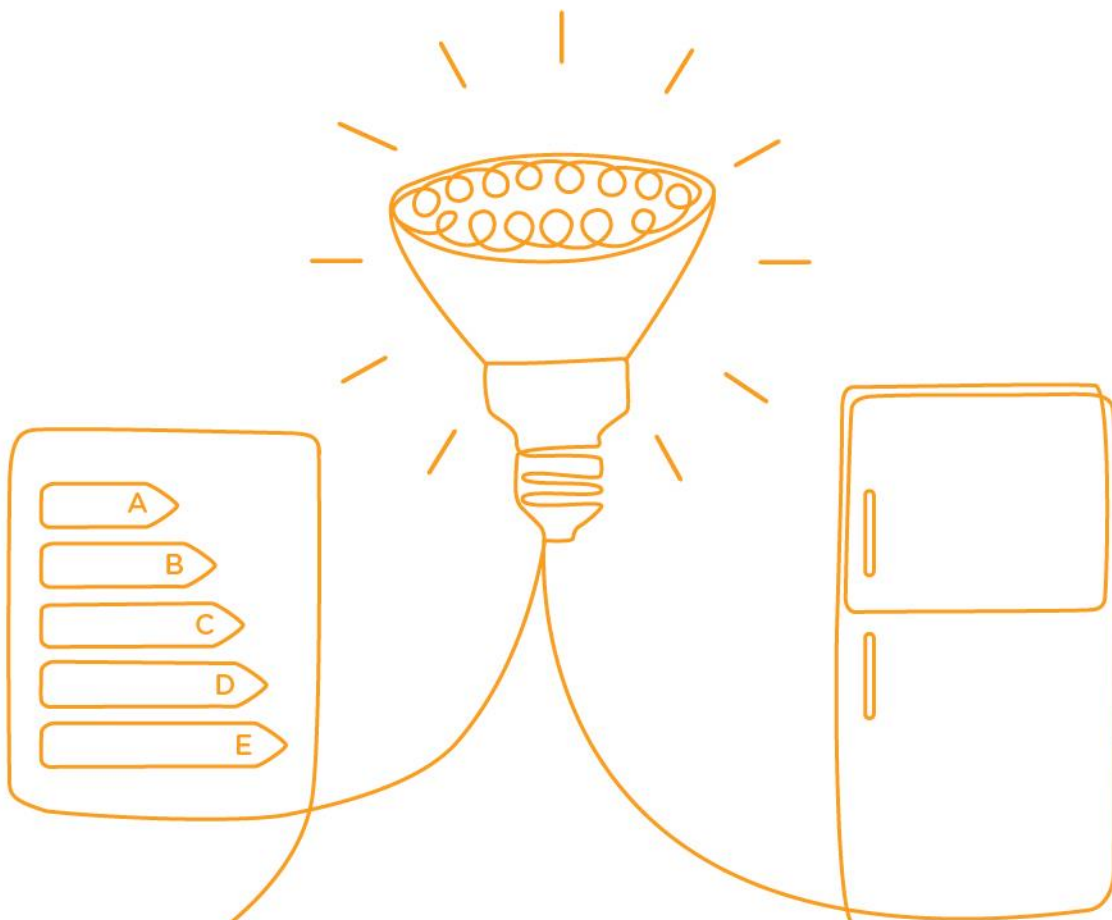


Energy Consumption of Computers in the Chinese Market

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Executive Summary

To support the California Energy Commission (CEC) in their rulemaking process on computers, CLASP conducted market research studies to identify the energy efficiency levels found in desktop and notebook computers currently on the US market.

The Environmental Protection Agency (EPA)'s ENERGY STAR dataset only provides a partial view of the US computers market, since it only covers ENERGY STAR-qualified models. No database is available that provides energy consumption information for the complete US market. Since computers are traded internationally, CLASP sought large datasets from other economies and accessed a public database of computers commercially available on the Chinese market that was developed as part of China's mandatory requirements for computers. The Chinese database covers all computers sold on the Chinese market¹ and so provides a complete picture of computer energy performance.

In cooperation with Hansheng Ltd, CLASP extracted all the relevant data from this database to facilitate analysis on computer energy consumption in the US market. There is significant overlap in the US and Chinese markets regarding manufacturer presence, although the share of desktop computers is larger in China compared to the US, and the share of notebook computers is smaller. The pattern of distribution of models listed between ENERGY STAR categories is different; however, there are sufficient models in each category to provide a meaningful basis for comparison. A full 47% of manufacturers listed in China's database are also listed in the US ENERGY STAR database for computers, and these manufacturers account for 79% of Chinese models. China's complete dataset is therefore a good proxy for assessing the status of the US computer market. This document explains the analysis that CLASP conducted on the Chinese data to identify the estimated shares of computers that meet the ENERGY STAR energy limits in the US.

Our analysis of the Chinese database suggests that 92% of desktop and 98% of notebook computers on the Chinese market could meet the ENERGY STAR v5.2 Typical Energy Consumption (TEC) limits.² This suggests that EPA's 2012 Unit Shipment and Market Penetration Report's market penetration rates for the US of 21% for desktops and 69% for notebooks may be significantly underestimated.

Furthermore, even when the TEC levels are reduced significantly below those required under ENERGY STAR v5.2, the proportion of computers that meet the energy requirements remain high. For example, 49% of desktop and 67% of notebook computer models on the Chinese market would still meet energy limits 30% lower than ENERGY STAR v5.2. Additionally, 17% of desktop models and 57% of notebook models would meet energy limits 40% below ENERGY STAR v5.2.

Analysis & Results

CLASP analyzed Chinese database in a number of ways in an attempt to identify how many products on the Chinese market meet the ENERGY STAR v5.2 specifications. The original extracted Chinese data can be found in the Excel worksheet "[CLASP China ENERGY STAR Comparison Computer Data 2013](#)," available on CLASP's website.³

¹ In principle - the compliance rate is not known.

² The database did not include information on PSU efficiency so it wasn't possible to check compliance against the full ENERGY STAR v5.2 specification

³ URL: http://clasponline.org/~media/Files/SLDocuments/2014/2014-10_US-Computer-Reports/CLASP-China-ENERGY-STAR-Comparison-Computer-Data_2013

The Chinese data was entered into the database between January 15 and August 22 2013 the database was accessed between the August 19 and August 27, 2013.

The project team used the following methods when analyzing the Chinese database for ENERGY STAR coverage levels:

1. All duplicated entries (over 11,000) were removed. In addition, a total of 10 entries with clear data errors - such as missing typical energy consumption (TEC) values - were also removed. These product removals did not impact the number of manufacturers found in the database.
2. Each entry was classified as either desktop, notebook, or other computer (the original Chinese database did not include this information).
3. The actual TEC was compared with the ENERGY STAR v5.2 TEC base allowance. The results of this analysis can be seen on the "Analysis-all" worksheet of the Excel data and are discussed in the results section below.
4. Expected adders were calculated for each product based on average extra allowances given to each product type (at the category level) within the ENERGY STAR v6.0 dataset. In other words, using the technical information in the ENERGY STAR v6.0 dataset, we calculated an average additional ENERGY STAR v5.2 TEC allowance for each type of product in the Chinese database. The adder allowance calculations can be found on the "Adders-Analysis" worksheet of the Excel data.
5. Each of the products in the database were then assessed to see if they met the estimated total ENERGY STAR v5.2 TEC allowances with the adders. The results of this analysis can be seen on the "Analysis-all" worksheet of the Excel data and are discussed in the results section below.
6. To test the potential impact of more stringent efficiency levels, the ENERGY STAR v5.2 TEC allowances were reduced by 10, 20, 30, 40 and 50%, and products in the database were then assessed to see if they met these revised TEC allowances with the adders. The calculations are found in the "Chinese-Dataset-No-Duplicates" worksheet, the findings detailed on the "Analysis-all" worksheet, and a final high level summary included on the "Summary" worksheet of the Excel data.

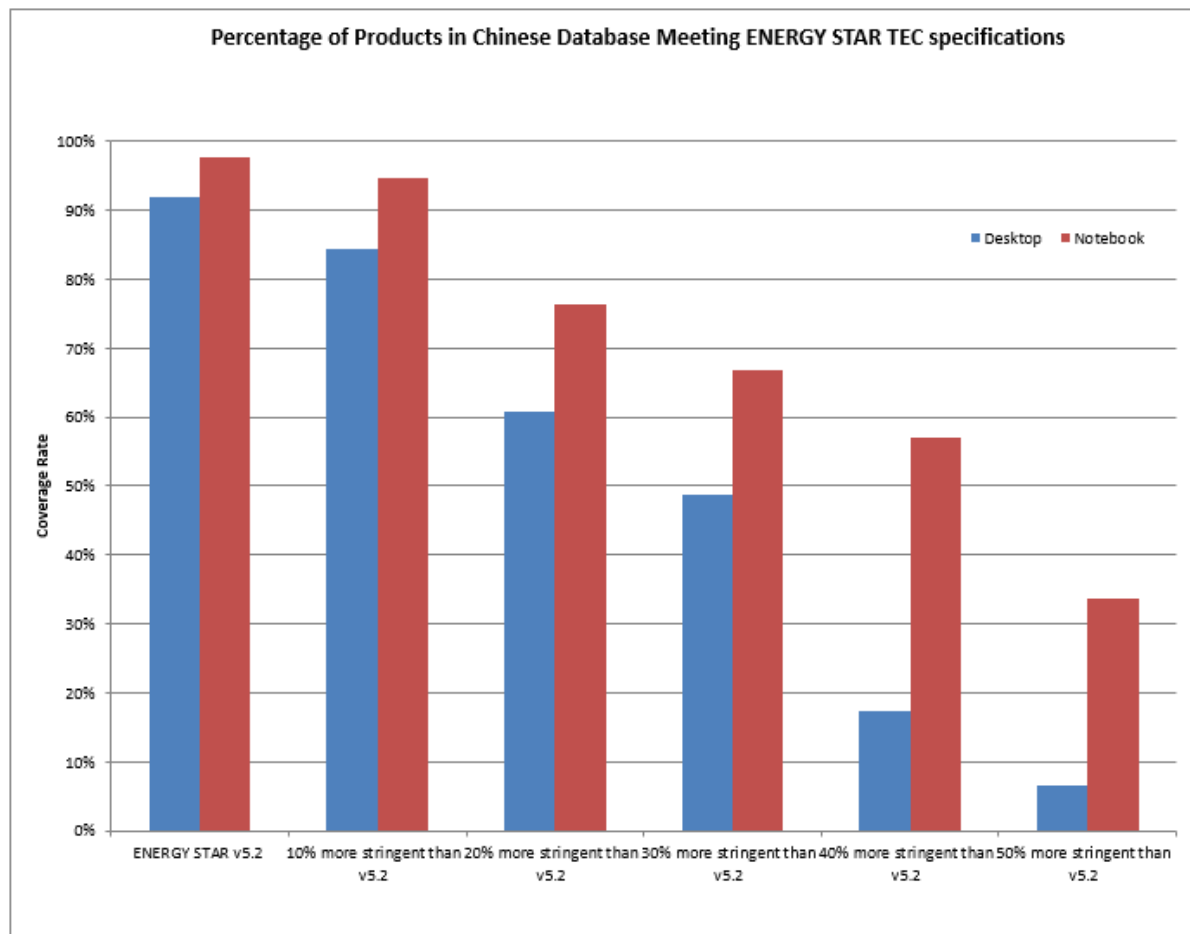
The level of specification information in the Chinese database is limited; it includes only the manufacturer name, model name, Chinese energy class, ENERGY STAR category, and TEC value. The lack of information about power supply unit (PSU) efficiency means that it is not possible to check compliance against the full ENERGY STAR v5.2 specification - only with the TEC limits.

Comparison with ENERGY STAR Coverage Levels

Figure 1 illustrates the estimated percentage of models in the Chinese database that would meet the ENERGY STAR v5.2 TEC allowances using the proxy analysis described above. It is clear from the analysis that a very high proportion of models in the Chinese database meet ENERGY STAR v5.2 TEC levels. The graph also shows that many models still meet the requirements when TEC levels are made progressively more stringent by 10, 20, 30, 40, and 50%, respectively. For example, almost half of desktops meet the requirements with the TEC level reduced by 30%, and more than half of laptops meet the requirements with the TEC level reduced by 40%.



Figure 1: Estimated number of models in the Chinese Database meeting ENERGY STAR v5.2 TEC levels with varying stringency



Comparing TEC levels between ENERGY STAR v5.2 and ENERGY STAR v6.0

EPA finalized the ENERGY STAR v6.0 specifications in September 2013, and they took effect in June 2014. It would have been interesting to compare compliance of the Chinese data against these new ENERGY STAR energy limits; however, the lack of technical information about components for each computer - such as the number of cores in each CPU, processor frequency, GPU frame buffer bandwidth, etc - meant that this was not possible.

Instead, the project team conducted an assessment of expected TEC reductions from ENERGY STAR v5.2 levels associated with increased ENERGY STAR v6.0 stringency. The analysis focused on identifying the average maximum TEC limits (measured against the ENERGY STAR v5.2 test methodology) for products in the ENERGY STAR v6.0 dataset that met both the ENERGY STAR v5.2 and ENERGY STAR v6.0 requirements.

This analysis shows that, when measured against the ENERGY STAR v5.2 methodology, desktop PCs on average⁴ would have to consume approximately 30% less energy, and notebooks 40% less energy, in order to meet the ENERGY STAR v6.0 requirements.

Note that this is not the same as saying that a desktop that has a TEC level of 30% less energy than ENERGY STARv5.2 would pass ENERGY STARv6.0; the test methodologies of the two versions are significantly different, and the difference for a specific model could vary considerably from these values, depending on its configuration. This just gives an indication of the average difference for a specific set of data.

Based on the estimated difference between the ENERGY STAR v6.0 and ENERGY STAR v5.2 energy limits, the analysis of the Chinese dataset shows that almost half of desktops, and more than half of notebooks, meet v5.2 energy limits that (on average) are equivalent to the estimated ENERGY STAR v6.0 levels of stringency (when measured with the ENERGY STAR v5.2 test methodology).

Comparison of Manufacturers and Number of Models in both Chinese and US ENERGY STAR Databases

The project team utilized the following process when analyzing the Chinese database to identify numbers of manufacturers active and products sold on the US market:

1. Each manufacturer listed on the Chinese database was reviewed to identify whether or not it sold desktop and/or notebook computers on the US market. In the first instance, where possible, the website of each manufacturer was reviewed to identify whether or not the company was active on the US market. This analysis was followed up by a review of the latest ENERGY STAR v5.2 database, which lists which manufacturers have desktop and/or notebook computers registered as being sold on the US market. This analysis can be seen on the “Analysis-Manufacturers-1” worksheet of the Excel data file. It should be noted that this analysis was completed at the manufacturer level rather than the individual product level. That is, the analysis is only concerned with whether or not a manufacturer sells desktops and/or notebooks on the US market. The team also checked whether or not each manufacturer sold ENERGY STAR-qualified products in the US.
2. To enable a comparison between the US and Chinese markets, the team reviewed the latest available version of the US ENERGY STAR v5.2 database to identify the share of ENERGY STAR-qualified desktop and notebook PCs.

Figure 2 illustrates the estimated share of desktop and notebook computer models in the Chinese database that are sold by manufacturers who also supply the US market. It shows that the manufacturers who supply most of the models⁵ in the Chinese database also sell in the US.

⁴ Across all ENERGY STAR performance categories

⁵ It is noted that the manufacturer proportion of product listing may not be reflected in market share. Manufacturers differ in their approach to registering a product - some do so at the family level - others at configuration level. The latter results in a higher number of registrations.

Figure 2: Estimated share of computer models in the Chinese database sold by manufacturers who also sell to the US market

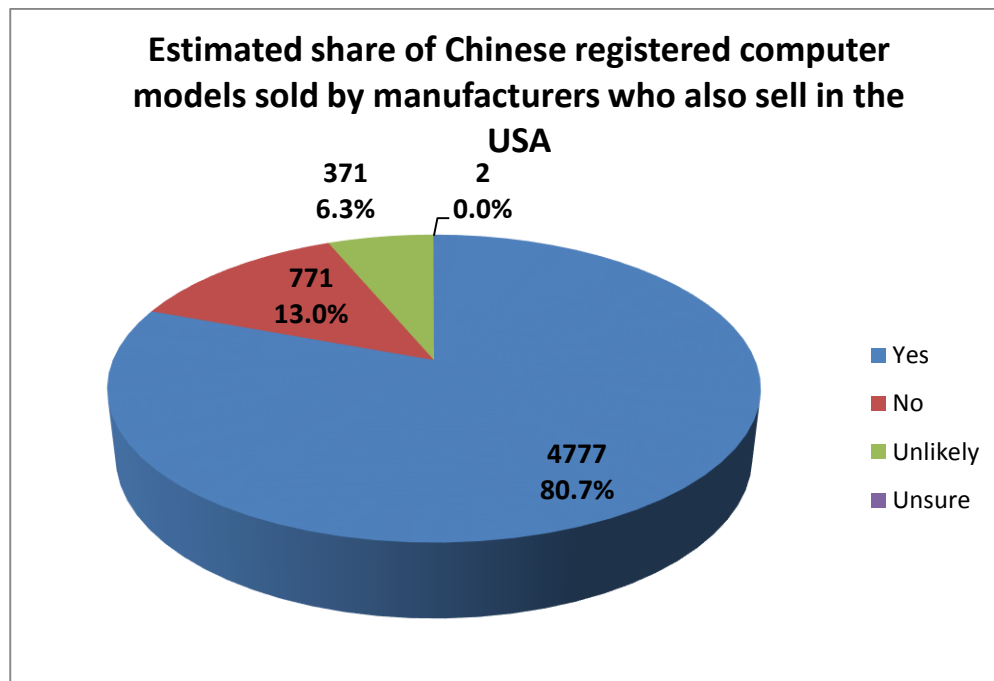


Figure 3 below depicts the share of Chinese manufacturers that are listed in both the Chinese database and the US ENERGY STAR database. Approximately half of the manufacturers listed in the Chinese database are also registering ENERGY STAR products in the US. However, Figure 4 shows that nearly 80% of Chinese-registered computer models are sold by manufacturers who are also listed in the US ENERGY STAR database. That is, the manufacturers who have the largest number of computer models listed in the China database are also listed in the US ENERGY STAR database.

Figure 3: Share of Chinese manufacturers listed on the Chinese database found on the US ENERGY STAR database

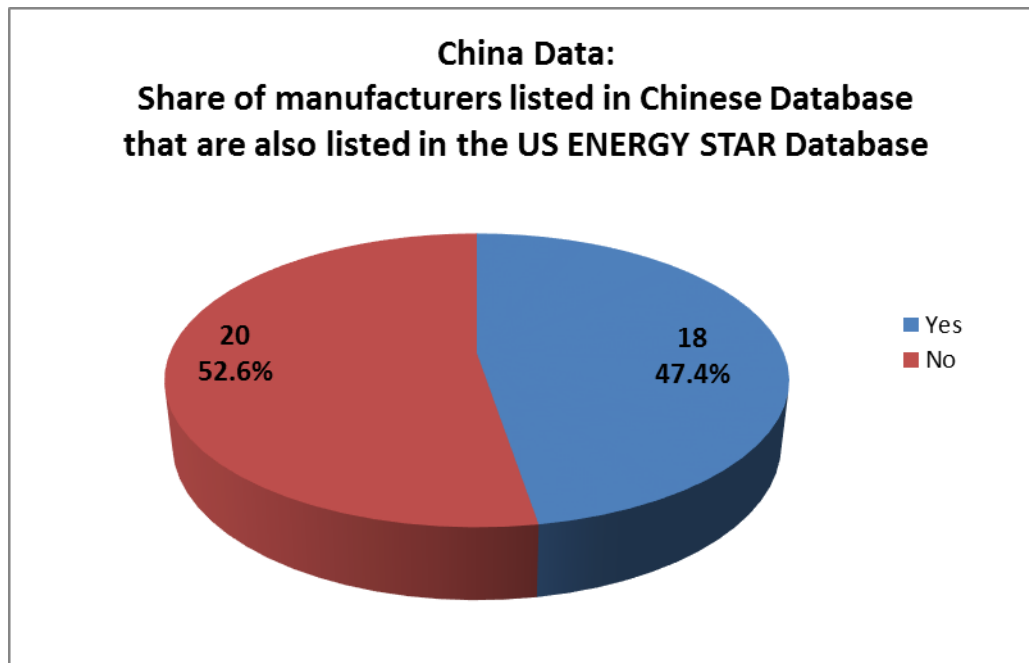
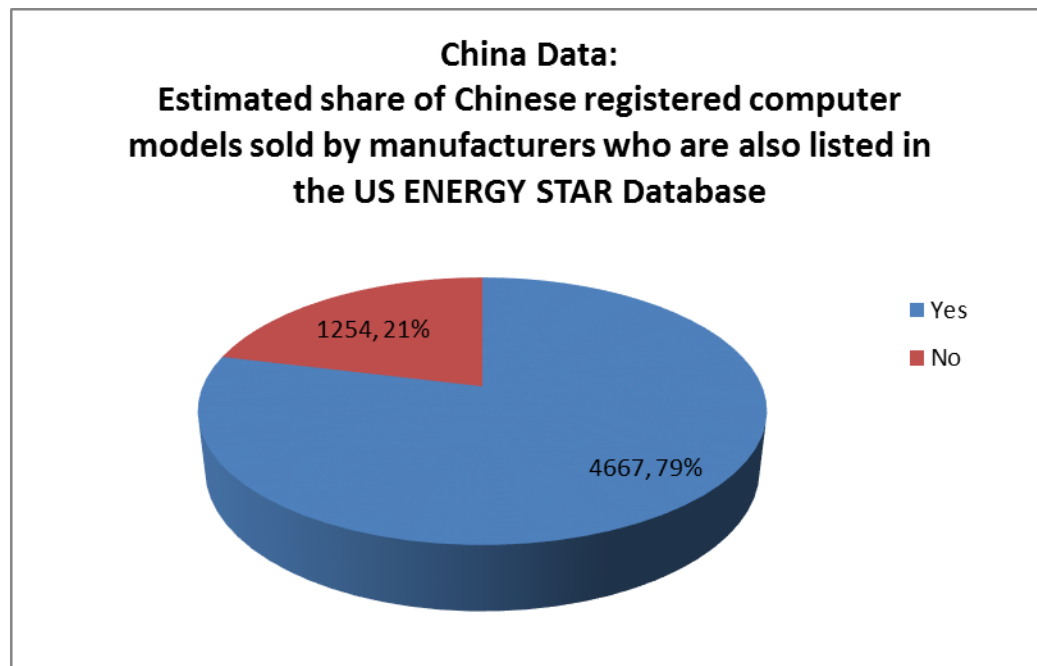


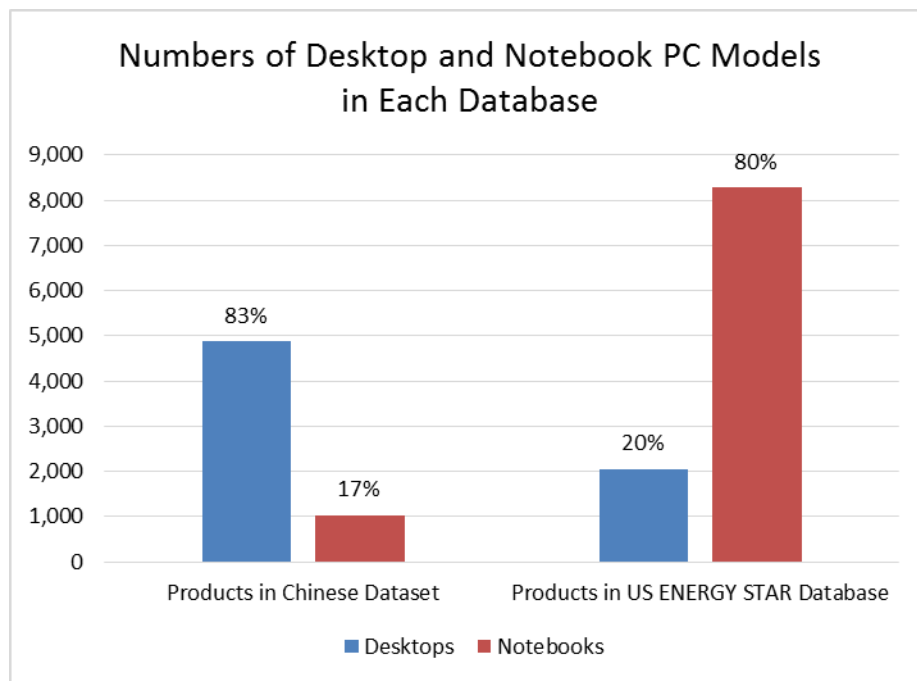
Figure 4: Share of computer models in the Chinese database that are sold by manufacturers who are listed on the US ENERGY STAR database



Together these results suggest that the Chinese database can provide some insights into the possible range of energy consumption for products on the US market.

illustrates the share of desktops and notebooks in the Chinese and US ENERGY STAR databases. It is evident that there is a clear dominance of desktops over notebooks in the Chinese database, whereas the opposite is true in the US ENERGY STAR database. This indicates that there are considerable differences in form factors between the two markets. However, there are still sufficient numbers in each category to provide a meaningful basis for comparison.

Figure 5 - Estimated share of desktop and notebook computer models in the Chinese and ENERGY STAR databases



The distribution of models by ENERGY STAR category for the Chinese and US ENERGY STAR databases is shown for desktop computers in Figure 6 and for notebooks in Figure 7 below.

Figure 6: Distribution of desktop computer models by ENERGY STAR categories in the Chinese and US ENERGY STAR databases

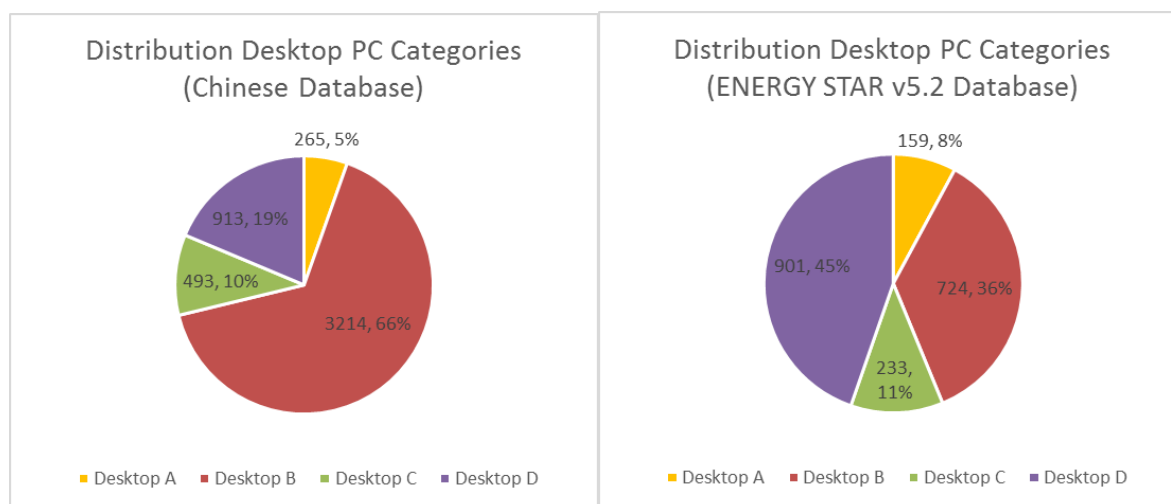
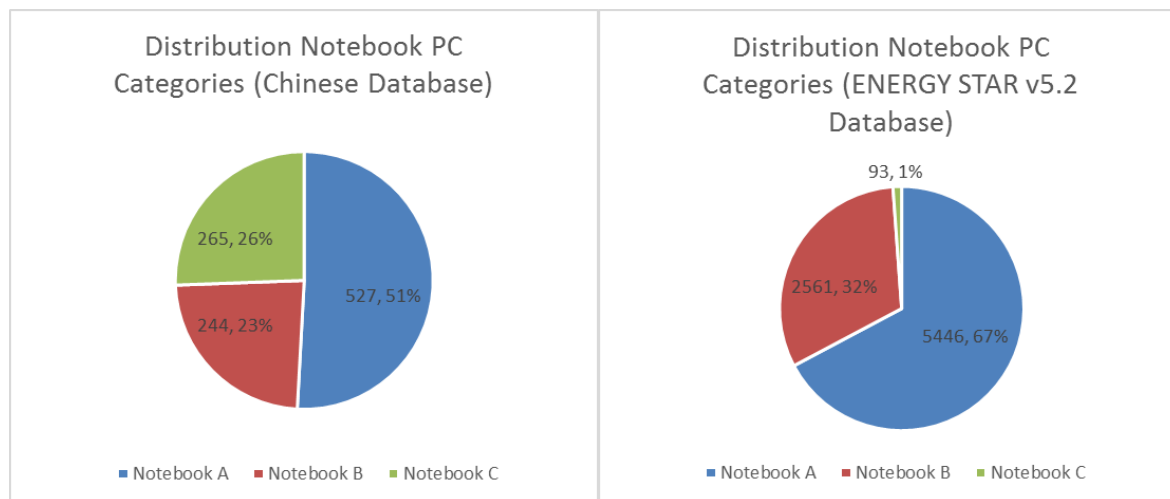


Figure 7: Distribution of notebook computer models by ENERGY STAR categories in the Chinese and US ENERGY STAR databases



In both cases, the distribution of models by category is different. For desktops, the USA database has significantly more of the higher performing categories listed. For notebooks, the reverse is true. However, in all cases there are sufficient numbers in each category to provide a meaningful basis for comparison.

Conclusions

Our analysis of the Chinese database suggests that 92% of desktop and 98% of notebook computers on the Chinese market could meet the ENERGY STAR v5.2 Typical Energy Consumption (TEC) limits⁶. This suggests that EPA's 2012 Unit Shipment and Market Penetration Report's market penetration rates for the US of 21% for desktops and 69% for notebooks may be significantly underestimated.

Furthermore, even when the TEC levels are reduced significantly below those required under ENERGY STAR v5.2, the proportion of computers that meet the energy requirements remain high. For example, 49% of desktop and 67% of notebook computer models on the Chinese market would still meet energy limits 30% lower than ENERGY STAR v5.2; 17% of desktop models and 57% of notebook models would meet energy limits 40% below ENERGY STAR v5.2.

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