 W/W). The US MEPS are for 3.2 W/W in cooling mode for similar sised reversible room air conditioners but are 3.8W/W (13 SEER) using the seasonal energy efficiency rating at four part load conditions applied to the central air conditioner units (which include but are not focused on, split room air conditioners in the US). Thus the not discounting potentially significant differences in measurement methods the older Top Runner requirements are nominally 39% higher than the US RAC MEPS and 32% higher than the EU class A threshold. The new Top Runner requirements are nominally 38% higher than the US Central Air conditioner MEPS, were there to be no significant impact due to differences in measuring part load performance. In reality there are likely to be significant differences but not to an extent sufficient to erase the stringency difference.

China's room air conditioner MEPS are set at 2.6 W/W for the main class of split room air conditioner and as they are tested at the ISO 5151 T1 condition are directly comparable with EU and the US and Japanese steady state requirements. The highest label class 1 requirement is 3.4 W/W. Separate requirements are imposed for variable speed drive RACs and these have to meet a minimum a seasonal energy efficiency ratio (SEER) if 3.0 W/W and attain 5.2 W/W if they are to reach the class 1 requirement. Thus normal split air conditioners that just meet Chinese MEPS are (very roughly) 57% less efficient than those that meet the new Top Runner requirements. The EU is also developing part load testing for room air conditioners and MEPS are under consideration through the auspices of the Ecodesign process.

Given this there are moderate prospects for harmonising important aspects of testing for room air conditioners (i.e. using the same test points and methodology even if part-load weightings may vary) and much more could be done to align product classifications so apples are treated in the same way as apples and oranges in the same way as oranges across economies. Given the significant differences in usage and electricity tariff the logic of and prospects for harmonised efficiency thresholds are not so strong but much could be done to bring them closer together and existing differences in regulatory settings are not fully explicable because of these factors.

5.2.4 Water heating appliances

China has MEPS for gas water heaters and combi boilers, electric storage water heaters and is developing requirements for heat pump water heaters.

Japan has Top Runner requirements for gas and oil-fired water heaters and the EU applies MEPS for gas and oil-fired combi-boilers (that heat sanitary hot water for the household and provide hot water (in a separate circuit) for whole-house hydronic heating systems). The EU is considering whether to introduce MEPS requirements for a range of water heating devices through the Ecodesign process and a technical study has been completed to support this effort.

The US has MEPS for six categories of water heater as follows:

1. Gas-fired Water Heater

2. Oil-fired Water Heater

3. Electric Water Heater

4. Tabletop Water Heater

5. Instantaneous Gas-fire Water Heater

6. Instantaneous Electric Water Heater

China and the US have MEPS and labelling for electric storage water heaters whereas the EU, India and Japan currently have no regulatory settings for these products, although the EU has operated an industrial voluntary agreement for a number of years.

The current situation for water heating appliances is fairly bleak. There are many different product types and most are complex in their design and operation. Water heater energy consumption is heavily affected by hot water demand, which is highly variable at a regional level, and by many climatic factors, which are also very variable.

There is very little international harmonisation in test procedures and efficiency metrics for water heaters and even for simple appliances, such as electric storage water heaters, the comparison of settings is very complex due to testing and efficiency metric differences. For reasons discussed in the section on test procedures, focusing on harmonisation of heat loss testing for storage water heaters is not likely to be a very productive focus for a global effort. This is not to say that international performance benchmarking would not be a useful exercise for water heating devices, but despite some significant recent efforts (e.g. the EcoHotWater study for the EU Ecodesign process) there is considerable work to do to clarify the situation. In the near term, however, harmonisation prospects are not good for this group of products.

5.3 Home entertainment and ICT appliances

Home entertainment and ICT equipment are widely internationally traded, have high inter-regional homogeneity and thus are good candidates for international harmonisation efforts.

5.3.1 Televisions

Televisions account for about half of consumer electronics electricity consumption and are a major a rapidly growing source of domestic power consumption. There are significant differences in efficiency between different TVs even when accounting for key functionality variables. As a result China, the EU and Japan apply MEPRs for Televisions and China and

India has voluntary energy labelling. The US has no MEPS or mandatory energy labels for TVs but a rulemaking process is pending and EnergyStar has specified performance requirements.

The methodological approach used in the Chinese, EU and Japanese MEPRs is similar in that energy thresholds are related to screen sise but differ in how products are classified by technology type and function.

The EU MEPS are the most straightforward and are the first to make use of the new international test standard, which addresses many deficiencies in earlier test procedures. The second stage of EU MEPS that come into force in 2014 are apparently significantly more stringent than the Top Runner requirements applied in Japan (e.g. nominally about 37% more stringent for a 32" CRT and about 43% more stringent for a 32" LCD); however, some of this difference may be explicable through differences in the test procedures applied. Similarly, the EU on-mode requirements are about 58% more demanding than the highest label category in the Indian label, although this may also be partially explicable in terms of test procedure differences. By contrast the EU MEPS for on-mode are slightly more demanding than the EnergyStar requirements for high definition televisions but are less demanding than the requirements for low definition TVs.

Both the EU and Japanese MEPRS address on mode and standby mode power requirements but the EU regulation also includes power management provisions such as automatic power down after 4 hours without a user response and measures to discourage units from being shipped in high illuminance modes as a default setting.

With the development of the new international test procedure and the launching of fresh and revision MEPS processes in the US and China respectively there may be reasonable prospects for greater international harmonisation in both performance measurement and specification terms; however, much work will be needed to help bring the major regulatory processes closer together. As TVs are essentially the same product the world over and are widely traded there is a strong case to be made for more internationally coordination in regulatory processes.

5.3.2 Digital television decoders (set top boxes)

China and the EU have MEPs in place for simple set top boxes. In the case of the EU these are estimated to reduce set top box power demand by 64% (6TWh as opposed to 14TWh in 2014 for set top boxes in the EU as a whole). There are no mandatory requirements in the other economies but EnergyStar requirements are specified which report to be 30% more efficient than standard set top box products. A study has recently been completed in the EU addressing complex set-top boxes and regulatory measures are under consideration. Given the absence of requirements in other economies and the wide degree of trade in digital television decoders there are be a product with reasonable prospects greater international coordination and regulatory alignment.

5.3.3 External power supplies

China, the EU and the US all have MEPS for external power supplies (EPS) (type class A) and the US is considering developing requirements for non-class A EPS. There are no requirements or labels for EPS in the other economies. The EU and US MEPS are fully harmonised, which came about as a result of sustained policy discussion between key technical experts and policy makers informing the decision process in both regions. China is planning to amend their EPS requirements in 2011 and this may be an opportunity to consider adopting the EU/US levels. In consequence there seem to be good prospects for enhanced harmonisation for EPS specifications.

5.3.4 Office equipment and ICT

The EU and US jointly manage EnergyStar specifications for office equipment and are signatories of a formal cooperative agreement on the issue. Other countries including Japan are also adopters of EnergyStar specifications for office equipment. China has developed national endorsement label requirements for many products including office equipment and ICT. Japan has set Top Runner requirements for computers (including PCs, laptops and servers) and magnetic disk drives and copiers. China has MEPS for computer monitors, copiers and printers and is investigating the possibility of introducing MEPS for servers.

The EU has completed Ecodesign studies for:

- personal computers (desktops and laptops) and computer monitors
- imaging equipment: Copiers, Faxes, Printers, Scanners, MFD

and the European Commission is considering the option of introducing regulatory requirements for all of these. Work is also underway on a study investigating networked standby. The EU discussion has centred on possible regulations addressing power supply efficiency levels, mandatory power management requirements, screen efficiency requirements and low power mode efficiency levels (minimum requirements for sleep, off and idle mode power demand). Some of the thresholds under consideration are harmonised with those specified in Energy Star, Table 5.1.

Table 5.1 ENERGY STAR Office Equipment

Product Category	**Current Criteria levels**	**Link to Energy Star Product Criteria**
Computers	Use energy efficient power supply. Operate efficiently in multiple modes of operation (Off, Sleep, and Idle). Include and enable power management features of the system and provide user education about these features	http://www.energystar.gov/index.cfm?c=computers.pr_crit_computers
Copiers and Fax Machines	ENERGY STAR specifications for Typical Electricity Consumption (TEC) as a function of: product; marking technology (e.g., Direct Thermal, InkJet); Product Speed; and Product Sise Format	http://www.energystar.gov/index.cfm?c=copiers.pr_crit_copiers
Digital Duplicators	Delivers the same performance as less efficient, conventional equipment. Models that meet the revised ENERGY STAR imaging equipment criteria will be more efficient and save users money over the lifetime of the product.	http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=DD
Enterprise Servers	Multiple criteria for power supply efficiency, active power and reporting requirements	http://www.energystar.gov/index.cfm?c=ent_servers.pr_crit_enterprise_servers
External Power Adapters	30% more efficient than conventional models, and are often lighter and smaller in sise, which makes it easier to transport products like laptops.	http://www.energystar.gov/index.cfm?c=ext_power_supplies.power_supplies_consumers
Mailing	ENERGY STAR specifications for Typical Electricity Consumption (TEC) as a function of:	http://www.energystar.gov/index.cfm?c=

Product Category	Current Criteria levels	Link to Energy Star Product Criteria
Machines	product; marking technology (e.g., Direct Thermal, InkJet); Product Speed; and Product Sise Format	printers.pr_crit_printers
Monitors	Multiple criteria for on mode, sleep mode, and off mode.	http://www.energystar.gov/index.cfm?c=monitors.pr_crit_monitors
Printers, Scanners, and All-in-Ones	ENERGY STAR specifications for Typical Electricity Consumption (TEC) as a function of: product; marking technology (e.g., Direct Thermal, InkJet); Product Speed; and Product Sise Format	http://www.energystar.gov/index.cfm?c=printers.pr_crit_printers
Water Coolers	Cold Only and Cook and Cold Bottled Units: < 0.16 kW-hours/day. Hot and Cold Bottled Units: < 1.20 kW-hours/day	http://www.energystar.gov/index.cfm?c=water_coolers.pr_crit_water_coolers

METI reports that the Top Runner requirements for computers were exceeded in the target fiscal year of 2007 even though they constituted a 69% improvement in efficiency compared with the 2001 level. This indicates the ongoing rapid improvement in computer processing capacity as a function of input power and suggests that while the Top Runner requirements may have been helpful they may have practically served as underpinning requirements for a rapidly advancing technology. Nonetheless there are substantial savings potentials from adopting more energy efficient office equipment and ICT. For example, using the technology applied in laptops typically saves over 50% of the energy used by desk top computers for the same functionality and the average efficiency of laptops can be improved by 35% cost effectively by using improved power management and a high efficiency power supply[vi].

There is increasing interaction between policy makers on efficiency settings for ICT and Office Equipment and there appears to be a willingness to work cooperatively to produce greater commonality and ambition in future policy settings. Given the wide spread use of Energy Star test procedures for ICT and Office Equipment and the high degree of commonality in products and international trade there could be good prospects for harmonisation of policy settings were international cooperative efforts to be strengthened.

5.4.4 Standby power

Most economies are currently regulating standby power levels on a product by product basis. The EU, however, has introduced horizontal standby power limits that currently require:

The power consumption of equipment in any condition providing only a reactivation function, or providing only a reactivation function and a mere indication of enabled reactivation function, shall not exceed 1.00 W.

The power consumption of equipment in any condition providing only information or status display, or providing only a combination of reactivation function and information or status display, shall not exceed 2.00 W.

From the end of 2012 the requirements become:

(a) Power consumption in 'off mode':

Power consumption of equipment in any off-mode condition shall not exceed 0.50 W.

(b) Power consumption in 'standby mode(s)':

The power consumption of equipment in any condition providing only a reactivation function, or providing only a reactivation function and a mere indication of enabled reactivation function, shall not exceed 0.50 W.

The power consumption of equipment in any condition providing only information or status display, or providing only a combination of reactivation function and information or status display shall not exceed 1.00 W.

The directive also makes the provision of low-power modes and energy management mandatory. The application of this regulation is limited to products corresponding to household and office equipment intended for use in the domestic environment, which, for information technology equipment, corresponds to class B equipment as set out in EN55022:2006. The scope is defined such that equipment that is not yet available on the market, but has similar functionalities to those products explicitly named in the regulation, are required to fulfil the requirements.

By making these provisions horizontal it avoids regulatory gaps caused by delays in the regulatory process or because of the standby power consumption of the many small electrical end-uses that often do not consume enough power to justify having a dedicated rulemaking. They thus ensure that all relevant products are covered. The Commission project power savings of over 70% from these measures (39TWh annually in 2020).

It is not clear whether other economies may follow suit although there would be clear energy savings advantages from doing do; however, many economies have already introduced standby power requirements for many products (this is true of the China, Japan and the US). As products subject to standby power requirements are widely traded and are common to all regions there is a tendency for whichever of the global requirements in the major economies is highest becomes the de facto standard for all economies, thus many economies may benefit from the EU regulations just as the EU has previously benefitted from the lead taken in the Top Runner regulations with respect to standby power. Nonetheless there is clear potential for greater cooperation in policy settings for standby power. The main reason why an economy may not choose to introduce horizontal requirements is that it may require a new legislative mandate as the requirements do not apply to any specific product class uniquely, thus the pace of regulatory development may depend on the primary legislative mandates in place. There is already considerable cooperation and commonality in test procedures and the recent IEC standard for standby power measurement greatly facilitates this.

5.4.5 Prospects for harmonisation

Home entertainment and ICT appliances have some of the greatest potential for internationally harmonised requirements, especially for office equipment, ICT and power supplies. For these products there is a high degree of harmonisation in the test procedures and efficiency metrics used and because the main industrial players serve a global market, they have a strong interest in the adoption of internationally aligned or harmonised efficiency requirements. Furthermore, as product types are common most governments will be happy to pool resources and work cooperatively with others to set specifications. The existing track record in this domain is encouraging and could be built upon further to establish even greater consensus.

5.4 Lighting

Lighting is common to all end-user sectors but is most significant in the commercial and residential sectors. Globally it accounts for 19% of all electricity consumption and is one of the end-uses with the greatest and most rapidly realised potential for significant cost-effective energy savings.

5.4.1 Non-directional lamps (GLS, CFli and non-directional halogen lamps)

Omni-directional lamps (i.e. lamps which emit light in all directions) are used predominantly in residential lighting and include standard incandescent lamps (known as GLS for General Lighting Service lamps), mains voltage halogen lamps and compact fluorescent lamps with integrated ballasts (CFLi). CFLi are typically between 4 and 5 times more energy efficient than GLS while the majority of halogen lamps are only slightly more energy efficient than GLS thus there are huge potential savings to be had from substituting GLS and halogen lamps by CFLi. Since early 2007 many governments around the world have moved to phase-out GLS. In the US regulations to phase-out GLS were adopted at the end of 2007 and in Europe comparable regulations were passed via an Ecodesign measure in 2008. Japan has announced their intention to phase-out GLS by 2012 but has not adopted Top Runner requirements yet. China is currently investigating the topic but has no existing regulation and nor does India. There are important differences in the regulations that have been adopted in the USA and the EU. The major energy savings arise from the substitution of GLS by CFLi as opposed to advanced halogen lamps (that are between 20 and 50% more efficient than a GLS but even the best are still three times less efficient than good CFLi). The EU regulations are drawn up such that they apply to all household lamps and set general requirements such that in practice if the lamp is opaque (as in it has frosted or diffuse coating) it has to reach the level of a reasonably efficient CFLi from September 2009 onwards. This requirement applies to all non-directional non-clear lamps for household use and effectively serves as a minimum energy performance specification for CFLi as well as removing frosted GLS and halogen lamps from the market. Clear lamps in the EU have to meet less stringent requirements that are phased in progressively from 2009 to 2016 such that standard GLS are phased out by wattage class from 2009 to 2011 and from 2016 only clear lamps that meet the most advanced type of clear halogen lamp performance level or better will be permitted for sale. In practice such halogen lamps are significantly more expensive to produce than CFLi and thus will only retain market share for applications where end-users are especially keen to have halogen lamp properties. The EU regulations also impose a range of additional quality requirements on CFLi, which essentially ensure that compliant CFLi are high quality products.

The US regulations are similar in effect in that they phase out conventional GLS by wattage class steps from 2012 to 2014. They do not initially impose such stringent requirements on alternative halogen substitutes and are worded initially such that only initially apply to incandescent lamps; however, they include provisions that require the DOE to initiate a rulemaking in 2014 to consider whether it is technologically feasible and economically justified to make the standards for “general service lamps” higher than the EISA 2007 levels. This definition of “general service lamps” includes general service incandescent lamps as well as: compact fluorescent lamps, general service light emitting diode (LED or OLED) lamps, and “any other lamps that the Secretary determines are used to satisfy lighting applications traditionally served by general service incandescent lamps”. If this rulemaking cannot produce savings that are greater than or equal to the savings from a minimum efficacy standard of 45 lumens per watt, effective January 1, 2020, then the Secretary shall prohibit the sale of any general service lamp that does not meet a minimum efficacy standard of 45 lumens per watt (this is referred to in the statute as a “backstop requirement” and is the only circumstance that may qualify as an outright “ban” on certain general service lamps, but only as a last resort). Thus they enshrine a minimum lamp efficacy of at least 45LPW from 2020 onwards for all major types of lamp.

The energy efficiency of CFLi is also regulated in the US as well as in China. CFLs used in desk lamps are regulated in Japan but not the standard CFLi types found in most parts of the world; however, incandescent lamps are not very common in Japanese households (unlike in the other four economies considered here) and thus while the savings potential from phasing out GLS is significant it is nowhere near as substantial as it is in the other economies. The same is true for CFLi as Japanese domestic lighting is dominated by tubular fluorescent lamps in a circular or linear shape (these are discussed in the next section). The US MEPS for CFLi are less stringent than those in the EU or China e.g. for a typical GLS substitute covered-CLFi emitting 800 lm they are 33% less stringent than those in the EU. The Chinese MEPS only apply to uncovered CFLi and in this case for an 800 lm lamp the US MEPs are roughly 28% less efficient than the Chinese requirements. Mandated CFLi efficiency thresholds were possibly less important in the past when GLS were permitted for sale but now there is a large shift to CFLi their relative performance levels both in terms of quality and efficacy will become more significant from a consumer satisfaction and energy savings perspective.

There is a vast potential for energy savings were the major economies of the world to join those such as the EU and US in phasing-out incandescent lamps in favour of substantially more efficient alternatives such as CFLi and the most efficient halogen lamps in the near term and LEDs in the medium to longer term. There are also reasonably good prospects for international harmonisation to occur. Several international initiatives are underway to develop:

- Common international test procedures and quality standards for CFLi
- Common international test procedures and quality measures for LEDs

There are also some significant projects getting underway to support those economies that have not yet adopted regulations prohibiting the sale of GLS to examine the options to transition away from such inefficient and obsolete lighting technologies towards much higher efficiency alternatives. These include the GEF sponsored Global Market Transformation for Efficient Lighting project, the GEF sponsored PILESLAMPS project in China, and the World Bank sponsored Lighting Africa initiative and the global Efficient Lighting Initiative as some prominent examples.

5.4.2 Directional lamps

Directional lamps are those which emit light in a limited or focused direction and include: GLS reflector lamps, halogen spot lights and CFLi reflector lamps. The halogen lamps can be mains voltage AC lamps or low-voltage (12V) DC lamps that use a transformer. All other things being equal the latter are typically 50% more efficient than the mains voltage varieties. Directional lamps, especially MR16 halogen reflector lamps (the main type of spot light) are very common in both residential and commercial buildings and are a significant source of lighting energy use; however, they are generally not regulated or subject to labelling due to a lack of adequate test procedures and test facilities. Moves are underway to develop general test procedures applicable to directional lamps in Australia, Canada, the EU and the USA and there are good reasons why it would make sense for these to become aligned in the future. If a generally applicable and internationally acceptable test procedure can be developed there is no reason why economies who currently have no requirements for directional lamps should not adopt it and this could be strong stimulus to the possible adoption of harmonised efficacy and performance requirements, thus directional lamps are a good candidate for accelerated harmonisation efforts. This topic is discussed in some depth in Appendix C. In fact the US has applied MEPS to certain classes of GLS reflector lamp since 1995 and has opened a rulemaking process which aims to revise the requirements applying to this classes of lamps by 2014; however, as these lamps (which are GLS reflector lamps with very specific bulb shapes) are practically only found in North America there is little value or prospect in harmonisation of requirements outside the NAFTA member economies. As the rulemaking also encompasses other directional lamps such as halogen spot lamps there is some value in exploring international harmonisation options although it is noted that the main class of halogen spot lamp (MR16s) are not covered by this rulemaking as their diameter falls below the scope covered in the ruling. There might be considerable energy savings benefit from adopting more universally applicable product categorisations that do not omit to cover significant parts of the lamp market.

5.4.3 Ballasts for fluorescent lamps

Ballasts are used by fluorescent and other discharge lamps to provide the start-up (ignition) current and to regulate the power supplied to the lamp following ignition to maintain an even light output. Ballasts can use a significant amount of electricity to function and thus their energy performance has an important impact on the overall efficiency of the fluorescent lighting system they operate. In consequence all the economies considered in this report apply regulations that affect the energy performance of ballasts except India. In the case of China, the EU and the US MEPS have been set applicable to fluorescent lamp ballasts. For Japan Top Runner requirements are specified for certain common combinations of fluorescent lamp and ballast. The US and China both define ballast efficiency using a ballast efficiency factor (BEF) metric whereas the EU and many other parts of the world use a ballast efficiency (%) value measured according to IEC test procedures. As a result it is not straightforward to compare the stringency of their requirements although a crude conversion can be made to give a rough indication of relative efficiency levels. Using such a conversion to move from BEF to ballast efficiency values and applying it in the most common case, a 32W T8 linear fluorescent lamp, the Chinese MEPS are for an efficiency of 75% and the Chinese class A level is 85%. The US only specifies ballast MEPS for those ballasts destined for use with T12 lamps (an older, less efficient technology) but in practice market average ballast efficiency levels are thought to be around 80%. The current EU MEPS (without needing to apply a conversion) are at 79.5% but become 87.8% from 2017. Thus, were China to adopt the EU 2017 levels, the minimum efficiency threshold would be increased by 14% and were the US to do so the market average efficiency would be increased by over 9%. The current US regulatory process for fluorescent lamp ballasts is considering extending the scope of the ballasts regulations which currently only cover 12% of fluorescent lamp ballasts sold in the USA. One of the issues has been the inadequacy of the BEF test procedure for testing of electronic ballasts and this may present an opportunity for the US to consider harmonising its ballast test procedure with the international method which is adequate for all classes of LFL ballast.

To understand the relative performance compared with the Japanese Top Runner requirements it is necessary to also look at the lamp efficiency requirements in place as the Top Runner regulations specify combined lamp and ballast performance levels. These are discussed in the next section.

5.4.4 Linear Fluorescent Lamps, ballasts and related systems

China, the EU and the US have MEPS for fluorescent lamps, while India has voluntary energy labelling of linear fluorescent lamps and Japan has integrated Top Runner requirements for lamps and ballasts combined. In the case of the most common class of 32W LFL lamps the Chinese MEPS require for an efficacy of 62 lm/W or above and the Chinese class A level is at 88 lm/W. The EU MEPS are set at 80lm/W, while the current US MEPS level is at 75 lm/W, but from 2012 becomes 89 lm/W; however, the US MEPS only apply to ballasts used with T12 lamps and not to the most common T8 lamp categories. The Indian label 1-star threshold is set at 61 lm/W (when tested at 100 hours of use) and the 5 star threshold is 92 lm/W. Thus were Europe to adopt the US 2012 levels as applied to T12 lamp ballasts for all LFL ballasts the minimum efficiency threshold would be increased by 10% and were China to do so the minimum would be increased by 30%. The Japanese Top Runner requirements set combined lamp and ballast performance specifications that differ by application and by the choice of technology used.

Table 5.2 shows a comparison of the lamp, ballast and luminaire efficiency for a typical 32W linear fluorescent lamp arrangement where if a value is not shaded it represents a nominal market average level but if it is shaded in pink it is a regulated threshold. Note in the case of Japan where the ballast and lamp performance requirement is combined the regulated values have been entered for the lamp and the ballast set at a nominal 100% efficiency because separate lamp and ballast requirements are not specified. In all cases luminare efficiency is assumed to be a nominal 85%, as luminaire losses are not regulated in any of the markets; however, 85% is an optimistic level in many cases and actual performance can often be far worse than this (i.e. as low as 60%). A row entitled controls is also included and is set to a nominal level of 1 in all cases; this is to remind the reader that system performance can be substantially increased by the use of lighting controls that adjust light output in response to occupancy and required light levels. From this comparison it can be seen that combining all of the best current or announced MEPS at the individual lamp and ballast level lead to a nominal system efficiency of 66.4 lm/W which is:

- 40.5% more efficient than current Chinese MEPS
- 4% more efficient than Chinese Class 1 requirements
- 23% more efficient than current EU MEPS
- 18.5% more efficient than EU MEPS in 2017
- 53% more efficient than Indian 1-star label requirements (assuming a ballast efficiency of 75%, as per the Chinese MEPS)
- 32% more efficient than Indian 5-star label requirements (assuming a ballast efficiency of 75%, as per the Chinese MEPS)
- 22.5% more efficient than current Japanese systems using a slow start ballast MEPRS
- 9% more efficient than current Japanese systems using a rapid start ballast MEPRS
- 10.5% less efficient than current Japanese systems using a high frequency ballast MEPRS
- 10% more efficient than current US MEPS for T12 ballasts with average T8 lamp efficacy
- 9% more efficient than US MEPS in 2012 for T12 ballasts with average T8 lamp efficacy
- 18.5% less efficient than current best available technology for lamps, ballasts and luminaires and between 10 and 60% less efficient again compared to the case where advanced lighting controls are used.

This comparison and analysis indicates that there is considerable savings potential from adopting the world's best MEPS in all economies at the individual component level but also reveals that much higher savings could be attained from moving to the world's best technology overall or by requiring performance levels consistent with the Japanese high frequency requirements. It also highlights the importance of having measures which cover all aspects of system efficiency, which in this case combines: lamps, ballasts, luminaires and controls. No economy currently regulates luminaire efficiency but there is the potential to do so. Similarly, there is potential to impose requirements or introduce incentives for lamp controls which could substantially increase the systems savings potentials above these levels.

Table 5.2 Comparison of fluorescent lamp system requirements and typical performance levels

System Component	China - Grade 3	China - Grade 1	Europe Regulation	Europe in 2017	Japan HF	Japan rapid start	Japan slow start	US Regulation	US Regs. in 2012	Best component MEPS	Best Available
Lamp Efficacy (lm/W)	62.0	88.0	80.0	80.0	86.5	71.0	60.5	75.0	89.0	89.0	95.4
Ballast Efficiency	75.0%	85.0%	79.5%	87.8%	100.0%	100.0%	100.0%	80.0%	80.0%	88%	91.4%
Luminaire Efficiency	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	90.0%
Controls	1	1	1	1	1	1	1	1	1	1	1
System Performance (lm/W)	39.5	63.6	54.1	59.7	73.5	60.4	51.4	51.0	60.5	66.4	78.5

There are reasonable prospects for greater harmonisation of energy performance requirements for fluorescent lighting. The technology is the same around the world; local usage environments are not significantly different and the products are very widely traded. The new international test procedure for ballasts is clearly fit for purpose and is more accurate than the BEF based approaches, thus there is a strong case for economies to adopt it. The US currently has an open regulatory process for fluorescent lamp ballasts and thus could consider extending their scope to all classes of LFL and adjusting the test procedure in line with the international standard. International fluorescent lamp test procedures are also adequate and could be universally adopted (there is already a large degree of international adoption of these). Regulations are undergoing revision in China and in the US and thus this presents an opportunity to explore greater harmonisation.

5.4.5 HID lamps, ballasts and related systems

Similar issues apply to high intensity discharge lamps and ballasts as to fluorescent lighting systems. The system efficiency depends on the combined efficiency of the lamps, ballasts and luminaires & optics. In practice economies currently specify requirements for the lamps and ballasts only if at all. At the current time:

- China has MEPS and labelling that apply separately to High Pressure Sodium (HPS) lamps & HPS ballasts and to Metal Halide (MH) lamps & MH ballasts
- The EU has MEPS for HID lamps that are differentiated by the colour rendering index (CRI) such that HPS lamps with CRI<60 are subject to one set of (higher) efficacy requirements and HPS with CRI> 60 and MH lamps with Ra ≤ 80 are subject to another (lower) set of efficacy requirements. From 2017 the requirements for MH lamps become slightly more stringent and there scope is extended to apply to all MH lamps regardless of their CRI.
- In addition, all HID lamps sold in the EU are subject to a common set of minimum requirements that effectively phase-out inefficient obsolete, but low initial cost, technologies such as Mercury Vapour (MV) lamps.
- The only US regulations currently in place prohibit the manufacture or import of ballasts for use with mercury vapour lamps and set MEPS for MH ballasts; however, an HID ruling for metal halide lamp ballasts and fixtures is due for 2012. There are no active regulatory processes targeting HPS lamps or ballasts.
- Neither Japan nor India have any kind of formal regulatory or labelling requirements for HID lamps despite the continuing use of less efficient mercury vapour based lighting systems in both economies.

In comparing the ambition of the current requirements for HPS systems the following observations can be made:

- China's MEPS for HPS lamps are 28% less stringent than the EU HPS MEPS for a typical 250W lamp.
- China's energy label class 1 requirements are 12% less stringent than the EU MEPS.
- US typical market efficiency for HPS lamps is about 7% less efficient than EU MEPS levels
- China's HPS ballast MEPS are identical to those in the EU for a typical 250W lamp application and both are about the same as the US market average HPS ballast efficiency

level, which suggests that US average HPS ballast efficiency could be increased by a few percent by introducing world best MEPS
- The world's best HPS system technology (not accounting for the control but including the effects of luminaire efficiency) is about 14% more efficient than the EU HPS MEPS using a standard luminaire with 75% efficiency.

In comparing the ambition of the current requirements for MH systems the following observations can be made:

- China's MEPS for MH lamps are 17.5% less stringent than the EU MH MEPS for a typical 250W lamp.
- China's energy label class 1 requirements are 10% more stringent than the EU MEPS.
- EU MH MEPs are about 8% less stringent than the EU and US market average efficiency levels and about 31% less efficient than the best available technology
- EU MH ballasts MEPS are 3% less stringent that those in the US
- Chinese ballasts MEPS are 8% less stringent that those in the US
- China's energy label class 1 requirements for MH ballasts are 2% more stringent than the US MEPS

The world's best HPS system technology (not accounting for the control but including the effects of luminaire efficiency) is about 14% more efficient than the EU HPS MEPS using a standard luminaire with 75% efficiency.

It is somewhat misleading to restrict these comparisons to within technology type comparisons as HID technologies overlap in the service they provide. In general HPS lamps offer high efficacy but with a lower CRI while MH provide higher CRI but lower efficacy; however, HPS SON lamps can also provide reasonable CRI (albeit at the penalty of a reduced efficacy compared to standard HPS) and thus compete head on with MH lamps. MH and HPS SON lamps provide all the lighting service that MV lamps do but at a much higher efficacy thus the principal energy saving approach an economy can take is to set general underpinning HID efficacy requirements that prohibit all of the least efficient lamp technologies such as MV and the even less efficient self-ballasted blended mercury lamps from the market. In the US the prohibition on MV ballasts sales has almost completed the removal of MV lamps from the market but in China, India and Japan they are still permitted and commonly used. Blended mercury lamps are never found in OECD markets; however, in China and India blended mercury lamps (that are typically 59% less efficient than a comparable MV lamp system and about 80% less efficient than a good MH lamp system) are not subject to any requirements. Were MV lamps to be subject to world best MEPS the replacement lamps would be 47% more efficient and were self-ballasted blended mercury lamps to also be subject to world best MEPS the replacement lamps would be 78% more efficient. Currently, the EU is the only economy to set all encompassing requirements for HID technologies which preclude the use of the least efficient systems whatever the technology applied.

5.4.6 LEDs

LEDs are a rapidly emerging lighting technology and look set to become a major part of the future lighting market. As a belle weather for this trend at the April 20010 Light Fair trade show in Germany (the world's largest) all the major lighting companies were exhibiting wide range of LED lighting technologies and Philips were only exhibiting solid state lighting technologies.

Currently LEDs to be applied in household lighting applications are subject to de-facto efficacy requirements in the EU Household Lamps regulations (which impose all encompassing requirements for clear lamps and for non-clear lamps); however, these would only apply if LEDs were arranged to provide a onmi-directional light source through the use of diffusers. As LEDs are generally directional light sources when applied to deliver light without the use of a diffuser they would mostly not be covered by this regulation. If they were arranged to use a diffuser they would be subject to the non-clear lamp requirements that are set at levels which can be met by superior halogen lamps and thus should be comfortably exceeded by current generations of LED technology.

LEDs will also become subject to the US backstop regulations for general service lamps that will apply from 2020 onwards and at that time would be required to meet an efficacy level of at least 45lm/W. As this is already attained by products in the market and LED efficacy levels continue to roughly double every two years meeting this efficacy level by 2020 should not present a difficulty.

More importantly for LEDs is the need to develop adequate and agreed international test procedures for both energy performance and quality purposes. Much is happening in this domain and this is discussed in the section addressing test procedures. This work also strongly relates to the on-going activity to develop adequate test procedures for directional light sources (see Appendix B). In general though LEDs are an emerging and Greenfield technology and thus present a tremendous opportunity to develop harmonised test procedures, efficiency metrics and performance requirements. They are the same technology worldwide and are widely traded thus they are a product which should be prioritised for international harmonisation efforts.

5.5 Other commercial end-uses

There are many significant commercial sector energy end-uses that are only partially covered by energy efficiency regulations in the five economies and thus there is considerable scope to extend the coverage of MEPRs and energy labels to more product types in all the economies. In general commercial sector energy use is rising faster than in other sectors and much of the equipment which is not currently subject to requirements has significant energy savings potential. The incomplete coverage of existing commercial sector requirements presents an opportunity for more harmonised international requirements as new test procedures and policy settings could be set in common or with reference to those in other economies.

5.5.1 Central air conditioners (ducted air conditioners)

Ducted air conditioners are a major energy end-use and are subject to MEPRs in China, Japan and the US. China also applies mandatory energy labelling for these products. Europe has no regulatory requirements for packaged central air conditioners and currently has no study investigating this product group.

The US requirements cover common packaged ducted AC units of up to 70kW in capacity in several sub categories. The Japanese requirements are limited to units of up to 28kW. Chinese requirements cover unitary air conditioners, air-blast duct air conditioners and rooftop air conditioners which have nominal chilling capacity of more than 7.1kW.

The categorisation of products varies by country but in broad terms:

- China's MEPS requirements are EERs of between 2.1 and 2.4 W/W for air cooled units and from 2.5 and 2.8 W/W for water cooled products
- Japan's Top Runner requirements are for EERs of 2.71 W/W in cooling only mode and of 3.06 W/W for reversible units
- US MEPS requirements are for SEERs of between 2.49 and 2.93 W/W for air cooled units and from 2.81 and 3.52 W/W for water cooled units

- In general then the Chinese requirements are about 22% less stringent than the Japanese values and the US MEPS are about 4% less stringent (albeit it is difficult to compare the SEER and EER values used in the latter case).

There are reasonable prospects for greater international harmonisation of unitary packaged air conditioner requirements. Product types are similar and as some major economies have not yet adopted such regulations there is an opportunity for them to follow the lead of others when they do so. The international test procedures are broadly applicable although there is likely to be a move to greater use of SEER ratings in the future, which are likely to apply different regional weightings to the principal test points even if the choice of test points is harmonised.

5.5.2 Chillers for commercial buildings

Despite being a large energy using end-use in all economies and having significant potential for efficiency gains chillers are only currently subject to energy labelling and MEPS in China. In the US ASHRAE (through its ASHRAE 90.1 code) publish non-nationally binding efficiency thresholds for chillers but which are incorporated into many state level building codes; however, chillers are not formerly among the commercial products which are regulated at the Federal level and would require alteration in the statutory settings or a decision by the Secretary of State for Energy to be included. The EU has previously commissioned a study into central air conditioning systems which also addressed chillers and the leading industry association EUROVENT requires chillers that it certifies to meet minimum efficiency performance thresholds, but it is not presently clear when and if they will become subject to mandatory requirements via the Ecodesign process. Japan and India currently have no labelling or mandatory energy performance requirements for chillers.

China's chiller MEPS are based on an integrated part load value assessment that determines chiller energy efficiency ratios at four part load conditions and produces an average weighted value based on the frequency of use at each part load test point. This has been found to be the best way to rate chiller and other large air conditioning equipment performance but it does complicate international comparison and harmonisation efforts because the choice of part load test conditions and the weighting given to each is typically sensitive to local usage behaviour and environmental conditions and these tend to vary from one region to another. However, the basic technology being used is similar everywhere and thus there is an opportunity to harmonise some of the testing conditions to at least allow comparison at those rating points.

Energy savings from the adoption of MEPR and labelling for chillers are likely to be significant as there continues to be significant spread in efficiency between the least and most efficient products on the market, thus chillers are seen to be a good candidate for partial harmonisation.

5.5.3 Commercial refrigeration equipment

Certain types of commercial refrigeration equipment (CRE) are regulated in the US as are beverage vending machines. Japan has Top Runner requirements for vending machines but nothing for CRE.

CRE product groups are being considered for Ecodesign regulations in the EU where a study has been completed and the findings are under consideration. Another Ecodesign study addressing refrigerating and freezing equipment (service cabinets, walk-in cold rooms, chillers, ice makers, ice cream and milk-shake machines) is still on-going.

China and India currently have no requirements for commercial refrigeration equipment.

The US regulations for CRE apply to various types of refrigerated display case but only if they have an integrated compressor. In practice the majority of CRE equipment used in US food retail outlets operates using an external cooling circuit that supplies coolth to a number of chilled and frozen food display cases and these systems are not subject to regulations due to the scope not permitting their inclusion. As CRE products have many similarities around the world and tend to be operated under similar conditions there is scope for internationally harmonised requirements even if there is only limited trade in products between the main regions. This is because the product groupings are relatively Greenfield (i.e. there are few current requirements and there are few entrenched regulatory practices in place) and the technologies applied are shared between regions. Thus there is considerable scope to copy or adapt existing international regulations as new requirements are introduced. Given the large amount of energy at stake and the considerable potential for savings the accelerated adoption of regulatory requirements for CRE should be a priority.

5.6 Industrial electric end-uses

With the exception of the most common classes of electric motors and transformers there are very few energy efficiency requirements applied to industrial electric end-uses in the five economies and yet there are tremendous opportunities for energy savings through introducing measures for industrial electric motor driven systems such as pumps, fans and compressors but also for some of the mechanical components used in such systems (such as gears and transmissions). There are signs that regulators in the major economies are beginning to appreciate the importance of these opportunities and thus there is likely to be renewed interest in regulations that target them. This presents a considerable opportunity for international harmonisation as Greenfield products are always simpler to cooperate and harmonise requirements for.

5.6.1 Electric motors

China, the EU and the USA apply MEPS for the most common types of industrial electric motors. The US and EU MEPS address AC asynchronous induction motors from 0.75 to 375kW. The Chinese MEPS cover motors of a similar size range. Neither Japan nor India currently has MEPRs for electric motors but India applies voluntary labelling to induction motors rated from 0.75kW to 15kW.

Today there are around four standardised efficiency classes which vary slightly in definition from country to country. The IEC 60034-30 standard introduced in 2008 offers a precisely defined and open-ended international efficiency classification scheme with three classes: IE1, IE2 and IE3. In Table the regional classification schemes are shown.

Table 5.3 Efficiency classes from different countries and the corresponding international standard

Motor efficiency class	International	USA	EU		China	India
Premium	IE3	NEMA Premium	-	Grade 1 (ca.IE3)	-	-
High	IE2	EPAct	Eff1	Grade 2	Y3 (possibly)	Eff1 (top label class)
Standard	IE1	-	Eff2	Grade 3	Y2	Eff2 (lower label class)
Below standard	IE0 (just used in this paper)	-	Eff3	-	Y (possibly)	-

The NEMA Premium requirement adopted in the USA and Canada matches the IEC IE3 level, whereas the IEC's IE2 level is roughly equivalent to the old EU Eff1 voluntary level (still used in India and which corresponds to the Chinese label Class 1 threshold). The IEC's IE3 level is roughly equivalent to the old EU Eff2 voluntary level (still used in India and which corresponds to the Chinese label Class 2 threshold). China's class 3 threshold matches the old Eff3 level.

There is thus considerable international harmonisation in both testing (although some economies have not yet moved over to the new IEC test standard), choice of efficiency metric (all economies use the output/input power expressed as a percentage) and in efficiency levels (which are at one of four different thresholds). China's MEPS are set at the old Eff3 level. The US's are set at the NEMA Premium/IE3 level and the EU's are set at the IE3 level unless a motor is shipped with an integrated variable speed drive in which case they are permitted to use the less stringent IE2 level. For a 10kW motor moving from Eff3 to IE3 efficiency levels will save about 5.4% although the relative savings are higher for smaller motors and less for larger motors. As electric motors account for 68% of industrial electricity demand and 19% of commercial sector electricity demand small percentage improvements lead to very substantial total energy savings.

The largest proportion of motor electricity consumption (about 68%) is attributable to mid-sised motors of between 0.75kW and 375kW of output power and these are the most common category currently regulated (these thresholds also correspond to the limits of scope of the IEC test procedures IEC 60034-30 and IEC 60034-31). Small electric motors of less than 0.75kW of output power are by far the most numerous type of motor but only account for about 9% of all electric motor power use. The only economy which has specific efficiency requirements for motors in this sise range is the US but there are many exceptions even in this coverage. Some of these motors are used in products which are already subject to MEPRs and thus are indirectly regulated. There are still gaps in regulatory requirements applying to mid-sised motors because different types of motors (i.e. those that are not AC synchronous induction motors) are not currently covered by efficiency requirements in any economy.

Large electric motors, of greater than 375kW output power, are usually high voltage AC motors that are custom designed, built to order and are assembled with an electro-mechanical system on site. They comprise just 0.03% of the electric motor stock in terms of numbers, but account for about 23% of all motor power consumption, thus they are a very significant source of global power consumption in their own right (about 10.4%). These motors are not currently subject to minimum energy performance regulations in any part of the world.

Electric motors are a good example of the successful application of formal and informal international harmonisation in energy efficiency requirements and suggest that it is quite possible to develop harmonised requirements for commonly traded and used products. The development of a set of common efficiency thresholds for the most important class of electric motors has allowed economies to pick and choose performance thresholds in response to their needs and to know that they are aligned with those in use elsewhere. The older Eff1 to Eff3 classification system that became commonly used in major parts of the world is giving way to the newer and more ambitious IEC IE1 to IE3 classification – this also includes an aspirational

IE4 level that is not yet applied in any economy but could become so as new more efficient products are introduced. The new IEC test method is more accurate than the older one and should be adopted by all economies as soon as possible. The challenge many economies face is to increase the coverage of motor requirements to apply to as many motor types as possible and to increase stringency to levels that are economically justified or justified by environmental benefits. There is clear evidence that those economies which apply mandatory efficiency requirements have significantly more efficient motor markets than those that don't; thus, there is a strong case for India and Japan to follow suit with the other major economies and to adopt mandatory energy performance requirements. There is also every prospect of a fully harmonised global system being developed and adopted albeit with the prospect for divergent efficiency thresholds continuing for some time. There would be considerable value from globally coordinated efforts to develop serviceable energy performance test procedures for the other significant classes of electric motor.

5.6.2 Industrial electric motor systems

Although electric motors directly consume the power used by industrial electric motor systems the major savings opportunities lie in optimising the electro-mechnical aspects of the systems and not from improving the motor efficiency per se. The principal industrial electric motor systems are:

- Mechanical movement
- Compressors
- Fans
- Pumps

There is a potential to improve the energy efficiency of industrial motor systems cost-effectively by roughly 20% to 30% and thereby to reduce total global electricity demand by about 10%. Of this about 4-5% is through the use of more efficient motors and the rest from optimising the system.

The three major routes to achieving these savings are:

- Use of properly-sised and energy-efficient motors;
- Use of adjustable-speed drives, where appropriate, to match the motor speed and torque to the system mechanical load requirements; this allows the replacement of inefficient

throttling devices and in some cases with "direct-drive" the avoidance of wasteful mechanical transmissions and gears;

- Optimisation of the complete system, including correctly sised motor, pipes and ducts, efficient gears and transmissions and efficient end-use equipment (fans, pumps, compressors, traction and industrial handling and processing systems) to deliver the required energy service with minimal energy losses.

Some of the major savings can be realised from the appropriate use of VFDs. These produce the highest benefits in systems with variable mechanical loads where torque increases nearly as the square of the rotational speed of the motor, namely for: pumps, fans and some other applications. In most cases cost effective savings can also be achieved when VFDs are used for conveyors, hoists, escalators and similar applications where the torque is more or less independent of the motor speed. Other major opportunities arise in motor driven systems from the use of efficient gears and transmissions.

With the exception of the EU motor MEPS which encourage the use of VSDs for integrated motors and drives China is the only economy that has regulatory requirements for any of the industrial electric motor driven systems. These include:

- GB19153-2009 Limited Values of Energy Efficiency and Evaluating Values of Energy Conservation for Displacement Air Compressors,
- GB19761-2009 The Minimum Allowable Values of Energy Efficiency and Evaluating Values of Energy Conservation for Fans,
- GB19762-2007 The Minimum Allowable Values of Energy Efficiency and Evaluating Values of Energy Conservation of Centrifugal Pumps for Fresh Water applications,
- GB21518-2008 Minimum Allowable Values of Energy Efficiency and Energy Efficiency Grade for AC Contactors.

The EU is considering adopting MEPS for Fans within a 125 W – 500 kW power range, including those integrated in other products. This includes products that are estimated to use about 20% of all power consumed in the EU. The estimated savings potentials from the measures under consideration is a colossal

China applies MEPS to displacement air compressors including: direct-drive portable reciprocating piston air compressors, oil-jet screw air compressors for general use, and oil-jet sliding vane air compressors for general use.

The EU has conducted Ecodesign studies for pumps and for fans and is currently considering the adoption of regulations applying to each.

This study does not attempt to compare the efficiency of the existing Chinese measures with those under consideration in the EU but notes the following:

- Serviceable international test procedures exist for industrial fan applications and the EU Ecodesign study on pumps has developed a very rigorous means of determining pump efficiency that could serve as a serviceable basis for a common international efficiency metric.
- Much more needs to be done to develop suitable test standards and efficiency metrics for the other applications.

5.6.3 Transformers

Transformers are a critical component of electricity transmission and distribution system. By stepping voltages up or down in the electricity network, they work to reduce transmission and distribution losses and improve the overall efficiency of a national electricity grid. The transformer market is primarily a custom-build industry, whereby sophisticated consumers such as electric utilities and large industrial consumers work directly with manufacturers to specify the desired electrical performance, including the loading design point and efficiency.

All the economies except for India either have or are in the process of establishing MEPRs for transformers, although there are important differences in coverage and the regulations themselves have two different metrics. India has a labelling scheme for transformers. The table below presents a summary of the range of covered products and the metrics used to establish minimum performance requirements.

Table 5.4 Transformer Program Coverage and Efficiency Metrics Applied

Country	Coverage	Efficiency Metric
China	Liquid-filled, from 30 to 1600 kVA and Dry-type, from 30 to 2500 kVA. Power transformer proposed, 31.5 MVA to 180 MVA.	Maximum levels of watts of core and watts winding losses.
Europe	Under development, anticipating coverage of liquid-filled and dry-type transformers, from 1 kVA to 500+ MVA	To be determined. Current voluntary system is based on specified limit on watts of core and winding losses
India	Liquid-filled and dry-type three-phase and double-wound non-sealed outdoor distribution transformers, 11 to 200 kVA	Maximum losses in watts (core + winding) is calculated at 50% and 100% loading, and star categories set by ranges at each kVA rating

Japan	Liquid-filled and dry-type, single and three-phase, 50Hz and 60Hz. Single-phase covers 5 to 500 kVA and three-phase 10 to 2000 kVA	Percent efficiency is calculated at 40% loading
United States	Liquid-filled and dry-type, single and three-phase, 10 to 2500 kVA	Percent efficiency is calculated at 35% or 50% loading. 35% for low-voltage dry-type and 50% for medium-voltage dry-type and liquid-filled.

In China maximum wattage losses for three-phase transformers were established under GB 20052-2006, covering 30 through 1600 kVA for liquid-filled transformers and 30 to 2500 kVA for dry-type transformers. These standards have two levels, one which became effective in 2006 (called S-9) and one that becomes effective in 2010 (called S-11). This new higher standard, S-11, has losses just slightly below the European voluntary labelling level of A-C'. China is also proposing to extend coverage to power transformers, ranging from 31.5 MVA to 180 MVA. This proposal also seeks to establish maximum levels of core losses and winding losses. The test methods cited for measuring transformer performance are GB 1094.1-1996, GB 1094.11-2007, GB 6450-1986, GB/T 10228-2008; GB/T 2009.15-1997 and GB/T 6451-2008. These test methods are based on IEC testing standards: IEC 60076-1:1993, IEC 60076-11:2004, IEC 60726:1982; IEC 60050-421:1990 and IEC 60050-321:1986. The rated metric of performance is watts of core and watts of winding losses measured as a function of the kVA rating of the transformer.

Europe currently has a transformer labelling scheme for liquid-immersed (oil or synthetic) transformers which classifies the transformers by maximum watts of losses. EN 50464-1 covers liquid-immersed transformers from 50 kVA to 2500 kVA intended for operation in three-phase distribution networks, for indoor or outdoor continuous service, 50 Hz, with a primary voltage between 3.6kV to 36 kV and a secondary voltage less than or equal to 1.1kV. The objective of this labelling scheme is to establish requirements related to the electrical performance and facilitate the specification of lower losses (i.e., higher efficiency). Performance parameters (load losses, no load losses) are specified at 75°C and transformers are tested according to EN 60076 (based on IEC 60076). The load (Pk) and no load (Po) losses are measured and compared to the subcategory of transformer. Load losses are divided into four classes, A_k (most efficient) to D_k (least efficient); and no-load losses are divided into five classes, A_o (most efficient) to E_o (least efficient).

In 2009, the European Commission initiated its work to define coverage and regulation of transmission and distribution transformers through its EuP process. This work will culminate in MEPRS for transformers in Europe with a very broad scope of coverage. Presently, the draft analysis contemplates coverage ranging from 1 kVA through 500+ MVA, and encompasses liquid-immersed and dry-type, single and three phase. Due to the early stage of this process, it has not yet been determined what the efficiency metric will be for this regulation (e.g., minimum percentage efficiency at a defined loading point or maximum watts of core and maximum watts of winding losses), therefore the test method and other details of the regulation have not yet been defined.

In India, a cooperative venture between public and private organizations established a five-star labelling program that establishes limits on total losses in transformers at 50 percent loading. The scheme recommends upgrading and installation of transformers with higher-star ratings (up to 5 stars). The program was developed by the Bureau of Energy Efficiency, a statutory body under the Ministry of Power. Manufacturers are now required to label every covered transformer, including liquid-filled and dry-type three-phase and double-wound non-sealed outdoor distribution transformers with kVA ratings from 11 to 200 kVA. The test methods used in India to qualify the star rating are Indian Standard (IS) 1180(Part 1) & (Part 2):1989, which are harmonized with IEC 60076.

Japan's electrical distribution system is designed with the last voltage step very close to the end user, thus the majority of units are pole-mounted single-phase transformers. Transformer efficiency is defined at 40% loading, and target average efficiency is set, based on the best products in the market in 2003. Japan also operates a "top-runner" programme, which is based not on the average efficiency of products sold, but on the highest efficiency level achievable. The program is expected to deliver approximately a 30.3% improvement in efficiency compared to 1999 levels. In Japan, labelling of transformers is mandatory, and a green label signifies a product that meets the minimum standard while other products receive an orange level. The Japanese test method for measuring performance of covered transformers is JIS C4304 and JIS C4306, where efficiency is recorded at 40% loading.

In the US, single-phase and three-phase distribution transformers rated 10kVA to 2500 kVA with primary voltages up to 35 kV are covered and regulated. The regulations apply to liquid-immersed and dry-type, including both low-voltage dry-type and medium-voltage dry-type. These transformers are required to meet or exceed a minimum percentage efficiency defined at

35% loading for low-voltage dry-type transformers and 50% loading for medium-voltage dry-type and liquid-immersed transformers. The US Department Energy established the test method for these products based around ANSI/IEEE C57.12.00 and ANSI/IEEE C57.12.01. A white paper authored by Virginia Transformer found that these standards were broadly similar in their testing approach, specifications and methodology to that of IEC 60076-1.

The US efficiency levels are among the highest in the world for liquid-immersed, although some degree of caution should be exercised when drawing comparisons due to differences in frequency (50 Hz vs. 60 Hz); the definitions of rated power are different between IEC and IEEE (kVA defined as input power or defined as output power); and percent efficiency can be measured at different loading points, depending on the country.

5.7 A ranking of end-uses for harmonisation potential and prospects

Arguably the greatest harmonisation potential resides where there are the least existing regulations but where there is the probability that new regulations will be forthcoming. The experience of harmonisation with external power supplies discussed previously illustrates how readily harmonisation can occur in such circumstances if there is a credible agency prepared to take the lead to promote an internationally harmonised approach. The experience of electric motors also shows that products with a relatively mature history of MEPRs can also achieve a much greater degree of harmonisation if the value proposition is clearly articulated and if there is a consistent effort to reach out to stakeholders to advance the case for alignment. In both cases the approach taken was informative and through rational persuasion rather than through a lock stepped regulatory structure and thus this seems to be the best route to attain harmonisation in the future. Given these factors and the circumstances by product type discussed in the preceding text Table 5.5 presents a first order attempt to rank end-uses in terms of their potential for harmonisation. The scoring system is a ranking out of a maximum possible score of 25. The score is derived by multiplying the score for relevance (from 1 to 5) by the score for harmonisation potential (from 1 to 5). The relevance score is a ranking of the energy savings potential and the degree of trade while the harmonisation potential is a ranking of the feasibility of achieving harmonised test procedures, product classifications and efficiency metrics.

Some of the highest scores are for products with high energy savings potentials but poor regulatory coverage such as industrial pumps, fans and compressors. Consumer electronics, lighting, ICT and some HVAC equipment also score highly. Note, that for some of these products each individual type and component has been listed (such as for each of the elements in an HID lighting system); however, there may be greater energy savings potential from harmonisation of requirements at the higher systems level e.g. for street lighting, than for the individual components.

Table 5.5 Summary of harmonisation prospects by energy using equipment type

DOMESTIC

Broad Service Area	End Use Area	End-Use	Relevance	Harmonisation Potential	Score
Domestic Lighting	Screw-based/Bayonet	GLS	2	3	6
	Screw-based/Bayonet	HL	3	3	9
	Screw-based/Bayonet	CFLi	3	4	12
	Screw-based/Bayonet	CFLn	2	4	8
	LFL	LFL	4	3	12
	Directional	HL (MV/LV)	3	4	12
	Directional	GLS	3	4	12
	Directional	LED	4	4	16

Broad Service Area	End Use Area	End-Use	Relevance	Harmonisation Potential	Score
Domestic HVAC	Boilers	Gas	3	1	3
	Boilers	Oil	3	1	3
	Boilers	Electric (resistance/HPs)	4	3	12
	Central heating	Radiators	1	1	1
	Central heating	Circulation pumps	1	3	3
	Fans	Ceiling	4	4	16
	Fans	Extraction	3	4	12
	Fans	Other	2	3	6
	Air con	RAC	5	4	20
	Ducted Air/Air	Central	2	4	8

Broad Service Area	End Use Area	End-Use	Relevance	Harmonisation Potential	Score
Domestic Hot water systems	Domestic water heaters	electric	3	3	9
	Domestic water heaters	gas	3	3	9
Major Domestic White Goods	White goods	Refrigerators	3	3	9
	White goods	Freezers	3	3	9
	White goods	Clothes Washers	3	3	9
	White goods	Clothes Dryers	2	3	6
	White goods	Dishwashers	2	4	8

Broad Service Area	End Use Area	End-Use	Relevance	Harmonisation Potential	Score
Consumer electronics	Consumer electronics	TVs	5	4	20
	Consumer electronics	Decoders	4	4	16
	Consumer electronics	Hi Fi	3	4	12
	Consumer electronics	VCR	2	4	8
	Consumer electronics	DVD	3	4	12
	Consumer electronics	Game station	3	4	12
	Consumer electronics	MP3 player	3	4	12
	Consumer electronics	Mobile Phones	3	4	12
	Consumer electronics	Chargers/Ext Power Supplies	5	5	25

Broad Service Area	End Use Area	End-Use	Relevance	Harmonisation Potential	Score
Domestic Cooking appliances	Hobs/Ranges	electric	2	2	4
	Hobs/Ranges	gas	2	2	4
	Hobs/Ranges	Range-hoods	3	3	9
	Ovens	electric	2	2	4
	Ovens	gas	2	2	4
	Ovens	microwave	2	4	8
	Ovens	combination	2	4	8
	Rice cookers	electric	3	3	9
	Rice cookers	gas	3	3	9
	Kitchen appliances	Mixers/Blenders	3	3	9
	Kitchen appliances	Coffee Makers	3	3	9
	Kitchen appliances	Kettles	3	3	9
Domestic Cleaning appliances	Cleaning appliances	Irons	2	3	6
	Cleaning appliances	Vacuum cleaners	2	3	6

COMMERCIAL

Broad Service Area	End Use Area	End-Use	Relevance	Harmonisation Potential	Score
Commercial Lighting	Directional	HL	3	4	12
	Directional	LED	4	4	16
	General area	GLS	3	4	12
	General area	LFL	4	3	12
	General area	LFL ballast	4	3	12
	General area	Luminaire	4	4	16
	Highbay/Outdoor	MH	4	4	16
	Highbay/Outdoor	MH ballast	4	4	16
	Highbay/Outdoor	CMH	4	4	16
	Highbay/Outdoor	CMH ballast	4	4	16
	Highbay/Outdoor	MV	4	4	16
	Highbay/Outdoor	MV ballast	4	4	16

Broad Service Area	End Use Area	End-Use	Relevance	Harmonisation Potential	Score
Commercial Lighting	Highbay/Outdoor	HPS	4	4	16
	Highbay/Outdoor	HPS ballast	4	4	16
	Outdoor	Traffic lights	3	3	9
	Outdoor	Pedestrian crossings	3	3	9
	Exit signs	Exit signs	3	2	6
Commercial HVAC	**Boilers**	**Gas**	**3**	**1**	**3**
	Boilers	Oil	3	1	3
	Boilers	Electric (resistance/HPs)	4	3	12
	Circulation	pumps	4	4	16
	Ventilation	AHU	4	4	16
	Ventilation	Other	4	4	16
	Air conditioning	RAC	5	4	20
	Air conditioning	Central packaged	4	4	16
	Air conditioning	Chillers	4	4	16
	Air conditioning	Chilled beam	3	4	12
Broad Service Area	**End Use Area**	**End-Use**	**Relevance**	**Harmonisation**	**Score**

Broad Service Area	End Use Area	End-Use	Relevance	Harmonisation Potential	Score
Commercial Hot water	Hot water systems	electric	3	3	9
	Hot water systems	gas	3	3	9
	Hot water systems	oil	3	3	9
Commercial Refrigeration	Refrigeration	Self contained	4	4	16
	Refrigeration	Built in	3	3	9
	Refrigeration	Remote condenser/compressors	4	3	12
	Refrigeration	Automatic icemaker	2	3	6
Commercial Laundry	Laundry	Clothes-washers	3	3	9
	Laundry	Dryers	2	3	6
Commercial Kitchen appliances	Kitchen	Dishwashers	**2**	**4**	**8**
	Kitchen	Cooking (electric)	2	2	4
	Kitchen	Cooking (gas)	2	2	4

				Potential	
ICT	ICT	Standby	3	4	12
	ICT	Networked standby	4	5	20
	ICT	Servers	4	5	20
	ICT	PCs	3	4	12
	ICT	Laptops	3	4	12
	ICT	Monitors	3	4	12
	ICT	Printers	3	4	12
	ICT	Fax machines	3	4	12
	ICT	Photocopiers	3	4	12
	ICT	Modems	3	4	12
Vending machines	Vending machines	Vending machines	4	4	16

INDUSTRIAL

Broad Service Area	End Use Area	End-Use	Relevance	Harmonisation Potential	Score
Motors	Induction	<0.75kW	5	4	20
	Induction	>0.75kW	5	5	25
	Induction	>375kW	5	4	20
	Others	Others	4	4	16
Motor driven systems	Mech. Movement	Mech. Movement	4	3	12
	Fans	Fans	5	5	25
	Compressors	Air	5	4	20
	Compressors	Other	5	4	20
	Pumps	Pumps	5	5	25
Transformers	Transformers	Transformers	3	4	12

6. ESTIMATION OF ENERGY, CO_2 AND COST SAVINGS POTENTIALS FROM HARMONISATION/ALIGNMENT OF MOST PROMISING PRODUCT TYPES

6.1 Comparisons of policy settings

In many of the economies considered in the study the coverage of energy efficiency standards and labelling is already high or will be within a few years. China and the USA have the highest coverage of MEPs and labelling as a proportion of total energy use in the residential and commercial sectors, followed by the EU and Japan (both similar), then India. The situation is far from static in any of these economies and new rafts of efficiency standards and/or labels are being introduced quite rapidly in all of them. This section begins with an analysis of some specific end-uses to provide concrete examples of how the currently adopted requirements address, or conversely fail to address, important aspects of equipment energy consumption and to thereby illustrate the types of potential that exists to improve coverage and policy ambition by adopting current best practice. The second part of this section examines for the specific cases of China, India and the EU how much energy consumption is addressed by existing policy measures and how much more could be saved were the current most comprehensive and stringent measures to be adopted. Should there be future iterations of this study it would be hoped to include comparable analyses for Japan and the US.

6.1.1 Impact of scope and ambition: the example of High Intensity Discharge lamps

Given the progressively broader coverage of minimum energy performance requirements in these economies the relative effectiveness of the measures in saving energy is increasingly a question of scope and ambition rather than whether a standard is in place or not. The example of high intensity discharge lamps, which are used for street lighting, outdoor lighting and also for high bay interior lighting is a good illustration of how these factors vary from one economy to the other and what further energy could be achieved through adopting international best practice in terms of scope and stringency. The main HID lamp technologies used internationally are high pressure sodium lamps (HPS), which have a relatively high efficacy (light output per unit input power) but emit a yellow/orange light with a low colour rendering index (a measure of how faithfully colours are reproduced by the source of illumination) and white light HID sources that include: metal halide lamps (MH), which have relatively high efficacy levels; mercury vapour lamps (MV), which are an outdated technology with low efficacy levels; and self-ballasted blended mercury lamps (SB MV), which operate on the mains power supply and don't use a separate ballast but which have very low efficacy levels. These latter have not been used in OECD countries for many years but are still very common in less affluent economies due to their low first cost. In addition to the lamp efficacy the system energy performance is also determined by the ballast efficiency and the optical efficiency of the luminaire, which is also related to the choice of light source. Lighting controls offer another option to reduce energy use and in recent times LED and plasma lamp street lights have been developed that offer the prospect of superior performance to HIDs in the near future.

Of the five economies, two (Japan and India) currently have no minimum energy performance requirements for HIDs. China has MEPS for High Pressure Sodium lamps (HPS), Metal Halide (MH) lamps and for HPS ballasts and MH ballasts. The US has MEPs for MH ballasts used with new luminaires (with different requirements depending on whether the ballast is to be used with a pulse-start MH or with a MH using an electronic-ballast). The US has no MEPS for MH or Mercury Vapour (MV) lamps but has banned the sale of new ballasts for use with MV lamps and thus is phasing them out at the rate the ballasts fail and are not permitted to be replaced. The EU has recently adopted MEPs that apply to all HID types and HID ballasts which have the effect of prohibiting the sale of all MV lamps and prohibiting the sale of the less efficient varieties of HPS and MH lamps and ballasts.

It is instructive to examine how the scope and ambition of these policy settings impacts the energy savings potentials from MEPRs. For example were China to adopt the world's most stringent MEPS for MH lamps and ballasts it is estimated that it would lower MH energy consumption by 29% but if they were to extend these requirements to apply to all white light HID sources and ballasts they would lower the energy consumption compared to MV lamps by 47% and for SB MV lamps by 78%. Overall this would eventually lower their street lighting energy use by 38%, see Table 6.1. Adopting the World's most stringent MEPS would eventually reduce EU street-lighting energy use by 15%, mainly through completing the phase-out of MV lamps as is already underway but also by improving MH efficiency by another 14%; however, using world best HID technology would increase this saving to 35% (partly through better optical efficiency of the luminaire).

The US has a lower savings potential, largely because it began to phase out MV through the ban on MV ballasts much earlier, but still could reduce HID energy use by about 25% were best HID technology adopted across the board. Overall this example illustrates the importance of not just having MEPS by lamp and component type but also of ensuring that when the service offerings between technologies are sufficiently similar (as they are for MH and MV) that the scope of the MEPS is broadened to preclude the inefficient technology option. In other words, applying MEPS within technology classes will often miss the larger savings to be had by making the requirements technology neutral but set at the level that requires the more efficient technology to be adopted.

This analysis also shows that current MEPS do not capture a significant proportion of the overall technical savings potential because they do not influence all the key aspects which influence the efficiency of the service operating as a system (e.g. the luminaire optical efficiency in this case).

Table 6.1 Estimated HID lighting savings potentials

Savings potential from adopting world's most stringent MEPS						
	China	**EU**	**India**	**Japan**	**USA**	**All**
MH	29%	14%	32%	17%	0%	13%
HPS	26%	0%	28%	17%	8%	14%
MV	47%	47%	47%	47%	47%	47%
SB MV	78%		78%			78%
All HID	38%	15%	42%	27%	5%	22%
Savings potential from adopting world highest efficiency HID technology						
	China	**EU**	**India**	**Japan**	**USA**	**All**
MH	47%	35%	49%	37%	25%	34%
HPS	40%	14%	42%	33%	20%	28%
MV	62%	62%	62%	62%	62%	62%
SB MV	85%	NA	85%	NA	NA	85%
All HID	53%	33%	56%	44%	25%	39%

6.1.2 Impact of scope and ambition: the example of non-directional domestic lighting

Non-directional domestic lighting provides another classic illustration of the importance of how the scope of MEPS is defined and how they address energy use to provide the primary service.

Until recently economies used to apply MEPS separately for each class of incandescent lamp, halogen lamp and CFLi, if they set requirements at all. This typically lead to energy savings of just a few percent per end-use as the least efficient lamps in each lamp technology class were eliminated from sale. However, in recent years the scope of regulations has been broadened and the manner in which functionality (service) is determined has also been better defined so that a wider set of technologies, all capable of providing the same lighting service, are mixed into the same rulemaking. This has the effect of excluding certain fundamentally inefficient technologies from the market and of attaining much higher efficiency levels.

For example, prior to 2007 the US set separate MEPS for incandescent lamps, CFLi, and various classes of reflector lamp which had the effect of precluding the least efficient products within each lamp technology class from sale. In the case of the incandescent reflector lamps the requirements only applied to lamps of standard shapes and in consequence new shapes of lamps appeared on the market that were exempt from the standards. Today these lamps (ER and BR reflector lamps) are only found in the North American market and appear to have been developed as a means of evading mandatory efficacy requirements. By contrast, from the end of 2007 the US EISA regulations changed the scope of the MEPS which were previously applied to incandescent lamps (GLS, standard incandescent lamps) such that in the future they applied to all omni-directional screw-based lamps of certain standard socket sises. Stringency was simultaneously increased, such that only some of the higher efficacy halogen technologies, CFLi and higher efficiency alternatives (e.g. LEDS) can meet them. As CFLi are slightly cheaper than the halogen alternatives this is likely to result in a large part of the future screw-based lamp market being taken by high efficacy CFLi and produce much greater energy savings (up to 80% compared with GLS). The US reflector lamp requirements still make a distinction based on lamp shape (which has negligible impact on the attainable performance) rather than applying universal requirements across the range of lamps providing comparable service, although this may change in future rulemakings (see discussion in Appendix C).

The EU's household lamp regulations of 2009 take the principle a step further in that they essentially only distinguish between clear and non-clear lamps (of whatever type) used for household applications. The non-clear lamps (which previously dominated EU GLS sales) are required to meet efficacy levels that currently can only be achieved by the better quality and higher efficacy CFLi. Thus, with a single ruling based on the premise of technology neutral performance requirements set near the level of the best currently available and affordable technology that can provide the required service, the MEPs have phased-out non-clear GLS and the less efficient classes of CFLi at the same time. The EU clear lamp requirements are set at levels that permit advanced halogen technology and better but get progressively more stringent over time so in the future only the most efficient (and expensive) halogen technology will be eligible which is likely to increase demand for CFLi and LEDs.

6.1.3 Impact of scope and ambition: the example of air conditioners and refrigerators

There are numerous other examples of where MEPRs have been set at levels that don't differentiate by the efficiency of the service offered but by the technology. For example, Japan previously set different Top Runner requirements for refrigerators and air conditioners that used variable frequency drives (inverters) and vacuum insulation panels (only in the case of refrigerators) and for the less efficient equipment, which didn't. Happily, in the most recent requirements these distinctions have been removed and now the efficiency thresholds are just set at the level of the more efficient technologies (without specifying what that technology is). Japan still maintains technology differentiated MEPRs for certain lighting products, however.

6.1.4 Directional lamps: harmonisation potential for an end-use not yet properly covered

Directional lamps are lamps that are designed to direct their light output rather than to shine light omni-directionally. Traditionally these have been incandescent reflector lamps but since the 1980s halogen reflector lamps entered the market and became very popular, especially in 230-240V mains power markets. In the 1990s CFL reflector lamps entered the market and in the last five years LEDs have started to emerge into general lighting applications. Directional lighting is one of the most appropriate uses of LEDs and competing with reflector lamps is likely to be one of the first general illumination markets that LEDs successfully enter. There are specific needs for energy performance testing standards for directional lamps (of whatever type) and lack of serviceable test standards has been a main reason why many regulatory authorities have not yet imposed requirements on this end-use. With the exception of the ER and BR incandescent reflector lamps found only in North America the other classes of reflector lamps are common to all markets and thus there is a universal need to develop serviceable test procedures and methodologies. Such energy performance measurement standards are a necessary element to support the development of LEDs but many other quality standards are also needed to allow the characteristics of LEDs to be properly determined. As numerous economies are currently developing or attempting to develop regulatory requirements for directional lamps including Australia, Canada, the EU and the USA and others are likely to follow this appears to be an ideal moment to aim to establish harmonised test procedures and potentially energy performance requirements; however, activities are underway in all these economies currently so if efforts are not made to bring these together there is a risk they will fragment and end up producing a set of incompatible and incomparable performance requirements. Appendix C explores these issues in more depth.

6.2 Policy coverage of MEPRs for the five economies

Reviewing the coverage of minimum energy performance regulations by economy is one means of determining the potential for increased savings through greater international harmonisation of regulatory settings. This section details the existing coverage in the five economies. It does not indicate the coverage of energy labelling or other policy instruments although these are often essential parts of the market transformation policy toolkit. Nor does it imply that having MEPRs is always appropriate as this can depend upon a number of other locally pertinent issues.

6.2.1 Minimum energy performance requirements in the domestic sector

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
Lighting	Screw-based/Bayonet	GLS	No	Yes	No	UD	Yes	Yes
	Screw-based/Bayonet	HL	No	Yes	No	No	Yes	Yes
	Screw-based/Bayonet	CFLi	Yes	Yes	No	No	Yes	Yes
	Screw-based/Bayonet	CFLn	Yes	Yes	No	Yes	No	Yes
	LFL	LFL	Yes	Yes	No	Yes	Yes/UD	Yes
	Directional	HL (MV/LV)	No	UD	No	No	UD	UD
	Directional	GLS	No	UD	No	UD	Yes	Yes
	Directional	LED	No	Yes	No	No	Pending	Yes

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
HVAC	Boilers	Gas	Yes	Yes	No	Yes	Yes	Yes
	Boilers	Oil	No	Yes	No	Yes	Yes	Yes
	Boilers	Electric (resistance/HPs)	No	UD	No	No	Yes	Yes
	Central heating	Radiators	No	UD	No	No	?	UD
	Central heating	Circulation pumps	Yes	Yes	No	No	No	Yes
	Fans	Ceiling	Yes	Pending	No	No	Yes	Yes
	Fans	Extraction	Yes	Pending	No	No	No	Yes
	Fans	Other	Yes	Pending	No	No	No	Yes
	Air con	RAC	Yes	Pending	No	Yes	Yes	Yes
	Ducted Air/Air	Central	Yes	Pending	No	Yes	Yes	Yes

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
Hot water systems	Domestic water heaters	electric	Yes	Pending	No	No	Yes	Yes
	Domestic water heaters	gas	Yes	Yes	No	Yes	Yes	Yes
Major Domestic White Goods	White goods	Refrigerators	Yes	Yes	No	Yes	Yes	Yes
	White goods	Freezers	Yes	Yes	No	Yes	Yes	Yes
	White goods	Clothes Washers	Yes	Pending	No	No	Yes	Yes
	White goods	Clothes Dryers	No	Pending	No	No	Yes	Pending
	White goods	Dishwashers	No	Pending	No	No	Yes	Pending

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
Consumer electronics	Cons. electronics	TVs	Yes	Yes	No	Yes	Pending	Yes
	Cons. electronics	Decoders	UD	Yes	No	No	No	Yes
	Cons. electronics	Hi Fi	No	UD	No	No	No	UD
	Cons. electronics	VCR	No	UD	No	Yes	No	Yes
	Cons. electronics	DVD	No	UD	No	Yes	No	Yes
	Cons. electronics	Game station	No	UD	No	No	No	UD
	Cons. electronics	MP3 player	No	UD	No	No	No	UD
	Cons. electronics	Mobile Phones	No	No	No	No	No	No
	Cons. electronics	Chargers/Ext Power Supplies	Yes	Yes	No	No	Yes	Yes

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
Domestic ICT	Home ICT	Standby	No	Yes	No	No	No	Yes
	Home ICT	PCs	UD	Pending	No	Yes	No	Pending
	Home ICT	Laptops	No	Pending	No	Yes	No	Pending
	Home ICT	Monitors	Yes	Pending	No	No	No	Yes
	Home ICT	Printers	No	Pending	No	No	No	Pending
	Home ICT	Fax machines	No	Pending	No	No	No	Pending
	Home ICT	Photocopiers	Yes	Pending	No	Yes	No	Yes
	Home ICT	Modems	No	UD	No	No	No	UD
	Home ICT	Chargers/Ext Power Supplies	Yes	Yes	No	No	Yes/Pending	Yes

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
Domestic Cooking appliances	Hobs/Ranges	electric	Yes	UD	No	No	Pending	Yes
	Hobs/Ranges	gas	UD	UD	No	Yes	Pending	Yes
	Hobs/Ranges	Range-hoods	Yes	NA	No	No	No	Yes
	Ovens	electric	Yes	UD	No	No	Pending	Yes
	Ovens	gas	UD	UD	No	Yes	Pending	Yes
	Ovens	microwave	No	UD	No	Yes	Pending	Yes
	Ovens	combination	No	UD	No	Yes	Pending	Yes
	Rice cookers	electric	Yes	No	No	Yes	No	Yes
	Rice cookers	gas	No	No	No	No	No	No
	Kitchen appliances	Mixers/Blenders	No	No	No	No	No	No
	Kitchen appliances	Coffee Makers	No	UD	No	No	No	UD

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
Cooking appliances	Kitchen appliances	Kettles	No	No	No	No	No	No
Cleaning appliances	Cleaning appliances	Irons	Yes	No	No	No	No	Yes
	Cleaning appliances	Vacuum cleaners	No	UD	No	No	No	UD
Outdoor appliances	Garden/Outdoor	Electric mowers	No	No	No	No	No	No
	Garden/Outdoor	Petrol mowers	No	No	No	No	No	No
	Garden/Outdoor	Shears/Trimmers	No	No	No	No	No	No
	Garden/Outdoor	Outdoor heaters	No	No	No	No	No	No
	Pool	Pool pumps	No	No	No	No	No	No
	Pool	Pool heaters	No	No	No	No	Pending	Pending
	Indoor/Outdoor	Jacuzzis	No	No	No	No	No	No

6.2.2 Minimum energy performance requirements in the commercial sector

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
Lighting	Directional	HL	Yes	Yes	No	No	?	Yes
	Directional	LED	No	No	No	No	UD	UD
	General area	GLS	No	Yes	No	UD	Yes	Yes
	General area	LFL	Yes	Yes	No	Yes	Yes	Yes
	General area	LFL ballast	Yes	Yes	No	integrated/No	Yes (T12 only)	Yes
	General area	Luminaire	No	No	No	No	MH fixture due 2012	No
	General area	Control	No	No	No	No	No	No
	Highbay	MH	Yes	Yes	No	No	UD	Yes
	Highbay	MH ballast	Yes	Yes	No	No	Yes	Yes
	Highbay	CMH	Yes	Yes	No	No	UD	Yes

Broad Service Area	End Use Area	End-Use	Economy					
			China	**Europe**	**India**	**Japan**	**United States**	**All**
Lighting	Highbay	CMH ballast	Yes	Yes	No	No	Yes	Yes
	Highbay	MV	No	Yes	No	No	Yes	Yes
	Highbay	MV ballast	No	No	No	No	Yes	Yes
	Highbay	LFL	Yes	Yes	No	Yes	Yes	Yes
	Highbay	LFL ballast	Yes	Yes	No	integrated/No	MV only	Yes
	Highbay	System	No	No	No	No	No	No
	Outdoor	MV	No	Yes	No	No	UD	Yes
	Outdoor	MV ballast	No	No	No	No	Yes	Yes
	Outdoor	MH	Yes	Yes	No	No	UD	Yes
	Outdoor	MH ballast	Yes	Yes	No	No	Yes	Yes
	Outdoor	CMH	Yes	Yes	No	No	UD	Yes
	Outdoor	CMH ballast	Yes	Yes	No	No	Yes	Yes

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
Lighting	Outdoor	HPS	Yes	Yes	No	No	UD	Yes
	Outdoor	HPS ballast	Yes	Yes	No	No	No	Yes
	Outdoor	Ballast	Yes	Yes	No	No	MV only	Yes
	Outdoor	System	No	No	No	No	MH fixture due 2012	UC
	Outdoor	Traffic lights	No	No	No	No	Yes	Yes
	Outdoor	Pedestrian crossings	No	No	No	No	Yes	Yes
	Exit signs	Exit signs	No	No	No	No	Yes	Yes

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
HVAC	Boilers	Gas	No	Pending	No	Yes	Yes	Yes
	Boilers	Oil	No	Pending	No	Yes	Yes	Yes
	Boilers	Electric (resistance/HPs)	No	UD	No	No	No	UD
	Boilers	System	No	No	No	No	No	No
	Circulation	pumps	Yes	Yes	No	No	No	Yes
	Ventilation	AHU	No	Pending	No	No	No	Pending
	Ventilation	Other	Yes	No	No	No	No	No
	Ventilation	System	No	No	No	No	No	No
	Air conditioning	RAC	Yes	Pending	No	Yes	Yes	Yes
	Air conditioning	Central packaged	Yes	No	No	Yes	Yes	Yes
	Air con.	Chillers	Yes	No	No	No	No	Yes

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
Air con.	Air conditioning	Chilled beam	No	No	No	No	No	No
	Air conditioning	System	No	No	No	No	No	No
Hot water	Hot water systems	electric	No	Pending	No	No	Yes	Yes
	Hot water systems	gas	No	Pending	No	Yes	Yes	Yes
	Hot water systems	oil	No	Pending	No	Yes	Yes	Yes
Refrigeration	Refrigeration	Self contained	No	UD	No	No	Yes	Yes
	Refrigeration	Built in	No	UD	No	No	Yes	Yes
	Refrigeration	Remote condenser/compressors	No	UD	No	No	No	UD
	Refrigeration	Automatic icemaker	No	No	No	No	Yes	Yes

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
Laundry	Laundry	Clothes-washers	No	UD	No	No	Yes	Yes
	Laundry	Dryers	No	UD	No	No	Yes	Yes
Kitchen appliances	Kitchen	Dishwashers	No	UD	No	No	Yes	Yes
	Kitchen	Cooking (electric)	No except rice-cookers (GB 12021.6-2008) and induction cookers (GB 21456-2008)	UD	No	No	?	UD
	Kitchen	Cooking (gas)	No	UD	No	Yes	?	Yes

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
ICT	ICT	Standby	No	Yes	No	No	No	Yes
	ICT	Networked standby	No	UD	No	No	UD	UD
	ICT	Servers	UD	UD	No	Yes	No	Yes
	ICT	PCs	UD	Pending	No	Yes	No	Yes
	ICT	Laptops	No	Pending	No	Yes	No	Yes
	ICT	Monitors	Yes	Pending	No	No	No	Yes
	ICT	Printers	No	Pending	No	No	No	Pending
	ICT	Fax machines	No	Pending	No	No	No	Pending
	ICT	Photocopiers	Yes	Pending	No	Yes	No	Yes
	ICT	Modems	No	UD	No	No	No	UD
Pumps	Pumps	Pumps	Yes	No	No	No	No	Yes

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
Motors	Motors	Motors<0.75kW	No	No	No	No	Yes	Yes
	Motors	Motors>0.75kW	Yes	Yes	No	No	Yes	Yes
Vending machines	Vending machines	Vending machines	No	UD	No	Yes	Yes	Yes

6.2.3 Minimum energy performance requirements in the industrial sector

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
Lighting	Directional	HL	Yes	Yes	No	No	?	Yes
	Directional	LED	No	No	No	No	UD	UD
	General area	GLS	No	Yes	No	UD	Yes	Yes
	General area	LFL	Yes	Yes	No	Yes	Yes	Yes
	General area	LFL ballast	Yes	Yes	No	integrated/No	Yes (T12 only)	Yes
	General area	Luminaire	No	No	No	No	MH fixture due 2012	No
	General area	Control	No	No	No	No	No	No
	Highbay	MH	Yes	Yes	No	No	UD	Yes
	Highbay	MH ballast	Yes	Yes	No	No	Yes	Yes
	Highbay	CMH	Yes	Yes	No	No	UD	Yes

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
Lighting	Highbay	CMH ballast	Yes	Yes	No	No	Yes	Yes
	Highbay	MV	No	Yes	No	No	Yes	Yes
	Highbay	MV ballast	No	No	No	No	Yes	Yes
	Highbay	LFL	Yes	Yes	No	Yes	Yes	Yes
	Highbay	LFL ballast	Yes	Yes	No	integrated/No	MV only	Yes
	Highbay	System	No	No	No	No	No	No
	Outdoor	MV	No	Yes	No	No	UD	Yes
	Outdoor	MV ballast	No	No	No	No	Yes	Yes
	Outdoor	MH	Yes	Yes	No	No	UD	Yes
	Outdoor	MH ballast	Yes	Yes	No	No	Yes	Yes
	Outdoor	CMH	Yes	Yes	No	No	UD	Yes
	Outdoor	CMH ballast	Yes	Yes	No	No	Yes	Yes

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
Lighting	Outdoor	HPS	Yes	Yes	No	No	UD	Yes
	Outdoor	HPS ballast	Yes	Yes	No	No	No	Yes
	Outdoor	Ballast	Yes	Yes	No	No	MV only	Yes
	Outdoor	System	No	No	No	No	MH fixture due 2012	UC
	Outdoor	Traffic lights	No	No	No	No	Yes	Yes
	Outdoor	Pedestrian crossings	No	No	No	No	Yes	Yes
	Exit signs	Exit signs	No	No	No	No	Yes	Yes

Broad Service Area	End Use Area	End-Use	Economy					
			China	Europe	India	Japan	United States	All
Motors	Induction	<0.75kW	No	No	No	No	Yes	Yes
	Induction	>0.75kW	Yes	Yes	No	No	Yes	Yes
	Induction	>375kW	No	No	No	No	No	No
	Others	Others	No	No	No	No	No	No
Motor driven systems	Mech. Movement	Mech. Movement	No	No	No	No	No	No
	Fans	Fans	No	Pending	No	No	No	Pending
	Compressors	Air	Yes	No	No	No	No	Yes
	Compressors	Other	No	No	No	No	No	No
	Pumps	Pumps	Yes/No	Pending	No	No	No	Yes/Pending
Transformers	Transformers	Transformers	Yes	UD	No	Yes	Yes	Yes

6.3 Analysing the impact of harmonising with World's Best energy performance requirements and assessing the impact of policy coverage and stringency

In the next three sections analyses are given of the impact of policy coverage and the ambition of the policy settings on the energy savings that could still be realised through the adoption of advanced MEPRS for the three major economies China, the EU and India. In each case results are given of the proportion of electricity, oil and gas consumption that is currently covered by MEPRs and estimates are also made of what energy use is not currently covered by such requirements. The results cover the electricity consumed in the domestic, commercial (including agriculture) and industrial sectors but not in transportation or other uses. For oil and gas consumption only non-transport related uses in the domestic and commercial sectors are considered. Thus the figures reported for all sectors do not include consumption in transportation end-uses of any kind and do not include oil and gas consumed in the industrial sector. In addition to analysing the current share of energy covered by MEPRs the analysis projects forward energy consumption by end-use in each economy and considers the following:

- The energy consumption that would be subject to MEPRS were the current "World Best" MEPRs to be adopted (for both 2020 and 2030)
- The energy savings in 2030 from adopting current World Best MEPS
- The energy savings in 2030 from adopting current World Best technology

These results are reported for each end-use and sector. The use of the term World's Best simply means the most stringent (in the case of MEPRS) or most efficient (in the case of technology). These are based on today's MEPRS in the five major economies considered here and do not assume any evolution of such requirements even though this is will clearly happen over the timeframe addressed. Nor does it consider the possibility that more stringent or more broadly-based policy settings are in place in other economies not addressed here; however, in practice, with a few exceptions, the most significant policies are applied within the five target economies of this study and so this simplification will only lead to a slight undercounting compared to a true World's Best analysis.

The analysis is thus intended to show what extra policy coverage and energy savings could be achieved in each economy from the adoption of regulatory requirements that already exist in another major economy. The terms World Best is a simplification because the manner in which it is implied takes no account of other factors that may be relevant to regulators in choosing such measures including:

- cost effectiveness with local energy prices and usage patterns
- industrial policy

- dynamic developments in technology, costs and usage behaviour
- the importance of environmental and energy security considerations in policy settings

Furthermore, the analysis only focuses on the impact of adopting mandatory energy performance requirements and does not consider the impacts of energy labelling, incentive schemes, procurement policies or other market transformation related policy measures. This is in order to limit the scope of the analysis to a more manageable task within the confines of the available project. By restricting the comparison to those requirements already in place somewhere in the five economies the analysis does; however, demonstrate that such measures are feasible and attainable and that at least one of the major economies has considered them appropriate for adoption. It therefore presents a picture of what more policy coverage and energy savings could be gained from international harmonisation to the current most stringent requirements. It is thus a conservative scenario in some respects because it does not take account of on-going increases in the ambition and coverage of policy settings into the future and what could be attained through a dynamic harmonisation process.

The rigour of the analysis is not consistent between the three economies addressed. In general more than one source of published data on the consumption of each end use was available for the EU and this enabled greater confidence in the attribution of energy consumption among the end uses than was the case for the other economies. In particular the EU analysis drew upon the results published in the various Ecodesign studies and from the JRC report *Electricity Consumption and Efficiency Trends in European Union - Status Report 2009*[iii]. IEA data[vii] was used for all economies to apply boundaries on the energy consumption by each sector and the reference case projections of energy use in 2020 and 2030 were taken from IEA World Energy Outlook[viii] forecasts. It is assumed in the scenarios presented here that the relative consumption by end-use remains static in each sector. This is clearly a major simplification but it would require a full and major bottom up modelling analysis to explore the relative changes in demand by end-use within each sector and this was beyond the scope of the current analysis. In the case of China and India much use was made of the energy consumption by end-use results published in the Global Carbon Impacts of Energy Using Products[ix] report produced for Defra in the UK and using findings produced with LBNL's BUENAS model. The modelling of demand by end-use addresses more end-uses and is more refined in the current analysis thus in order to attribute energy consumption within the end-uses ratios were applied based on data from other economies (notably the EU) and the expert judgement of the analysts. The findings could therefore certainly be improved through the use of the best available data on consumption by end-use known to each economy and this is an activity that could be addressed in any future analyses. As such the results from the analysis should be considered to be indicative rather than definitive. The details of the modelling methodology are described in Appendix D.

6.4 Impact of policy coverage and ambition: the example of China

China has the largest number of mandatory equipment regulations among the major economies. Details of many of these are given in Part 3 of this report. In total China applies MEPS to 43 specific end-uses and is developing regulations for 6 more energy using equipment types. Most of the equipment types subject to MEPS are also required to display a mandatory categorical energy label or indicate the equipment performance on a rating plate and catalogues according to a set of efficiency classifications. An even larger list of energy using equipment is eligible to receive an endorsement label. Despite this there are still some significant gaps in policy coverage and some significant end-uses that are not yet regulated in China but which are in one or more of the other major economies. The most important are the following:

- GLS lamps (these are not subject to MEPS and are consequently still permitted for sale in China)
- Standby power (as a horizontal requirement)
- Mercury vapour lamps and self-ballasted mercury lamps (these are not subject to MEPS and are consequently still permitted for sale in China)
- Commercial gas and electric hot water systems
- Commercial refrigeration equipment
- Computers and servers (both under development)
- Vending machines
- Commercial gas and oil-fired boilers and commercial electric space heating devices
- Commercial cooking appliances
- Directional lamps and halogen lamps
- Gas cooking appliances (these are under development)
- Oil-fired boilers and water heaters
- Electric space heaters
- Microwave ovens
- Range hoods (extractor fans)
- Clothes dryers
- Dishwashers
- LEDs
- Set top boxes
- VCRs and DVDs

Among those products which are not subject to MEPS in any of the economies, the most important in China are:

- Commercial air handling units

- Some classes of industrial electric fan
- Some classes of industrial electric pump
- Electric motors of > 375kW and also of <1kW

6.4.1 Energy coverage of existing regulations

Current regulations in place in China cover:

- 62% of domestic electricity consumption and 24% of domestic oil and gas consumption
- 47% of commercial electricity consumption and 0% of commercial oil and gas consumption
- 75% of industrial electric motor consumption and 24% of industrial electric motor system consumption

Overall regulations address 64% of the electricity consumption in the domestic, commercial and industrial sectors and 10% of the oil and gas consumption in the domestic and commercial sectors; see Figures 6.1 to 6.4 and Tables 6.2 to 6.4.

In exploring opportunities to improve policy coverage the biggest gaps are for domestic and commercial oil and gas applications and (in common with all economies) for industrial electric motor driven systems (although China currently has the highest policy coverage in this sector). Large opportunities also exist for lighting (GLS, MV, self ballasted-mercury and halogen lamps), commercial electrical applications (refrigeration applications, air handling units, space heating).

6.4.2 Impacts of adopting World Best Regulations

Were the World's Best MEPRS to be adopted the coverage would become:

- 98% of domestic electricity consumption and 89% of domestic oil and gas consumption
- 61% of commercial electricity consumption and 100% of commercial oil and gas consumption
- 75% of industrial electric motor consumption and 24% of industrial electric motor system consumption

Adoption of World's Best MEPRs would increase the overall coverage of regulations to:

- 73% of the electricity consumption in the domestic, commercial and industrial sectors
- 96% of the oil and gas consumption in the domestic and commercial sectors;

See Figures 6.5 to 6.12 and Tables 6.2 to 6.4.

The additional energy savings in 2030 from adopting World Best MEPRs are estimated to be:

- 19% of domestic electricity consumption (229 TWh/year)
- 4% of domestic oil and gas consumption (39 TWh/year)
- 21% of commercial electricity consumption (216 TWh/year)
- 7% of commercial oil and gas consumption (91TWh/year)
- 3% of industrial electricity consumption (118 TWh/year)

Overall some 564 TWh of electricity and 130 TWh of oil and gas could be saved annually, amounting to about 8% of all energy use in the sectors considered.

6.4.3 Impacts of utilising World Best Technology

A simple analysis of the savings potential from using today's most energy efficient technology reveals the following annual energy savings would be realised by 2030:

- 49% of domestic electricity consumption (593 TWh/year)
- 8% of domestic oil and gas consumption (77 TWh/year)
- 45% of commercial electricity consumption (462 TWh/year)
- 12% of commercial oil and gas consumption (154 TWh/year)
- 25% of industrial electricity consumption (994 TWh/year)

Overall some 2048 TWh of electricity and 231 TWh of oil and gas could be saved annually, amounting to about 27% of all energy use in the sectors considered. The technologies considered only include energy end-use technologies and do not address other systems which may affect energy demand such as building envelopes etc.

Figure 6.1: Energy consumption and energy subject to MEPS in 2010 for China

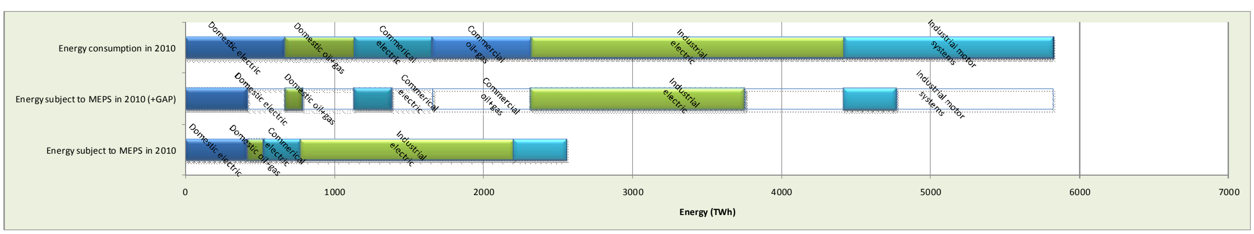


Table 6.2: Energy consumption, energy subject to MEPS, and potential future savings for China: Domestic sector

	Domestic (electric) (TWh)									Domestic (oil+gas) (TWh)			
	Lighting	HVAC	Hot Water	White Goo	Consumer	Standby	ICT	Cooking	**Total**	Heating	Hot Water	Cooking	**Total**
Energy consumption in 2010	121	99	83	174	141	14	11	26	668	370	31	68	469
Energy consumption in 2020	171	139	118	244	239	20	16	35	982	512	54	108	674
Energy consumption in 2030	240	196	153	343	188	28	23	45	1216	646	81	279	1005
Energy subject to MEPS in 2010	30	3	83	173	124	0	1	1	414	82	31	0	114
Energy subject to MEPS in 2020 (with pending)	42	4	118	243	233	0	12	34	686	141	54	33	228
Energy subject to MEPS in 2020 (with worlds best)	167	139	118	243	235	20	2	35	959	512	54	33	598
Energy subject to MEPS in 2030 (with worlds best)	235	196	153	341	183	28	3	45	1184	646	81	41	767
MEPS coverage 2010	25%	3%	100%	99%	88%	0%	12%	4%	62%	22%	100%	0%	24%
MEPS coverage 2020 (with pending)	25%	3%	100%	99%	98%	0%	75%	96%	70%	28%	100%	30%	34%
MEPS coverage 2020 (with worlds best)	98%	100%	100%	99%	99%	100%	12%	99%	98%	100%	100%	30%	89%
MEPS coverage 2030 (with worlds best)	98%	100%	100%	99%	97%	100%	12%	99%	97%	100%	100%	15%	76%
Additional 2030 savings from Worlds Best MEPS	94	21	8	32	50	21	2	2	229	35	3	2	39
Additional 2030 savings from Worlds Best Technology	155	98	54	172	80	25	4	7	593	65	6	7	77
Additional 2030 savings from Worlds Best MEPS	39%	10%	5%	9%	27%	74%	9%	4%	19%	5%	4%	1%	4%
Additional 2030 savings from Worlds Best Technology	64%	50%	35%	50%	42%	90%	16%	16%	49%	10%	7%	2%	8%

Figure 6.2: Energy consumption and energy subject to MEPS in 2010 for China: Domestic sector

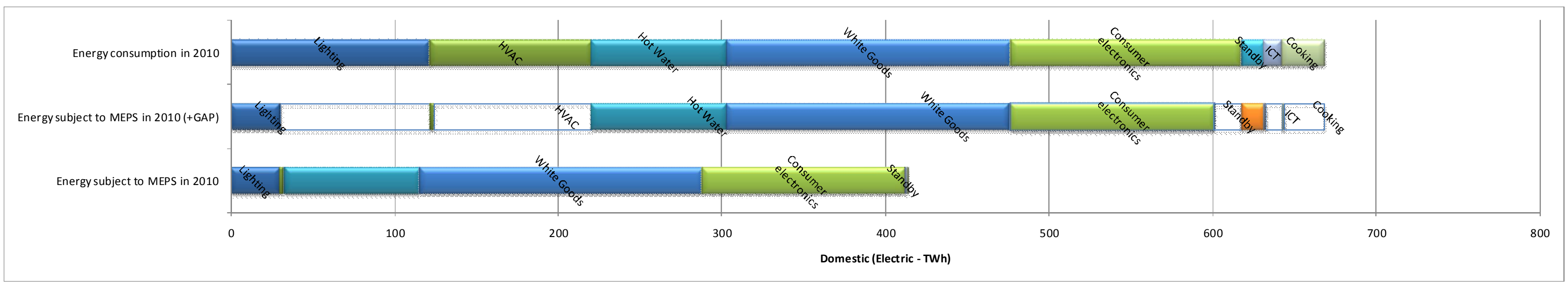


Table 6.3: Energy consumption, energy subject to MEPS, and potential future savings for China: Commercial sector

	Commercial (electric) (TWh)									Commercial (oil+gas) (TWh)			
	Lighting	HVAC	Hot Water	Refrigerat	Standby	ICT	Cooking	Pumps	Total	Heating	Hot Water	Cooking	Total
Energy consumption in 2010	153	264	3	32	4	33	1	31	521	623	19	24	666
Energy consumption in 2020	215	371	4	46	5	47	2	43	732	861	33	38	932
Energy consumption in 2030	303	521	5	64	8	66	2	61	1030	1087	49	98	1234
Energy subject to MEPS in 2010	145	67	0	0	0	4	0	31	247	0	0	0	0
Energy subject to MEPS in 2020 (with pending)	211	95	0	0	0	35	0	43	384	0	0	0	0
Energy subject to MEPS in 2020 (with worlds best)	215	95	4	46	5	39	0	43	447	861	33	48	942
Energy subject to MEPS in 2030 (with worlds best)	303	133	5	64	8	55	0	61	629	1087	49	61	1197
MEPS coverage 2010	95%	26%	0%	0%	0%	12%	0%	100%	47%	0%	0%	0%	0%
MEPS coverage 2020 (with pending)	98%	26%	0%	0%	0%	74%	0%	100%	52%	0%	0%	0%	0%
MEPS coverage 2020 (with worlds best)	100%	26%	100%	100%	100%	84%	0%	100%	61%	100%	100%	127%	101%
MEPS coverage 2030 (with worlds best)	100%	26%	100%	100%	100%	84%	0%	100%	61%	100%	100%	62%	97%
Additional 2030 savings from Worlds Best MEPS	115	79	1	6	6	3	0	6	216	87	1	3	91
Additional 2030 savings from Worlds Best Technology	145	268	2	16	7	7	0	15	462	141	3	10	154
Additional 2030 savings from Worlds Best MEPS	38%	15%	10%	10%	74%	5%	0%	10%	21%	8%	2%	3%	7%
Additional 2030 savings from Worlds Best Technology	48%	51%	40%	25%	90%	11%	16%	25%	45%	13%	6%	10%	12%

Figure 6.3: Energy consumption and energy subject to MEPS in 2010 for China: Commercial sector

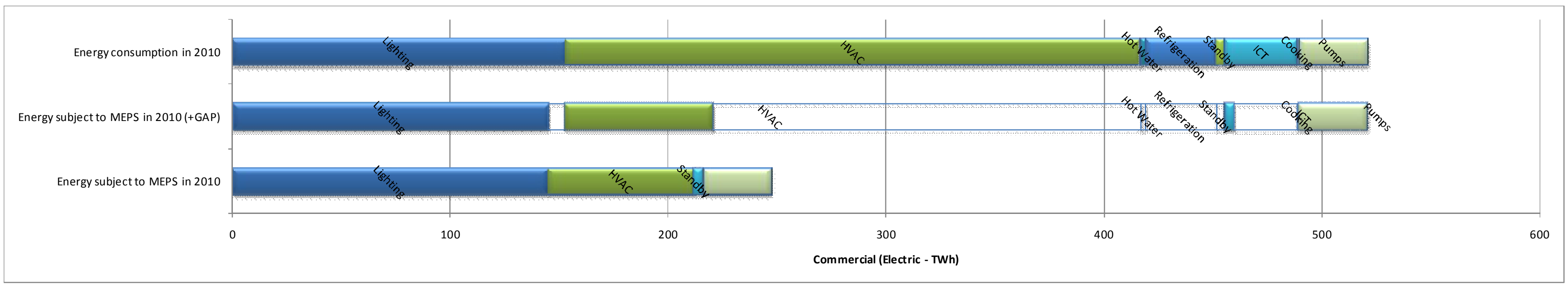


Table 6.4: Energy consumption, energy subject to MEPS, and potential future savings for China: Industrial sector and all sectors

	Industry (electricity) (TWh)								All (TWh)		
	Motors >1kW	>375kW	Pumps	Mech. Mo	Fans	Compress	Other	Total	Electricity	Oil+Gas	All
Energy consumption in 2010	1079	359	294	532	224	350	659	2097	3286	1135	4420
Energy consumption in 2020	1495	498	408	738	311	485	914	2906	4620	1605	6226
Energy consumption in 2030	2072	690	565	1022	430	673	1266	4027	6273	2238	8511
Energy subject to MEPS in 2010	1079	0	0	0	0	350	0	1429	2090	114	2203
Energy subject to MEPS in 2020 (with pending)	1495	0	0	0	0	374	0	1868	2938	228	3165
Energy subject to MEPS in 2020 (with worlds best)	1495	0	0	0	0	485	0	1980	3387	1540	4927
Energy subject to MEPS in 2030 (with worlds best)	2072	0	0	0	0	673	0	2744	4557	1964	6521
MEPS coverage 2010	100%	0%	0%	0%	0%	100%	0%	68%	64%	10%	50%
MEPS coverage 2020 (with pending)	100%	0%	0%	0%	0%	77%	0%	64%	64%	14%	51%
MEPS coverage 2020 (with worlds best)	100%	0%	0%	0%	0%	100%	0%	68%	73%	96%	79%
MEPS coverage 2030 (with worlds best)	100%	0%	0%	0%	0%	100%	0%	68%	73%	88%	77%
Additional 2030 savings from Worlds Best MEPS	95	0	23	0	0	0	0	118	564	130	694
Additional 2030 savings from Worlds Best Technology	178	46	226	204	172	168	0	994	2048	231	2279
Additional 2030 savings from Worlds Best MEPS	5%	0%	4%	0%	0%	0%	0%	3%	9%	6%	8%
Additional 2030 savings from Worlds Best Technology	9%	7%	40%	20%	40%	25%	0%	25%	33%	10%	27%

Figure 6.4a: Energy consumption and energy subject to MEPS in 2010 for China: Industrial sector

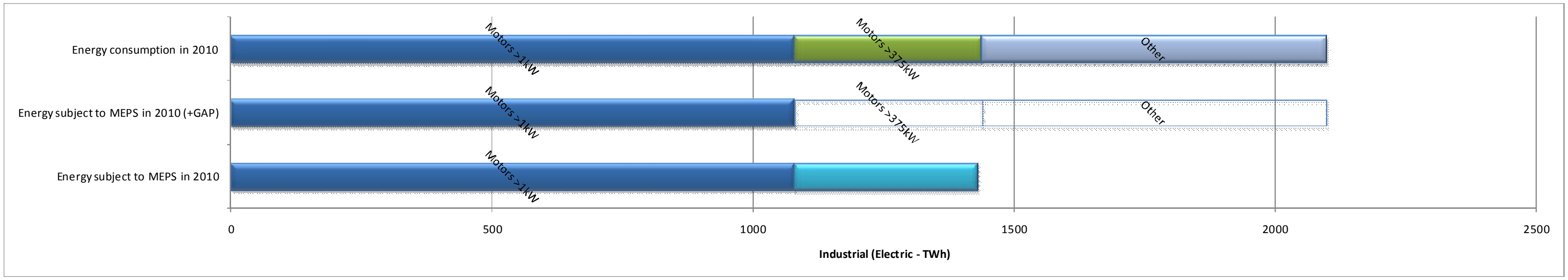


Figure 6.4b: Energy consumption and energy subject to MEPS in 2010 for China: Industrial sector

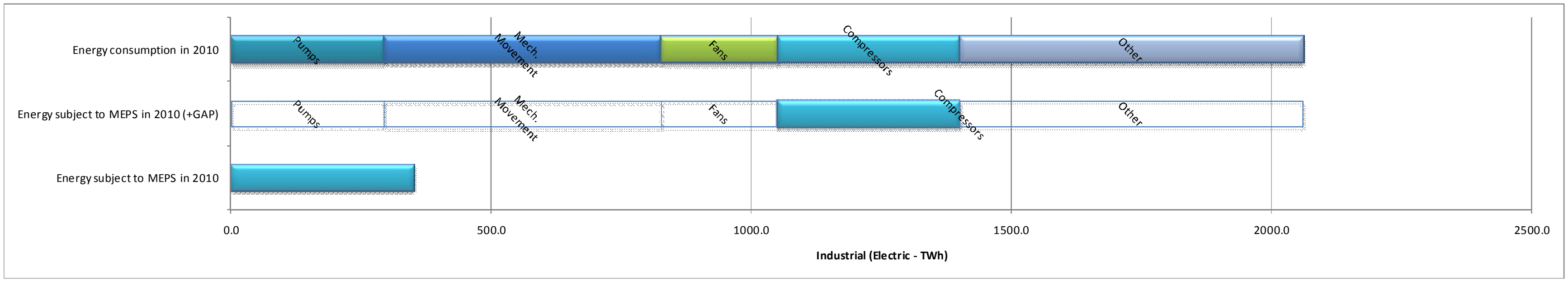


Figure 6.5: Energy consumption and energy subject to current world best MEPS in 2020 for China: Domestic sector

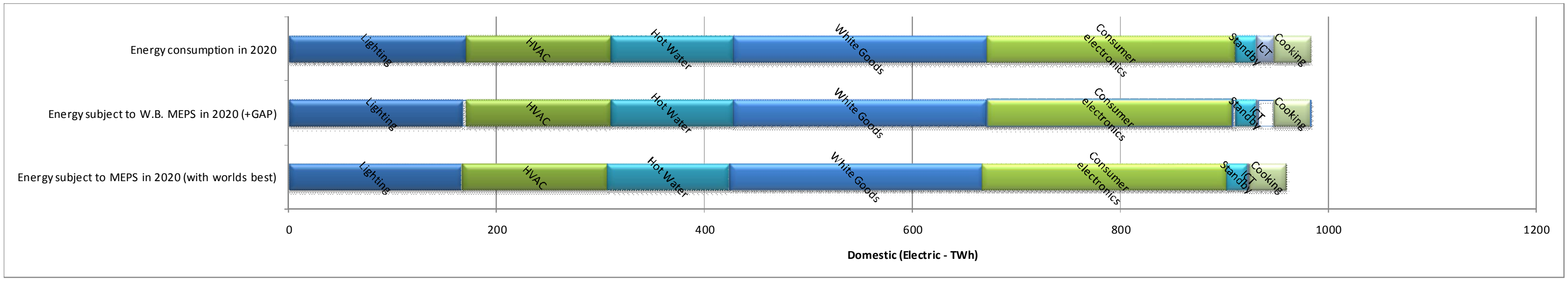


Figure 6.6: Energy consumption and energy subject to current world best MEPS in 2020 for China: Commercial sector

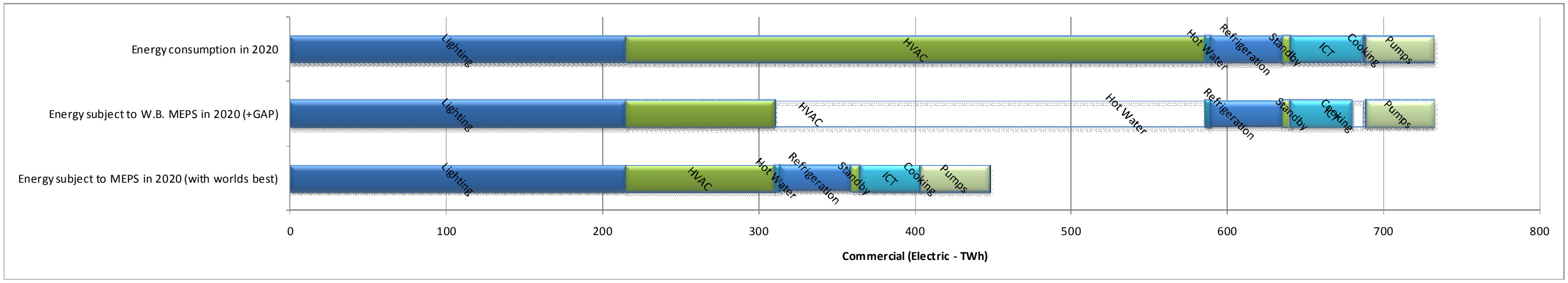


Figure 6.7a: Energy consumption and energy subject to current world best MEPS in 2020 for China: Industrial sector

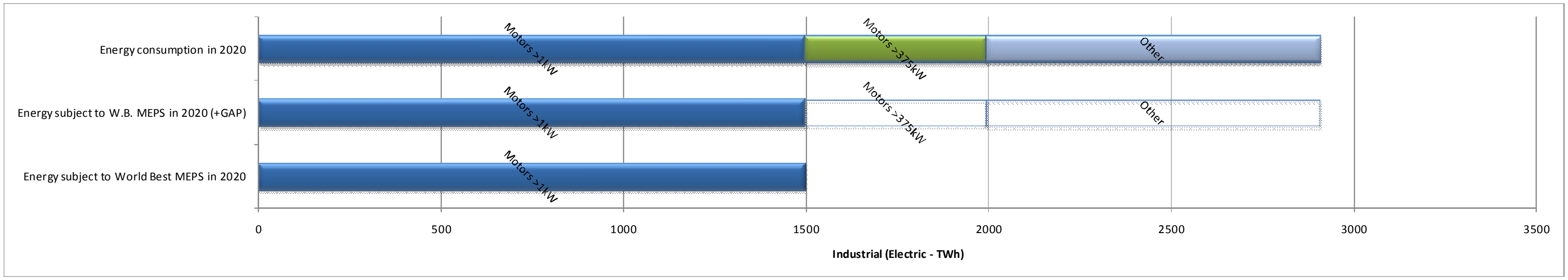


Figure 6.7b: Energy consumption and energy subject to current world best MEPS in 2020 for China: Industrial sector

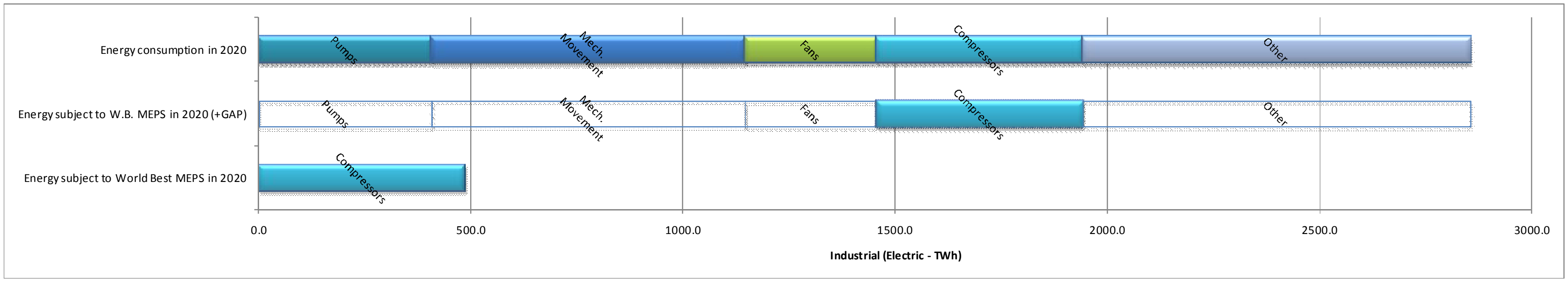


Figure 6.8: Energy consumption and energy subject to current world best MEPS in 2030 for China: Domestic sector

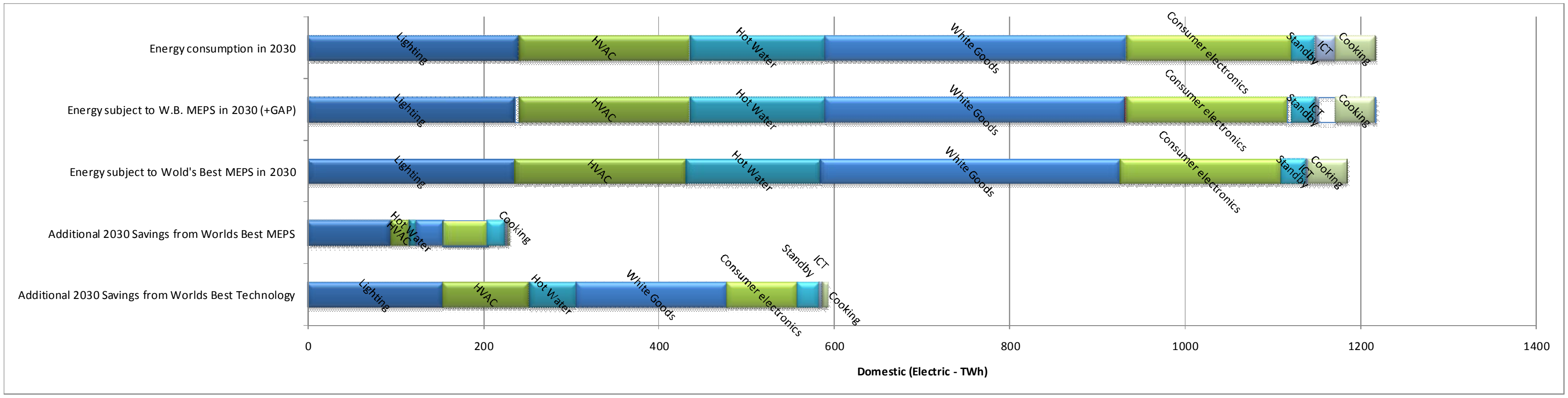


Figure 6.9: Energy consumption and energy subject to current world best MEPS in 2030 for China: Commercial sector

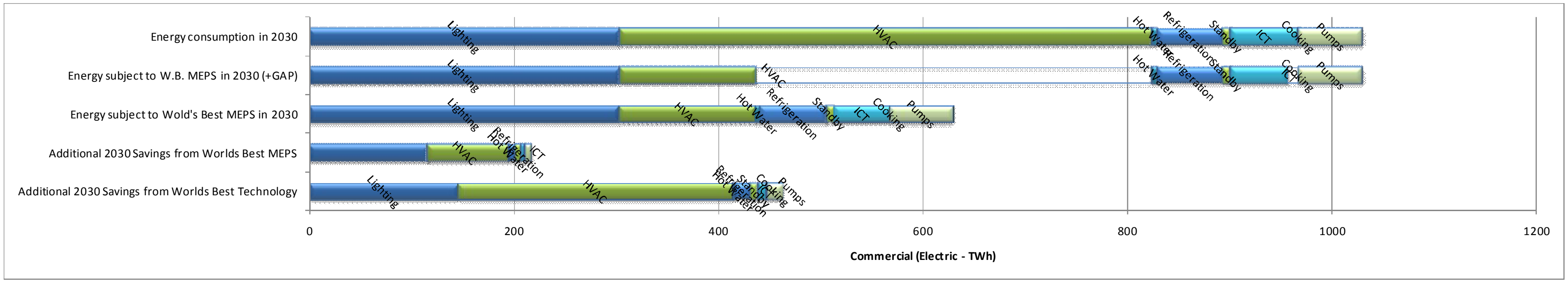


Figure 6.10a: Energy consumption and energy subject to current world best MEPS in 2030 for China: Industrial sector

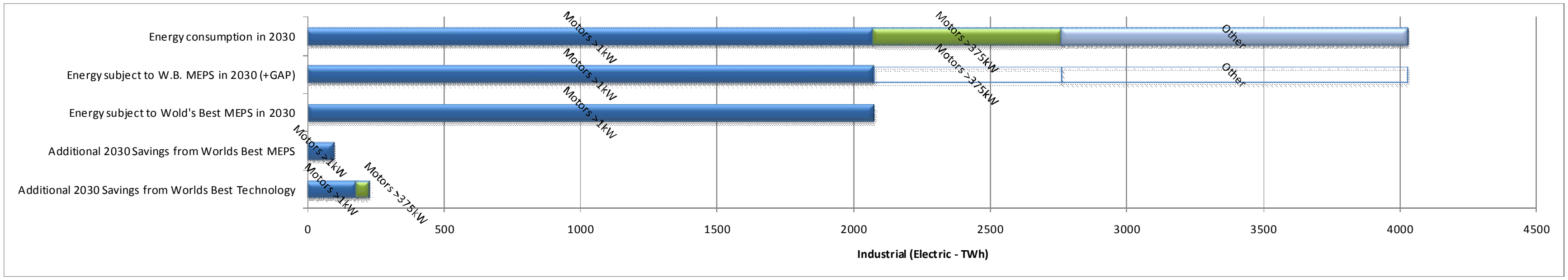


Figure 6.10b: Energy consumption and energy subject to current world best MEPS in 2030 for China: Industrial sector

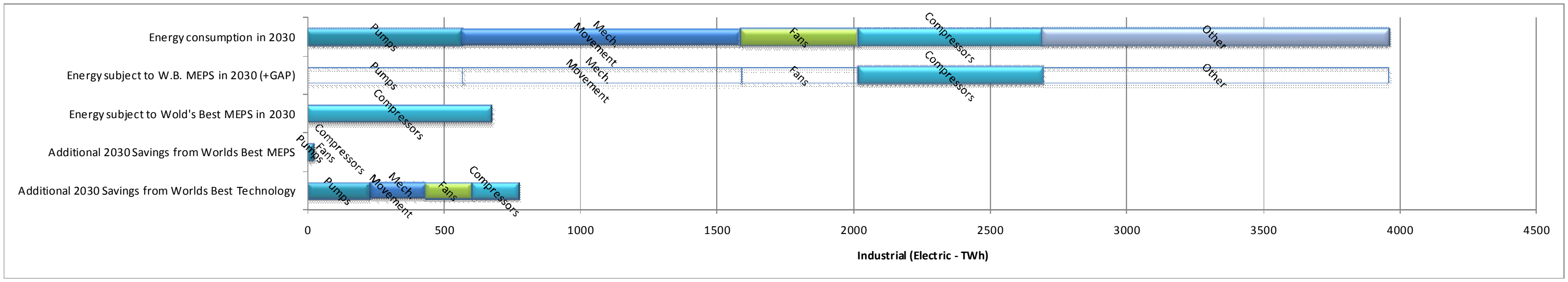


Figure 6.11: Energy consumption and energy subject to current world best MEPS in 2020 for China: All sectors

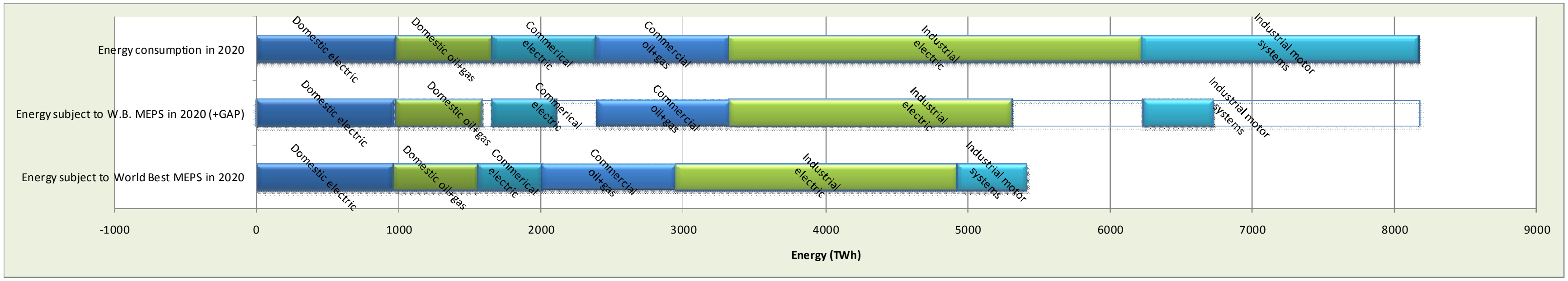
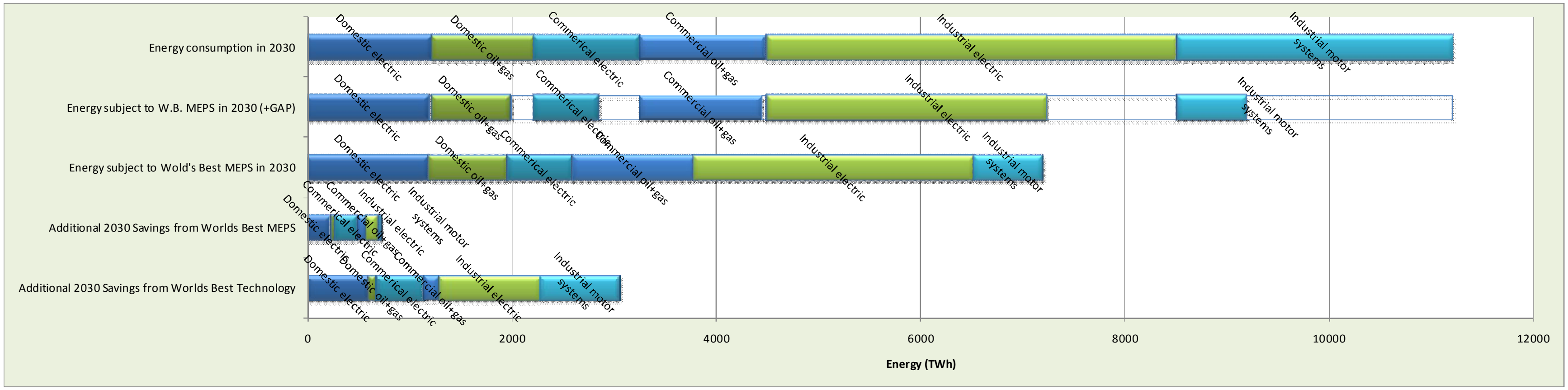


Figure 6.12: Energy consumption and energy subject to current world best MEPS in 2030 for China: All sectors



6.5 Impact of policy coverage and ambition: the example of the European Union

The EU, which includes some of the first countries in the world to have set energy efficiency standards, ironically took rather a long time to adopt framework legislation to facilitate the rapid adoption of mandatory requirements. However, since the adoption of the Ecodesign directive (EUP 2005) in 2005 a proactive process has been underway to develop and adopt implementing regulations that require minimum performance levels to be satisfied by a range of different energy using equipment types. The projected impact of these measures can be seen in Table 6.5. From this it is apparent that in 2008 the MEPS in place in the EU only covered 4% of electricity use in all sectors and 72% of oil and gas use in the residential and commercial sectors. As of April 2010 the coverage had increased to 38% of electricity use in all sectors and about the same share of oil and gas use in the residential and commercial sectors.

MEPS which are currently pending regulatory approval are liable to increase this coverage to 75% of electricity use in all sectors and about the same share of oil and gas use in the residential and commercial sectors. Were the world's best MEPS to be adopted this would increase to 85% of electricity use in all sectors and 98% of oil and gas use in the residential and commercial sectors. Adopting these MEPS would save about 200 TWh of additional energy use per year in 2030 compared to what is envisaged with the existing and pending regulations, yet universal adoption of the world's best current technology would save about 940TWh annually.

Details of the EU's mandatory equipment regulations are given in Part 3 of this report. The EU currently has nine mandatory equipment MEPS regulations but these apply to a much wider set of equipment. Of all the economies considered the EU has shown the most willingness to apply broadly based regulations that apply to as wide a range of products of a general type as possible. Examples of this holistic approach include regulations for: the standby power, HID and fluorescent lamps and ballasts, Televisions and electric motors. In addition to these eight domestic equipment types are subject to mandatory energy labelling and office equipment is eligible for voluntary endorsement labelling (Energy Star).

Despite this there remain significant gaps in policy coverage. Some of the most significant end-uses that are not yet regulated in the EU, but which are in one or more of the other major economies are:

- Electric domestic space heaters
- Extraction fans and other residential fan type
- Room air conditioners
- Chillers
- Central packaged air conditioners

- Domestic electric water heaters
- Clothes dryers
- Dishwashers
- VCRs and DVDs
- Computers and servers
- Gas and electric cooking appliances
- Commercial space and water heating equipment
- Commercial refrigeration equipment
- Vending machines
- Commercial laundry appliances
- Commercial cooking appliances
- Small electric motors < 1kW
- Some classes of industrial fans
- Some classes of industrial pumps
- Some classes of industrial air compressors
- Distribution transformers

Among those products which are not subject to MEPS in any of the economies, the most important in the EU are:

- Commercial air handling units
- Some classes of industrial electric fans
- Some classes of industrial electric pump
- Electric motors of > 375kW and also of <1kW

6.5.1 Energy coverage of existing regulations

Current regulations in place in the EU cover:

- 39% of domestic electricity consumption and 97% of domestic oil and gas consumption
- 31% of commercial electricity consumption and 0% of commercial oil and gas consumption
- 75% of industrial electric motor consumption and 0% of industrial electric motor system consumption

Overall regulations address 42% of the electricity consumption in the domestic, commercial and industrial sectors and 71% of the oil and gas consumption in the domestic and commercial sectors; see Figures 6.13 to 6.16 and Tables 6.5 to 6.7.

In exploring opportunities to improve policy coverage the biggest gaps are for domestic and commercial electric end uses, commercial oil and gas applications and (in common with all economies) for industrial electric motor driven systems. Large opportunities also exist for: domestic electric space and water heating, commercial space and water heating, commercial ventilation and air conditioning, commercial refrigeration, computers and other ICT equipment, industrial electric fans, pumps and compressors.

6.5.2 Impacts of adopting World Best Regulations

Were the World's Best MEPRS to be adopted the coverage would become:

- 97% of domestic electricity consumption and 97% of domestic oil and gas consumption
- 70% of commercial electricity consumption and 97% of commercial oil and gas consumption
- 75% of industrial electric motor consumption and 24% of industrial electric motor system consumption

Adoption of World's Best MEPRs would increase the overall coverage of regulations to:

- 77% of the electricity consumption in the domestic, commercial and industrial sectors
- 97% of the oil and gas consumption in the domestic and commercial sectors;

See Figures 6.17 to 6.25 and Tables 6.5 to 6.7.

The additional energy savings in 2030 from adopting World Best MEPRs compared to what is likely to be adopted assuming the pending Ecodesign proposals are adopted as regulations is estimated to be:

- 5% of domestic electricity consumption (50 TWh/year)
- 0.4% of domestic oil and gas consumption (9 TWh/year)
- 6% of commercial electricity consumption (53 TWh/year)
- 6% of commercial oil and gas consumption (63 TWh/year)
- 3% of industrial electricity consumption (41 TWh/year)

Overall some 145 TWh of electricity and 72 TWh of oil and gas could be saved annually, amounting to about 3% of all energy use in the sectors considered.

6.5.3 Impacts of utilising World Best Technology

A simple analysis of the savings potential from using today's most energy efficient technology reveals the following annual energy savings would be realised by 2030:

- 34% of domestic electricity consumption (50 TWh/year)
- 7% of domestic oil and gas consumption (160 TWh/year)
- 27% of commercial electricity consumption (258 TWh/year)
- 11% of commercial oil and gas consumption (63 TWh/year)
- 22% of industrial electricity consumption (289 TWh/year)

Overall some 875 TWh of electricity and 268 TWh of oil and gas could be saved annually, amounting to about 17% of all energy use in the sectors considered. The technologies considered only include energy end-use technologies and do not address other systems which may affect energy demand such as building envelopes etc.

Figure 6.13: Energy consumption and energy subject to MEPS in 2010 for the EU

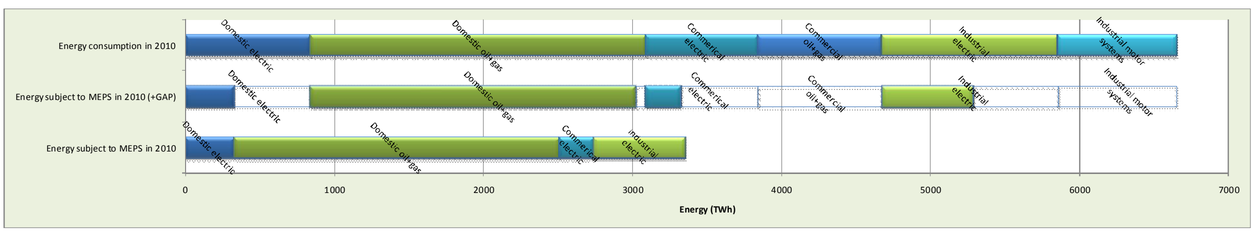


Table 6.5: Energy consumption, energy subject to MEPS, and potential future savings for the EU: Domestic sector

	Domestic (electric) (TWh)									Domestic (oil+gas) (TWh)			
	Lighting	HVAC	Hot Water	White Goo	Consumer	Standby	ICT	Cooking	**Total**	Heating	Hot Water	Cooking	**Total**
Energy consumption in 2010	87	192	71	233	100	45	37	74	839	1742	441	68	2251
Energy consumption in 2020	61	219	81	260	77	24	42	84	846	1817	451	74	2342
Energy consumption in 2030	70	249	92	293	98	15	47	96	961	1892	461	88	2441
Energy subject to MEPS in 2010	66	0	0	127	88	45	0	0	325	1742	441	0	2184
Energy subject to MEPS in 2020 (with pending)	51	219	81	260	77	24	42	74	826	1817	451	0	2268
Energy subject to MEPS in 2020 (with worlds best)	61	219	81	260	68	24	34	73	818	1817	451	0	2268
Energy subject to MEPS in 2030 (with worlds best)	70	249	92	293	88	15	39	83	929	1892	461	0	2353
MEPS coverage 2010	75%	0%	0%	54%	88%	100%	0%	0%	39%	100%	100%	0%	97%
MEPS coverage 2020 (with pending)	84%	100%	100%	100%	100%	100%	100%	88%	98%	100%	100%	0%	97%
MEPS coverage 2020 (with worlds best)	100%	100%	100%	100%	89%	100%	81%	87%	97%	100%	100%	0%	97%
MEPS coverage 2030 (with worlds best)	100%	100%	100%	100%	90%	100%	81%	87%	97%	100%	100%	0%	96%
Additional 2030 savings from Worlds Best MEPS	3	26	9	0	1	0	4	8	50	0	9	0	9
Additional 2030 savings from Worlds Best Technology	19	124	37	108	15	4	7	14	328	132	28	0	160
Additional 2030 savings from Worlds Best MEPS	4%	10%	10%	0%	1%	0%	9%	9%	5%	0%	2%	0%	0%
Additional 2030 savings from Worlds Best Technology	26%	50%	40%	37%	16%	25%	16%	14%	34%	7%	6%	0%	7%

Figure 6.14: Energy consumption and energy subject to MEPS in 2010 for the EU: Domestic sector

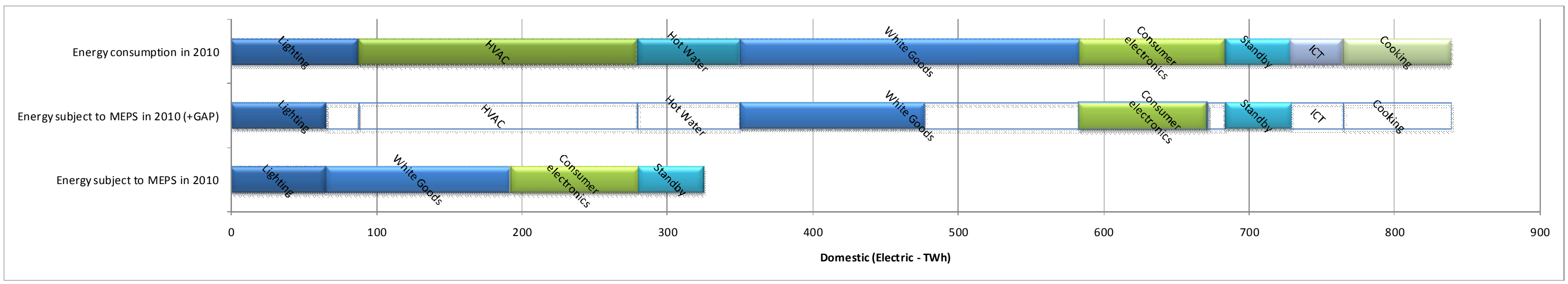


Table 6.6: Energy consumption, energy subject to MEPS, and potential future savings for the EU: Commercial sector

	Commercial (electric) (TWh)									Commercial (oil+gas) (TWh)			
	Lighting	HVAC	Hot Water	Refrigerat	Standby	ICT	Cooking	Pumps	Total	Heating	Hot Water	Cooking	Total
Energy consumption in 2010	168	223	109	68	10	84	42	47	751	626	181	24	831
Energy consumption in 2020	192	229	124	78	3	95	47	53	823	678	198	26	902
Energy consumption in 2030	219	267	142	89	6	109	54	61	946	730	216	31	977
Energy subject to MEPS in 2010	168	54	0	0	10	0	0	0	232	0	0	0	0
Energy subject to MEPS in 2020 (with pending)	192	126	0	78	3	67	47	53	568	0	0	0	0
Energy subject to MEPS in 2020 (with worlds best)	192	79	124	78	3	46	0	53	576	678	198	0	876
Energy subject to MEPS in 2030 (with worlds best)	219	90	142	89	6	52	0	61	658	730	216	0	946
MEPS coverage 2010	100%	24%	0%	0%	100%	0%	0%	0%	31%	0%	0%	0%	0%
MEPS coverage 2020 (with pending)	100%	55%	0%	100%	100%	70%	100%	100%	69%	0%	0%	0%	0%
MEPS coverage 2020 (with worlds best)	100%	34%	100%	100%	100%	48%	0%	100%	70%	100%	100%	0%	97%
MEPS coverage 2030 (with worlds best)	100%	34%	100%	100%	100%	48%	0%	100%	70%	100%	100%	0%	97%
Additional 2030 savings from Worlds Best MEPS	2	23	14	9	0	6	0	0	53	58	4	0	63
Additional 2030 savings from Worlds Best Technology	61	96	57	22	1	12	9	0	258	95	13	0	108
Additional 2030 savings from Worlds Best MEPS	1%	8%	10%	10%	0%	5%	0%	0%	6%	8%	2%		6%
Additional 2030 savings from Worlds Best Technology	28%	36%	40%	25%	25%	11%	16%	0%	27%	13%	6%		11%

Figure 6.15: Energy consumption and energy subject to MEPS in 2010 for the EU: Commercial sector

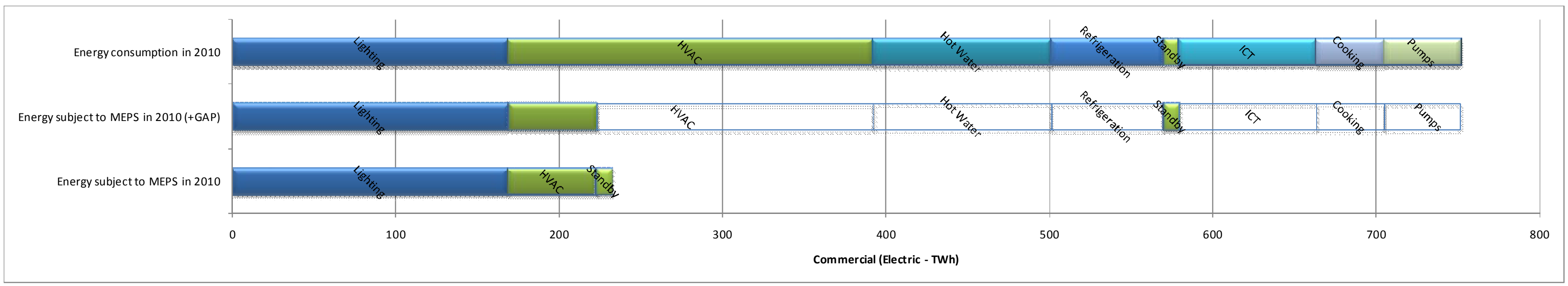


Table 6.7: Energy consumption, energy subject to MEPS, and potential future savings for the EU: Industrial Sector and all sectors

	Industry (electricity) (TWh)									All (TWh)		
	Motors	>1kW	>375kW	Pumps	Mech. Mo	Fans	Compress	Other	Total	Electricity	Oil+Gas	All
Energy consumption in 2010		609	203	166	301	127	198	372	1185	2775	3082	5856
Energy consumption in 2020		634	211	173	313	132	206	388	1233	2903	3244	6147
Energy consumption in 2030		660	220	180	326	137	214	404	1284	3190	3418	6609
Energy subject to MEPS in 2010		609	0	0	0	0	0	0	609	1167	2184	3350
Energy subject to MEPS in 2020 (with pending)		634	0	173	0	0	0	0	807	2201	2268	4470
Energy subject to MEPS in 2020 (with worlds best)		634	0	0	0	0	206	0	840	2235	3144	5379
Energy subject to MEPS in 2030 (with worlds best)		660	0	0	0	0	214	0	875	2462	3299	5761
MEPS coverage 2010		100%	0%	0%	0%	0%	0%	0%	51%	42%	71%	57%
MEPS coverage 2020 (with pending)		100%	0%	100%	0%	0%	0%	0%	65%	76%	70%	73%
MEPS coverage 2020 (with worlds best)		100%	0%	0%	0%	0%	100%	0%	68%	77%	97%	88%
MEPS coverage 2030 (with worlds best)		100%	0%	0%	0%	0%	100%	0%	68%	77%	97%	87%
Additional 2030 savings from Worlds Best MEPS		17	0	7	0	7	11	0	41	145	72	217
Additional 2030 savings from Worlds Best Technology		39	10	67	65	55	54	0	289	875	268	1142
Additional 2030 savings from Worlds Best MEPS		3%	0%	4%	0%	5%	5%	0%	3%	5%	2%	3%
Additional 2030 savings from Worlds Best Technology		6%	5%	37%	20%	40%	25%	0%	22%	27%	8%	17%

Figure 6.16a: Energy consumption and energy subject to MEPS in 2010 for the EU: Industrial sector

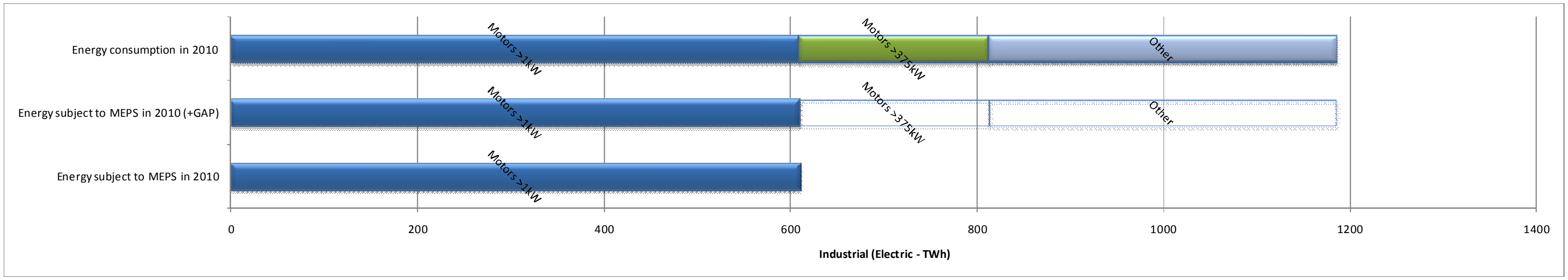


Figure 6.16b: Energy consumption and energy subject to MEPS in 2010 for the EU: Industrial sector

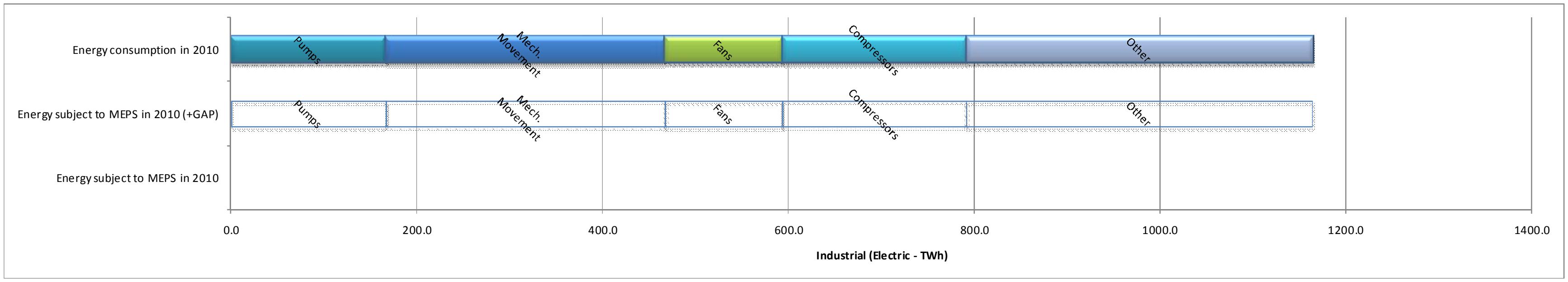


Figure 6.17: Energy consumption and energy subject to current world best MEPS in 2020 for the EU: Domestic sector

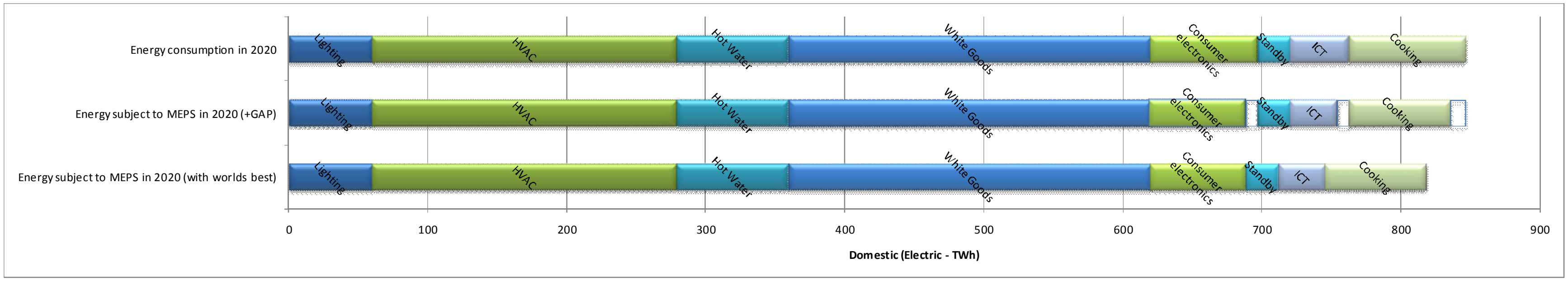


Figure 6.18: Energy consumption and energy subject to current world best MEPS in 2020 for the EU: Commercial sector

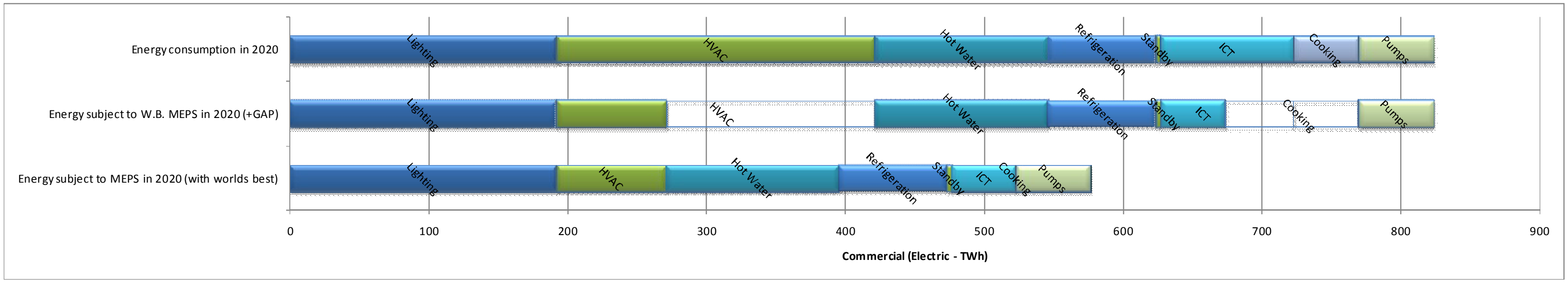


Figure 6.19a: Energy consumption and energy subject to current world best MEPS in 2020 for the EU: Industrial sector

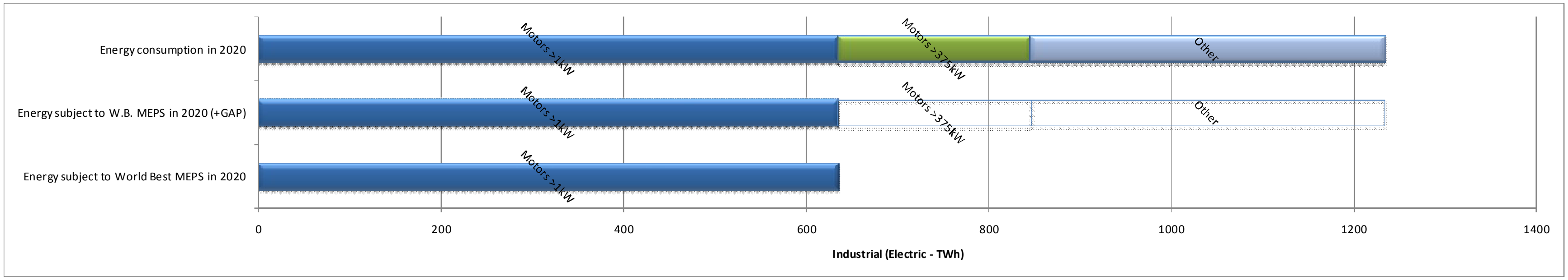


Figure 6.19b: Energy consumption and energy subject to current world best MEPS in 2020 for the EU: Industrial sector

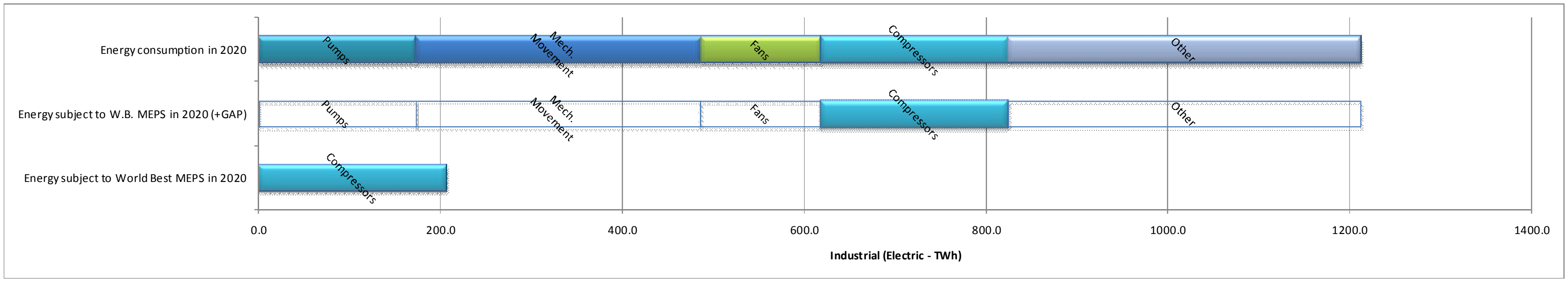


Figure 6.20: Energy consumption and energy subject to current world best MEPS in 2030 for the EU: Domestic sector

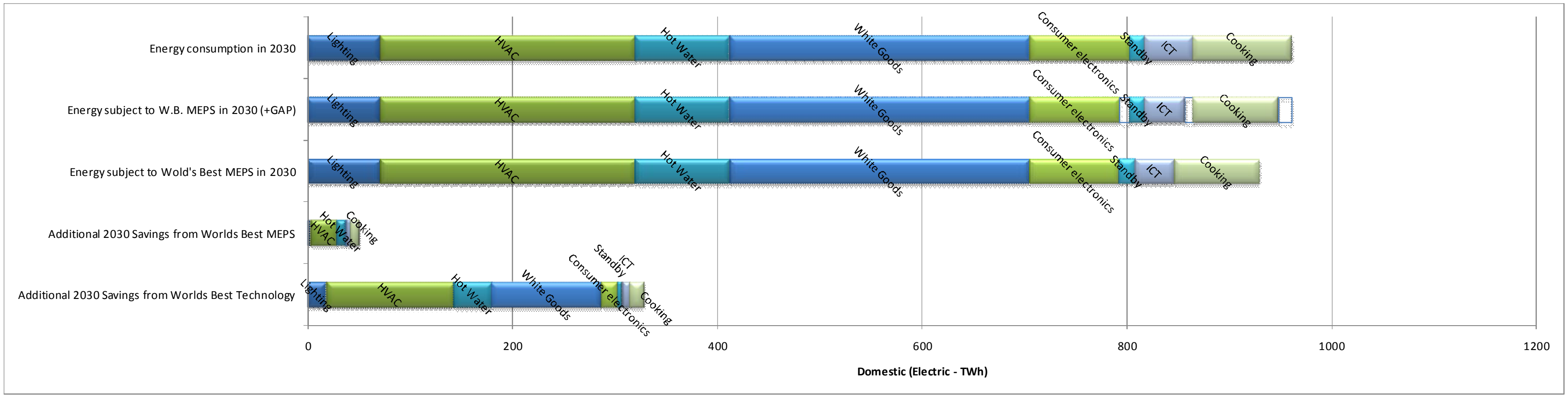


Figure 6.21: Energy consumption and energy subject to current world best MEPS in 2030 for the EU: Commercial sector

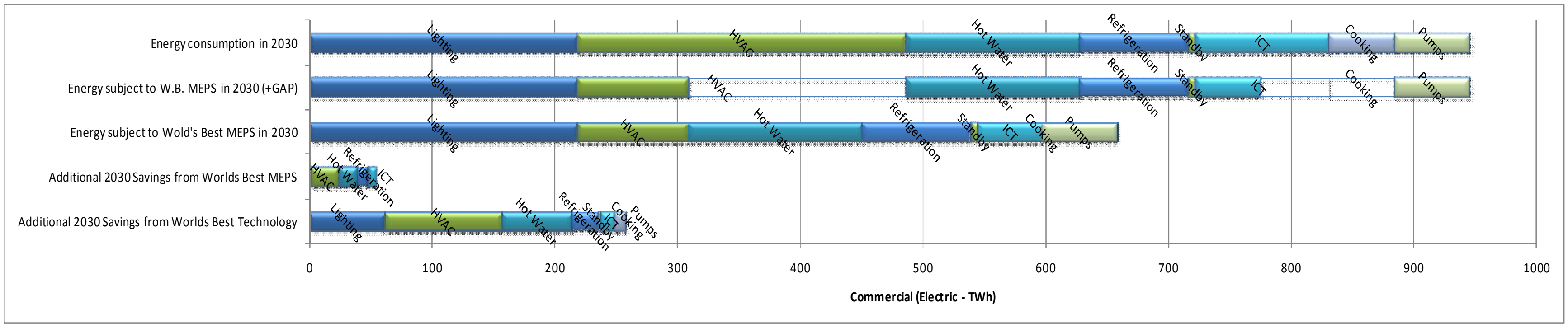


Figure 6.22a: Energy consumption and energy subject to current world best MEPS in 2030 for the EU: Industrial sector

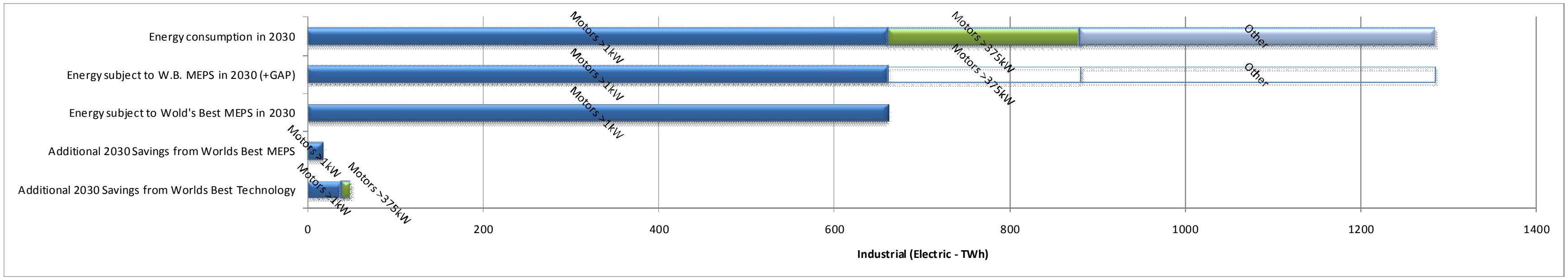


Figure 6.22b: Energy consumption and energy subject to current world best MEPS in 2030 for the EU: Industrial sector

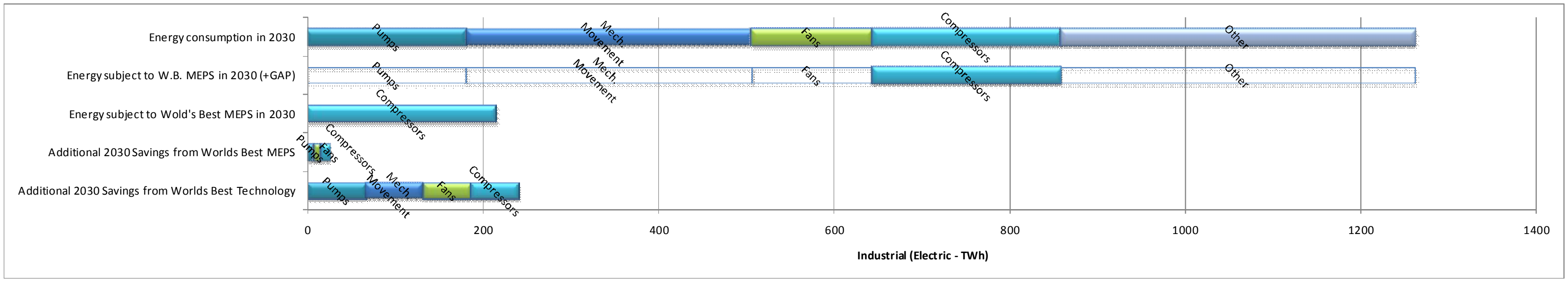


Figure 6.23: Energy consumption and energy subject to MEPS in 2010 for the EU: All sectors

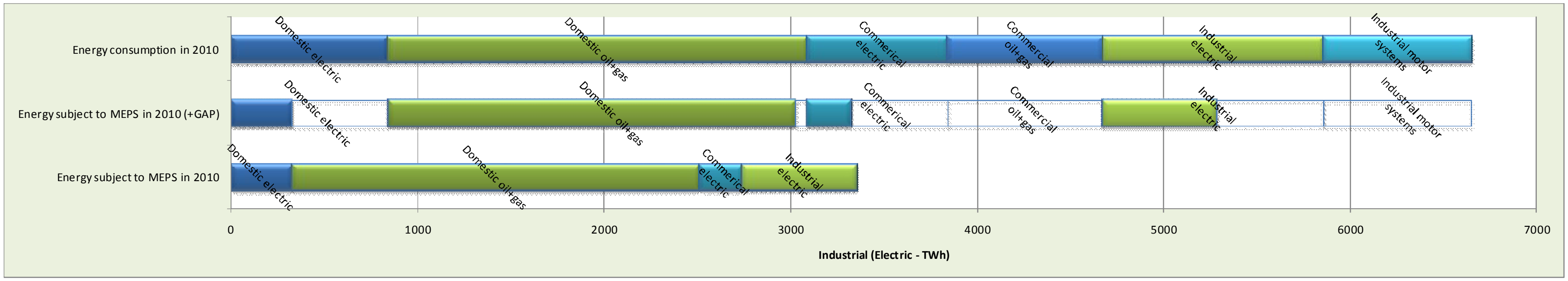


Figure 6.24: Energy consumption and energy subject to current world best MEPS in 2020 for the EU: All sectors

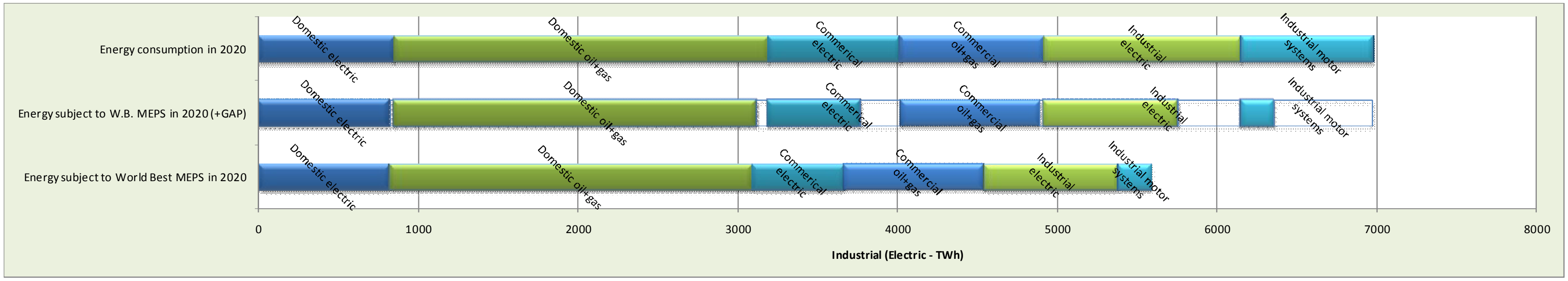
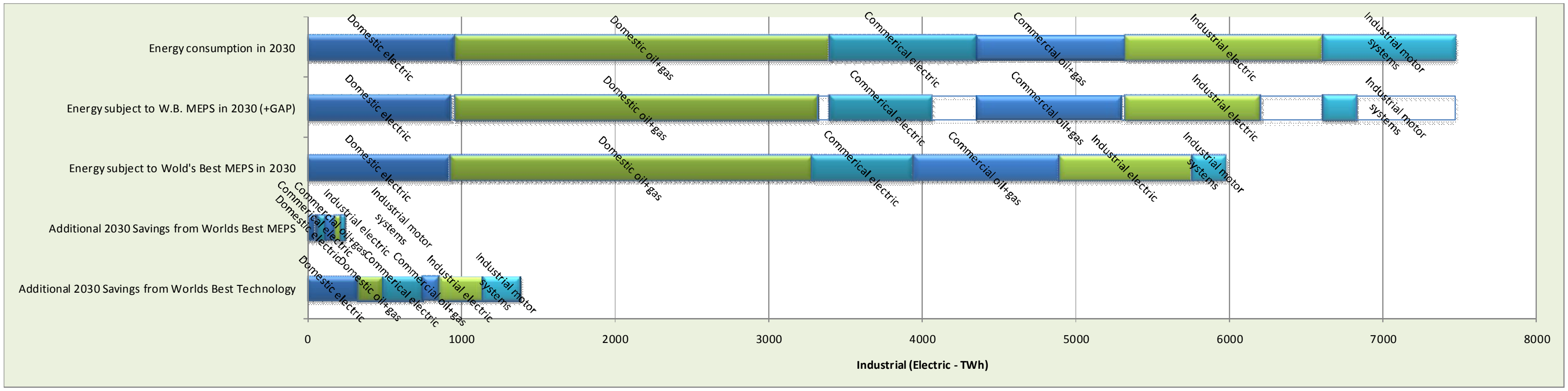


Figure 6.25: Energy consumption and energy subject to current world best MEPS in 2030 for the EU: All sectors



6.6 Impact of policy coverage and ambition: the example of India

India currently applies mandatory energy labelling to two products and voluntary energy labelling to nine other product classes. Of the five economies considered in this study it was the last to introduce equipment policy measures and thus far it applies no mandatory equipment energy efficiency requirements. In this respect it is like a great many other countries in the world, but as a consequence the energy efficiency of its equipment market is less developed compared to the other four economies considered in this report. Details of India's labelling scheme are given in Part 3 of this report.

6.6.1 Energy coverage of existing mandatory regulations

As there are no mandatory energy performance regulations in place in India none of the equipment types are covered by such policies and the coverage in the domestic, commercial and industrial sectors is currently 0%.

6.3.2 Impacts of adopting World Best Regulations

Were the World's Best MEPRS to be adopted the coverage would become:

- 96% of domestic electricity consumption and 96% of domestic oil and gas consumption
- 92% of commercial electricity consumption and 93% of commercial oil and gas consumption
- 75% of industrial electric motor consumption and 24% of industrial electric motor system consumption

Adoption of World's Best MEPRs would increase the overall coverage of regulations to:

- 84% of the electricity consumption in the domestic, commercial and industrial sectors
- 95% of the oil and gas consumption in the domestic and commercial sectors;

See Figures 6.26 to 6.37 and Tables 6.8 to 6.10.

The additional energy savings in 2030 from adopting World Best MEPRs are estimated to be:

- 34% of domestic electricity consumption (278 TWh/year)
- 4% of domestic oil and gas consumption (19 TWh/year)
- 29% of commercial electricity consumption (136 TWh/year)
- 6% of commercial oil and gas consumption (9 TWh/year)
- 5% of industrial electricity consumption (40 TWh/year)

Overall some 453 TWh of electricity and 28 TWh of oil and gas could be saved annually, amounting to about 18% of all energy use in the sectors considered.

6.6.3 Impacts of utilising World Best Technology

A simple analysis of the savings potential from using today's most energy efficient technology reveals the following annual energy savings would be realised by 2030:

- 58% of domestic electricity consumption (476 TWh/year)
- 9% of domestic oil and gas consumption (39 TWh/year)
- 43% of commercial electricity consumption (200 TWh/year)
- 11% of commercial oil and gas consumption (18 TWh/year)
- 22% of industrial electricity consumption (178 TWh/year)

Overall some 853 TWh of electricity and 57 TWh of oil and gas could be saved annually, amounting to about 34% of all energy use in the sectors considered. The technologies considered only include energy end-use technologies and do not address other systems which may affect energy demand such as building envelopes etc.

Figure 6.26: Energy consumption and energy subject to MEPS in 2010 for India

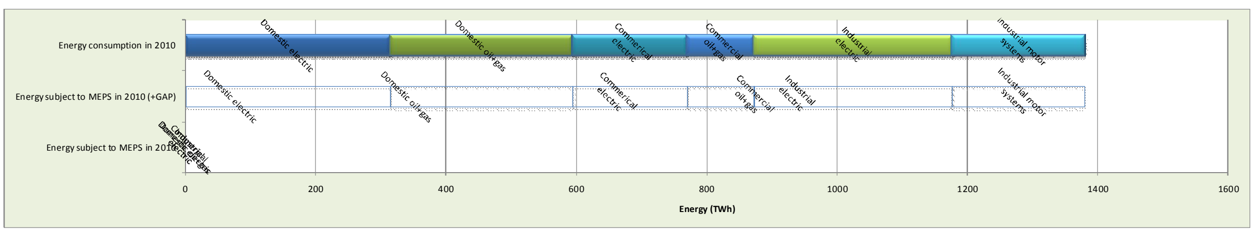


Table 6.8: Energy consumption, energy subject to MEPS, and potential future savings for India: Domestic sector

	Domestic (electric) (TWh)									Domestic (oil+gas) (TWh)			
	Lighting	HVAC	Hot Water	White Goo	Consumer	Standby	ICT	Cooking	**Total**	Heating	Hot Water	Cooking	**Total**
Energy consumption in 2010	88	57	1	97	47	11	9	2	314	212	54	13	279
Energy consumption in 2020	143	93	2	158	77	18	15	3	510	251	63	26	340
Energy consumption in 2030	232	151	3	256	125	30	24	6	827	305	77	52	434
Energy subject to MEPS in 2010	0	0	0	0	0	0	0	0	0	0	0	0	0
Energy subject to MEPS in 2020 (with pending)	0	0	0	0	0	0	0	0	0	0	0	0	0
Energy subject to MEPS in 2020 (with worlds best)	140	93	2	156	74	18	2	3	488	251	63	13	327
Energy subject to MEPS in 2030 (with worlds best)	227	151	3	253	120	30	3	5	793	305	77	26	408
MEPS coverage 2010	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MEPS coverage 2020 (with pending)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MEPS coverage 2020 (with worlds best)	98%	100%	100%	99%	96%	100%	12%	88%	96%	100%	100%	50%	96%
MEPS coverage 2030 (with worlds best)	98%	100%	100%	99%	96%	100%	12%	88%	96%	100%	100%	50%	94%
Additional 2030 savings from Worlds Best MEPS	93	53	0	74	33	22	2	0	278	12	5	1	19
Additional 2030 savings from Worlds Best Technology	152	86	1	153	52	27	4	1	476	21	9	8	39
Additional 2030 savings from Worlds Best MEPS	40%	35%	15%	29%	26%	74%	9%	8%	34%	4%	7%	3%	4%
Additional 2030 savings from Worlds Best Technology	66%	57%	40%	60%	42%	90%	16%	14%	58%	7%	12%	16%	9%

Figure 6.27: Energy consumption and energy subject to MEPS in 2010 for India: Domestic sector

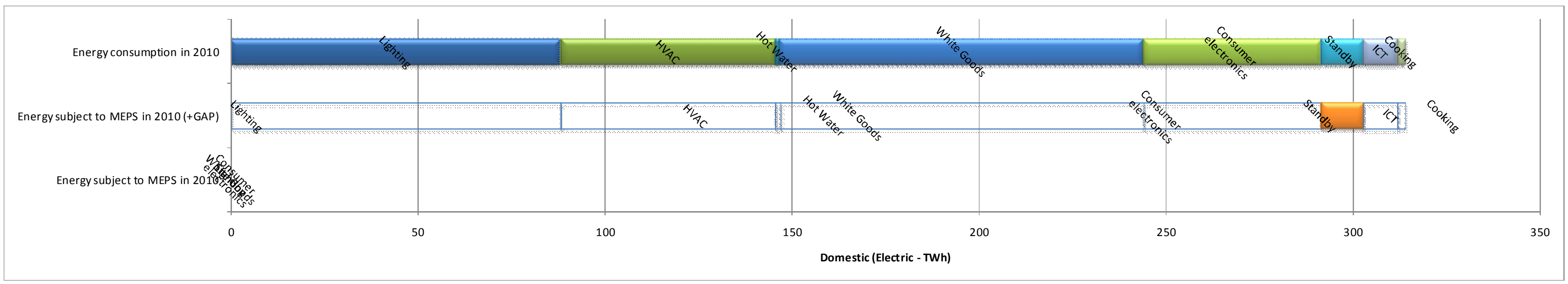


Table 6.9: Energy consumption, energy subject to MEPS, and potential future savings for India: Commercial sector

	Commercial (electric) (TWh)									Commercial (oil+gas) (TWh)			
	Lighting	HVAC	Hot Water	Refrigerat	Standby	ICT	Cooking	Pumps	Total	Heating	Hot Water	Cooking	Total
Energy consumption in 2010	65	55	1	10	1	10	1	32	176	76	22	5	103
Energy consumption in 2020	105	90	1	16	2	17	2	52	285	90	26	9	125
Energy consumption in 2030	171	146	2	26	3	27	3	85	463	110	32	18	159
Energy subject to MEPS in 2010	0	0	0	0	0	0	0	0	0	0	0	0	0
Energy subject to MEPS in 2020 (with pending)	0	0	0	0	0	0	0	0	0	0	0	0	0
Energy subject to MEPS in 2020 (with worlds best)	105	73	1	16	2	14	0	52	264	90	26	0	116
Energy subject to MEPS in 2030 (with worlds best)	171	118	2	26	3	23	0	85	428	110	32	0	141
MEPS coverage 2010	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MEPS coverage 2020 (with pending)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MEPS coverage 2020 (with worlds best)	100%	81%	100%	100%	100%	84%	0%	100%	92%	82%	100%	0%	93%
MEPS coverage 2030 (with worlds best)	100%	81%	100%	100%	100%	84%	0%	100%	92%	0%	100%	0%	89%
Additional 2030 savings from Worlds Best MEPS	65	55	0	3	2	1	0	8	136	9	0	0	9
Additional 2030 savings from Worlds Best Technology	83	82	1	6	3	3	0	21	200	14	1	3	18
Additional 2030 savings from Worlds Best MEPS	38%	38%	10%	10%	74%	5%	0%	10%	29%	8%	1%	0%	6%
Additional 2030 savings from Worlds Best Technology	49%	56%	40%	25%	90%	11%	16%	25%	43%	13%	2%	15%	11%

Figure 6.28: Energy consumption and energy subject to MEPS in 2010 for India: Commercial sector

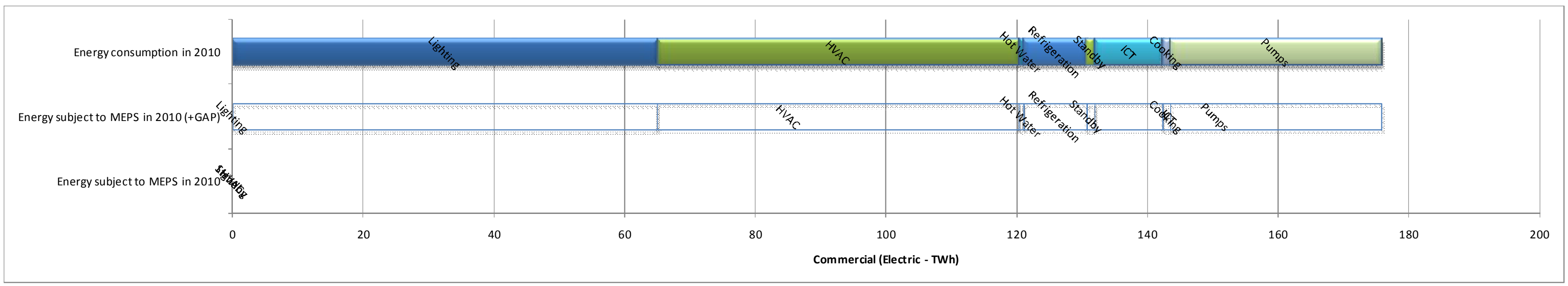


Table 6.10: Energy consumption, energy subject to MEPS, and potential future savings for India: Industrial sector and all sectors

	Industry (electricity) (TWh)								All (TWh)		
	Motors >1kW	>375kW	Pumps	Mech. Mo	Fans	Compress	Other	Total	Electricity	Oil+Gas	All
Energy consumption in 2010	156	52	43	77	32	51	96	304	794	382	1176
Energy consumption in 2020	258	86	70	127	54	84	157	501	1296	465	1761
Energy consumption in 2030	425	141	116	210	88	138	260	826	2116	593	2709
Energy subject to MEPS in 2010	0	0	0	0	0	0	0	0	0	0	0
Energy subject to MEPS in 2020 (with pending)	0	0	0	0	0	0	0	0	0	0	0
Energy subject to MEPS in 2020 (with worlds best)	258	0	0	0	0	84	0	341	1093	443	1537
Energy subject to MEPS in 2030 (with worlds best)	425	0	0	0	0	138	0	563	1783	549	2332
MEPS coverage 2010	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MEPS coverage 2020 (with pending)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MEPS coverage 2020 (with worlds best)	100%	0%	0%	0%	0%	100%	0%	68%	84%	95%	87%
MEPS coverage 2030 (with worlds best)	100%	0%	0%	0%	0%	100%	0%	68%	84%	93%	86%
Additional 2030 savings from Worlds Best MEPS	21	0	7	0	4	7	0	40	453	28	481
Additional 2030 savings from Worlds Best Technology	39	10	17	42	35	34	0	178	853	57	910
Additional 2030 savings from Worlds Best MEPS	5%	0%	6%	0%	5%	5%	0%	5%	21%	5%	18%
Additional 2030 savings from Worlds Best Technology	9%	7%	15%	20%	40%	25%	0%	22%	40%	10%	34%

Figure 6.29a: Energy consumption and energy subject to MEPS in 2010 for India: Industrial sector

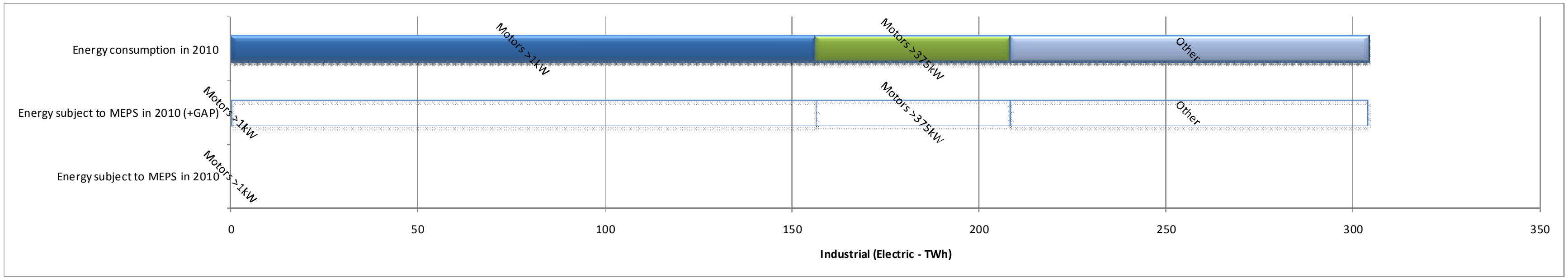


Figure 6.29b: Energy consumption and energy subject to MEPS in 2010 for India: Industrial sector

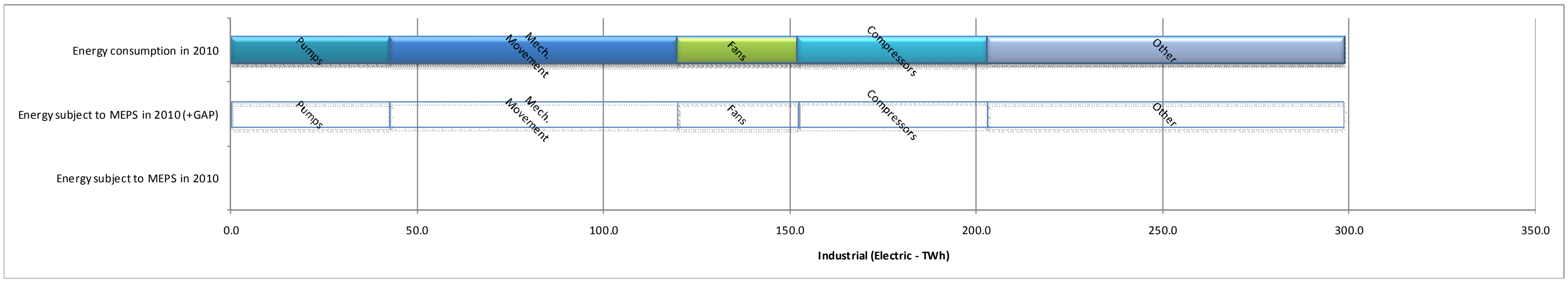


Figure 6.30: Energy consumption and energy subject to current world best MEPS in 2020 for India: Domestic sector

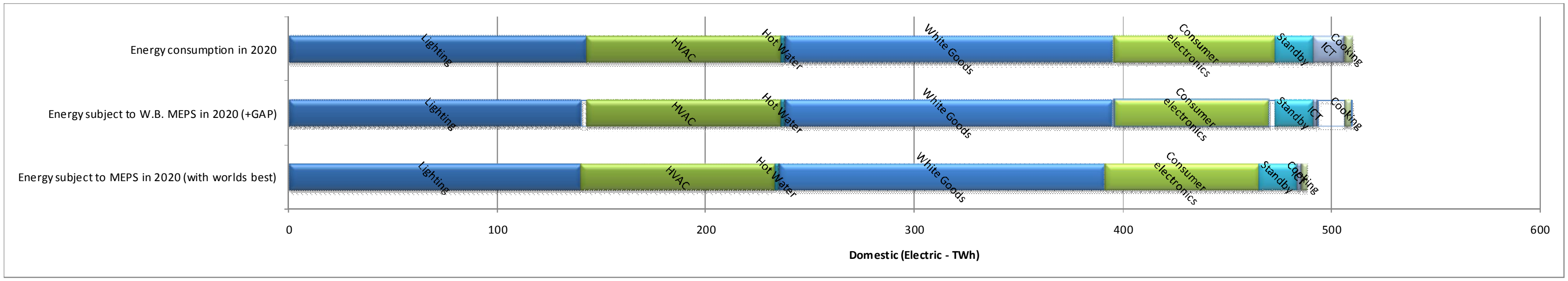


Figure 6.31: Energy consumption and energy subject to current world best MEPS in 2020 for India: Commercial sector

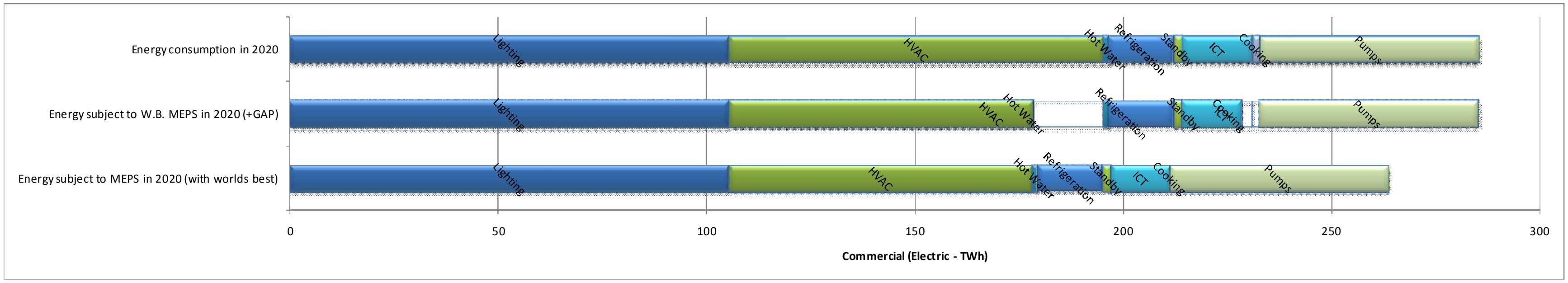


Figure 6.32a: Energy consumption and energy subject to current world best MEPS in 2020 for India: Industrial sector

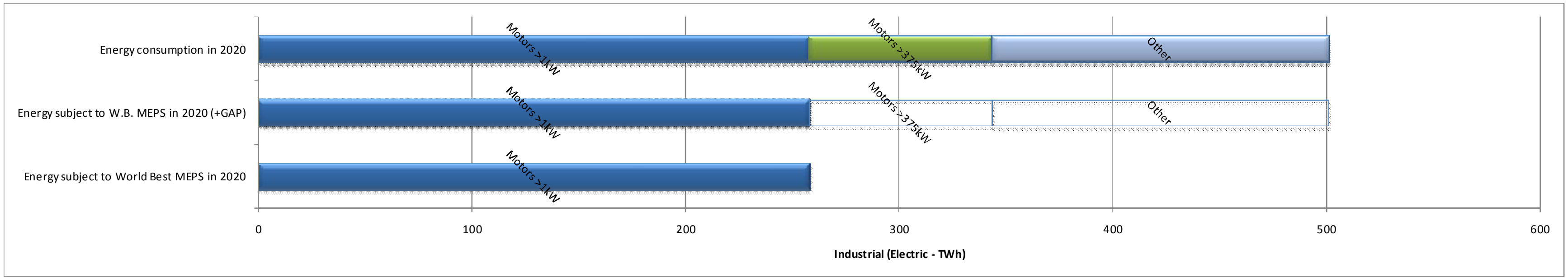


Figure 6.32b: Energy consumption and energy subject to current world best MEPS in 2020 for India: Industrial sector

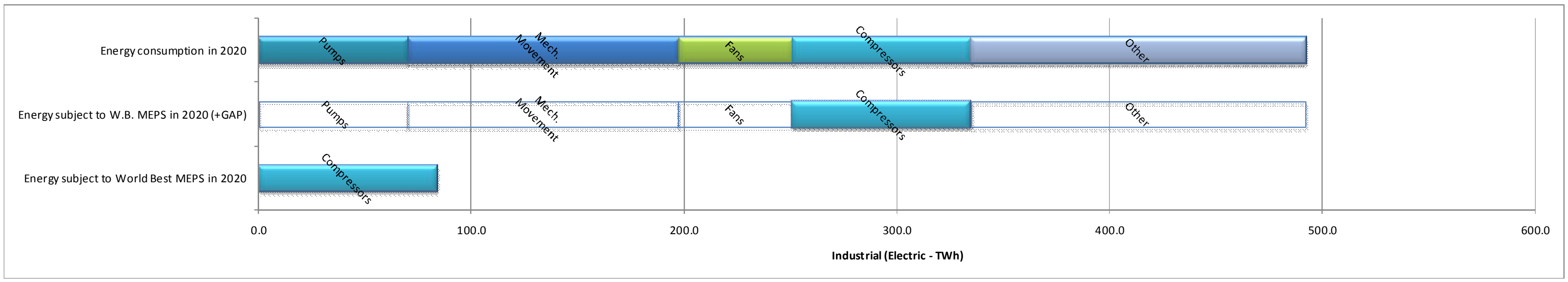


Figure 6.33: Energy consumption and energy subject to current world best MEPS in 2030 for India: Domestic sector

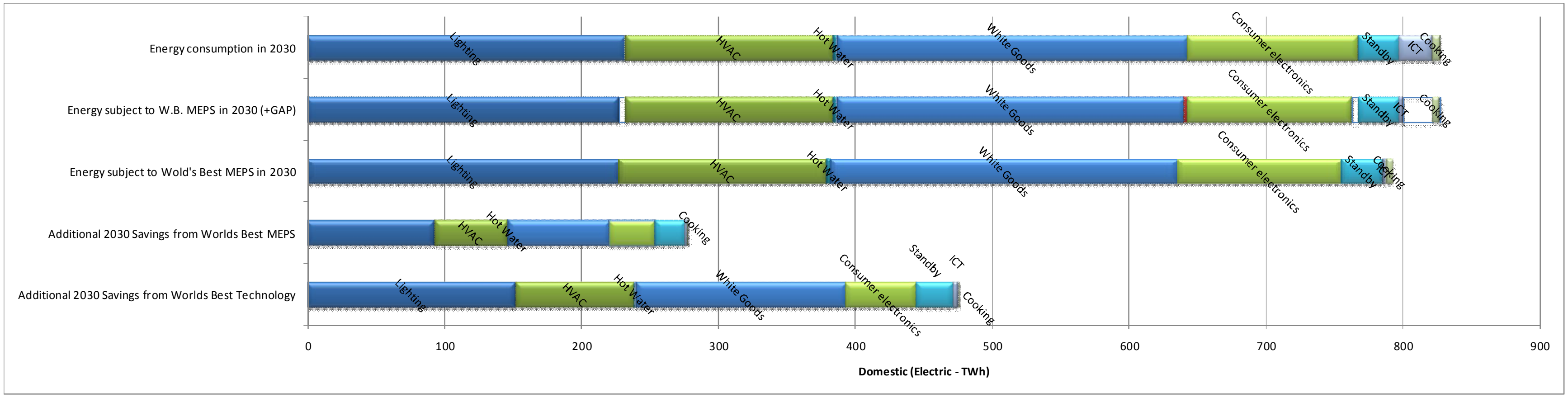


Figure 6.34: Energy consumption and energy subject to current world best MEPS in 2030 for India: Commercial sector

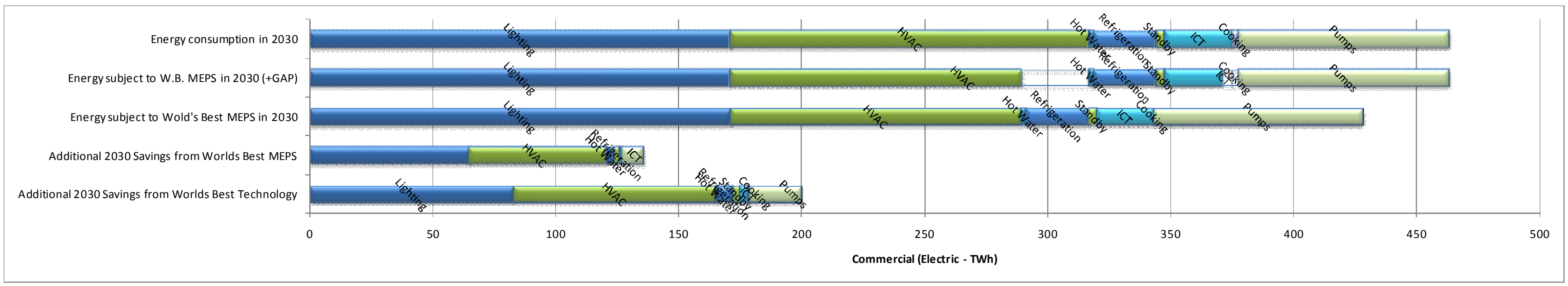


Figure 6.35a: Energy consumption and energy subject to current world best MEPS in 2030 for India: Industrial sector

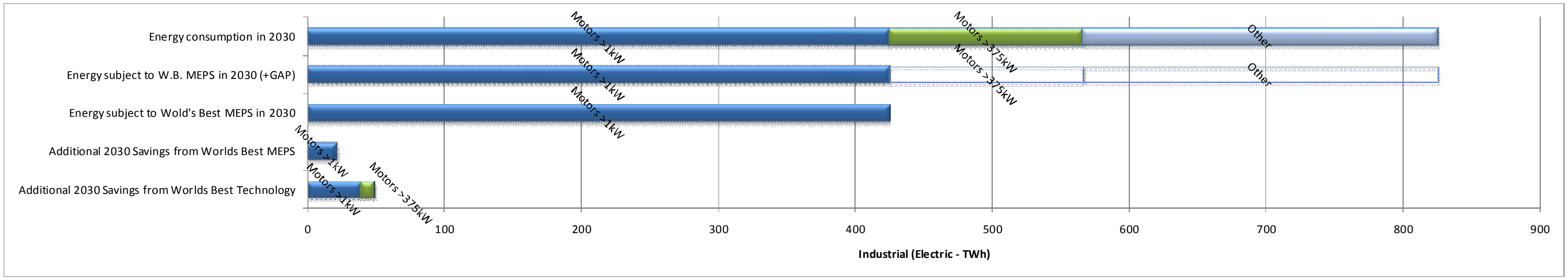


Figure 6.35b: Energy consumption and energy subject to current world best MEPS in 2030 for India: Industrial sector

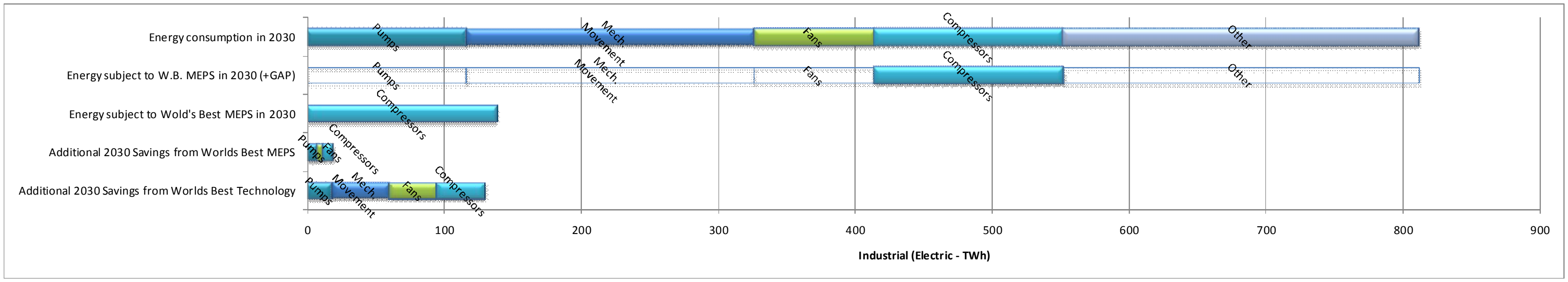


Figure 6.36: Energy consumption and energy subject to current world best MEPS in 2020 for India: All sectors

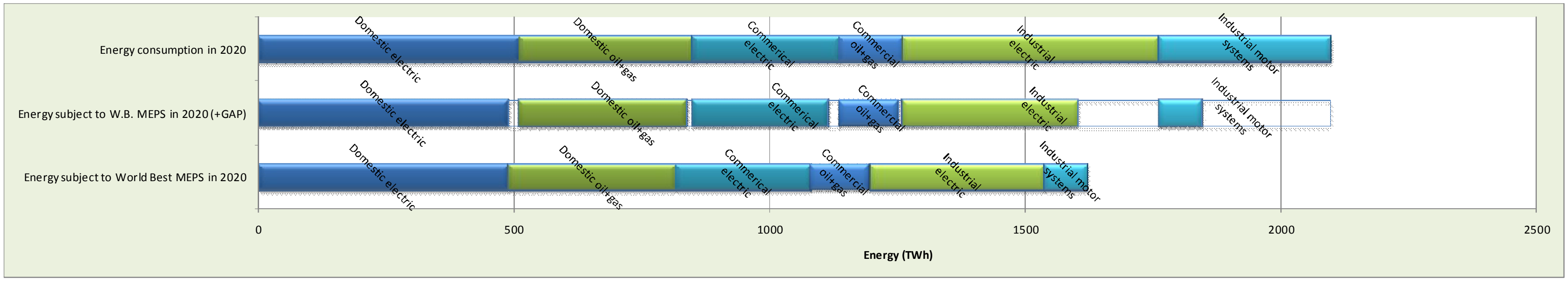
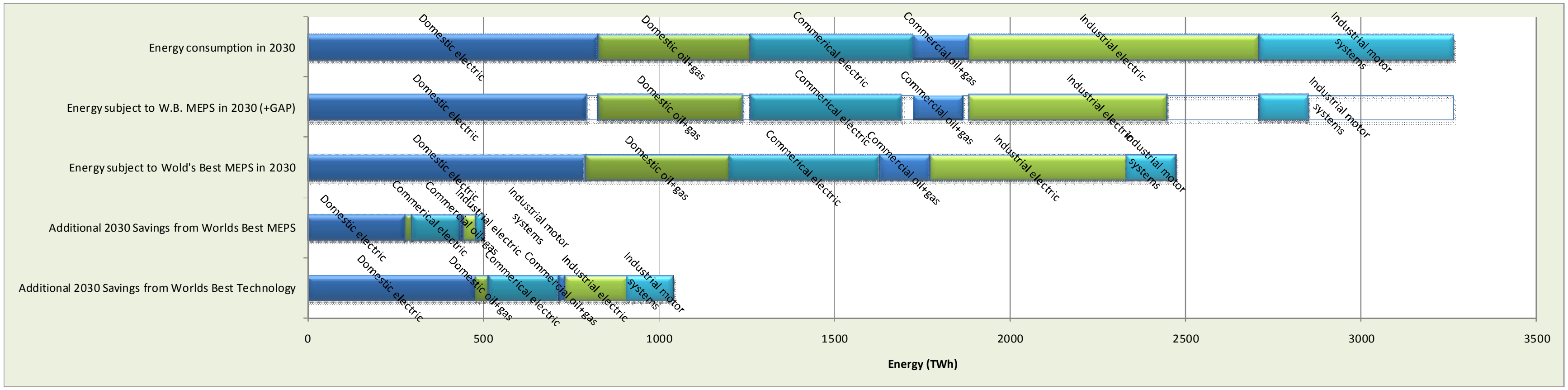


Figure 6.37: Energy consumption and energy subject to current world best MEPS in 2030 for India: All sectors



6.7 Policy coverage and ambition: comments on Japan

Although modelling the energy demand coverage and savings potential from broader based and highest stringency MEPRS in Japan is beyond the scope of the current study some remarks can be made regarding the scope and ambition of the existing requirements and where adoption of World Best MEPRS is likely to increase energy savings in Japan.

Since the adoption of the Top Runner programme Japan has become one of the leading nations in terms of the ambition of its requirements. Some 19 equipment categories are subject to Top Runner requirements and where it is straightforward to compare efficiency requirements the Top Runner levels are usually at or near the highest currently in place. Top Runner requirements are particularly prevalent for the domestic sector where most major energy using product types are covered. Larger gaps are in the commercial sector and with the exception of distribution transformers no industrial sector products are covered. The following significant end-uses are not yet subject to Top Runner requirements:

- GLS and halogen lamps
- CFLi
- Other directional lamps
- Electric fans
- Domestic electric hot water heaters
- Chillers
- Clothes washers
- Clothes dryers
- Dishwashers
- TV decoders (set top boxes)
- Video game consoles
- Monitors
- Printers
- Electric cooking appliances
- HID lamps and ballasts
- Pumps (industrial and circulation type)
- Air handling units and ventilation equipment
- Electric hot water heaters
- Commercial refrigeration equipment
- Standby power (in a horizontal sense)
- Commercial electric cooking appliances
- Electric motors (all types and sise ranges)
- Industrial electric fan systems
- Industrial air and liquid compressors
- Networked standby

In some cases such as for clothes washers, dryers and dishwashers the lack of Top runner requirements is not likely to be significant because their usage is very low or the savings potential is very low in Japan. Some products like GLS and CFLi are not used as much in Japan as they are in comparable economies but they are still sufficiently widespread for significant savings to accrue from the adoption of regulatory measures. The equipment types which probably with the largest energy savings potentials in Japan and that are not currently subject to Top Runner specifications are:

- Electric motors (all types and sise ranges)
- Industrial electric fan systems
- Pumps (industrial and commercial sector types)
- Air handling units and ventilation equipment
- Commercial refrigeration equipment
- HID lamps and ballasts
- Chillers
- GLS and halogen lamps
- TV decoders (set top boxes)
- Monitors
- CFLi

Most of these are subject to MEPS in at least one other major economy.

In addition to this these opportunities Japan may well have energy savings opportunities from strengthening existing requirements for TVs and from setting efficiency requirements for fluorescent lighting that remove some of the less efficient technologies, such as slow start ballasts. In the case of TV's apparently less stringent requirement than those in place in the EU may partly be explicable due to differences in the test procedure and this would benefit from further investigation. In many cases Japan uses nationally specific test procedures whose results are difficult to compare directly with more broadly used international test procedures and this complicates comparison of energy efficiency requirements for some product types.

6.8 Policy coverage and ambition: comments on the USA

Although modelling the energy demand coverage and savings potential from broader based and highest stringency MEPRS in the USA is beyond the scope of the current study some remarks can be made regarding the scope and ambition of the existing requirements and of where adoption of World Best MEPRS is likely to increase energy savings.

The US has the oldest continuous MEPS programme among the major economies and currently applies minimum energy performance regulations for 51 product categories. This is nominally higher than for other economies but the number of regulations is an imperfect indicator of coverage because it depends on the energy use of the product sub-types covered in each principal product regulation. Nonetheless it is clear that the coverage of MEPS in the USA is the highest or among the highest in the five economies. The US MEPS apply to all the sectors but have highest coverage in the domestic sector and lowest in the industrial, as is true of most economies. The following significant end-uses are not yet subject to MEPS in the USA although some are under-going regulatory review:

- TVs
- Computers and servers
- Fluorescent lamp ballasts that are used for other than T12 lamps
- Directional lamps other than incandescent reflector lamps
- Chillers
- Extractor fans and range-hoods
- Standby power (in a horizontal sense)
- TV decoders (set top boxes)
- VCR and DVD players
- HiFi and audio equipment
- Video game consoles
- Small kitchen appliances (coffee makers, blenders, etc.)
- Monitors
- Printers, photocopiers and MFDs
- Electric cooking appliances
- HID lamps and ballasts (specifically MH lamps and ballasts, HPS lamps and ballasts and general HID efficacy requirements that address any technology)
- Pumps (for industrial and commercial applications but also domestic circulation and pool pumps)
- Air handling units and ventilation equipment
- External compressors and refrigeration systems for commercial refrigeration applications
- Commercial cooking appliances
- Some classes of small electric motor of < 0.75kW and all electric motors of > 375kW
- Industrial electric fan systems
- Industrial air and liquid compressors
- Networked standby

From this it is apparent that there are still significant gaps in coverage and some equipment types with large savings potentials are not yet addressed. Many of the equipment types listed above are covered via other, sifter policy instruments such as Energy Star thresholds for ICT, home entertainment and office equipment. Chillers are covered in ASHRAE 90.1 requirements but these are voluntary at the Federal level and only become mandatory at the state level if a state writes them into their mandatory building codes.

The equipment types which probably with the largest energy savings potentials in the US and that are not currently subject to MEPS specifications are:

- Industrial electric fan systems
- Pumps (industrial and commercial sector types)
- Industrial air and liquid compressors
- Air handling units and ventilation equipment
- TVs
- External compressors and refrigeration systems for commercial refrigeration applications
- Ballasts for other than T12 lamp applications
- HID lamps and ballasts
- Chillers
- TV decoders (set top boxes)

Most of these are subject to MEPS in at least one other major economy. In addition, the stringency of several of the existing MEPS could be increased in line with current highest international requirements. Some examples of where the US requirements appear to be less demanding than the most stringent applied in the other economies are:

- CFLi
- GLS and halogen lamps (with no non-clear coatings)
- Room air conditioners and certain other types of air conditioner

Comparison of requirements for several product types was not feasible because of significant differences in the test procedure, product classification and efficiency metrics.

6.9 What could the global savings be?

Based on the findings presented above it is clear that all economies would increase energy savings were they to adopt minimum energy performance regulatory requirements in line with the most stringent currently in place. The magnitude of the savings varies from 5% to 21% in the case of total electricity consumption across all non-transport sectors and from 2% to 6% in the case of total oil and gas consumption across all non-transport and industrial sectors.

Applying these results to a very simple global analysis produces the following rough estimates of annual savings potentials in 2030 at the global level from the adoption of World's Best MEPRs:

- 4000TWh of final electricity demand (12% of the demand in the sectors addressed)
- 28 Mtoe of final gas demand (4% of the demand in the sectors addressed)
- 24 Mtoe of final oil demand (4% of the demand in the sectors addressed)

- 2600 Mt of CO_2 emissions (11% of emissions from the sectors addressed)

Applying the results to a very simple global analysis produces the following rough estimates of annual savings potentials in 2030 at the global level from the adoption of World's Best end-use equipment technology:

- 11000TWh of final electricity demand (33% of the demand in the sectors addressed)
- 69 Mtoe of final gas demand (9% of the demand in the sectors addressed)
- 52 Mtoe of final oil demand (9% of the demand in the sectors addressed)
- 6700 Mt of CO_2 emissions (28% of the emissions from the sectors addressed)

These savings do not assume any fuel substitution efforts which could increase the savings in certain sectors such as hot water and space heating. Both sets of results assume that the OECD economies have similar savings potentials to the EU, and that the rest of the world has similar savings potentials to India except China for which the results determined in Section 6.3 are applied. IEA World Energy Outlook projections were used for the base case scenario against which the savings were derived.

There are very large uncertainties with these estimates and more work needs to be done on the future to refine them, however some reassurance can be taken from considering these findings are roughly consistent with slightly similar analyses aiming to answer related questions such as those reported in the IEA's 25 Concrete Energy Efficiency Policy Measures analysis and those from the BUENAS model reported by Defra. Overall, they show that a great deal of energy could be saved through rapid adoption of existing MEPRS on a global basis but they also suggest that existing requirements fall far short of best (i.e. most energy efficient) available technology performance levels and thus much more could be saved by the adoption of dynamic World Best requirements that make a greater effort to accelerate the uptake of energy efficient technology solutions.

7. CONCLUSIONS

This report has assessed a range of factors pertinent to the harmonisation discussion and has found the following:

- In current markets there is partial but incomplete alignment of equipment energy performance test procedures and energy efficiency metrics with different degrees of alignment depending on the equipment type and the economies concerned
- Where efficiency is not directly comparable regulators are more inclined to set conservative efficiency requirements often operating in the belief that local requirements are best or near best world practice but have no simple means of comparing with those in peer economies
- The coverage of existing regulatory policies varies appreciably by economy and by energy usage sector and end-use; the biggest gaps are in the industrial electric motor driven systems domain and in the commercial sector, but important gaps in coverage continue to exist in all economies and in all sectors
- The main savings that would result from broader harmonisation of efficiency policies is from increasing the coverage of equipment subject to efficiency regulations (specifically minimum energy performance regulations)
- Very significant savings can also be had by adjusting the scope of coverage of existing requirements to be more inclusive in the range of technologies addressed and specifically to ensure no technology is omitted that could provide the fundamental energy service demanded; thus broad-based adoption of the most universal existing requirements is likely to save the most energy most rapidly
- Were the most stringent existing regulations to be broadly adopted significant additional energy savings would be accrued. This is especially true of the following end-uses: lighting, HVAC, pumps, fans, compressors and electric motors
- Full global adoption of the current most stringent and broadly based regulations would save about 12% of global energy demand in the sectors addressed and about 2600Mt of CO_2 emissions per annum in 2030
- However, these values are only about 43% of the savings that are technically feasible from universal adoption of today's most efficient end-use equipment technologies for the same period
- Were such technologies to be universally adopted the savings would increase to about 28% of global energy demand in the sectors addressed and about 6700 Mt of CO_2 per annum in 2030 without any change in the level of service provision

7.1 Back to Reality

Traditionally the major OECD member economies of the EU, Japan and the USA have only paid limited regard to the test procedures and policy settings in place in the other major economies when setting their own requirements. This has led to today's pattern where product policy-settings are only weakly internationally aligned, with some notable exceptions, beyond the regional level. By contrast the major emerging economies of China and India have generally paid more regard to the policy requirements in place in other major markets as the starting point for many of their own policy development deliberations. In recent times there has been an increased interest within all the major economies in understanding what is happening in other jurisdictions when introducing or revising MEPRs and energy labels.

This development suggests there is an opportunity to share information and to establish cooperative efforts to lower program costs and increase overall effectiveness and dynamism. The research presented in this report reveals, that in the medium-term, there are numerous product/end-use specific harmonisation efforts that would benefit from greater support and would facilitate direct performance comparison and hence accelerated higher policy ambition. These include:

- targeted harmonised test procedure development (aiming to secure globally harmonised test requirements and efficiency metrics for all new or emerging products which don't yet have test procedures e.g. for LEDs) and alignment efforts (supporting efforts to agree aligned revision of existing test procedures and efficiency metrics)
- instigating & supporting dialogues on best practice and opportunities with respect to harmonised conformity assessment
- pooling international data used in techno-economic assessments of savings potentials that underpin standards development and setting processes
- sharing information on best practice in standards setting tools and methodologies
- sharing information of policy settings, scope and ambition

Were there to be accelerated adoption of leading international energy efficiency policy requirements it would produce significant savings even within economies that currently have many of the highest energy efficiency policy settings. For economies that currently have only limited efficiency requirements the savings from accelerated adoption of world's best requirements would stimulate much larger savings. There are clear signs that all major economies are becoming more receptive to dialogue and information exchange on the policies in place and in all cases there is increasing pressure to adopt international best practice, or at least not be too far behind it. The most viable route therefore is one that takes a soft path and aims to strengthen awareness and cooperative actions while illustrating what is achievable through broad-based and suitably ambitious policy settings. The key will be in ensuring the right information is available and presented at the pertinent decision making forum at the right time. Regulatory processes are unlikely to wait while others responsible for a different jurisdiction deliberate thus ensuring decision makers are aware of relevant regulatory processes ahead of time is essential if alignment is to occur. When alignment has already occurred (e.g. for external power supplies or for industrial electric motors) this is exactly what has happened and these are the models that need to be replicated if greater, meaningful harmonisation is to occur in the future.

APPENDIX A: BACKGROUND OF EU PROGRAMME

On 9 March 2007, the European Council –the Heads of State and Government of the EU's 27 Member States - agreed on an integrated climate and energy policy, backed up by a detailed action plan. The European Commission believes the EU effort is unique across the globe for having binding, regional targets for energy and climate policy and that Europe is taking a leadership position in order to build up an international consensus on combating climate change. Energy efficiency regulations are a corner stone of this new energy policy.

In its Communication of November 2008 - 'Energy efficiency: delivering the 20% target' - the Commission concluded that the current energy efficiency legislation alone would not deliver sufficient energy savings to meet the 20% saving objective. Main obstacles to energy efficiency improvements are the poor implementation of existing legislation and the lack of consumer awareness.

Energy efficiency is both the result of policy developments and the application of concrete measures. There are five pillars (tools) to the EU's specific energy efficiency policy:

(1) the general policy framework and the actions taken under the European Energy Efficiency Action Plan;
(2) the National Energy Efficiency Action Plans based on the framework Directive on Energy Services;
(3) the legal framework for the most important consumption sector - buildings - and energy consuming products;
(4) flanking policy instruments such as targeted financing, provision of information and networks like the Covenant of Mayors and Sustainable Energy Europe; and
(5) international collaboration on energy efficiency.

The Commission has proposed an Energy Efficiency Package in November 2008 to step up efforts towards achieving the 20% energy saving objective. The package consists of:

- legislative proposals i.e. a recast of the Energy Performance of Buildings Directive, a proposal to recast the Energy Labelling Directive and a proposal for a new Directive introducing a labelling scheme for tyres;

- A Commission decision establishing guidelines which clarify the calculation of the amount of electricity from cogeneration, and a Communication on cogeneration.

The proposed recast of the Energy Performance of Buildings Directive is a core element of the package as the energy saving potential of buildings is enormous: energy use in residential and commercial buildings is responsible for about 40% of the EU's total final energy consumption and 36% of the EU's total CO2 emissions. The cost-effective energy saving potential is 30% by 2020.

The Energy Performance of Buildings Directive promotes the improvement of the energy performance of buildings within the Community. Its recast has the following main elements:

- abolishing the 1000 square metre threshold for requirements on existing buildings that undergo a major renovation;
- strengthening the content and the role of the energy performance certificate and the one on inspection of boilers and air-conditioning systems;
- providing a benchmarking tool for the minimum energy performance requirements.

The Swedish Presidency aims to reach an agreement by the end of 2009.

In the Action Plan on Sustainable Product Policy from July 2008 the Commission outlined a new framework for energy and resource-efficient products. The Action Plan complements the EU "growth and jobs" agenda and the very ambitious climate and energy package, reinforced by the European Heads of State and Government in December 2008. The EU environmental target of a 20 % reduction in greenhouse gases and of 20 % energy savings by 2020 should be turned into an opportunity for businesses. A range of policies at EU and national level already foster energy and resource-efficient products and raise consumer awareness, such as the EU framework for the Ecodesign of energy-using products, labelling schemes, and financial incentives granted by Member States to those that buy eco-friendly products. The Action Plan integrates the potential of these different policy instruments, and provides for new action where gaps exist:

- Ecodesign requirements for more products;
- Reinforced energy and environmental labelling;
- Incentives and public procurement for highly performing products.

Statutory Authorisations and Direction

A framework of directives and regulations to improve energy efficiency in energy-using products, buildings and services is in force in Community law. These include the Eco-Design Directive,[4] the Energy Star Regulation,[5] the Labeling Directive[6] and its 8 implementing Directives, the Directive on Energy End-Use Efficiency and Energy Services[7] and the Energy Performance of Buildings Directive.[8] The

[4] OJ L 191, 22.7.2005, p. 29.

[5] (EC) N° 2422/2001

[6] Directive 92/75/EC, OJ L 297, 13.10.1992, p. 16-19.

[7] OJ L 114, 27.4.2006, p. 64.

Commission will encourage Member States towards an ambitious implementation and enforcement of these instruments to ensure the rapid development of a European internal market for energy-efficient goods and energy services and a lasting market transformation. Where there is scope for additional legislative and supporting measures to be taken to strengthen and accelerate the development of this market, these measures will also be given priority.

Directive 2005/32/EC of the European Parliament established a framework for the setting of Ecodesign requirements for energy-using products, amending Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC. Published in the Official Journal of the European Union (L 121 22.7.2005), this so-called "Ecodesign" framework directive defines the principles, conditions and criteria for setting environmental requirements for energy-using appliances. The directive makes no direct provision for mandatory requirements of specific products, instead it establishes that these requirements be done at a later stage for given products following consultations with interested parties and an impact assessment.

In principle, the framework directive applies to all energy-using products that are placed on the market, excluding vehicles. All energy sources are covered, including electricity and solid, liquid and gaseous fuels.

The Ecodesign Directive so far allows setting compulsory minimum ecodesign requirements for energy-using products, such as lighting, refrigerators, televisions or industrial motors. Energy-using products consume a large proportion of energy and other natural resources in the EU. The Commission is currently extending the directive to all energy-related products – products which do not consume energy during use but have an indirect impact on energy consumption, such as water-using devices or windows. For example, water-saving taps and shower heads can reduce water consumption and therefore the energy used for hot water, and by consequence save resources and money, without altering the user's perceived well-being.

Next to minimum requirements, the Ecodesign directive will also define voluntary benchmarks of environmental performance, achieved by highly performing products.

Eco-design for energy-using appliances

Eco-design works to reduce the environmental impact of products, including the energy consumption throughout their entire life cycle. Apart from modifying the behavior of the end user, there are two complementary ways of reducing the energy consumed by products: (1) labeling to raise awareness of consumers on the real energy use in order to influence their buying decisions (such as labeling schemes for domestic appliances), and (2) energy efficiency regulations that are imposed on products from an early stage on the design phase.

The production, distribution, use and end-of-life management of energy-using products (EuP) is associated with a considerable number of environmental impacts, namely the consequences of energy

[8] OJ L 1, 4.1.2003, p. 65.

consumption, consumption of other materials/resources, waste generation and release of hazardous substances to the environment. It is estimated that over 80% of all product-related environmental impacts are determined during the design phase of a product. Against this background, Eco-design aims to improve the environmental performance of products throughout the life-cycle by systematic integration of environmental aspects at a very early stage in the product design. Eco-design works to reduce energy consumption of products including household electrical appliances like clothes washers and refrigerators. Information concerning the product's environmental performance and energy efficiency must be visible if possible on the product itself, thus allowing consumers to compare before purchasing.

In 2008/2009, the Commission adopted nine implementing Regulations[9] under the Ecodesign Directive to improve the energy efficiency of household and office equipment (standby and off-mode), simple set-top-boxes, household lamps, street and office lighting, external power supplies, industrial motors, circulators, televisions, refrigerators and freezers. It published an Ecodesign Working Plan 2009-2011[10] setting out an indicative list of energy-using product groups which will be considered priorities for the adoption of implementing measures.

New energy efficiency performance requirements for a number of product groups including computers, monitors, imaging equipment and complex set top boxes will soon be treated in the Consultation Forum. The Commission may suggest voluntary initiatives from industry instead of mandatory legislation for these product groups.

Directive 2005/32/EC on the Ecodesign of Energy-using Products establishes EU-wide rules to ensure that disparities among national regulations do not become obstacles to intra-EU trade. The Directive does not introduce directly binding requirements for specific products, but instead defines the conditions and criteria for setting, through subsequent implementing measures, requirements regarding environmentally relevant product characteristics and allows them to be improved quickly and efficiently. Products that fulfill these requirements will benefit both businesses and consumers, by facilitating free movement of goods across the EU and by enhancing product quality and environmental protection.

The Directive encourages manufacturers to design products with the environmental impacts in mind throughout their entire life cycle. In other words, the Commission is able to initiate an Integrated Product Policy (IPP) which will accelerate the market shift toward improving the environmental performance of products and appliances. There are no obligations for all energy-using products, but instead are for those

[9] standby, OJ L 339, 18.12.2008, p. 45; simple set-top boxes, OJ L 36, 5.2.2009, p. 8; lamps and ballasts, OJ L 76, 24.3.2009, p. 3 and p. 17; external power supplies, OJ L 93, 7.4.2009, p. 3; electric motors, circulators, televisions and refrigerators/freezers OJ L 191, 23.7.2009, p. 26, p. 35, p. 42 and p. 53, http://ec.europa.eu/energy/efficiency/ecodesign/legislation_en.htm

[10] COM (2008) 660 final, 21.10.2008, http://ec.europa.eu/enterprise/eco_design/workingplan.htm

meeting criteria such as environmental impact and volume of trade in the internal market and which have clear potential for improvement. This would include, for example, where market forces fail to make progress on efficiency in the absence of a legal requirement.

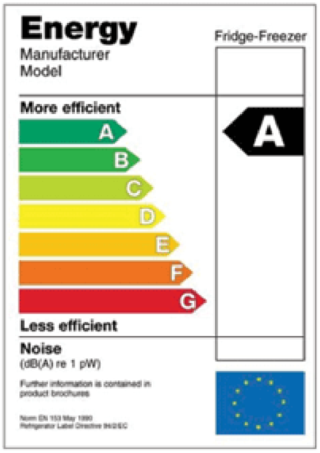
This policy initiative is expected to increase the effectiveness and synergies of other EU legislative acts and initiatives concerning environmental aspects of products. Examples of related measures are the Directives regulating the management of waste from electrical and electronic equipment (WEEE) and the use of certain hazardous substances used in this equipment (RoHS), as well as Directives related to the energy efficiency of appliances such as the Energy labeling Directive. Existing Directives on minimum energy efficiency requirements shall be considered as implementing this Directive for the products that they cover with regard to energy-efficiency during use.

Product Labeling

While the Ecodesign directive seeks to promote a technical improvement of products, labelling enhances transparency for consumers by indicating the energy or environmental performance of products.

The EU regulatory framework regarding labeling of energy-related products and appliances was established in the Energy Labeling Directive (92/75/EEC) for which implementing Directives for the following household appliances have been adopted:

- Refrigerators, freezers and refrigerator-freezers ;
- Clothes washers, clothes dryers and combination products;
- Dishwashers ;
- Ovens ;
- Lighting sources ; and
- Air-conditioning appliances.



Energy labels provide information to end-users about the energy consumption and performance of appliances and equipment. The product labeling requirements are mandatory and common for all Member States. Household appliances offered for sale, hire or hire-purchase shall be accompanied with information relating to their energy consumption or other features, such as energy use, noise and volume.

The energy efficiency of the product is rated according to a scale of energy levels ranging from A to G. The letter 'A' stands for the most energy efficient, and the 'G' for the least energy efficient. There is also other important information clearly presented on the energy label, for example the energy label for incandescent lightbulbs shows its 'lumen' rating, an indication of the product's light output, and 'Watt', the consumption of electricity.

The Energy Rating label enables consumers to compare the energy efficiency of appliances. Manufacturers also see it as an incentive to improve the energy performance of their products, and position themselves as the premium. A few examples for products and their ranges are provided below.

Lightbulbs - the label shows the classification of the lightbulb's electrical consumption relative to a standard (GLS or incandescent) light bulb that produces the same brightness (lumen). Class A & B represent the energy savers options. They are the most efficient type of light bulb and use up to 80% less energy than standard incandescent light bulbs. Class D includes mains voltage halogen bulbs, and classes E and F are the standard incandescent light bulbs and are the least efficient options.

A	B	C	D	E	F	G
20-50%	50-75%	75-90%	90-100%	100-110%	110-125%	>125%

Refrigerators and Freezers - the value is calculated according to the consumption and the internal (i.e., useful) volume of the appliance. The numerical values are an index, they are not calculated in units of energy consumption (kWh). Note that the range of letters on this label includes values for A+ and A++ which would represent the premium efficiency models in this product grouping.

A++	A+	A	B	C	D	E	F	G
<30	<42	<55	<75	<90	<100	<110	<125	>125

Clothes Washers - the energy efficiency scale is calculated using a cotton cycle at 60°C (140°F) with a maximum declared load. This load is typically 6 kg. The energy efficiency index used on the label represents kWh per kilogram of washing.

A	B	C	D	E	F	G
<0.19	<0.23	<0.27	<0.31	<0.35	<0.39	>0.39

Dishwashers - the energy performance of this appliance is calculated based on the number of place settings. For the most common sise of appliance, the 12 place setting machine the following classes apply. The units in the energy label ranging from A to G are expressed in kWh per 12 place settings.

A	B	C	D	E	F	G
<1.06	<1.25	<1.45	<1.65	<1.85	<2.05	>2.05

On the 30 and 31 March 2009, the Regulatory Committee agreed to new labeling requirements for televisions, fridges and freezers and washing machines. New classes are also proposed for other product groups. The new proposed labeling categories are based on the present labeling scheme, with premium efficiency levels that are better than class A. The proposed energy labels for fridges and freezers were not rejected by the European Parliament the 6th May 2009, however the labeling requirements for televisions were rejected. There is concern that these new labeling classes could add confusion as to whether class A represents an efficient product when more efficient products are made and labeled with ratings greater than class A.

Industry has been generally positive about the Commission's new labeling classes, as they fear that downgrading their products' classification will decrease their sales. Consumer groups, however, have criticised the new labels claiming that they would undermine efforts to encourage consumers to buy more energy efficient appliances.

The Commission proposes that mandatory labelling of products according to their energy or environmental performance is extended to a wider range of products, including energy-using and energy-related products. The Energy Labelling Directive (92/75/EC) so far obliges manufacturers and retailers to provide consumers with labels indicating the energy consumption of household appliances, such as washing machines, dishwashers, ovens or air-conditioning appliances. A wider range of products will be labelled about their energy or environmental performance to improve consumers' awareness. For example, labels indicating the insulation capacity of windows would help consumers to choose better windows when renovating their home, and save money on their electricity or gas bill.

Energy Star

The EU ENERGY STAR program follows an Agreement between the Government of the US and the European Community to co-ordinate energy labeling of energy-efficient office equipment. This includes copiers (i.e., imaging equipment), personal computers, monitors, etc. In Europe, the program is managed and administered by the European Commission. In the US, it is managed and administered by the US Environmental Protection Agency and the US Department of Energy.

The EU maintains a website providing information on their program, and opportunities for office equipment users and manufacturers to learn more and to register as a "partner" in this EU process: http://www.eu-energystar.org/.

European Commission Roles and Responsibilities

In January 2007, the European Commission put forward an integrated energy/climate change proposal that addressed the issues of energy supply, climate change and industrial development. Two months later, European Heads of State endorsed the plan and agreed to an Energy Policy for Europe which calls for the following by 2020:

- 20% energy saving
- 20% reduction in greenhouse gas (GHG) emissions

- 20% share of renewables in overall EU energy consumption
- 10% renewable energy component in transport fuel

Achieving these ambitious targets will require a concerted effort across all sectors of the economy and by all Member States. An EU-wide approach is needed to ensure that the effort for reaching the 20% energy saving target is shared equitably between Member States.

Energy efficiency is a means of achieving energy saving as more efficiency reduces energy consumption. Yet, energy efficiency is not the same as energy saving: an expanding population heats and cools more houses, drives more kilometers and uses more electrical devices. Energy efficiency has already brought tangible results: the final energy use would have increased by 115 Mtoe ('Million tonnes of oil equivalent') or 11% per year over the 1997-2006 period had there been no energy efficiency improvements. This is one third of all crude oil imports into the EU-27 in 2006.

There are several players in the European Commission who are involved in setting the agenda for energy-efficient products and equipment. A few of the key players and their responsibilities follows below:

The Directorate-General for Energy and Transport - DG TREN is responsible for the development of EU transport and energy policies, including dealing with State aid, managing the financial support programs for the trans-European networks and technological development and innovation. The issues and challenges of policy in both energy and transport require action at European level; no single national government can address them successfully alone. By working in concert, European Union Member States and European industry can develop solutions which best meet the needs of citisens and our economy, whilst minimizing damage to our environment

The Directorate-General for Enterprise and Industry – DG ENTR is working to reduce administrative burden, stimulating innovation, encouraging sustainable production, ensuring the smooth functioning of the European Union's internal market for goods, opening up business opportunities in space and security research - these are just a few examples of what the European Commission is doing to create a friendly environment for businesses. DG ENTR is responsible for the Action Plan for Sustainable Industrial Policy and is co-managing with DG TREN the Ecodesign Directive and its implementing measures.

The Directorate-General for Environment - DG ENV is one of the more than 40 Directorates-General and services that make up the European Commission. Commonly referred to as DG Environment, it has just under 750 staff working on environmental issues ranging from climate change to biodiversity, air quality, chemicals, waste, water and civil protection. The objective of the Directorate-General is to protect, preserve and improve the environment for present and future generations. To achieve this it proposes policies that ensure a high level of environmental protection in the European Union and that preserve the quality of life of EU citisens. The four priorities of the DG for the years 2002 to 2012 are climate change; nature and biodiversity; environment, health and quality of life; and natural resources and waste.

Executive Agency on Competitiveness and Innovation – an Executive Agency within the European Commission who focus on energy, the environment, business support, multi-modal transport, communication and finance. The EACI includes both European Commission officials and professionals coming from the private sector. They all share a commitment to the European way of linking competitiveness and innovation with environmental protection and a cleaner energy future.

The remit of Executive Agencies is to help the Commission manage EU programs more efficiently and with improved results. Executive Agencies are organisations established in accordance with Council Regulation (EC) No 58/2003 (OJ L 11, 16.1.2003) with a view to being entrusted with certain tasks relating to the management of one or more Community programs. These agencies are established for a fixed period.

The EACI coordinates its work with DGTREN, DG ENTR and DGENV. EACI manages the program areas called "Eco-innovation" and "Intelligent Energy Europe" which is about changing consumption and production patterns and market uptake of technologies, products and services to reduce our impact on the environment. The focus of the Eco-innovation initiative is to find sustainable solutions that make better use of precious resources, reduce the negative side-effects of the EU economy on the environment and create economic benefits and competitive advantage. In addition, they recognise that there is a growing world market for environmental products and services, and innovation in these areas represents a business opportunity for the EU. The Intelligent Energy Europe program promotes the market transformation in the field of energy efficiency and renewable energy.

Philosophical Foundation and Approach

Ecodesign works to reduce the environmental impact of products, including the energy consumption throughout their entire product life cycle. Apart from the user's behavior, there are two ways of reducing the energy use: labeling to raise consumer awareness of the real energy use to influence the purchasing decision, and energy efficiency requirements imposed on the products.

The production, distribution, use and end-of-life management of energy-using products (EuPs) are associated with a considerable number of important impacts on the environment, namely the consequences of energy consumption, consumption of other materials/resources, waste generation and release of hazardous substances to the environment. Some studies have estimated that over 80% of all product-related environmental impacts are determined during the design phase of a product. In this context, Ecodesign aims to improve the environmental performance of products throughout the life-cycle by systematic integration of environmental aspects at a very early stage in the product design cycle.

Sustainable Industrial Policy Action Plan

One of the great challenges faced by economies today is the integration of environmental sustainability with economic growth and welfare through the decoupling of environmental degradation and economic growth. This is an objective for the European Union, but the growing demand for energy and resources are challenging this objective. Europe is working toward a more energy and resource efficient economy, where sustainable consumption and production will enable businesses to transform environmental challenges into opportunities and provide a better deal for consumers. The challenges are to improve the overall environmental performance of products throughout their life-cycle, to boost the demand for better products and production technologies and to help consumers in making informed choices.

On 16 July 2008, the European Commission presented the Sustainable Consumption and Production and Sustainable Industrial Policy (SCP/SIP) Action Plan. This Plan includes a series of proposals on sustainable consumption and production that will contribute to improving the environmental performance of products and increase the demand for more sustainable goods and production technologies. It also seeks to encourage EU industry to take advantage of opportunities to innovate. The Council endorsed the Action Plan in its conclusions adopted on 4 December 2008.

A range of policies at EU and national level already foster resource efficient and eco-friendly products and raise consumer awareness. The proposals complement these policy instruments and provide measures where gaps exist.

The list of actions in the Sustainable Consumption and Production and Sustainable Industrial Policy (SCP/SIP) Action Plan encompasses:

- Ecodesign requirements for more products;
- Reinforced energy and environmental labelling;
- Incentives and public procurement for highly performing products;
- Green public procurement practices;
- Consistent product data and methodologies
- Work with retailers and consumers;
- Supporting resource efficiency, eco-innovation and enhancing the environmental potential of industry;
- Promoting sustainable production and consumption internationally.

A New Framework for Environmental Product Policy

A range of policies at EU and national level already foster resource efficient and eco-friendly products and raise consumer awareness, such as the EU framework for the Ecodesign of energy-using products, labelling schemes, and financial incentives granted by Member States to those that buy eco-friendly products. The Action Plan complements and integrates the potential of these different policy instruments, and provides for new action where gaps exist.

Energy and resource-efficient products: The Ecodesign Directive

The Ecodesign Directive so far allows setting compulsory minimum ecodesign requirements for energy-using products, such as boilers, water heaters, computers, televisions or industrial fans. Energy-using products consume a large proportion of energy and other natural resources in the EU. It is proposed to extend the directive to all energy-related products – products which do not consume energy during use but have an indirect impact on energy consumption, such as water-using devices or windows. For example, water-saving taps and shower heads can reduce water consumption and therefore the energy used for hot water, and by consequence save resources and money, without altering the user's perceived well-being.

Next to minimum requirements, the Ecodesign directive will also define voluntary benchmarks of environmental performance, achieved by highly performing products. If some water boilers reduce their energy consumption to a larger extent than other similar products, this high performance should indeed serve as a benchmark for industry.

Reinforced energy and environmental labelling

While the Ecodesign directive ensures a technical improvement of products, labelling enhances transparency for consumers by indicating the energy or environmental performance of products.

The Commission proposes that mandatory labelling of products according to their energy or environmental performance is extended to a wider range of products, including energy-using and energy-related products. The Energy Labelling Directive (92/75/EC) so far obliges manufacturers and retailers to provide consumers with labels indicating the energy consumption of household appliances, such as washing machines, dishwashers, ovens or air-conditioning appliances. A wider range of products will be labelled about their energy or environmental performance to improve consumers' awareness. For example, labels indicating the insulation capacity of windows would help consumers to choose better windows when renovating their home, and save money on their electricity or gas bill.

The EU Ecolabel is a voluntary label which is awarded to the most environment-friendly products on the market. It enables private consumers and public authorities alike to identify and buy 'greener' products. The scheme will be strengthened by widening the number of products covered and making the system less costly and bureaucratic. It will thus act as an incentive for manufacturers to go beyond the mandatory minimum product standards. Due to its broader scope the Ecolabel will also cover products and services, including food and drink products, for which ecodesign and energy related requirements will not be set.

Setting Incentives

The Action Plan proposes that only products attaining a certain level of energy or environmental performance can receive incentives and be procured by Member States and the EU institutions. This level will be identified through one of the labelling classes, when mandatory labelling is set for a particular product group (see above). But it will be up to Member States whether and in which form to provide incentives. Today, national or regional incentives to consumers that buy eco-friendly products are granted for very different levels of energy or environmental performance. For example, the insulation performance required for getting incentives for an energy-efficient window is twice as high in some regions than in others close by and with similar climatic conditions. This hampers economies of scale for eco-friendly products.

Promoting Green Public Procurement

Public authorities spend 16% of EU GDP on the purchase of goods and services. In particular in certain sectors such as construction, transport, office equipment, cleaning services, public purchasers could give strong signals to the market place by asking for greener goods, thereby stimulating the supply of more environmentally friendly goods and services. In addition to the instruments above, further voluntary measures aim to increase the potential benefits of Green Public Procurement: The Commission will provide guidance and tools for public authorities to green their procurement practices. This will include common environmental criteria, the setting of targets and providing model tender specifications. This shared approach will help to avoid market distortions in Europe. A separate Communication on Green Public Procurement details these measures.

Consistent data and methods on products

To implement this policy, consistent and reliable data and methods are required to assess the overall environmental performance of products and their market penetration and to monitor progress. The Commission will build on ongoing work in this field, so that, inter alia, data on products and related environmental impacts collected under different tools are shared.

Work with Retailers and Consumers

Retailers are in a strong position to influence sustainable consumption. Individual retailers will commit for example to offering more sustainable timber products, to promote the purchase of energy-saving light bulbs, and to reduce their own carbon footprint.

A Retail Forum will be set up to promote the purchase of more sustainable products, to reduce the environmental footprint of the retail sector and its supply chain, and to better inform consumers. Other stakeholders, such as producers, consumer and other non-governmental organisations, will also be involved.

The Commission will also support actions to increase consumer awareness and help them make more informed choices, for instance by developing tools to inform young people and on-line education tools for adults on sustainable consumption.

Promoting Eco-Friendly and Leaner Production

A range of actions will provide further impetus to promote resource efficient and eco-innovative production:

Boosting resource efficiency

Resource efficiency means creating more value while using fewer resources. In the EU, resource productivity (measured by GDP per resource use, €/kg) has improved 2,2% per annum in real terms over the past 10 years. This means that the EU has been able to stabilise resource use in a growing economy. This should continue at least at the same pace. Tools to monitor, benchmark and promote resource efficiency will be further developed; detailed material-based analysis and targets will be addressed in a second step.

Supporting eco-innovation

The level of innovation can be measured by the amount of patents in the area. According to the OECD, eco-innovation patents in the EU are on the rise and best performing Member States grant 3.5 patents per € 1 billion of GDP. Tools will be developed to monitor, benchmark and boost the uptake of eco-innovation in the EU as part of a wider EU innovation policy.

Furthermore, an EU wide environmental technology verification scheme will be established to provide reliable third-party verification of the environmental performance of new technologies. This will be a voluntary, partially self-financed scheme, based on a regulatory framework. It will help to provide confidence to new technologies emerging on the market.

Enhancing the environmental potential of industry

Revise the EMAS Regulation - the voluntary EU eco-management and audit scheme, EMAS, helps companies to optimise their production processes and make more effective use of resources. The scheme will be significantly revised to increase the participation of companies, and reduce the administrative burden and costs to Small and Mediums Sised Enterprises (SMEs).

Developing industrial policy initiatives for environmental industries

Environmental industries provide solutions for measuring, preventing and correcting environmental damage to water, air and soil, and for problems such as waste, noise, and damage to eco-systems. They include sectors such as waste and waste water management, renewable energy sources, environmental consulting, air pollution, and eco-construction.

The global market for environmental industries was estimated to be €1000 billion in 2005 and could reach €2200 billion in 2020.

The Commission will first analyse the barriers to the expansion of eco-industries and to their full uptake by traditional industries, such as administrative burdens and obstacles to financing of innovation. The objective is to create a friendly regulatory environment for the development of environmental industries in the EU. The potential of ICT for delivering sustainable solutions will also be explored.

Helping Small and Medium Sise Enterprises

The Enterprise Europe Network and other channels will encourage SMEs to adopt environmentally friendly and energy efficient solutions. The action will also aim at developing content for training and disseminating tailor-made information and know-how about energy saving and environmental compliance for small companies.

Contributing to Sustainable Consumption and Production Internationally

Promote sectoral approaches in international climate negotiations

Industry sectors are starting to develop agreements in order to commit to specific emission reductions or energy efficiency targets. Businesses in emerging as well as developed economies thus commit to reduce their greenhouse gas emissions. It also avoids that some companies of a sector suffer from carbon constrain while others competitors benefit from carbon havens. The Commission will support such approaches in the context of future international negotiations on climate change. Activities will include capacity-building in key emerging economies and determining key elements to build such approaches as part of a comprehensive international climate change agreement for the period after 2012.

Promote and share good practice internationally.

Sustainable consumption and production policies (SCP) will be promoted, in particular as part of the United Nations SCP 10-Year Framework Programme (Marrakesh Process). The Action Plan will provide a contribution for future work that is carried out in collaboration with the UN, and additional action will be taken to strengthen partnerships in this field. In addition, the European Commission in its Energy Efficiency Action Plan proposed to act on energy efficiency in international relations. This has taken shape on June 8 with the launch of the International Partnership for Cooperation on Energy Efficiency which brings together G8 countries, China, India, Korea and the European Community. The IPEEC will be a high level, open, broad and inclusive partnership of the nations seeking to maximise the benefits of energy efficiency through voluntary cooperation.

Promote international trade in environmental goods and services.

The EU continues its efforts for trade policy and industry dialogue to work towards the elimination of tariffs for trade of low carbon technologies and environmentally friendly products and services.

Examples of Gains in Efficiency and Cost Reduction

Efficient use of resources is attractive, because it reduces the negative environmental impacts and increases the competitiveness of the economy. 30% of energy used in buildings could be reduced with positive economic effects in 2030. Better window insulation could reduce a household's heating energy needs by more than one fifth, while reducing related costs by 11%. Significant gains are also estimated for baths, showers and taps.

Legal Documents Proposed and Roadmap

The following documents accompany today's Action Plan:

- Proposal for the extension of the Ecodesign Directive
- Proposal for the revision of the Ecolabel Regulation
- Proposal for the revision of the EMAS Regulation
- Communication on Green Public Procurement

This will be shortly followed by the:

- Proposal for the revision of the Energy Efficiency Labelling Directive
- Proposal for a Regulation for an Environmental Technology Verification scheme

The Commission will present the legislative proposals to the EU Council of Ministers and the European Parliament. The proposals will go through the "co-decision" procedure, in which the European Parliament adopts legislation jointly with the Council.

These proposals are an integral part of the European Union's renewed Sustainable Development Strategy (EU SDS) which reinforces the EU's long-standing commitment to meet the challenges of sustainable development and builds on initiatives and instruments at EU and international level. The building blocks of the European Union's policy on sustainable consumption and production include:

- Integrated Product Policy (IPP)
- Thematic Strategy on the Sustainable Use of Natural Resources
- Thematic Strategy on Waste Prevention and Recycling
- Eco-Management and Audit Scheme (EMAS)
- Ecolabel Scheme
- Environmental Technologies Action Plan (ETAP)
- Green Public Procurement (GPP)
- Eco-design of Energy Using Products Directive (EuP)
- European Compliance Assistance Programme - Environment & SMEs

Action Plan for Energy Efficiency

The Energy Efficiency Action Plan (EEAP) of 2006[11], endorsed at the Spring 2007 European Council[12], states that it is technically and economically feasible to achieve at least 20% energy consumption reductions compare to the business-as-usual scenario by 2020 and details a plan that will put EU on the way for reaching this objective. Due to the significant barriers to energy efficiency and the need to tackle them with a diverse and continuous policy mix, the Plan was conceived as a first step in the process. It was acknowledged that further policy measures will be needed, depending on the progress, and therefore its mid-term evaluation and revision was envisaged for 2009. A review of this Action Plan is currently ongoing.

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The Commission considers the biggest energy savings are to be made in the following sectors: residential and commercial buildings (tertiary), with savings potentials estimated at 27% and 30% respectively, the manufacturing industry, with the potential for a 25% reduction, and transport, with the potential for a 26% reduction in energy consumption. These energy savings correspond to 390 million tonnes of oil equivalent (Mtoe) each year or €100 billion per year up to 2020. They would also help reduce CO2 emissions by 780 million tonnes per year. These savings come in addition to an estimated 1.8% (or 470 Mtoe) reduction in annual consumption from other measures already adopted and normal replacements of material.

Achieving the 20% reduction will help address the EU's impact on climate change and dependence on fossil fuel imports. The Action Plan will also boost industrial competitiveness, increase exports of new technologies and will have positive benefits in terms of employment. The savings from the Action Plan will offset the investments put into innovative technologies.

Effective action on energy-consuming equipment and appliances requires working on two fronts: standards for the energy yield of appliances and an appropriate, consumer-focused system to label and evaluate energy performance. The Action Plan provides for the adoption of Eco-Design minimum standards to improve the energy yield of 14 groups of products (including boilers, televisions and light fittings) and to extend it to other products in the long-term. In addition, the Commission hopes to strengthen the rules on labeling, in particular by regularly updating classifications and extending these rules to other equipment.

Criteria for Determining if a Regulation Needs Updating

Article 16 of the Ecodesign Directive specifies that the Commission shall publish a working plan setting out, for the three following years, an indicative list of energy-using product groups which will be considered priorities for the adoption of implementing measures. The working plan should build on the work done since the adoption of the Ecodesign Directive in 2005, including recommendations for reviewing measures. The nine implementing measures adopted in 2008/2009 contain a review clause.

For the Energy Labeling Directive, there are no overarching set of principles or rules that say that the labels must be revised when something happens or that committees/the commission must review labels according to a certain schedule; however, the framework directive does articulate the principles which guide whether a product is considered appropriate to be labeled or not. The Commission chairs meetings of the common Ecodesign and Energy Labeling Regulatory Committee, which is comprised of formally nominated delegations from each Member State and the Commission takes guidance from this committee on the revision of labels and its schedule (see 92/75/EEC of 22 September 1992). The Committee typically meets at least twice a year but there is no fixed schedule).

The Energy Labeling Directive only applies to household energy-using appliances and has led to eight implementing directives being issued for given appliance types (some of these have since been revised). The scope of this directive is limited, which is why there is an active discussion about revising it to permit non-energy using products (e.g. windows) and non-household products (e.g. motors) to receive energy labels.

Compliance Certification Reporting

Mandatory compliance certification reporting is called market surveillance in Europe. Moreover, there exist some volunatary certification programs by industry associations.

Member States are responsible for market surveillance under the Ecodesign Directive 2005/32/EC. The national market surveillance authorities must monitor that products covered by implementing Regulations may be placed on the EU market and/or put into service only if they comply with those Regulations and bear the CE marking. The CE marking symbolises the conformity of the product with the applicable Community requirements, regardless if safety, health, energy-efficiency or other environmental requirements are set out in the applicable product legislation. Article 3 of the Ecodesign Directive stipulates that authorities are entitled to organise appropriate checks on compliance with the implementing Regulations, to oblige the manufacturer to recall non-compliant products from the market, to require the provision of all necessary information and to take samples of products and subject them to compliance tests.

The Ecodesign Directive stipulates that the conformity assessment procedures shall be specified by the implementing measures. The adopted measures leave to manufacturers the choice between the internal design control and the management system for conformity (self-certification, detailed in a technical documentation accompanying the product). Decision No 768/2008/EC on a common framework for the marketing of products defines a full set of conformity assessment procedure, from self-certification with supervised product checks to third party certification (so-called modules A-H), which the Commission may use in further mandatory measures.

Some industry associations, such as Eurovent who are significant players in the heating, ventilation and air-conditioning market, require all products listed in their catalogue to be voluntary certified.

The process is similar US-based schemes, where associations organise their own challenge testing programs and members agree that other members can challenge the performance declaration of their products and if the supplier is found in error they agree to pay the testing costs and to withdraw or correctly label their products. This voluntary approach is used in Europe for the major household appliances sold through CECED members.[13] Typically these associations and their programs cover 80-90% of the market for the products they address.

[13] CECED represents the household appliance industry in Europe. Its member companies (i.e., Arçelik, BSH Bosch und Siemens Hausgeräte GmbH, Candy Group, De'Longhi, Electrolux Holdings, Fagor, Gorenje, Liebherr, Indesit Company, Miele, MTS, Philips, Saeco, SEB and Whirlpool Europe) employ over 200,000 people, are mainly based in Europe, and have a turnover of about €40 billion. If upstream and downstream business is taken together, the sector employs over 500,000 people.

There is also a significant amount of third-party certification done via the retailer/distribution networks but this is according to specific retailer requirements. Some member states organise certification of products that appear in their additional promotional campaigns such as the UK's Energy Efficiency Recommended program or Denmark's Electricity-Savings Trust's A-club.

In essence, there is a self-declaration system and that products which carry the CE marking are supposed to respect all EU legal requirements including for truthful labeling and energy declarations. The labeling law varies by Member State but in many cases the retailers are legally liable for the truthfulness of the information declared. The Ecodesign regulations are directly binding in all Member States, and the manufacturers or importers are legally liable for the compliance of their products.

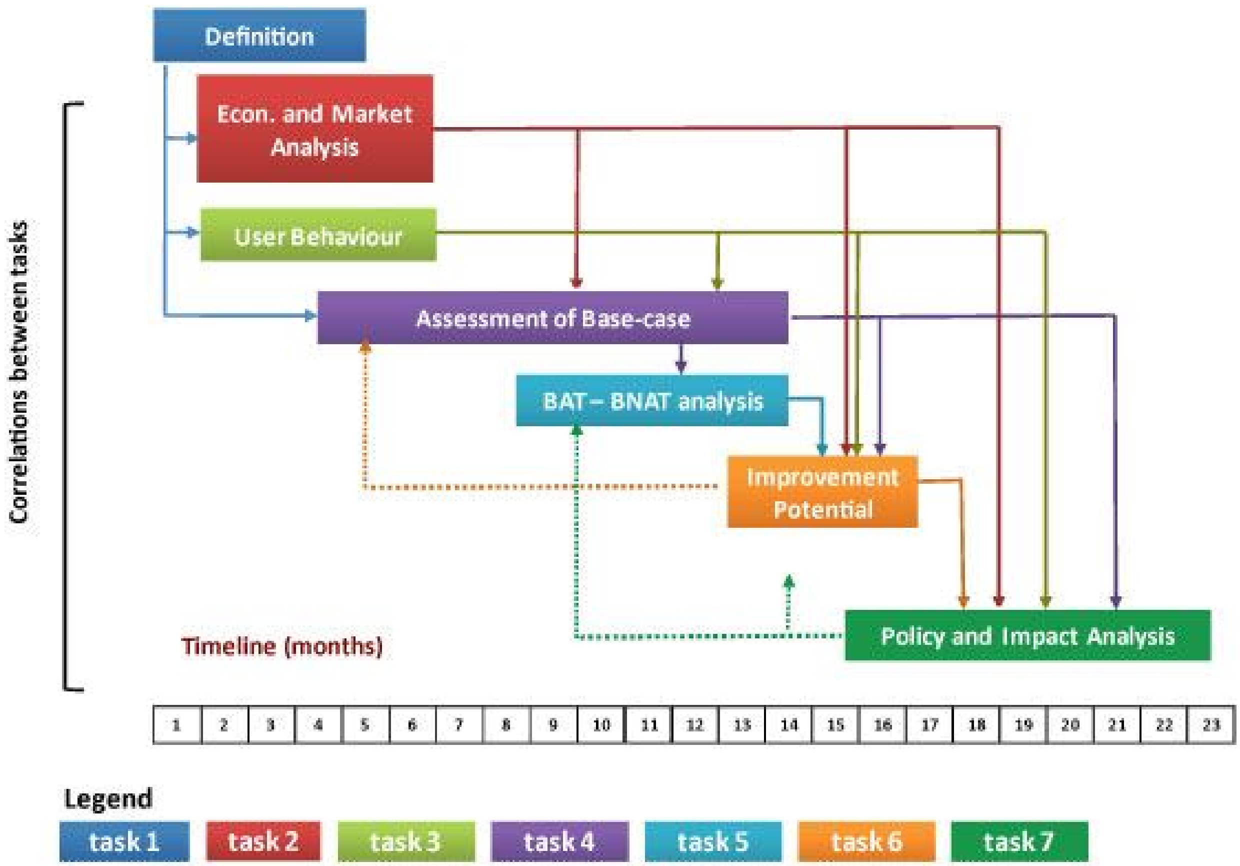
Methodology study for Ecodesign of Energy-using Products

The aim of the underlying Methodology study for Ecodesign of Energy-using Products (MEEUP) is to evaluate whether and to which extent various energy-using products fulfill certain criteria that make them eligible for implementing measures under the Ecodesign of EuP Directive 2005/32/EC; these criteria are specified in Article 15 and Annexes I and II of the Directive. The text below has been adapted from "Methodology Study Eco-design of Energy-using Products: Final Report MEEUP Methodology Report" prepared by Van Holsteijn en Kemna BV, 2005.

Preparatory studies are drafted for each of the products being regulated, with the following structure distinguishing product specific sections:

1. Product Definition, Standards & Legislation;
2. Economics & Market;
3. Consumer Analysis & Local Infrastructure;
4. Technical Analysis Existing Products;
5. Definition of Base Case(s);
6. Technical Analysis of Best Available Technology;
7. Improvement Potential;
8. Policy, Impact and Sensitivity Analyses.

This original structure was followed, but later modified by DG-ENTR to seven steps, where steps 4 and 5 were combined into one. The figure on the following page shows the flow between the various steps, shown over a timeline of approximately two years. Please note that the analytical teams conducting the actual research on these products may modify the task structure slightly, as appropriate for products and their respective stakeholder groups.



The following provides further detail on the analyses conducted, and the rationale behind these analyses.

Step 2 discusses what will be and what can be the scope of implementing measures under the 2005/32/EC. What is the domain of Ecodesign in practice, as an extra dimension to the current research and product development activities? Product developers define the geometry, select the materials and the manufacturing processes and prescribe the use of the new products. As such they are a major determining factor in the environmental impact that the new products will have, if the legislator succeeds in formulating realistic, clear and accurately defined implementing measures. Looking downstream, the designer can conceive how a product should be used and eventually disposed off, but the actual use may be different. This is especially important as Energy-using Products (EuP) –as opposed to many non-EuP—have by definition a relevant environmental impact in the use phase of the product.

Step 3 sets out to prepare the tools for assessing the environmental impact. It takes the environmental indicators from the tender document and the 2005/32/EC Directive as a basis and develops a methodology that defines the system boundaries, partitioning problems, etc. and translates the underlying emissions and resources in a product's life-cycle into these mostly aggregated indicators with appropriate weighting factors. Accepted scientific principles play a role in this process and a very important consideration has been that the methodology needs to be consistent with the existing legislation.

Chapter 4 considers the necessary information on the underlying emissions and resources used, such as the Integrated Pollution Prevention and Control (IPPC) Best Available Techniques (BREFs), and emission/resources data supplied by the materials industry. Furthermore, in the same chapter some specific problems relating to data retrieval for the use phase are discussed. This relates to test standards, consumer behavior and system analysis.

Chapter 5 presents the data and reporting tool that allow the translation of product-specific information (materials, geometry, etc.) into environmental impacts. For around 100 materials and processes a so-called Unit Indicator table was built, containing per unit of material (e.g. in kg) or process (e.g. in kWh/ GJ) 14 environmental indicators (and 2 auxiliary parameters) per unit material (in kg) and per process (e.g. in kWh). These environmental indicators are Energy, Water (process & cooling), Waste (hazardous & non-hazardous), Global Warming Potential (GWP), Acidification Potential (AP), Volatile Organic Compounds (VOC), Persistent Organic Pollutants (POP), Heavy Metals (to air & to water) carcinogenic Policyclic Aromatic Hydrocarbons (PAH), Particulate Matter (PM) and the Eutrophication Potential of certain emissions to water (EP). Auxiliary parameters relate to electricity use and to feedstock input.

Chapter 6 deals with the Market Analysis and related subjects, such as the product definitions and classification. Regarding existing legislation, the chapter gives an overview of the worldwide labeling and Minimum Efficiency Standards for EuP that should be taken into account during the preparatory studies. In terms of hard data on sales and stock of particular EuP it is recommended to use both the PRODCOM data for more generic trade and production data that are consistent with official statistics, but also and primarily use specialist marketing sources to generate sales and stock data that are supported by the industry sectors. The last part of this chapter deals with market trends and the pricing data that serve as an input for the monetary Life Cycle Cost definition.

Chapter 7 sketches the outlines of the methodology to assess the improvement potential. The first step is the definition of one (or more) Base Case(s) that characterise the average new EU product. This sets the reference for improvement. It also bundles all the information from the various environmental, technical and economical information that was assessed in the previous chapters. Apart from the functional parameters, it defines the emissions and resources consumption for the 14 indicators and it determines the Life Cycle Costs, i.e. the monetary cost to the end-user not only for the purchase of the product but also for the discounted running costs.

Chapter 8, the final part of the study, is an ex-post study of the environmental improvements according to several scenario's, the estimated impact on industry and consumers of certain measures and a sensitivity analysis that shows how robust the rationale for implementing measures is in the light of price variations and alternative partitioning methods (e.g. for recycling).

APPENDIX B: BACKGROUND OF US PROGRAMME

There are two ways that national energy conservation standards are established in the United States. The first is through an act of Congress, who declare and set energy conservation standards through legislation and the second is through a three-year public rulemaking process, conducted by DOE. In the Congressional approach, an appropriate energy conservation standard level is determined and adopted through an act of Congress. For example, energy conservation standards were established for exit signs by the Energy Policy Act of 2005, which adopted the ENERGY STAR level for exit signs as the national minimum energy performance standard.

The second method of establishing energy conservation standards is through an analytical rulemaking conducted by the DOE. Coverage authority and direction to evaluate a product for energy conservation standards is given to DOE by Congress. DOE then manages a three-year rulemaking process which involves public meetings, draft analyses published for review, stakeholder comments and proposed and final positions taken on the standard level. In establishing the energy conservation standard level, DOE takes into consider seven statutory criteria including issues like manufacturability, safety and economic justification. These two approaches are discussed in the following sections of this chapter.

Statutory History

Minimum standards of energy efficiency for many major appliances were established by the U.S. Congress in Part B of Title III of the Energy Policy and Conservation Act (EPCA) of 1975, Public Law 94-163. This framework legislation was then amended by a series of laws starting in 1978. The Congressional legislative history that established and shaped the codes and standards program in the U.S. is provided in Table B1. To access these laws establishing federal appliance and equipment standards and DOE's authority to review, revise, and issue standards, see the United States Code, Title 42, Chapter 77, Subchapter III, Part A—Energy Conservation Program for Consumer Products Other Than Automobiles and Part A-1—Certain Industrial Equipment.[14]

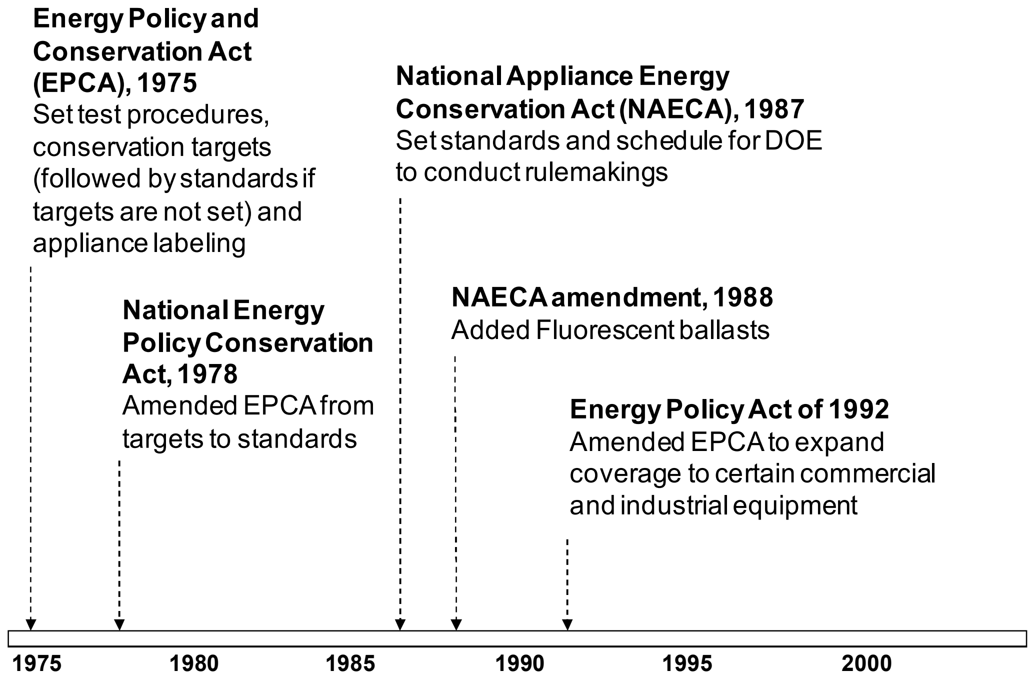
The timeline in Figure B.1 depicts the first few decades of the Federal energy conservation standards program, which started in 1975.

[14] http://frwebgate.access.gpo.gov/cgi-bin/usc.cgi?ACTION=BROWSE&TITLE=42USCC77&PDFS=YES

Table B.1. Congressional Acts and the US Energy Conservation Standards Program

Congressional Legislation	References
Energy Policy and Conservation Act (EPCA) of 1975	Public Law 94-163
National Energy Conservation Policy Act of 1978	Public Law 95-619
National Appliance Energy Conservation Act of 1987	Public Law 100-12
National Appliance Energy Conservation Amendments of 1988	Public Law 100-357
Energy Policy Act of 1992	Public Law 102-486
Energy Policy Act of 2005	Public Law 109-58
Energy Independence and Security Act of 2007	Public Law 110-140

Figure B-1. US Statutory Timeline for Energy Conservation Standards, 1975 to 1992



Federal appliance efficiency standards started in 1975, as part of a national response to the oil shocks and heightened awareness of energy conservation. At that time, several states were adopting state appliance efficiency standards. The Energy Policy and Conservation Act of 1975 (EPCA) established a federal energy conservation program for major household appliances by calling for appliance efficiency targets. (Public Law 94-163)

EPCA established test procedures, conservation targets (followed by standards if targets are not set), and labeling requirements for certain major household appliances. EPCA also provided for DOE to establish test procedures for evaluating compliance by manufacturers with applicable efficiency standards. In 1978, DOE was authorised to set mandatory energy efficiency standards for 13 household appliances and products under the National Energy Conservation and Policy Act of 1978 (NECPA). (Public Law 95-619)

In 1986, appliance manufacturers recognised that operating under one, uniform Federal standard for a product was preferable to having to comply with a variety of state standards.

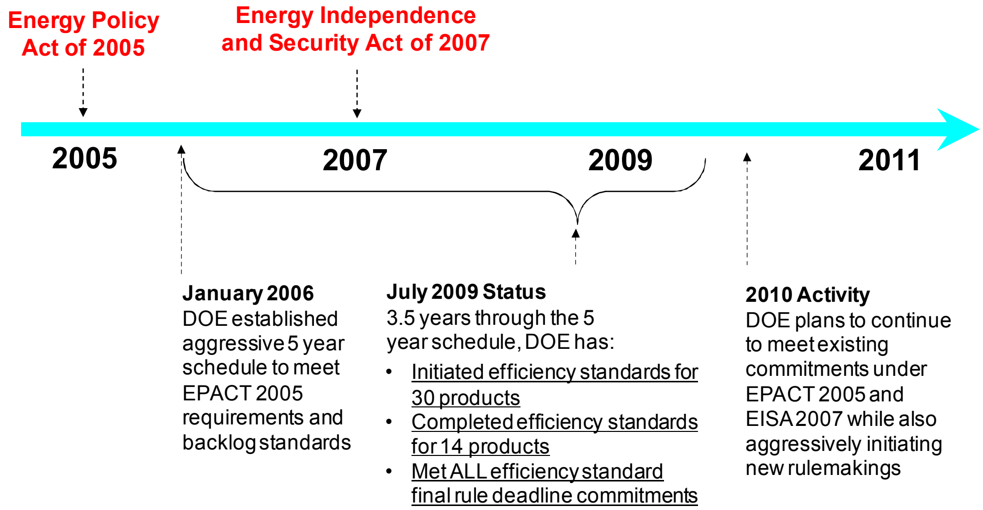
In response to this development, in 1987, EPCA was amended and updated by the National Appliance Energy Conservation Act (NAECA), which superseded existing state requirements. (Public Law 100-12) The products covered by these standards included refrigerators and freezers, room air conditioners, central air conditioners and heat pumps, water heaters, furnaces, dishwashers, clothes washers and dryers, direct heating equipment, ranges and ovens, and pool heaters. NAECA also contains requirements and deadlines for updating the initial standards through rulemakings conducted by DOE using criteria included in the law. For instance, in conducting the rulemakings to update the standards, the Secretary is required to standards at levels that achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. NAECA 1988 added ballasts to the statutory list of covered products. (Public Law 100-357)

The Energy Policy Act of 1992 (EPACT 1992) further amended EPCA to expand the coverage of the standards program to include certain industrial equipment, including commercial heating and air-conditioning equipment, water heaters, certain incandescent and fluorescent lamps, distribution transformers, and electric motors. (Public Law 102-486) EPACT 1992 established maximum water flow rate requirements for certain plumbing products and provided for voluntary testing and consumer information programs for office equipment and luminaires. EPACT 1992 also established a labeling program for commercial products. It also allowed for the future development of standards for many other products.

In September 1995, DOE announced a formal effort to consider further improvements to the process used to develop appliance efficiency standards. On July 15, 1996, the Department published Procedures for Consideration of New or Revised Energy Conservation Standards for Consumer Products, which established guidelines for DOE regarding the consideration and promulgation of new or amended appliance efficiency standards under EPCA. 61 FR 36974 (July 15, 1996). This process improvement rule is discussed in detail in section 3.5 of this report.

There was no legislative activity following EPACT 1992 until the Energy Policy Act of 2005. The timeline below depicts the most recent five years of the Federal Appliance Efficiency Standard program, starting with the Energy Policy Act of 2005. The diagram also highlights some recent DOE activity and achievements.

Figure B-2. US Statutory Timeline for Energy Conservation Standards, 2005 to Date



EPACT 2005 significantly expanded and changed DOE's regulatory requirements in appliance standards. (Public Law 109-58) EPACT 2005 established numerous energy conservation standards for many types of products and expands the DOE's authority to regulate other product areas. New standards are legislated for ceiling fan light kits, dehumidifiers, unit heaters, torchiere lamps, medium base compact fluorescent lamps, fluorescent lamp ballasts, mercury vapor lamp ballasts, illuminated exit signs, traffic signals and pedestrian signals, commercial pre-rinse spray valves, low voltage dry-type distribution transformers, commercial package air-conditioning and heating equipment; commercial refrigerators, freezers, and refrigerator-freezers; automatic commercial ice makers; and commercial clothes washers.

On December 19, 2007, the President signed into law the Energy Independence and Security Act of 2007 (EISA), (Public Law 110-140). This law amends EPCA and increases the number of rulemakings DOE must issue beyond its then existing obligations. The enactment of EISA substantially elevated the level of activity within the Appliance Standards Program. The statute required DOE to develop several new test procedures and energy conservation standards, as well as prescribing new energy conservation standards and test procedures for certain products.

EISA set out energy conservation standards for a number of products that were the subject of active rulemaking. By doing so, EISA eliminated or modified DOE's obligation to develop standards for those products, including, for example, the electric motors (1-200 hp) rulemaking.

In addition, EISA introduced new standby power requirements for residential products. All test procedures for covered residential products are required to be amended to include test procedures for standby mode and off mode energy consumption. However, EISA specifies deadlines for the incorporation of standby mode and off mode energy consumption into the test procedures of certain enumerated products, including battery chargers, external power supplies, clothes dryers, room air conditioners, fluorescent lamp ballasts, residential clothes washers, residential furnaces, residential boilers, residential water heaters, direct heating equipment, pool heaters, dishwashers, ranges and ovens, microwave ovens, and residential dehumidifiers. In addition, all energy conservation standards for covered products adopted after July 1, 2010 must incorporate standby mode and off mode energy consumption. Several rulemakings to amend the aforementioned test procedures are now underway. For each product, DOE is working with stakeholders to apply the statutory definitions in EISA 2007 (e.g., the definitions for “standby mode” and “off mode”) to the product. In doing so, DOE remains cognisant of industry norms, definitions issued by other standards-developing bodies, and the technical characteristics of the product. An example of this would be DOE’s use of IEC 62301 to assist in its evaluation of standby mode and off mode energy consumption.

EISA also added three new product rulemakings (residential clothes washers, walk-in coolers and freezers, and metal halide lamp fixtures) that are all due to be completed by the end of 2011. Moreover, the statute directs DOE to undertake other energy conservation standards rulemakings for battery chargers, external power supplies, furnace fans, dishwashers, and general service incandescent lamps. Of the fifteen products for which EISA 2007 specified schedules for incorporating standby mode and off mode into the test procedures, eight are due before the end of 2009. The remaining seven are scheduled for completion in 2010 and 2011.

EISA also revised EPCA to require that DOE review and update all energy conservation standards and test procedures on an ongoing basis. This means that every energy conservation standard and every test procedure must be reviewed, in a public participative process, ever 6 and 7 years respectively. Specifically, the statute now requires:

- Six years after issuance of a final rule establishing an energy conservation standard, DOE must either publish a notice of proposed rulemaking (NOPR) to amend the standard or a notice of determination that an amended standard is not warranted (42 U.S.C. 6295(m)(1) and 6313(a)(6)(C)(i)).

- DOE must review all test procedures on a seven-year cycle (42 U.S.C. 6293(b)(1)(A) and 6314(a)(1)).

Section 307 of EISA removed the requirement that DOE to publish an Advance Notice of Proposed Rulemaking (ANOPR) in its energy conservation standards rulemakings for residential products. For certain products where DOE has taken a decision not to issue an ANOPR, it has still continued to hold public meetings to receive stakeholder input on DOE’s preliminary analyses.

Section 308 of EISA established new authority for DOE to issue direct final rules in cases where a fairly representative group of stakeholders (including manufacturers, States, and efficiency advocates) jointly submit a recommended standard level. This authority could eliminate months of time from schedule for a consensus rule, which is typically a three-year process. In many cases, stakeholder proposals are based on the work of voluntary standards organisations, such as ASHRAE. The requirements for using this authority include sufficient notice to allow all stakeholders to have an opportunity to review and comment on the final rule.[15]

Energy Conservation Standards Methodology

This section of the report presents information on the process DOE follows in establishing of energy conservation standards. DOE conducts an extensive analysis (described by the Process Improvement Rule) in order to comply with seven statutory criteria in EPCA. These criteria and the underpinning analyses form the basis for the Secretary of Energy's decision with respect to the appropriate national energy conservation standard.

Maximum Efficiency that is Technologically Feasible and Economically Justified

EPCA lists seven criteria that DOE must take into consideration when establishing a new or amended energy conservation standard. (42 U.S.C. 6295(o)(2)) The Secretary is required to choose the standard level that is designed to achieve the maximum improvement in energy-efficiency that is technologically feasible and economically justified. In making this determination, the Secretary reviews stakeholder comments on the proposed standard level and determines whether the benefits of the standard exceed the burdens by the greatest extent possible concerning these seven criteria.[16]

The seven statutory criteria represent the key questions that the Secretary takes into consideration when proposing and adopting the U.S. national standards:

(II) the savings in operating costs throughout the estimated average life of the covered product in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered products which are likely to result from the imposition of the standard;

(III) the savings in operating costs throughout the estimated average life of the covered product in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered products which are likely to result from the imposition of the standard;

(IV) the total projected amount of energy, or as applicable, water, savings likely to result directly from the imposition of the standard;

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[15] DOE efforts are conducted consistent with the National Technology Transfer and Advancement Act (P.L. 104-113) was signed into law on March 7, 1996, as set forth in OMB Circular A-119 - Federal Register (63 FR 8545) on February 19, 1998.

[16] DOE rulemakings are conducted consistent with OMB circular A-4.

(V) any lessening of the utility or the performance of the covered products likely to result from the imposition of the standard;

(VI) the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from the imposition of the standard;

(VII) the need for national energy and water conservation; and

(VIII) other factors the Secretary considers relevant.

Standards Development Process

In September 1995, DOE announced a formal effort to consider improvements to the process used to develop appliance efficiency standards, calling on energy efficiency groups, manufacturers, trade associations, state agencies, utilities and other interested parties to provide input to guide the Department. On July 15, 1996, the Department published Procedures for Consideration of New or Revised Energy Conservation Standards for Consumer Products (hereinafter referred to as the Process Rule). 61 FR 36974. The Process Rule set forth guidelines for developing efficiency standards. These guidelines are designed to provide for greater and more productive interaction between the Department and interested parties throughout the process. They are also designed so that key analyses are performed earlier in the process, with early opportunities for public input to, and comment on, the analyses. The guidelines are consistent with the procedural requirements of law, but add some important steps to enhance the process. The improvements can be summarised as follows.

- Provide for early input from stakeholders
- Increase the predictability of the rulemaking timetable
- Reduce the time and cost of developing standards
- Increase the use of outside technical expertise
- Eliminate problematic design options early in the process
- Conduct thorough analyses of impacts
- Use transparent and robust analytical methods
- Fully consider non-regulatory approaches
- Articulate policies to guide the selection of standards
- Support efforts to build consensus on standards
- Establish an annual priority-setting process to focus available resources on those efficiency standards likely to produce the greatest benefits

The process was designed with stakeholders in mind and with the intent to enhance the productivity of the program through improved communication. Collaboration and interaction with stakeholders has enhanced the quality of the resulting rules, typically by way of additional analysis conducted as issues are raised. In addition to ensuring that its analyses address the seven EPCA criteria and follow the Process Rule guidelines for developing regulations, the Department must follow numerous procedural requirements—mandated by various statutes and Executive Orders—and perform all associated supporting analysis. These requirements are integrated into the rulemaking process, analysis, and documents. The following presents the list of analyses that DOE conducts when considering the appropriate efficiency level for an energy conservation standard: The analyses that DOE performed for the advance notice of proposed rulemaking (ANOPR) include:

- **Market and Technology Assessment** to characterise the market (including manufacturers, shipments and trends) and to review technologies and approaches for making the covered product more efficient;
- **Screening Analysis** to evaluate technology options for improving efficiency that should not be considered further in the rulemaking because of issues with safety, utility, manufacturability or other defined criteria;
- **Engineering Analysis** to study the relationship between manufacturing a product to be more efficient and associated increases in the cost;
- **Energy Use and End-Use Load Characterisation** to generate energy use estimates for the covered product in service and end-use load or consumption profiles;
- **Markup Analysis** to convert manufacturer prices to retail / installed customer prices;
- **Life-Cycle Cost (LCC) Analysis** to calculate, at the consumer level, the discounted operating cost savings over the average life of the product, compared to any increase in the retail / installed costs likely to result from the efficiency standard;
- **Shipments Analysis** to estimate shipments of distribution transformers over the time period examined in the analysis;
- **National Impact Analysis** to assess the aggregate impacts at the national level of consumer payback, net present value (NPV) of total consumer LCC, national energy savings (NES), and national employment.
- **Life-Cycle Cost Subgroup Analysis** to evaluate impacts on identifiable subgroups of customers who may be disproportionately affected by a national efficiency standard;
- **Manufacturer Impact Analysis** to estimate the financial impact of standards on manufacturers of the covered product and to calculate impacts on competition, employment at the manufacturing plant, and manufacturing capacity;
- **Utility Impact Analysis** to estimate the effects of proposed standards on the installed capacity and generating base of electric utilities (i.e., reduction in electricity sales);
- **Employment Impact Analysis** to estimate the impacts of standards on net jobs eliminated or created in the general economy as a consequence of increased spending on the more efficient products and reduced customer spending on energy;
- **Environmental Assessment** to evaluate the impacts of proposed standards on certain environmental indicators including CO_2; and
- **Regulatory Impact Analysis** to present major alternatives to proposed standards that could achieve comparable energy savings at a reasonable cost.

These analyses are all conducted over the three-year rulemaking period. Figure B-3 presents the interconnected analytical framework in a typical DOE energy conservation standards rulemaking, including some of the approaches to the analysis, key inputs, major analysis sections, and outputs.

Figure B-3. Flow-Diagram of a DOE Energy Conservation Standards Rulemaking

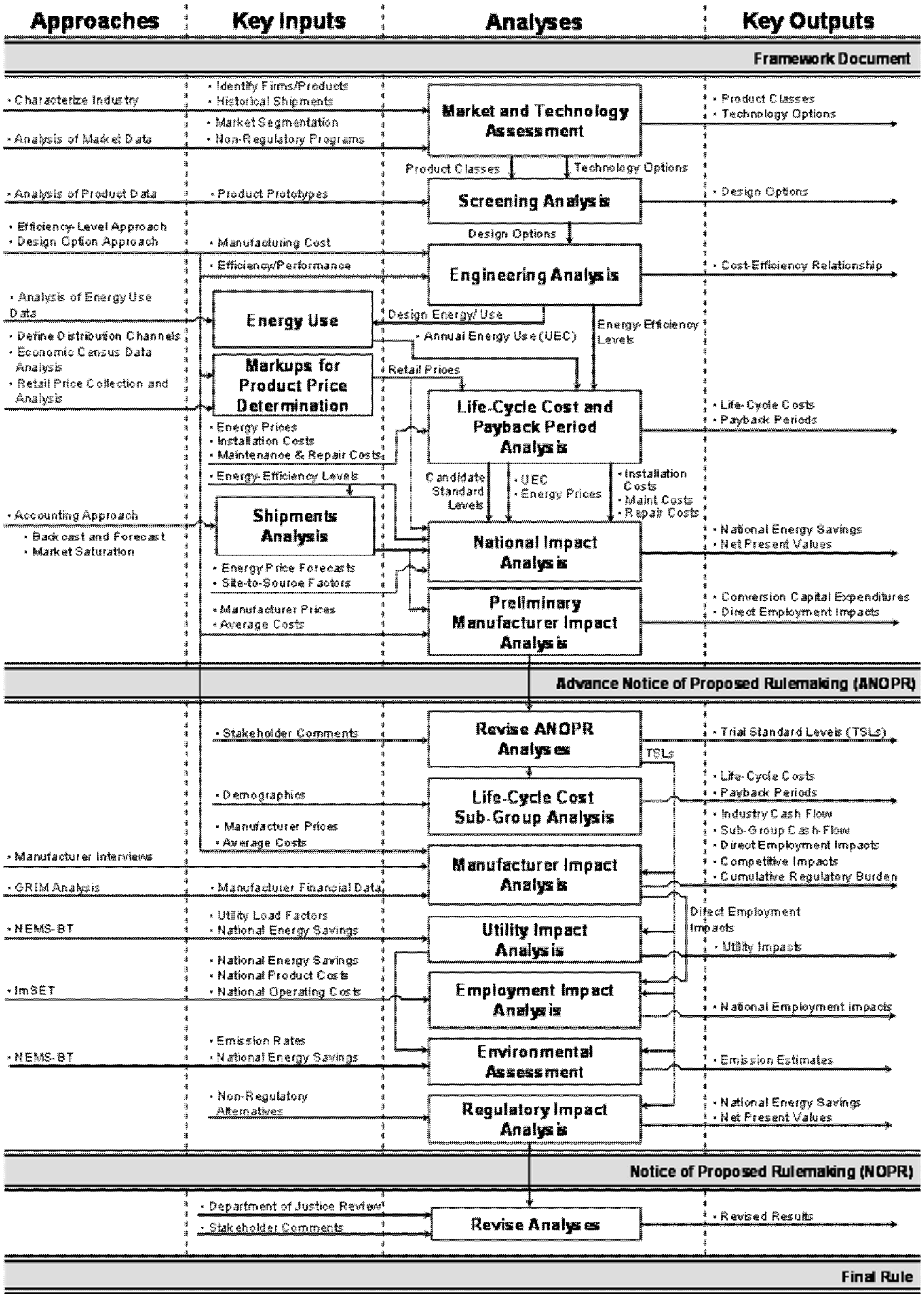


Table B.2 shows how EPCA's seven criteria are taken into consideration by the Secretary of Energy. The table identifies which rulemaking analyses address the EPCA factors, and whether DOE performs each analysis during the pre-NOPR or NOPR stage of the rulemaking. The sections below briefly describe each of these analyses.

Table B.2. Seven EPCA Criteria and Associated DOE Analyses

EPCA Criteria	Analyses DOE Performs	Rulemaking Stage
(I) the savings in operating costs throughout the estimated average life of the covered product in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered products which are likely to result from the imposition of the standard;	Life-cycle cost and Payback Analysis (including markups)	Pre-NOPR
	LCC Subgroup Analysis	NOPR
	Manufacturer Impact Analysis	NOPR
(II) the savings in operating costs throughout the estimated average life of the covered product in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered products which are likely to result from the imposition of the standard;	Life-cycle cost and Payback Analysis (including markups)	Pre-NOPR
(III) the total projected amount of energy, or as applicable, water, savings likely to result directly from the imposition of the standard;	National Impact Analysis including shipments	Pre-NOPR
(IV) any lessening of the utility or the performance of the covered products likely to result from the imposition of the standard;	Screening Analysis	Pre-NOPR
	Engineering Analysis	Pre-NOPR
(V) the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from the imposition of the standard;	Manufacturer Impact Analysis	NOPR
(VI) the need for national energy and water conservation; and	National Impact Analysis including shipments	Pre-NOPR
(VII) other factors the Secretary considers relevant.	Environmental Assessment	NOPR
	Utility Impact Analysis	NOPR
	Employment Impact Analysis	NOPR
	Regulatory Impact Analysis	NOPR

The Department's analysis in support of the development of new or amended standards is designed to identify the efficiency level that represents the maximum improvement in energy efficiency that is technologically feasible and economically justified on the basis of the seven statutory criteria.

In the following sections, additional detail is provided on each of the rulemaking analyses. Note that these are general descriptions, and that for actual rulemakings, the methodology and/or inputs assumed may have to be adjusted to be in keeping with the product and its markets. As discussed earlier, these analyses are presented and described in the "Procedures, Interpretations and Policies for Consideration of New or Revised Energy Conservation Standards for Consumer Products" (also called the "Process Rule"), 10 CFR 430, Subpart C, Appendix A. In that policy statement, DOE outlined all of its procedural improvements, including a review of DOE's: 1) economic models, 2) analytic tools, 3) methodologies, and 4) non regulatory approaches. The Process Rule recommended that DOE take into account uncertainty and variability by carrying out scenario or probability analysis. The following sections provide a general description of the analytic components of the improved rulemaking framework.

Market and Technology Assessment

This Assessment characterises the markets and existing technology options for making the covered product more energy-efficient. In the market assessment, DOE develops information on the present and past industry structure and market characteristics of the product(s) concerned. The market assessment consists of both quantitative and qualitative efforts to assess the industry and products based on publicly available information. Issues addressed in this market assessment included: 1) national shipments; 2) identification of the largest players in the industry; 3) existing non regulatory efficiency improvement initiatives; 4) developments around standards in States and neighboring countries; and 5) trends in product characteristics and retail markets. The information collected served as resource material that DOE used throughout the rulemaking.

In the technology assessment, DOE develops information about existing technology options and designs to improve energy-efficiency. In consultation with interested parties, DOE identified several technology options and designs for consideration. Another key part of the technology assessment is subdividing the covered products into classes that DOE can use in its rulemaking. Covered products are generally subdivided into product classes using the following criteria: a) the type of energy used, b) capacity, and c) performance related features that affect consumer utility or efficiency. DOE may set different efficiency standards to different product classes. DOE developed its product classes using information obtained from manufacturers, trade associations, and other interested parties. As an example, for water heaters, electric, oil and gas-fired water heaters would all be included in different product classes to ensure that the analysis and standard level developed takes into account the unique engineering and technical aspects of the covered product.

Screening Analysis

The screening analysis considers whether certain technologies should be used in the rulemaking analysis according to four screening criteria: 1) technologically feasible, 2) practicable to manufacture, install, and service, 3) do not have an adverse impact on product utility or product availability, and 4) do not adversely impact health and safety. DOE develops an initial list of efficiency enhancement design options from the technologies identified in the technology assessment. DOE then reviews that list to determine if the design options are technologically feasible, practicable to manufacture, install, and service, would not adversely affect product utility or product availability, or would not have adverse impacts on health and safety. The screening analysis is important because in the engineering analysis, DOE will only consider those efficiency enhancement design options that passed the four screening criteria. It should be noted that cost is not a screening criterion. In the distribution transformer rulemaking analysis, even though silver is a better conductor than copper, it was screened out of the rulemaking on the basis that it would not be practicable to manufacture due to the fact that there would not be sufficient supplies of silver to replace all the copper and aluminum wire being used by the transformer industry each year.

Engineering Analysis

The engineering analysis develops cost versus efficiency relationships for products that are the subject of a rulemaking, estimating manufacturer costs of achieving increased efficiency levels. DOE uses manufacturing costs to determine retail prices in the LCC analysis, and also uses them in the manufacturers impact analysis (MIA). The engineering analysis also determines the maximum technologically feasible energy efficiency level. In general, the engineering analysis estimates the efficiency improvement potential of individual design options or combinations of design options that pass the four criteria in the screening analysis. The maximum technologically feasible level, another output from the engineering analysis, is the highest level of efficiency that can be achieved by adding efficiency improvements and/or design options, both commercially feasible and in prototypes. The design options comprising the maximum technologically feasible level must have been physically demonstrated in at least a prototype form to be considered technologically feasible.

In general, DOE can use three methodologies to generate the manufacturing costs needed for the engineering analysis. These methods are:

1. the design-option approach – reporting the incremental costs of adding design options to a baseline model;
2. the efficiency-level approach – reporting relative costs of achieving improvements in energy efficiency; and
3. the reverse engineering or cost assessment approach – involving a "bottom up" manufacturing cost assessment based on a detailed bill of materials derived from transformer teardowns.

In conducting an engineering analysis, DOE also recognises that regulatory changes occurring outside of the standards-setting process can affect manufacturers of products. Some of these changes can also affect the efficiency of the product. DOE attempts to identify all "outside" issues that can impact the engineering analysis. This might include environmental regulations, import duties on certain components, or other regulatory requirement.

Energy Use and End-Use Load Characterisation

The energy use and end-use load characterisation produces energy use estimates and end-use load shapes for covered products. The energy use estimates enabled evaluation of energy savings from the operation of the appliance or equipment at various efficiency levels, while the end-use load characterisation allows for the evaluation of the impact on monthly and peak demand for electricity.

Markups for Equipment Price Determination

DOE derives this installed price (or retail price) by applying markups to the manufacturer selling price it determined in the engineering analysis. This analysis considers the value chain, through which products are distributed and associated markups at each of those stages. Thus, markups, shipping costs, sales tax, and installation costs (if appropriate) are the costs associated with bringing a product to market are accounted for in this analysis.

Life-Cycle Cost and Payback Period Analyses

The LCC analysis, which calculates the discounted savings in operating costs throughout the estimated average life of the covered product compared to any increase in the installed cost for the product likely to result directly from the imposition of a standard. In determining economic justification, the Energy Policy and Conservation Act (EPCA) directs DOE to consider a number of different factors, including the economic impact of potential standards on consumers. (42 U.S.C. 6295 (o)(2)(B)(i))

To consider the economic impacts of standards, DOE calculates changes in LCC that are likely to result from the standard levels considered, as well as a simple payback period. DOE calculates both the LCC and the payback period (PBP) using a Monte Carlo statistical analysis so these results are presented as distributions of consumers with a variety of inputs rather than point values. The effect of standards on individual consumers includes a change in operating expense (usually decreased) and a change in purchase price (usually increased). DOE analyzed the net effect by calculating the change in LCC as compared to the base case. Inputs to the LCC calculation include the installed consumer cost (purchase price plus shipping, sales tax, and installation cost), operating expenses (energy and maintenance costs), lifetime of the equipment, and a discount rate.

The PBP analysis, which calculates the amount of time needed to recover the additional cost that consumers pay for increased efficiency. Numerically, the simple payback period is the ratio of the increase in purchase price to the decrease in annual energy costs.

Within the economic analysis, The statute states that if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy, as calculated under the applicable test procedure, then there shall be a rebuttable presumption that such standard level is economically justified. 42 U.S.C. 6295(o)(2)(B)(iii) If DOE finds this to be the case in a rulemaking, it continues to study other, higher, energy efficiency levels, and this level constitutes a minimum level that will be selected by the Secretary.

Shipments Analysis

DOE prepares shipment forecasts of covered products in the base case and each potential standards case as an input to the NES spreadsheet model. This study takes into account the elasticity of demand (if any), meaning the degree to which, as a product becomes more expensive, consumers purchase fewer of them. The shipments model starts with an estimate of the overall growth and then estimates increases in shipments using estimates of the relative market share for different covered products.

National Impact Analysis

The National Energy Savings and National Net Present Value impacts are the cumulative energy and economic effects of an energy conservation standard across the U.S. economy. DOE projects the impacts from the year the standard would take effect through a selected number of years in the future. DOE analyzes energy savings, energy cost savings, equipment costs, and NPV of savings (or costs) for each efficiency standard level. The national energy and cost savings (or increases) that would result from energy conservation standards depend on the projected energy savings per unit and the anticipated numbers of units sold. DOE creates base case shipments projections and candidate efficiency standard level projections.

To make the analysis accessible and transparent to all stakeholders, DOE uses a Microsoft Excel spreadsheet model to calculate the NES and the NPV (i.e., national economic costs and savings from new standards). Users can change input quantities within the spreadsheet to test the impact of alternative input assumptions. Unlike the LCC analysis, the NES spreadsheet does not use distributions for inputs or outputs. Users can demonstrate sensitivities by running different scenarios using the spreadsheet.

Life-Cycle Cost Subgroup Analysis

In this analysis, DOE examines the results from the LCC analysis to evaluate the cost impacts on particular consumer subgroups to determine if they would be differentially affected by potential energy conservation standards in a significant manner. The analysis of these subgroups depends on identifying subgroups with economic characteristics that sets them apart from the average user. Factors that could result in differential impacts to subgroups include differences in purchase price, energy price, usage profiles, and other factors. To the extent possible, DOE obtains estimates of the variability in each input quantity and considered this variability in its calculation of consumer impacts. DOE discusses the variability in each input quantity and likely sources of information with the interested parties.

Manufacturer Impact Analysis

DOE conducts the manufacturer impact analysis to estimate the financial impact of efficiency standards on manufacturers of those covered products and to assess the impact of such standards on employment and manufacturing capacity. The MIA has both quantitative and qualitative components. The quantitative part of the MIA primarily relies on an industry-cash-flow model that takes into account industry cost structure, shipments, and pricing strategies. The model's key output is the industry net present value (INPV), and it assesses the financial impact of higher efficiency standards by comparing changes in INPV between the base case and the various efficiency levels under consideration by DOE. The qualitative part of the analysis addresses factors such as the material supply chain, manufacturing techniques and equipment, and market and product trends, and includes a subgroup assessment of the impacts on small manufacturers.

DOE also conducts an assessment of impacts on appropriate subgroups of manufacturers. DOE is aware that smaller manufacturers, niche players, or manufacturers exhibiting a cost structure that differs from the industry average and who could be more negatively impacted by energy efficiency standards.

Utility Impact Analysis

DOE conducts the utility impact analysis to assess how utilities are affected through the reduction in electricity generation resulting from the increased energy efficiency standard. To perform the utility impact analysis, DOE uses a customised version of the Energy Information Administration's National Energy Modeling System (NEMS). NEMS is a large, general-equilibrium energy-economy model of the United States that EIA has developed over several years, primarily for the purpose of preparing the Annual Energy Outlook.

Employment Impact Analysis

DOE conducts the employment impact analysis to assess the impacts of standards on employment in both the manufacturing industry for the covered product and any relevant service industries, including energy suppliers, and the economy in general. DOE separates employment impacts into direct and indirect impacts. Direct employment impacts—discussed in the manufacturer impact analysis—would result if standards led to a change in the number of employees at manufacturing plants and related supply and service firms. Indirect employment impacts result from energy efficiency standards causing jobs to be eliminated or created in the general economy (other than in the manufacturing sector DOE is regulating). Indirect impacts may result both from expenditures shifting among goods (substitution effect), and from incomes changing, which will lead to a change in overall expenditure levels (income effect). An important indirect employment effect may arise from shifting investment from the energy sector into more (or less) labor-intensive industries.

Environmental Assessment

DOE conducts an environmental assessment as required under the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321 et seq.), regulations of the Council on Environmental Quality (49 CFR parts 1500-1508), DOE regulations for compliance with NEPA (10 CFR part 1021), and the Secretarial Policy on the National Environmental Policy Act (June 1994). The main environmental concern addressed is usually emissions from fossil-fuel-fired electricity generation. Power plant emissions include oxides of nitrogen (NOx) and sulfur dioxide (SO2), as well as carbon dioxide (CO2). The first two are major causes of acid precipitation, which can affect humans by reducing the productivity of farms, forests, and fisheries, decreasing recreational opportunities, and degrading susceptible buildings and monuments. NOx emissions are also precursor gases to urban smog and are particularly detrimental to air quality during hot, still weather. CO2 emissions are believed to contribute to raising the global temperature via the "greenhouse effect."

Regulatory Impact Analysis

DOE conducts a regulatory impact analysis pursuant to Executive Order 12866, Regulatory Planning and Review, which is subject to review under the Executive Order by the Office of Information and Regulatory Affairs. 58 FR 51735 (October 4, 1993). DOE identifies and evaluates major non-regulatory alternatives as feasible policy options to achieve consumer product energy efficiency. These alternatives are evaluated in terms of their ability to achieve significant energy savings at a reasonable cost, and compared these results to the effectiveness of the rule. Under the Process Rule, DOE is committed to continually explore non-regulatory alternatives to standards, some of which include: consumer rebates; consumer tax credits; manufacturer tax credits; voluntary energy efficiency targets; early replacement and bulk government purchase contracts.

Energy Star

ENERGY STAR is a joint program of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy that works through identifying and labeling energy-efficient products to save consumers money and protect the environment. According to EPA estimates, with the help of ENERGY STAR, in 2008 Americans saved over $19 billion in electricity bills and avoided greenhouse gas emissions equivalent to 29 million cars.

The EPA introduced ENERGY STAR in 1992 as a voluntary labeling program designed to identify and promote the use of energy-efficient products to reduce greenhouse gas emissions. Computers and monitors were the first labeled products. Through 1995, EPA expanded the program to additional office equipment products and residential heating and cooling equipment. In 1996, EPA partnered with the DOE for particular product categories. The ENERGY STAR label is now on major appliances, office equipment, lighting, home electronics, and more. EPA has also extended the label to cover new homes and commercial and industrial buildings.

Through its partnerships with more than 15,000 private and public sector organisations, ENERGY STAR delivers the technical information and tools that organisations and consumers need to choose energy-efficient solutions and best management practices. ENERGY STAR has successfully delivered energy and cost savings across the country, saving businesses, organisations, and consumers $19 billion in 2008 alone. Over the past decade, ENERGY STAR has been a driving force behind the more widespread use of such technological innovations as efficient fluorescent lighting, power management systems for office equipment, and low standby energy use.

ENERGY STAR provides a trustworthy label on over 60 product categories (and thousands of models) for the home and office. These products deliver the same or better performance as comparable models while using less energy and saving money. ENERGY STAR also provides easy-to-use home and building assessment tools to encourage energy-efficiency improvements in this critical market.

For detailed and up-to-date information on the ENERGY STAR program, please visit the homepage: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.

Table B.3: ENERGY STAR Appliances and Heating and Cooling Products

Product Category	Current Criteria Levels	Link to Energy Star Product Criteria
Air-source Heat Pumps	>= 8.2 HSPF/ >=14.5 SEER/ >=12 EER* for split systems >= 8.0 HSPF/ >=14 SEER/ >=11 EER* for single package equipment including gas/electric package units	http://www.energystar.gov/index.cfm?c=airsrc_heat.pr_crit_as_heat_pumps
Battery Chargers	Not available yet	Not available yet
Boilers	Rating of 85% AFUE* or greater (About 6% more efficient than the minimum federal standards.)	http://www.energystar.gov/index.cfm?c=boilers.pr_crit_boilers
Ceiling Fans	Specification defines residential ceiling fan airflow efficiency on a performance basis: CFM* of airflow per watt of power consumed by the motor and controls. Efficiency is measured on each of 3 speeds.	http://www.energystar.gov/index.cfm?c=ceiling_fans.pr_crit_ceiling_fans
Central Air Conditioners	>=14.5 SEER/ >=12 EER* for split systems >=14 SEER/ >=11 EER* for single package equipment including gas/electric package units	http://www.energystar.gov/index.cfm?c=airsrc_heat.pr_crit_as_heat_pumps
Clothes Washers	Minimum Modified Energy Factor (MEF) of 1.8 and a maximum Water Factor (WF) of 7.5	http://www.energystar.gov/index.cfm?c=clotheswash.pr_crit_clothes_washers
Dehumidifiers	Energy efficiency is measured in liters of water removed per kilowatt-hour of energy consumed. Ranges from >= 1.20 to >= 1.80 L/kWh for standard capacity units. >= 2.50 L/kWh for high capacity units.	http://www.energystar.gov/index.cfm?c=dehumid.pr_crit_dehumidifiers
Dishwashers	Standard Sised Models: <= 324 kWh/year, <= 5.8 gallons/cycle	http://www.energystar.gov/index.cfm?c=dishwash.pr_crit_dishwashers

Product Category	Current Criteria Levels	Link to Energy Star Product Criteria
	Compact Sised Models <= 234 kWh/year , <= 4.0 gallons/cycle	
Freezers	Full Sise Freezers: At least 10% more energy efficient than the minimum federal government standard (NAECA). Compact Freezers: At least 20% more energy efficient than the minimum federal government standard (NAECA).	http://www.energystar.gov/index.cfm?c=refrig.pr_crit_refrigerators
Furnaces	Gas Furnaces: Rating of 90% AFUE* or greater Oil Furnaces: Rating of 85% AFUE or greater	http://www.energystar.gov/index.cfm?c=furnaces.pr_crit_furnaces
Geothermal Heat Pumps	EER and COP are the key criteria for Water to Air, Water to water, and DGX heat pumps	http://www.energystar.gov/index.cfm?c=geo_heat.pr_crit_geo_heat_pumps
Home Sealing (Insulation)	Not available	Not available
Light Commercial Heating & Cooling Products	Multiple criteria for different sises of CACs and Air Source Heat Pumps, including: SEER, EER, and IPLV	http://www.energystar.gov/index.cfm?c=lchvac.pr_crit_lchvac
Refrigerators	Full Sise and Compact Refrigerators: At least 20% more energy efficient than the minimum federal government standard (NAECA).	http://www.energystar.gov/index.cfm?c=refrig.pr_crit_refrigerators
Room Air Conditioners	Multiple criteria set for different capacities of Room ACs	http://www.energystar.gov/index.cfm?c=roomac.pr_crit_room_ac
Room Air Cleaners	Room air cleaner minimum performance requirement: >= 2.0 CADR/Watt (Dust) Standby Power Requirement**: <= 2	http://www.energystar.gov/index.cfm?c=room_airclean.pr_proc_room_ac

Product Category	Current Criteria Levels	Link to Energy Star Product Criteria
	Watt(s)	
Ventilating Fans	Multiple criteria set for different types of Ventilating fans	http://www.energystar.gov/index.cfm?c=vent_fans.pr_crit_vent_fans

Table B.4 ENERGY STAR Water Heaters

Product Category	Current Criteria levels	Link to Energy Star Product Criteria
Gas Condensing	A nominal input of 75,000 BTU/hour or less and a rated storage volume from 20 to 100 gallons.	http://www.energystar.gov/index.cfm?c=water_heat.pr_crit_water_heaters
Heat Pump	A maximum current rating of 24 amperes, voltage no greater than 250 volts, and a transfer of thermal energy from one temperature to a higher temperature level for the purpose of heating water. Unit must have "integrated" or "drop-in" configuration.	http://www.energystar.gov/index.cfm?c=water_heat.pr_crit_water_heaters
High-Efficiency Gas Storage	A nominal input of 75,000 BTU/hour or less and a rated storage volume from 20 to 100 gallons.	http://www.energystar.gov/index.cfm?c=water_heat.pr_crit_water_heaters
Solar Hot Water Systems	OG-300 rating from the SRCC. Auxiliary tank must be residential-class	http://www.energystar.gov/index.cfm?c=water_heat.pr_crit_water_heaters
Whole-Home Gas Tankless	A nominal input of over 50,000 BTU/hour up to 200,000 BTU/hour and a rated storage volume of 2 gallons or less.	http://www.energystar.gov/index.cfm?c=water_heat.pr_crit_water_heaters

Table B.5 ENERGY STAR Home Envelope

Product Category	Current Criteria levels	Link to Energy Star Product Criteria
Home Sealing (Insulation and Air Sealing)	ENERGY STAR estimates that a knowledgeable homeowner or skilled contractor can save up to 20% on heating and cooling costs (or up to 10% on their total annual energy bill) by sealing and insulating.	http://www.energystar.gov/index.cfm?c=home_sealing.hm_improvement_sealing
Roof Products	Low Slope roofs must have an initial solar reflectance of >= 0.65. After 3 years, the solar reflectance must be >= 0.50. Steep Slope roofs must have an initial solar reflectance of >= 0.25. After 3 years, the solar reflectance must be >= 0.15	http://www.energystar.gov/index.cfm?c=roof_prods.pr_crit_roof_products
Windows, Doors, & Skylights	Multiple criteria based on location and climate zones	http://www.energystar.gov/index.cfm?c=windows_doors.pr_crit_windows

Table B.6 ENERGY STAR Home Electronics

Product Category	Current Criteria levels	Link to Energy Star Product Criteria
Battery Charging Systems	Not available	Not available
Combination Units	Multiple criteria for TV/VCR and TV/DVD Combination Units	http://www.energystar.gov/index.cfm?c=tv_vcr.pr_crit_tv_vcr
Cordless Phones	Multiple criteria for the Standby Mode Power Consumption Requirement	Http://www.energystar.gov/index.cfm?c=phones.pr_crit_phones
DVD Products	Multiple criteria for the Auto power down, Sleep mode, Standby Mode, and On Mode Power Consumption Requirement	http://www.energystar.gov/index.cfm?c=audio_dvd.pr_crit_audio_dvd
D-to-A Converter Boxes	Not available	Not available

Product Category	Current Criteria levels	Link to Energy Star Product Criteria
External Power Adapters	30% more efficient than conventional models, and are often lighter and smaller in sise, which makes it easier to transport products like laptops.	http://www.energystar.gov/index.cfm?c=ext_power_supplies.power_supplies_consumers
Home Audio	Multiple criteria for the Auto power down, Sleep mode, Standby Mode, and On Mode Power Consumption Requirement	http://www.energystar.gov/index.cfm?c=audio_dvd.pr_crit_audio_dvd
Set-top Boxes	Not available	http://www.energystar.gov/index.cfm?c=settop_boxes.settop_boxes
Televisions	Multiple Criteria for On mode Power level requirements	http://www.energystar.gov/index.cfm?c=tv_vcr.pr_crit_tv_vcr

Table B.7 ENERGY STAR Office Equipment

Product Category	Current Criteria levels	Link to Energy Star Product Criteria
Computers	Use energy efficient power supply. Operate efficiently in multiple modes of operation (Off, Sleep, and Idle). Include and enable power management features of the system and provide user education about these features	http://www.energystar.gov/index.cfm?c=computers.pr_crit_computers
Copiers and Fax Machines	ENERGY STAR specifications for Typical Electricity Consumption (TEC) as a function of: product; marking technology (e.g., Direct Thermal, InkJet); Product Speed; and Product Sise Format	http://www.energystar.gov/index.cfm?c=copiers.pr_crit_copiers
Digital Duplicators	Delivers the same performance as less efficient, conventional equipment. Models that meet the revised ENERGY STAR imaging equipment criteria will be more efficient and save users money over the lifetime of the product.	http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=DD
Enterprise	Multiple criteria for power supply efficiency,	http://www.energystar.gov/index.cfm?c=

Product Category	Current Criteria levels	Link to Energy Star Product Criteria
Servers	active power and reporting requirements	ent_servers.pr_crit_enterprise_servers
External Power Adapters	30% more efficient than conventional models, and are often lighter and smaller in sise, which makes it easier to transport products like laptops.	http://www.energystar.gov/index.cfm?c=ext_power_supplies.power_supplies_consumers
Mailing Machines	ENERGY STAR specifications for Typical Electricity Consumption (TEC) as a function of: product; marking technology (e.g., Direct Thermal, InkJet); Product Speed; and Product Sise Format	http://www.energystar.gov/index.cfm?c=printers.pr_crit_printers
Monitors	Multiple criteria for on mode, sleep mode, and off mode.	http://www.energystar.gov/index.cfm?c=monitors.pr_crit_monitors
Printers, Scanners, and All-in-Ones	ENERGY STAR specifications for Typical Electricity Consumption (TEC) as a function of: product; marking technology (e.g., Direct Thermal, InkJet); Product Speed; and Product Sise Format	http://www.energystar.gov/index.cfm?c=printers.pr_crit_printers
Water Coolers	Cold Only and Cook and Cold Bottled Units: < 0.16 kW-hours/day. Hot and Cold Bottled Units: < 1.20 kW-hours/day	http://www.energystar.gov/index.cfm?c=water_coolers.pr_crit_water_coolers

Table B.8 ENERGY STAR Lighting

Product Category	Current Criteria levels	Link to Energy Star Product Criteria
LED Lighting	At least 75% less energy than incandescent fixtures and getting more efficient all the time	http://www.energystar.gov/index.cfm?c=fixtures.pr_fixtures
Light Bulbs (CFLs)	An ENERGY STAR qualified compact fluorescent light bulb (CFL) will save about $30 over its lifetime and pay for itself in about 6 months. It uses 75 percent less energy and lasts about 10 times longer than an incandescent bulb.	http://www.energystar.gov/index.cfm?c=cfls.pr_cfls

Product Category	Current Criteria levels	Link to Energy Star Product Criteria
Light Fixtures	75% less energy than incandescent fixtures	http://www.energystar.gov/index.cfm?c=fixtures.pr_fixtures
Decorative Light Strings	ENERGY STAR qualified decorative light strings — many which feature LED technology — consume 75% less energy than conventional incandescent lights strands.	http://www.energystar.gov/index.cfm?c=dls.pr_dls

Table B.9 ENERGY STAR Commercial Food Service

Product Category	Current Criteria levels	Link to Energy Star Product Criteria
Commercial Dishwashers	Multiple criteria for High Temp Efficiency Requirements	http://www.energystar.gov/index.cfm?c=comm_dishwashers.pr_crit_comm_dishwashers
Commercial Fryers	Multiple criteria for Gas and Electric Fryers	http://www.energystar.gov/index.cfm?c=fryers.pr_crit_fryers
Commercial Griddles	Multiple criteria for single and double sided commercial electric griddles	http://www.energystar.gov/index.cfm?c=griddles.pr_crit_comm_griddles
Commercial Hot Food Holding Cabinets	Commercial hot food holding cabinets must have an idle energy rate of **40 watts per cubic foot or less** to qualify as ENERGY STAR.	http://www.energystar.gov/index.cfm?c=hfhc.pr_crit_hfhc
Commercial Ice Machines	Multiple criteria for harvest rate, energy use limit, and potable water use limit	http://www.energystar.gov/index.cfm?c=comm_ice_machines.pr_crit_comm_ice_machines
Commercial Ovens	Multiple energy efficiency and idle energy rate criteria for Gas and Electric ovens, full and half sise	http://www.energystar.gov/index.cfm?c=ovens.pr_crit_comm_ovens
Commercial Refrigerators &	Multiple criteria for maximum daily energy consumption (MDEC) for different sise manufacturers	http://www.energystar.gov/index.cfm?c=commer_refrig.pr_crit_commercial_refrigerators

Product Category	Current Criteria levels	Link to Energy Star Product Criteria
Freezers		
Commercial Steam Cookers	Multiple criteria for different sise steam cookers	http://www.energystar.gov/index.cfm?c=steamcookers.pr_crit_steamcookers

Table B.10 ENERGY STAR Other Commercial Products

Product Category	Current Criteria levels	
Enterprise Servers	Multiple criteria for rated power at different loads for computer server power	http://www.energystar.gov/index.cfm?c=ent_servers.pr_crit_enterprise_servers
Roof Products	Multiple criteria for low slope, steep slope roofs on energy efficiency and reliability	http://www.energystar.gov/index.cfm?c=roof_prods.pr_crit_roof_products
Vending Machines	Qualifying new and rebuilt models shall consume equal to or less energy in a 24-hr period than the values obtained from the equations in criteria.	http://www.energystar.gov/index.cfm?c=vending_machines.pr_crit_vending_machines

Federal Trade Commission Labeling

The Federal Trade Commission (FTC) was founded in 1914 for the purposes of helping to protect and advance consumer interests. Created as part of the US Government response to prevent monopolistic behavior from companies operating in the United States, the FTC has a number of divisions and mandates that cut across the market and affect the lives of every consumer. The FTC pursues vigorous and effective law enforcement; advances consumers' interests by sharing its expertise with federal and state legislatures and U.S. and international government agencies; develops policy and research tools through hearings, workshops, and conferences; and creates practical and plain-language educational programs for consumers and businesses in a global marketplace with constantly changing technologies.

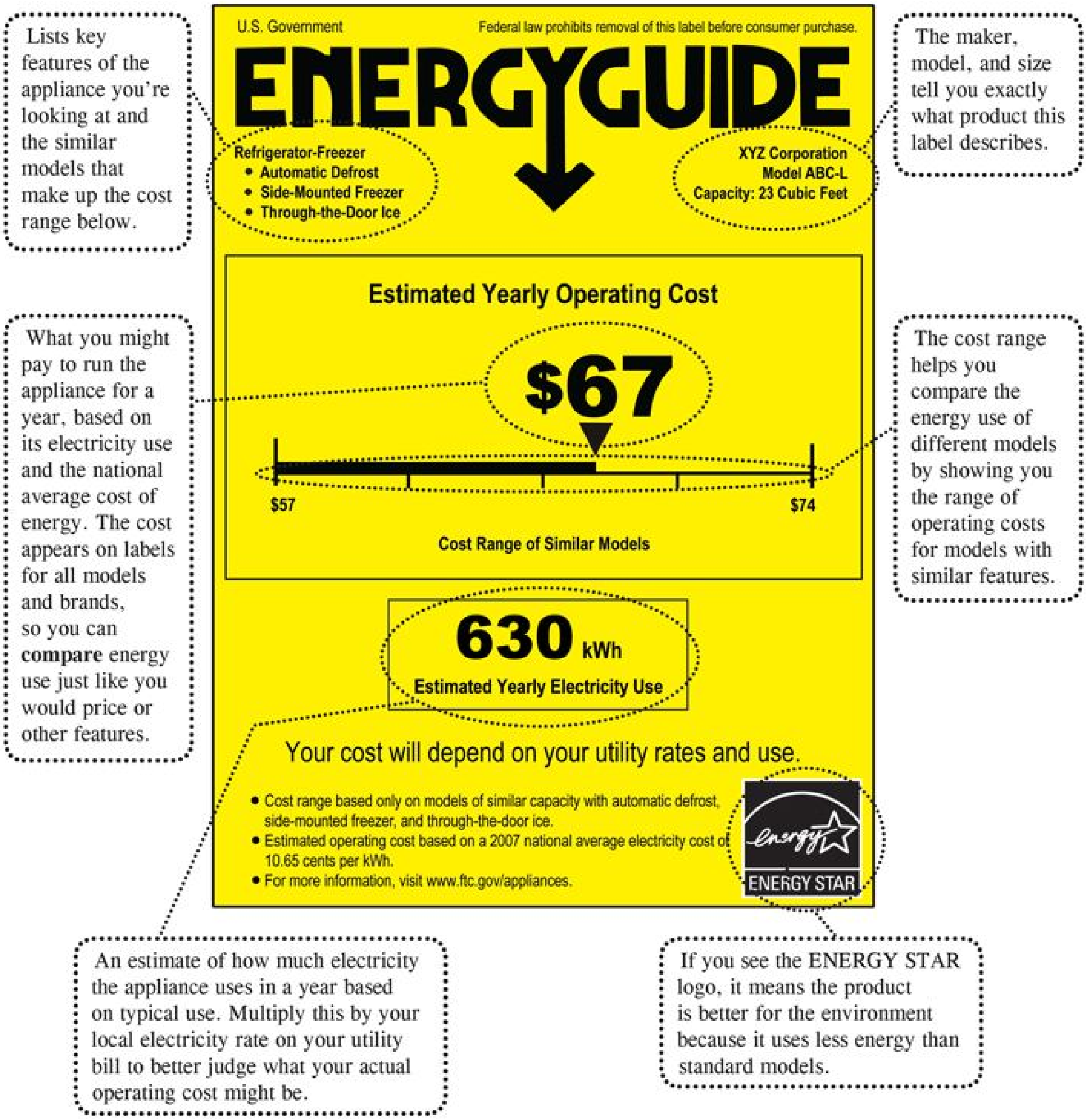
One division of the FTC focuses on energy and appliance labeling. In this area, the FTC specifically works on issues surrounding the disclosure of energy costs for home appliances (the Appliance Labeling Rule), octane ratings of gasoline (the Fuel Rating Rule), and the efficiency rating of home insulation (the R-Value Rule). The FTC regulates the information reported on a packaging of a general service light bulb, all the way to the information presented on the EnergyGuide label which provides energy consumption and cost of standard operation to enable consumers to make comparisons between various models on the retail sales floor.

The EnergyGuide label applies to the following list of products and appliances: clothes washers, dishwashers, refrigerators, freezers, water heaters, window air conditioners, central air conditioners, furnaces, boilers, heat pumps, and pool heaters. The label is mandatory, meaning its required on all covered products, not just the high-efficiency products. And, the metrics reported on the label are determined through the use of test procedures that are set and adopted by DOE. This ensures that manufacturers have one test for both FTC's label and DOE's regulatory program, ensuring consistency in the measurements and reducing burden placed on product and equipment manufacturers.

One of the features of the EnergyGuide label is that it provides an estimate of the operating costs of the tested equipment, based on the national average price for energy. Since energy prices vary across the market and consumer usage profiles are different, actual costs of ownership will vary for different consumers, however the label is meant to convey the national average. Further, the EnergyGuide labels do experience some variability between themselves, reflective of different systems in households. For example, dishwasher labels have two costs — one for consumers who use an electric water heater, and one for those who use a natural gas water heater. In essence, the EnergyGuide label provides consumers with a means of comparing energy usage across similar appliances.

The national average price for electricity and the range of prices are updated every five years. Having one consistent set of prices enables manufacturers to all base their estimated costs on the same reference electricity price, and thus result in comparable labels.

Figure B.4: How to Use the Energy Guide Label[17]



[17] http://www1.eere.energy.gov/consumer/tips/energyguide.html

Table B.11 lists all of the products that are required to display an EnergyGuide label. In addition to these products, the FTC also requires labeling for lamps, plumbing products, and ceiling fans, although these labels are not in an "EnergyGuide" format.

Table B.11 Products Covered by the EnergyGuide Label

DOE Appliance Standard covered product	**Energy Guide Product**
Ceiling Fans	Labeled
Central Air Conditioners and Central Air Conditioning Heat Pumps	Labeled
Direct Heating Equipment	Labeled
Dishwashers	Labeled
Furnace Fans	Labeled
Furnaces	Labeled
Mobile Home Furnace	Labeled
Packaged terminal air conditioners and packaged terminal heat pumps (ASHRAE)	Labeled
Pool heaters	Labeled
Refrigerators, Freezers and Refrigerator-Freezers	Labeled
Residential Boilers	Labeled
Residential Clothes washers	Labeled
Residential Water heaters	Labeled
Room Air Conditioners	Labeled
Single package vertical air conditioners and single package vertical heat pumps	Labeled
Small Furnaces	Labeled
Storage water heaters, instantaneous water heaters, and unfired hot water storage tanks (ASHRAE)	Labeled
Unit Heaters	Labeled

APPENDIX C: CASE STUDY OF DIRECTIONAL LAMPS

This appendix presents an analysis of the harmonisation issues pertaining to the development of test procedures and efficiency regulations for directional lamps. It presents the current status of various national or regional efforts to develop and regulate these lamps and discusses the options for an internationally harmonised effort.

C1. Overview

There are currently three countries that regulate directional lamps – Australia, Canada and the United States, and all three of these countries are actively reviewing their test methods and MEPS. In addition, the European Commission is looking to regulate and establish energy conservation standards for these products for the first time. The fact that all of these regulatory entities are developing both test procedures and MEPS simultaneously presents an excellent opportunity for harmonization.

Although there are differences in coverage between these three countries, generally the regulations for Canada and the United States have worked toward having relatively similar regulatory scopes of coverage. Canada and the United States tend to work toward harmonised regulatory requirements in order to reduce burden on manufacturers and associated costs to consumers. In Australia, the scope of coverage is broader than Canada and the United States, and new interim regulatory standards adopted in 2008 are scheduled to be phased in starting October 2010 and then October 2012. The US also recently adopted new regulatory requirements for incandescent reflector lamps, which take effect in July 2012, and Canada is conducting an analysis to determine whether these same levels are appropriate for its market. Overall, after adjusting for voltage differences, the US and Australia have largely comparable efficacy requirements for large diameter lamps, and Australia has stronger efficacy requirements on the small diameter.

In the US and Canada, by carving out exemptions from the regulation, manufacturers and consumers were incentivized to find opportunities to circumvent the reflector lamp regulations. This resulted in a ten-year growth trend in BR and ER shaped lamps. The regulators are now addressing this market gap now, however it could have been avoided in the first place by simply regulating all directional lamps, regardless of shape and focusing instead on function.

The following text describes the scope of coverage and regulatory standards for Australia, Canada and the United States.

Table C-1. Summary of MEPS for Directional Lamps Internationally

Country	Minimum Energy Performance Standards	Adopted	Effective	Lamp Types*
Australia	AS NZS 4934.2(Int)-2008 Incandescent lamps for general lighting services - Minimum Energy Performance Standards	March 2008 (Interim)	October 2010	Low-voltage halogen
			October 2012	Mains voltage reflector lamps
Canada	CSA C862-01 Performance of incandescent reflector Lamps (Table 1)	Nov. 1995	April 1996	Incandescent and halogen reflector lamps
		April 2003	Jan. 2003	BR lamps; ER lamps other than ER lamps with a nominal power of 50, 75 or 120 W
Canada	CSA C862-01 Performance of incandescent reflector Lamps (Table 2)	April 2003	Jan. 2003	ER lamps with a nominal power of 50, 75 or 120 W
USA	10 CFR 430.32(n)(4)	EPACT 1992	Nov. 1995	Incandescent and halogen reflector lamps
USA	10 CFR 430.32(n)(5)	July 2009	July 2012	Incandescent and halogen reflector lamps

* Note: at the highest level, these are the categories of lamp types covered, however within each regulatory authority, there are specific scopes of coverage which are discussed in the individual sections that follow.

C2. Australia

Australia's regulatory programme for directional lamps focuses on establishing MEPS for extra low-voltage (ELV) halogen reflector lamps and mains-voltage incandescent and halogen directional lamps. The following definitions for these two product groups were published in the Interim Australian/New Zealand Standard, "Incandescent lamps for general lighting services, Part 2: Minimum Energy Performance Standards (MEPS) requirements" (AS/NZS 4934.2(Int):2008).

ELV halogen reflector - these lamps have the following attributes:

(a) Shapes: MR 11-16.

(b) Caps: Bi-pin.

(c) Nominal voltage: 5–24 V (inclusive).

Mains voltage reflector (including halogen) - these lamps have the following attributes:

(a) Tungsten filament or tungsten halogen lamp burner, with reflector.

(b) Shapes: PAR, ER, R, RE, XR, YR, ZR or MR 11-16.

(c) Caps: E14, E26, E27, B15, B22d or GU10.

(d) Nominal voltage >220 V.

(e) Not including primary coloured lamps.

The Australian scope of coverage for directional lamps is more expansive than that of Canada and the United States. The Australian regulation encompasses all the common base-types found both on low-voltage and line-voltage reflector lamps. Standard line voltage in Australia is 240-250V, therefore having the nominal listed as simply greater than 220V will include vast majority of the market. Furthermore, the scope includes a wide variety of lamp shapes, and is neither constrained by lamp diameter nor by wattage range.

In terms of constraints, the Australian scope of coverage applies to incandescent and halogen lamps, and does not include reflector lamps that are based on compact fluorescent, metal halide or light emitting diode technologies. It is, however, unclear whether these products may be covered under separate regulations are constitute products that the Australian government is intending to cover in the future.

The Australian MEPS are based on a single equation that is phased in to the covered product in two stages. The MEPS are scheduled to become mandatory for all ELV halogen reflector lamps beginning in October 2010 and for all mains voltage reflector lamps beginning in October 2012. The minimum efficacy requirement for these reflector lamps is a function of the natural log of the lumen output of the lamp:

Initial efficacy shall be $\geq 2.8 \ln(L) - 4.0$

Where:

L = Initial luminous flux of the lamp in lumens

Due to the fact that there is no minimum or maximum wattage, this MEPS level is broadly applicable to reflector lamps sold in Australia. Figure 0-1 plots the Australian regulation, along with the United States' EPACT 1992 levels for scale. It should be noted that the EPACT 1992 levels were never applicable in Australia, however they represent a halogen technology level that was required in the United States for certain reflector lamps since 1995 and in Canada since 1996. The EPACT 1992 levels are presented in wattage versus efficacy, and thus have been converted to lumen versus efficacy for this illustration. Furthermore, the EPACT 1992 levels were established for 120V wattage lamps, and thus have been adjusted to what levels they would have been (i.e., lower) on a 240V system.

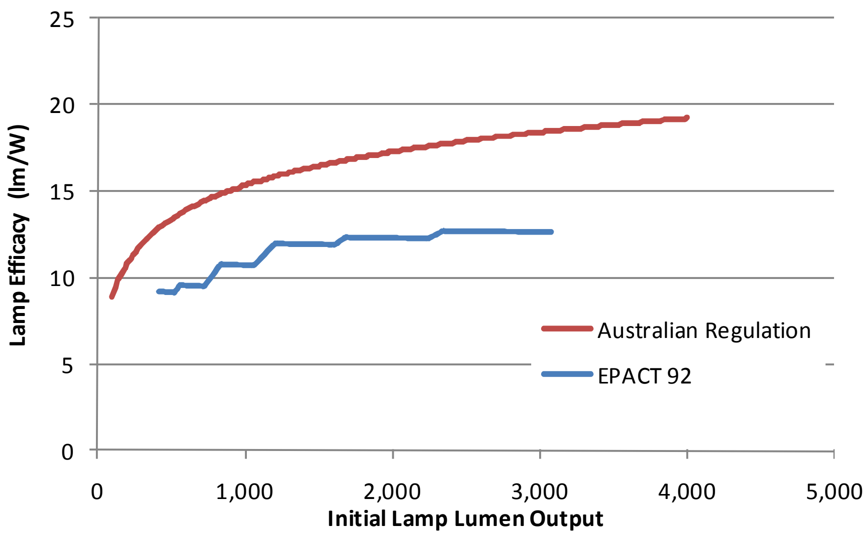


Figure 0-1. Plot of Australian MEPS Compared with Voltage Adjusted EPACT 1992

It should be noted that the Australian regulation also has a minimum median lamp life of 2000 hours and lumen maintenance period of at least 80% of initial lumen output after 75% of rated life. This calculation of lumen maintenance excludes any lamps in the sample that fail prior to the 75% of rated life test.

C3. Canada

In Canada, Natural Resources Canada (NRCan)'s Office of Energy Efficiency establishes regulatory requirements of consumer products and commercial equipment, including incandescent reflector lamps (i.e., directional lamps). In November 1995, Canada updated its Energy Efficiency Regulations (SOR/94-651) to include incandescent reflector lamps, adopting a standard level harmonised with the United States EPACT 1992, and which became effective in April 1996. Canada then issued Amendment 6 to establish minimum energy performance standards for certain products, including incandescent reflector lamps. Amendment 6 was registered on April 10, 2003 and published in the Canada Gazette Part II on April 23rd. This Amendment which covered and regulated certain bulge reflector (BR) and ellipsoidal reflector

(ER) shaped reflector lamps, starting on January 1, 2003. Canada is actively working on revisions to its regulations on incandescent reflector lamps (i.e., Bulletin stating NRCan's intentions is expected in May 2010), which will raise the efficacy requirements and increase its scope of coverage for BR and ER shaped lamps.

Canadian MEPS for reflector lamps apply to three lamp categories: (1) general service incandescent reflector lamps; (2) BR lamps and (3) ER lamps. Although they are expected to change in the near future, the current regulatory definitions for each of these terms follow below:

"general service incandescent reflector lamp" means an incandescent reflector lamp[18]

(a) with an R bulb shape, a PAR bulb shape or a bulb shape similar to R or PAR that is neither ER nor BR, as described in ANSI C79.1,

(b) with an E26/24 single contact or E26/50 × 89 skirted, medium screw base,

(c) with a nominal voltage or voltage range that lies at least partially between 100 volts and 130 volts,

(d) with a diameter greater than 70 mm (2.75 inches), and

(e) that has a nominal power of not less than 40W and not more than 205W,

but does not include

(f) a coloured incandescent reflector lamp, or

(g) an incandescent reflector lamp that

(i) is of the rough or vibration service type with

(A) a C-11 filament, as described in the IES Handbook, with five supports exclusive of lead wires,

(B) a C-17 filament, as described in the IES Handbook, with eight supports exclusive of lead wires, or

[18] The Canadian regulations also define the term "incandescent reflector lamp" as a lamp in which light is (a) produced by a filament heated to incandescence by an electric current, and (b) directed by an inner reflective coating on the outer bulb.

(C) a C-22 filament, as described in the IES Handbook, with 16 supports exclusive of lead wires,

(ii) is of the neodymium oxide type and has a lens containing not less than 5% neodymium oxide,

(iii) has a coating or other containment system to retain glass fragments if the lamp is shattered, and is specifically marked and marketed as an impact resistant lamp,

(iv) is specifically marked and marketed for plant growth use and

(A) has a spectral power distribution that is different from that of the lamps described in paragraphs (a) to (e), and

(B) contains a filter that suppresses yellow and green portions of the spectrum, or

(v) is specifically marked and marketed

(A) as an infrared heat lamp,

(B) for heat-sensitive use,

(C) for mine use,

(D) for marine, aquarium, terrarium or vivarium use, or

(E) for airfield, aircraft or automotive use.

"BR lamp" means an incandescent reflector lamp as described in ANSI C79.1, but does not include any of those lamps that have: (a) a diameter of 95.25 mm (BR30) and a nominal power of less than 66 W, (b) a diameter of 92.5 mm (BR30) and a nominal power of 85 W, or (c) a diameter of not less than 120.65 mm (BR38) but not more than 127 mm (BR40) and a nominal power of less than 121 W.

"ER lamp" means an incandescent reflector lamp as described in ANSI C79.1.

The pending revisions will address issues such as the diameter (d) in the definition of a general service incandescent reflector lamp. This will be reduced from 2.75 inches to 2.25 inches, to bring it into alignment with the US regulation promulgated by the Energy Independence and Security Act of 2007 (EISA 2007). In addition, the exemption for BR lamps will be narrowed to only include (a) BR30 (95mm) and BR40 (127mm) of 50 watts or less and (b) BR30 and BR40 of 65 watts.

Given these definitions, there are certain reflector lamps that are not included in the Canadian regulations, such as:

- Reflector lamps with base types other than E26 medium screw base, such as common MR-11 and MR-16 base types including 2-Pin GU5.3; GU10, GX5.3 and G4, as well as candelabra and other screw base types smaller than E26.
- MR-16 lamps are a popular directional lamp in the Canadian market, and yet the reflector has a 2-inch diameter, meaning it is not included in the scope of coverage for Canada's MEPS.
- Compact fluorescent reflector lamps, ceramic metal halide reflector lamps or LED reflector lamps that may be used as replacements for certain halogen directional lamps because the definition of incandescent reflector lamp only applies to heated-filament lamps.
- Certain BR and ER lamps, which exclude the popular 65 watt rated model.

As discussed above, NRCan is in the process of updating its regulatory requirements in to eliminate the separate set of less stringent efficacy requirements for certain ER lamps, and is proposing to adopt one table of efficacy requirements that applies to all covered reflector lamps (see Table C-2) with a retroactive effective date proposed of June 1, 2009.

Table C-2. Minimum Average Lamp Efficacy – R, PAR, BPAR, BR and ER Lamps*

Nominal Lamp Wattage	Minimum average lamp efficacy (lm/W)
40-50	10.5
51-59	11.0
60-85	12.5
86-115	14.0
116-155	14.5
156-205	15.0

* Note that this regulation will not apply to BR30 (95mm) and BR40 (127mm) lamps of 50 watts or less and BR30 and BR40 lamps of 65 watts which are excluded by definition.

Although Table C-2 may look similar to the United States' EPACT 1992 regulatory level, NRCan has modified two of the nominal lamp wattage ranges to slightly increase the efficacy requirement for one group. Table C-3 below depicts this change in the second and third product classes. The second and third wattage product classes have been modified to shift lamps with wattages ranging from 60 through 66 watts so they are held to a more stringent efficacy requirement (12.5 lm/W rather than 11.0 lm/W).

Table C-3. NRCan Modification to Average Lamp Efficacy MEPS

Product Class	NRCan Lamp Wattage	US DOE Lamp Wattage	Minimum average lamp efficacy (lm/W)
1	40-50	40-50	10.5
2	51-59	51-66	11.0
3	60-85	67-85	12.5
4	86-115	86-115	14.0
5	116-155	116-155	14.5
6	156-205	156-205	15.0

In the anticipated regulatory update, if NRCan intends to harmonize with the US DOE's regulatory standard for incandescent reflector lamps passed in July 2009, Table C-4 presents the MEPS that would be proposed in Canada.

Table C-4. NRCan Proposed MEPS for General Service Incandescent Reflector Lamps

Rated Lamp Wattage	Lamp Spectrum	Lamp Diameter	Rated Voltage	Minimum Average Lamp Efficacy (lm/W)
40 – 205	Standard Spectrum	> 63.5 mm (2.5 inches)	≥125 V	$6.8*P^{0.27}$
			<125 V	$5.9*P^{0.27}$

		≤ 63.5 mm (2.5 inches)	≥125 V	$5.7*P^{0.27}$
			<125 V	$5.0*P^{0.27}$
40 – 205	Modified Spectrum*	> 63.5 mm (2.5 inches)	≥125 V	$5.8*P^{0.27}$
			<125 V	$5.0*P^{0.27}$
		≤ 63.5 mm (2.5 inches)	≥125 V	$4.9*P^{0.27}$
			<125 V	$4.2*P^{0.27}$

C4. United States of America

The United States has regulated incandescent reflector lamps (US term for directional lamps) for nearly 15 years. The original efficacy requirements were established legislatively in the Energy Policy Act of 1992 (EPACT 1992), Public Law 102-486. These efficacy requirements were designed to eliminate the standard incandescent reflector (R) lamp, replacing it with a Parabolic Aluminized Reflector (PAR) halogen lamp. DOE was also required by EPACT 1992 to conduct two subsequent reviews to determine if the efficacy levels established for reflector lamps should be revised. DOE completed the first of those two revisions in July 2009, issuing higher efficacy requirements that will take effect in July 2012. The second review will start in early 2011 and is scheduled to be completed in June 2014. While DOE was conducting the first of its reviews of the EPACT 1992 regulation, Congress passed the Energy Independence and Security Act of 2007 (EISA 2007) to revise the legislative language that had previously excluded BR and ER shaped lamps from regulation. These changes to the statutory law have enabled DOE to now start analysing efficacy regulations for these lamp types, which it will be doing in a separate standards rulemaking procedure.

According to the definition established by EPACT 1992 and amended by EISA 2007, the following is the scope of coverage for DOE's regulatory authority for incandescent reflector lamps, blown-parabolic aluminised reflector (BPAR) lamps, bulge reflector (BR) lamps and ellipsoidal reflector (ER) lamps:

> *Incandescent reflector lamp (commonly referred to as a reflector lamp) means any lamp in which light is produced by a filament heated to incandescence by an electric current, which: is not colored or designed for rough or vibration service applications that contains an inner reflective coating on the outer bulb to direct the light; has an R, PAR, ER, BR, BPAR, or similar bulb shapes with an E26 medium screw base; has a rated voltage or voltage range that lies at least*

partially in the range of 115 and 130 volts; has a diameter that exceeds 2.25 inches; and has a rated wattage that is 40 watts or higher.

BPAR incandescent reflector lamp means a reflector lamp as shown in figure C78.21–278 on page 32 of ANSI C78.21–2003.

BR incandescent reflector lamp means a reflector lamp that has—

(1) A bulged section below the major diameter of the bulb and above the approximate baseline of the bulb, as shown in figure 1 (RB) on page 7 of ANSI C79.1–1994, (incorporated by reference, see §430.3); and

(2) A finished size and shape shown in ANSI C78.21–1989 (incorporated by reference; see §430.3), including the referenced reflective characteristics in part 7 of ANSI C78.21–1989.

BR30 means a BR incandescent reflector lamp with a diameter of 30/8ths of an inch.

BR40 means a BR incandescent reflector lamp with a diameter of 40/8ths of an inch.

ER incandescent reflector lamp means a reflector lamp that has—

(1) An elliptical section below the major diameter of the bulb and above the approximate baseline of the bulb, as shown in figure 1 (RE) on page 7 of ANSI C79.1–1994, (incorporated by reference; see §430.3); and

(2) A finished size and shape shown in ANSI C78.21–1989, (incorporated by reference; see §430.3).

ER30 means an ER incandescent reflector lamp with a diameter of 30/8ths of an inch.

ER40 means an ER incandescent reflector lamp with a diameter of 40/8ths of an inch.

The scope of coverage provided by the definitions above do not cover all reflector (i.e., directional) lamps that are sold in the US market. A few of the gaps afforded by this scope of coverage include the following:

- The definition only allows for the coverage of E26 medium screw base lamps, which does not include the common MR-11 and MR-16 base types, such as 2-Pin GU5.3; GU10, GX5.3 and G4.

- Although EISA 2007 extended coverage to small diameter reflector lamps (i.e., down from 2.75 inch diameters to 2.25 inches), the popular MR-16 directional lamp has a 2-inch diameter, and is therefore excluded from coverage.
- The definition only applies to incandescent and halogen lamps, it does not include compact fluorescent, metal halide or light emitting diodes (although metal halide may be covered and regulated by DOE in a separate rulemaking).

Although DOE covers medium screw base compact fluorescent lamps (CFL), as directed by section 135(c) of the Energy Policy Act of 2005 (EPACT 2005), the scope of coverage does not include directional (i.e., reflector) CFLs.[19] DOE's authority to regulate CFLs is on 'general service' CFLs, which (by definition) does not include reflector CFLs.

For high-intensity discharge (HID) lamps, DOE is conducting a determination analysis on whether or not to regulate HID lamps (which may include directional ceramic metal halide lamps), scheduled to be completed in June 2010. If DOE makes a positive determination on coverage and regulation of HID lamps, it is likely that this rulemaking will include directional low-wattage ceramic metal halide lamps that can be found in commercial retail applications replacing halogen reflector lamps.

For light emitting diode (LED) lamps, DOE is scheduled to conduct an energy conservation standards rulemaking on LED lamps starting in 2014 and scheduled to be completed in January 2017. The scope of this rulemaking is 'general service LED' lamps, and therefore is subject to the same list of non-general service exclusions that affects CFLs (see footnote 19 on previous page). Therefore, although directional LED lamps are emerging as a popular application for this light source, it is not expected to be covered and regulated in the scope of that rulemaking.

Table C-5 provides the current minimum average efficacy requirements for incandescent reflector lamps. This table of standards was set by the Energy Policy Act of 1992 and became effective in 1995. This table will remain in effect until it is superseded by the new table of efficacy requirements promulgated by DOE in July 2009 which takes effect in July 2012 (see Table C-6).

Table C-5. United States Efficacy Requirements for Incandescent Reflector Lamps

[19] The statutory definition, as incorporated into the Code of Federal Regulations (10 CFR Part 430.2) states that it does not include lamps that are "(ii) Unlikely to be used in general purpose applications, such as the applications described in the definition of 'General Service Incandescent Lamp' in this section;" The definition of General Service Incandescent Lamp explicitly excludes reflector lamps because general service incandescent lamps and incandescent reflector lamps are regulated separately. Therefore, regulated CFLs in the US only include non-directional (i.e., general illumination service), and directional (reflector) CFLs are outside DOE's scope of coverage.

Nominal Lamp Wattage	Minimum average lamp efficacy (lm/W)
40-50	10.5
51-66	11.0
67-85	12.5
86-115	14.0
116-155	14.5
156-205	15.0

Table C-6 presents the new MEPS for incandescent reflector lamps. In this table, separate minimum average efficacy requirements are established for reflector lamps according to the spectral emission, the lamp diameter and the rated voltage of the lamp. To provide a tangible reference point, the minimum efficacy of a 100 watt incandescent reflector lamp is provided in the right-hand most column of Table C-6.

Table C-6. New US Efficacy Requirements for Incandescent Reflector Lamps, 2012

Rated Lamp Wattage / Spectrum	Lamp Diameter (inches)	Rated Voltage	Minimum Average Efficacy (lm/W)	Example lm/W for 100W lamp
40 – 205W, Standard Spectral Emission	>2.5	≥125V	$6.8*P^{0.27}$	23.6
		<125V	$5.9*P^{0.27}$	20.5
	≤2.5	≥125V	$5.7*P^{0.27}$	19.8
		<125V	$5.0*P^{0.27}$	17.3
40 – 205W, Modified Spectral Emission	>2.5	≥125V	$5.8*P^{0.27}$	20.1
		<125V	$5.0*P^{0.27}$	17.3
	≤2.5	≥125V	$4.9*P^{0.27}$	17.0
		<125V	$4.2*P^{0.27}$	14.6

Note 1: P is equal to the rated lamp wattage, in watts.

Note 2: Standard spectrum means any incandescent reflector lamp that does not meet the definition of modified spectrum in 430.2.

Figure C-2 illustrates two of the incandescent reflector lamp MEPS adopted by the DOE in July 2009, compared to the Energy Policy Act of 1992 levels which became effective in 1995. The two shown are the efficacy requirements for 40-205 watt standard spectral emission lamps, less than 125 volts and having a diameter greater than 2.5 inches ("large diameter") or less than 2.5 inches ("small diameter"). The new MEPS level will supersede the EPACT 1992 levels on the 15th July 2012. Depending on the product class, the new MEPS will require a 100W reflector lamp to increase its efficacy by between 24 and 46 percent over the EPACT 1992 regulations.

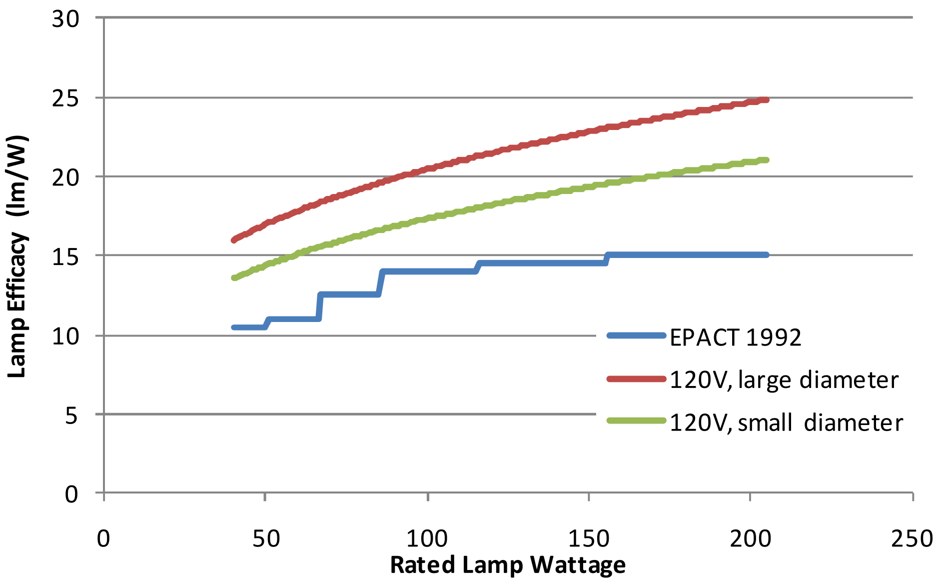


Figure C-2. US DOE Minimum Efficiency Standards for Certain Reflector Lamps

DOE has two subsequent energy conservation standard rulemakings scheduled that pertain to incandescent reflector lamps. The first will be to evaluate and potentially establish MEPS for BR and ER lamps and small diameter incandescent reflector lamps. This rulemaking has recently started and is scheduled to be completed by December 2011. The second will be a review (the second cycle) of regulations on incandescent reflector lamps in general. That rulemaking is scheduled to start in the first quarter of 2011 and be completed by June 2014.

C5. Comparison of Scope of Coverage and MEPS

In this section, some of the key differences between the various regulations of Australia, Canada and the United States are discussed. In addition, a comparison of the MEPS levels is presented.

Table C-7 presents a comparison of the scopes of coverage for the various regulatory standards in Australia, Canada and the United States. It should be noted that all three countries are actively reviewing and potentially revising their regulations. The reviews underway include issues relating to coverage as well as the efficacy requirements and schedule for when these requirements would become effective.

Although the table does not provide all the detail associated with the scopes of coverage (e.g., the treatment of BR lamps), in general terms it enables a reasonably rapid, at-a-glance comparison between the countries reviewed. As shown, the Australian scope is the broadest, in part because it encompasses the MR-16 lamp diameter and base-types.

Table C-7. Comparison of Scopes of Coverage for Countries Studied

Lamp Property	Australia	Canada	United States
Lamp Shapes	PAR, ER, R, RE, XR, YR, ZR or MR11-16	R, PAR, BPAR, BR and ER	R, PAR, BPAR, BR and ER
< 2.25 Inch Diameter	Yes, includes MR11 – MR16	Not covered	Not covered
Wattages	All wattages	40 – 205 Watts	40 Watts and higher (although only set MEPS up to 205W)
Voltages	5-24V and >220V	At least partially between 100 and 130V	At least partially between 115 and 130V
Base Type	Bi-pin, E14, E26, E27, B15, B22d or GU10	E26 only	E26 only
Modified Spectrum Lamps	Same MEPS for standard lamps and modified spectrum	Anticipate will adopt US requirements	Same requirement, but will have lower target than new regs for standard lamps in 2012

Figure C-3 provides a comparison of the MEPS levels that have been adopted by Australia, Canada and the United States. On this graph, it is important to note that the US and Canadian regulations are based on a line-voltage of 120V AC, and that the Australian regulation is based on lamps operating at 240V AC. The higher voltage requires the use of a thinner and longer filament for the same power rating, which will naturally have a lower efficacy than the shorter, thicker filaments used at 120V. For example, a 100-watt, 120V general service lamp will produce about 17 lumens per watt, while a 100-watt, 240V lamp with the same lamp life will only produce about 12.8 lumens per watt. Therefore, the efficacy requirements for Australia were adjusted to account for the different voltage of the US and Canada, enabling a side-by-side comparison in the following figure.

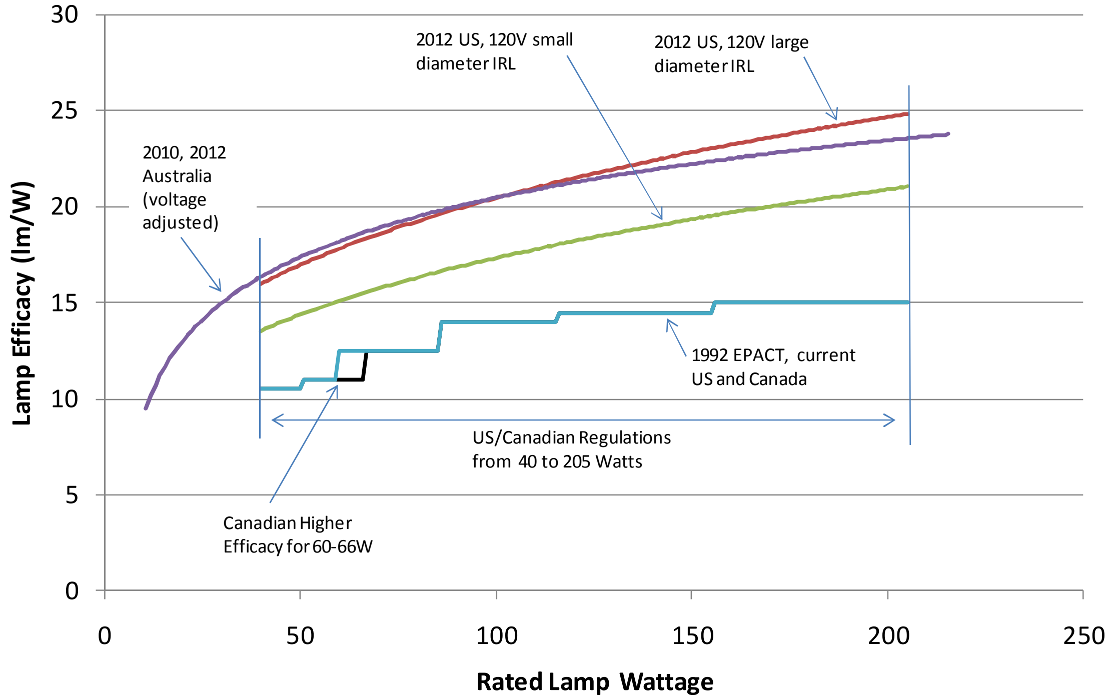


Figure C-3. Comparison of MEPS Levels for Incandescent Reflector Lamps

A few observations can be made about the MEPS curves for these three countries:

- The slope of all the MEPS shows a similar pattern, based on the physics of the tungsten filament. The efficacy is lower at low wattages and increases at higher wattages.
- All of the new MEPS are higher than the original EPACT 1992 levels, which represent standard halogen technology from nearly twenty years ago.
- The Australian regulation spans a wider range of wattages as it is not confined to the 40-205 watt range like the US and Canada regulations.
- The new large diameter (i.e., greater than 2.75 inches) regulation in the US that takes effect in 2012 is largely the same as the Australian efficacy regulation, after adjusting for differences in mains voltage.
- The new Australian regulation is also applicable to small diameter directional lamps (i.e., less than 2.75 inches), thus after adjusting for voltage, the Australian MEPS are more stringent than the US regulations for these lamp types.

APPENDIX D: METHODOLOGY TO DETERMINE ENERGY SAVINGS

The energy savings modelled in this report from the adoption of best practice MEPRS or from the adoption of best current technologies are modelled in a simple but consistent manner. They are certainly not the last word on the estimation of such potentials but are intended to give a reasonable first estimate in the absence of a more sophisticated analysis. For each economy and end-use considered the approach taken is as follows:

a) Gather estimates of the energy consumption by end-use in 2010 and produce such estimates for all end-uses considered in the analysis
b) Determine market average efficiency levels for new products in 2010 by each end-use
c) Project average new product efficiency levels forward from 2010 to 2030 under a base case scenario
d) Project reference case energy consumption and energy-related CO_2 emissions to 2030 by end-use
e) Determine world's highest existing energy efficiency requirement by end-use
f) Determine energy efficiency level of world's most energy efficient technology by end-use
g) Project new product and stock energy efficiency trends to 2030 were world's best MEPRs to be adopted by a given date
h) Project new product and stock energy efficiency trends to 2030 were world's best current technology to be adopted by a given date
i) Convert these projections into energy consumption and CO_2 projections and determine savings compared to the base case

To help organise and make these projections a simple bottom-up spreadsheet energy and CO_2 model was developed that tracked and projected each end use. The modelling approach was necessarily considerably simplified compared to proper detailed energy models and simplified stock technology adoption assumptions were made as described below. The approach taken to each of these elements is now discussed in turn.

Gather estimates of the energy consumption by end-use in 2010 and produce such estimates for all end-uses considered in the analysis

Whenever possible the most recent data on the energy consumption of each end use if gathered from available economy specific studies. The preference is to use data reported in regulatory development or impact assessment studies or in integrated and consistent end-use assessment studies. This was the case for most end-uses considered in the EU and to some extent for those used in China. In particular the EU analysis drew upon the results published in the various Ecodesign studies and from the JRC report *Electricity Consumption and Efficiency Trends in European Union - Status Report 2009*[iii]. In the case of India no regulatory studies of were available for use in this research but some non-regulatory third party studies were available and used for this purpose. If no such data was available the estimates produced by the BUENAS model and reported in the study Global Carbon Impacts of Energy Using Products[10] report produced for Defra in the UK were used. However, for many products no such data was available (especially for India and China). In these cases the consultants estimated specific end-use energy consumption by assuming that the share of sector energy use was consistent with that reported in another (proxy) economy but then adjusted by the study teams own understanding of the penetration and use of the given technology in the economy in question. Thus in some cases the estimates are partially based on the best estimate of consultants who have over twenty years experience conducting end-use energy consumption estimates in a myriad of different economies including all the ones treated here. However, in these cases the overall consumption of the sector is always made to match the estimated total consumption for the broader consumption sector. This could be done at the more macro level of the residential, commercial or industrial sectors for the fuel type considered (electricity, oil or gas) or if more disaggregate data is available e.g. for cooking in the residential sector, the sum of the cooking appliance energy use is adjusted to match that based on best estimates of consumption shares by end-use within the sub-sector. IEA data[11] was used for all economies to apply boundaries on the energy consumption by each sector and the reference case projections of energy use in 2020 and 2030 were taken from IEA World Energy Outlook[12] forecasts

Thus in summary a hierarchy of information approach is taken where total sector level consumption by fuel is viewed as the most reliable data, followed by data on consumption by individual end-use reported in regulatory or end-use monitoring studies, followed by estimates produced at the specific end-use or aggregated end-use level in studies derived from the Global Carbon Impacts of Energy Using Products[13] study; followed by proxy economy end-use market share estimates adjusted for the consultants knowledge of the adoption rates, efficiency and usage patterns of specific end-use technologies in the given sector and economy. In reality much of the data used above was not available for 2010 but for a variety of years more or less up to 2010. In this case the model uses projections from previous studies (regulatory assessment and impact studies, market trend studies, and the Global Carbon Impacts of Energy Using Products[14] projections) and makes the aggregate of the assumptions match sector base-case fuel growth projections in the IEA's World Energy Outlook.

Determine market average efficiency levels for new products in 2010 by each end-use

This draws upon data from regulatory studies, market monitoring studies and in the event that none of these are available from proxy economy data adjusted for what is known as the typical difference in efficiency level between the economies and taking into account the anticipated impact of any existing MEPRs and/or labelling schemes. When only regulatory or labelling thresholds are available assumptions are made about the market average product efficiency in relation to those thresholds based on the maturity of the regulatory settings and what is known about typical efficiency levels for other end-uses where the efficiency in relation to the regulatory settings is better known. The influence of time is also factored in to project the efficiency trends to 2010 if only data for earlier years was available.

Project average new product efficiency levels forward from 2010 to 2030 under a base case scenario

If previous existing projections for base case efficiency trends are available from regulatory studies or other sources these are used. Otherwise assumptions about autonomous energy efficiency improvement rates are made that are consistent with those that have been used and projected for other products and sectors but which take account of the starting point and assume an asymptotic trend toward a common autonomous efficiency level over time. If regulations are pending or are likely to be adopted at a certain efficiency level (i.e. there is a specific proposal already under advanced consideration within a regulatory process) it is assumed that they will be. Otherwise the base case assumes there are no new regulations for the end-use under consideration.

Project reference case energy consumption and energy-related CO2 emissions to 2030 by end-use

Again when estimates have already been published in regulatory studies these are used. Alternatively those projected by the Global Carbon Impacts of Energy Using Products[15] study were assumed unless the projection is believed to be flawed for some other reason. The whole sector energy use by fuel is assumed to match the projections under the reference case scenarios of the IEA's World Energy Outlook. Thus end-uses for which there are no published base case energy consumption forecasts are assumed to take up the residual consumption to match the IEA forecasts by sector in proportion to their share of energy use in 2010. This is obviously a gross simplification but was necessary to simplify the rapid production of a first order estimate by end-use under a base case scenario.

CO_2 emissions are determined by using emissions factors consistent with the IEA World Energy Outlook forecasts under the reference scenario.

Determine world's highest existing energy efficiency requirement by end-use

This is done by comparing current regulatory settings for the main types of end-use equipment used in the whole end-use product class after making allowances for any differences in test procedure and efficiency metric applied. In some cases, where there is a strong commonality in both across the economies this action was relatively straightforward and average efficiencies only had to be adjusted to take account of any known differences in adoption of specific sub-technologies. Expert judgement was required to approximate the differences when there was greater diversity in the test procedures and efficiency metrics. In this case the process is less accurate but is informed by the consultant's long experience in doing such adjustments and some previous work that investigated options to convert between efficiency metrics for some of the end-uses.

Determine energy efficiency level of world's most energy efficient technology by end-use

In this case the consultant's knowledge of existing technologies and their performance levels was applied to gauge the most energy efficient current technology by product class and to determine their energy efficiency levels according to a standardised measure that could then be directly compared to the levels applied in existing regulatory levels and or market average energy efficiency levels.

Project new product and stock energy efficiency trends to 2030 were world's best MEPRs to be adopted by a given date

The impact of the MEPRs adopted is superimposed over the autonomous energy efficiency improvements previously derived to determine the trend in new product energy efficiency to 2030. Stock energy efficiency trends are then derived by integrating the efficiency trends over the mean product life span.

Project new product and stock energy efficiency trends to 2030 were world's best current technology to be adopted by a given date

The process followed is the same as described above except it is assumed that all new products attain the energy efficiency level of the world's most energy efficient technology as opposed to that of the most ambitious MEPRs from the given date.

Convert these projections into energy consumption and CO2 projections and determine savings compared to the base case

The energy consumption and CO_2 emissions under the two higher efficiency scenarios are calculated by comparing the ratio of product energy efficiency trends to those in the reference case scenario and multiplying the reference case energy consumption and energy-related CO_2 emissions to 2030 accordingly.

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