Lessons learned from international energy labelling programs for strengthening the China Energy Label program

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Abstract

China first introduced the China Energy Label, its mandatory energy information label, in 2005 and it has expanded over the last eleven years to cover 33 key energy-using products. This energy labelling program, along with the complementary mandatory efficiency standards and subsidies for efficient products, have contributed to driving market transformation with growing shares for efficient products and appliances. While successful, policy and technical barriers to effectively implementing the China Energy Label, particularly in terms of compliance, exist. Key barriers include an incomplete legal basis, unclear responsibilities, lack of effective information sharing and distribution, lack of necessary resources and lack of systematic monitoring of compliance. This study reviews some of the longest existing and most successful international energy labelling programs in order to identify remaining gaps in the Chinese program and recommend specific areas for improvement.

We conducted an international technical review of the U.S. EnergyGuide and U.S. ENERGY STAR labels, the Australia Energy Label, the European Union Energy Label, and the Japan Top Runner and Energy Saving Label programs to identify success factors and best practices for the following programmatic elements: legal basis and institutions, technical specification and development, implementation, enforcement and penalties, financial and human resources, technical capacity, information sharing, program evaluation and stakeholder participation and involvement. Based on a qualitative evaluation of the actual barriers and challenges to the implementation of the China Energy Label, we conducted a gap analysis between the China Energy Label and international best practices to identify areas for improvement. Specific policy recommendations for improving each programmatic element of the China Energy Label to strengthen the program are provided.

Introduction

As one of the world's largest producers of energy-using products, China is also home to a growing domestic market for energy-using products with urbanization and economic growth as key drivers. In order to promote equipment energy efficiency improvements, China introduced mandatory minimum energy performance standards (MEPS) in 1989 and the program now covers 64 residential, commercial and industrial equipment and products. However, MEPS only set a floor for the minimum energy efficiency required for products on the market and additional policies and measures are needed to pull the market towards more efficient products. In the absence of consumer awareness and education about energy-efficient products, especially on how high operational costs can offset the initial cost advantage of inefficient products, consumers continue to prefer low initial cost but high energy-consuming products. As a result, there is insufficient demand for energy-efficient products, which in turn deters producers from innovating and manufacturing energy-efficient products. Unless these highly efficiency products are produced and widely adopted, it will be difficult to achieve the cost reduction benefits associated with economies of scale and access technological improvement. In light of this barrier, China introduced the China Energy Label (CEL),

its mandatory energy information label, in 2005 and it has expanded over the last eleven years to cover 35 key energy-using products[1]. As of the end of 2015, the CEL covered 16 residential products, 6 industrial products, 10 commercial and office products and 3 lighting products. The CEL helps consumers identify energy-efficient products by ranking the energy efficiency of a particular product model from Grade 1 through 5 (or 3 for some products) based on its energy performance relative to other similar product models. Grade 1 represents products with the highest energy efficiency while Grade 5 (3) represents products with the lowest energy efficiency, with the threshold for Grade 5 (3) set at the MEPS level. If a product is rated Grade 2 or above, it is considered an energy efficient product. The China Energy label also provides basic information on the product model's energy consumption and efficiency indicators. In 2014, China introduced a pilot QR code on the China Energy Label for selected products to provide more information and functionalities to consumers, manufacturers and market supervisors. On June 1, 2016, a new layout for the China Energy Label was introduced under the revised Management Measures of Energy Label with a revised format for the Grade 1 through 5 scale and the formal addition of the QR code for all products. Figure 1 shows the original and revised format of the CEL.

From 2009 to 2012, China established a national subsidy program for appliances that ultimately covered 17 products including major residential products of air conditioners, clothes washers, televisions, lighting products and also some industrial equipment. Varying levels of subsidies were provided to qualifying product models that were rated Grade 2 or higher. The subsidy programs, along with growing awareness of the CEL, have helped spur market transformation in some key product markets, with room air conditioners, television, front-load clothes washers and CFL market-average efficiencies increasing faster than the targeted efficiency levels in revised MEPS (Khanna et al. 2016).

Despite these new developments, there are still policy and technical barriers to effectively implementing the China Energy Label, particularly in terms of compliance. For example, a random product check-testing of 9 popular products with high energy efficiency ratings conducted by China National Institute of Standardization[2] and the CEL Center in 2010 found discrepancies between the nameplate energy performance rating claimed by the manufacture and the actual performance results from testing (Zhang, 2012). Since the CEL does not mandate independent external verification of the claimed energy efficiency, there is a risk that manufacturers will overstate it. Discrepancies between the nameplate rating and actual performance is a major challenge to the CEL program as it erodes consumers' confidence about the reliability of product information and undermines the CEL objectives. Other key barriers to the CEL program include an incomplete legal basis, unclear responsibilities, lack of effective information sharing and distribution, lack of necessary resources and lack of systematic monitoring for compliance. This paper aims to address these barriers by reviewing some of the longest existing and most successful international energy labelling programs in order to identify remaining gaps in the Chinese program and recommend specific areas for improvement. The next section describes the study methodology, followed by overview of reviewed energy labels, international analysis of success factors, a summary of China gap analysis and ends with key policy recommendations for the CEL program.

Methodology

This paper evaluates international experiences with energy labelling programs in Australia, Japan, the United States (U.S.) and the European Union (EU) with emphasis on each program's legal basis and governing institutions, technical specifications and development process for label criteria, implementation, enforcement measures and noncompliance penalties, financial and human resource input, technical capacity to support efficiency testing, information sharing practice and program evaluation efforts. In-depth reviews and evaluation of each program and program element were based on a comprehensive literature review of published reports, academic papers, laws, and other publications as well as interviews with selected key program managers, consultants and researchers. After reviewing these programmatic elements for each program, a comparison across the selected international programs was conducted to identify best practices, success factors and lessons learned. Then, based on a qualitative evaluation of the actual barriers and challenges to the implementation of the CEL, we conducted a gap analysis between the CEL and international best practices to identify areas for improvement. The in-depth programmatic review and comparative analysis of each program combined with the gap analysis of the CEL program provides the foundation for specific policy recommendations for improving each programmatic element of the CEL to strengthen the program. During the course of the research, a number of workshops and reviews were held with the policymakers, government advisors, and industry experts and their feedback and suggestions were incorporated into the report. The proposed policies have been fully vetted by the Chinese government.

Overview of reviewed energy labels

AUSTRALIA ENERGY LABEL

The mandatory national Australia Energy Rating Label was implemented in 1999 to avoid a patchwork of labeling programs after three mandatory state energy labeling programs were initiated by New South Wales, Victoria and South Australia in the 1980s and 1990s. The Australian Energy Label features a star rating that gives a comparative assessment of the model's energy efficiency and an estimate of the annual energy consumption of the appliance model. The label originally featured a 1 to 5 star rating, but was recently revised to include a scale of 1 to 10 stars for some products, with increases in half increments up to 6 stars followed by full stars thereafter (Australia Energy

1. More information on the China Energy Label program can be found at: http://www.energylabel.gov.cn/en/.

2. China National Institute of Standardization (CNIS) is the technical body responsible for development MEPS in China. The CEL Center was established within CNIS to manage CEL registration and monitor use of the CEL.

Figure 1. China Energy Label, Original (left) and Revised Versions (right).

Label, 2017). Products with more than 6 stars are considered super-efficient products. The label is mandatory in all Australian states and territories and New Zealand for eight categories of products, including refrigerators, freezers, clothes washers, clothes dryers, dishwashers, air conditioners (single phase, non-ducted), televisions and computer monitors. Implementation of the label is based on manufacturer self-certification and registration, but extensive check-testing with targeted product selection for testing has been used to support monitoring and enforcement of the label.

U.S. ENERGY STAR AND ENERGYGUIDE PROGRAMS

The U.S. EnergyGuide labeling program was established by the Federal Trade Commission (FTC) in 1980 in response to legislation calling for a labeling program to improve energy efficiency and provide information to assist consumers in making purchase decisions. In 2007, following a two-year regulatory review of the program, the FTC introduced a new, streamlined EnergyGuide label that displays estimated yearly operating costs (in terms of electricity cost) in addition to energy consumption information (US FTC, 2017). The EnergyGuide label shows where a particular model falls in a spectrum of the highest and lowest energy consumption or efficiency estimates of similar appliance models, and that model's estimated yearly operating costs and energy consumption. The EnergyGuide label is required for 12 products.

The ENERGY STAR endorsement labeling program was introduced as a joint program of the U.S. Environmental Protection Agency (EPA) and the Department of Energy (DOE) in 1992 to promote products that are more efficient than the minimum energy performance standards (MEPS). The ENERGY STAR label now covers over 70 product categories for major home appliances, office equipment, lighting, data center equipment, and home electronics (US EPA, 2017). In 2011, the ENERGY STAR program launched the Most Efficient designation to recognize truly exceptional, inspirational or leading edge efficiency performance without confusing consumers or harming the ENERGY STAR brand. The Most Efficient designation targets a very small proportion of highly efficient models (e.g., the top 5 % efficient models for TVs) on the market and estimated energy savings for designated products range from 20 % to 60 %.

EU ENERGY LABEL

The EU Directive 1992/75/EEC introduced mandatory comparative energy information labeling for household refrigerators, washing machines and dryers, dishwashers, ovens, water heaters and hot water storage, lighting and air conditioners and 16 product groups are covered by the EU Energy Label today (EU Energy Label, 2017). The EU energy label ranks a product's annual efficiency relative to other similar models, originally from grade A (the most efficient) to grade G (the least efficient). Under this directive, suppliers are responsible for providing accurate technical documentation for the label's information. Member states then have to ensure suppliers fulfill their labeling obligations, prohibit other labels that do not comply with the labeling requirements or may mislead or confuse consumers and initiate educational and promotional campaigns to support the labels. In 2010, the Energy Labeling Directive was revised to include commercial and industrial equipment and the additional classes of A+, A++, A+++ were introduced for some products to distinguish amongst the highly efficient class A products that had reached a large share of the market. In July 2015, the European Commission proposed a return to the single 'A to G' label scale to make it easier for consumers to understand and compare products, but the new proposal has not been approved yet. Implementation of the EU Energy Label is done at the member state level and based on the principle of manufacturer self-declaration. Enforcement and market monitoring are carried out by member states and some countries including Denmark, Germany, Hungary, the Netherlands, Spain, Sweden and the UK have verification testing programs.

JAPAN ENERGY LABEL

In order to comply with labeling requirements set under the national Energy Conservation Law, Japan's voluntary Energy Saving Labeling Program was launched on August 21, 2000. This labelling program is linked to Japan's Top Runner standards program, which are set as the highest efficiency currently existing in the market plus consideration of the potential technological improvements for efficiency between the time of the value-setting and the target year (Japan Energy Label, 2017). Once the target year is reached and the standard is in effect, manufacturers are considered in compliance if the average efficiency of all products sold, rather than the efficiency of every product sold, can meet the target standard. For each product model, the label provides consumers with information on the applicable Top Runner target year, a particular model's achievement rate relative to the Top Runner target, and its annual energy consumption. The model also features a green "e" mark for products that achieve over 100 % of the target and an orange "e" mark for products that do not achieve the target. The 2006 Revised Law Concerning the Rational Use of Energy introduced uniform guidelines for labeling and created Japan's Uniform Energy-saving Label, which includes the voluntary energy label information but also provides a 5-star rating system for a product's efficiency and its estimated electricity bill. At the end of 2015, the Uniform Energy-saving Label covers 6 product groups while the voluntary energy saving label covers 21 product groups.

International success factors and best practices

LEGAL BASIS AND INSTITUTIONS

International experiences reveal key differences and similarities in the legal framework for labeling programs in the USA, Australia, EU and Japan. With the exception of the Australian labeling program, which was created from individual state proposals, the other three mandatory energy labeling programs were all founded with a strong legal basis in national energy conservation laws. Australia's labeling program was also formalized and centralized with the national GEMS regulation in 2012, thereby strengthening the existing program with a new legal backing. This shows that energy labeling programs have been recognized by national laws to support energy conservation and efficiency efforts, or in the case of Australia, energy as well as greenhouse gas emissions reduction. Similarly, the USA's ENERGY STAR labeling program was also established by national air quality law, the Clean Air Act. In terms of the legal basis for label implementation, U.S. and recent Australian laws clearly define regulatory agencies responsibility for implementation and enforcement. The EU differs in that it calls on member states to implement the national energy label, which has resulted in different implementation and enforcement schemes with varying levels of effectiveness.

TECHNICAL SPECIFICATION AND DEVELOPMENT

The label development processes in the four regions are very similar in that they all follow a similar process: conducting market and technological analysis to determine labelling thresholds followed by holding public comments and review periods for proposed labelling requirements. There are, however, some key differences in the responsible parties for developing labels and between the processes of the different programs. The setting of both Australia and Japan's energy label are closely linked to their respective MEPS and Top Runner target programs, and the label revisions occur when the standards are revised. (This is also true for China, where the CEL specification development and revisions are exclusively linked to its MEPS development/revision and follow the same analyses.) ENERGY STAR labeling revisions, on the other hand, occur independent of the U.S. standards revisions process and are based on guiding principles such as a high market shares qualifying for the label, or every three years for certain products. If applicable, this approach could be considered a success factor since it provides greater flexibility for label revisions to occur quickly, as label revisions can be undertaken without waiting for the minimum standards to be revised, which may take longer due to a more rigorous and often contentious process. The flexibility to revise ENERGY STAR label requirements also helps to ensure that the labels are able to adapt and accurately reflect quickly changing markets and increasing penetration of efficient models. Another success factor observed in the ENERGY STAR is its newly launched Most Efficient designation, which intends to complement the existing label but provide additional information to help certain consumers identify the top most efficient product models. This program can be particularly helpful for products where efficient models have already achieved high market shares, such as televisions and computers.

IMPLEMENTATION, VERIFICATION AND COMPLIANCE

Although implementation mechanisms such as certification and manufacturer self-declared energy reporting based on testing were included in the regulatory framework for all four international labelling programs, the extent and form of enforcement and compliance verification mechanisms differ significantly. All four regions have requirements for manufacturers to test and self-declare the energy performance of products covered by the labelling programs, while the USA and Australia also requires manufacturers to certify that their products meet the labelling requirements as part of the registration process. Japan and the EU do not have specific certification requirements, although both programs have additional reporting and documentation requirements. Australia differs in that its product registration program was historically approved and managed by local jurisdictions, although the online registration system and recent introduction of a centralized GEMS regulator have increased the centralization of certification and registration. The certification requirements observed in the USA and Australia can be considered a success factor as they put more credibility and rigor in the manufacturers' self-declared energy performance information being used in labels. Of the two certification programs, ENERGY STAR has the most rigorous requirements that include testing only in EPA accredited laboratories and certification of testing results by approved certification bodies. The use of third-party testing and certification partners help EPA guarantee the integrity of test reports without needing to dedicate significant government resources to support implementation and enforcement. The ENERGY STAR labelled products also have to undergo ongoing verification testing, including those organized by both the government (U.S. DOE) and certification bodies. These additional requirements help ensure the integrity of the program by systematically validating manufacturer self-declared information but may increase the cost of the process for manufacturers, potentially making it more difficult to include for mandatory labelling programs.

The US ENERGY STAR, Australia and EU Energy Labelling programs all feature national-level labelling display compliance surveys and verification testing to verify energy performance. Australia and some EU countries such as the UK and the Denmark have consistently undertaken verification testing of energy performance of labeled products, large-scale retailer inspections and surveys of label display compliance over long periods of time. For example, the European Commission has funded a series of programs for compliance testing, including Appliance Testing for Energy Label Evaluation (ATLETE), the first European testing project with collaborative approach, which tested 80 refrigerating appliances from 2009 to 2011; ATLETE II, which tested 50 washing machines from 2012 to 2014 in the EU (ATLETE, 2017; Krivošík and Attali, n.d); and ComplianTV, which assessed 172 TV models from 2013 to 2015 (ComplianTV, 2017; Tinetti, n.d.).

Another example is the European Energy Efficiency Compliant Products (EEpliant) project, successor of the European Eco-design Compliance Project (Ecopliant), which brings responsible national and regional authority bodies to work together in taking enforcement action for noncompliant products. EEpliant select individual products that have high risk of noncompliance within the targeted product groups. After test-

ing and compliance verification, results are shared among the responsible authorities and enforcement actions are required to be taken at the national level on noncompliant products (EEpliant, 2016)The Australian and EU programs also feature targeted selected products and two stages of testing. Australia's extensive and sophisticated verification check-testing program, in particular, can be seen as a best practice with its carefully developed product and model selection methodologies that help target products with greater risk for non-compliance and annual public reporting of test results. The noticeable improvement in compliance rates over time – despite selection methodology with greater sampling bias towards products more likely to fail – further illustrates the success and effectiveness of Australia's check-testing program.

The consistency of check-testing over time observed in Australia and some EU countries such as Denmark and the Netherlands is also an important success factor as it clearly signals to manufacturers the importance placed by regulators on compliance. The U.S. ENERGY STAR pilot check-testing is relatively new, but includes similar feature as the Australian and EU programs including targeted selected and two stages of testing[3]. Japan conducts periodic retail inspections and very limited check-testing, but relies mostly on informal enforcement mechanisms such as a public "name and shame" approach to deter manufacturers from non-compliance.

ENFORCEMENT AND PENALTIES

Inspection and verification testing is generally supported by enforcement instruments such as financial or legal sanctions. For the mandatory energy labelling programs, civil penalties or sanctions for non-compliance of varying magnitudes have been issued. But because fines often require costly legal and administrative action, alternative penalties have included publicly shaming non-compliant manufacturers by publicizing their failures and issuing orders for corrective action. As a voluntary label, the penalty for ENERGY STAR non-compliance is disqualification from the program with potential for legal action against trademark violation if manufacturers refuse to cease use of the label. The availability and use of these financial and legal sanctions help support enforcement by providing a deterrence to non-compliance for manufacturers.

FINANCIAL AND HUMAN RESOURCES

Different levels of available information on budget availability and constraints as well as different scope and responsibilities make it difficult to directly compare national or regional standards and labelling programs, but some broad similarities and differences can be noted. Despite differing scopes, most of the programmatic budgets for the labelling programs were in the range of USD $2 million (Japan) to over USD $20 million (ENERGY STAR) per year, assuming 2014 currency exchange rates (ASE, 2013). The lowest funded program internationally was the U.S. EnergyGuide label, which received only $215,000 in 2011 (U.S. GAO, 2013), and information was not available for the total labeling budget for EU member states. This shows that a specified national budget is a key success factor for a robust and effective labeling program as it provides the resources needed to support label development and implementation.

Another important success factor is a designated budget for monitoring and enforcement, which specifically exists to ensure that labels are effectively implemented, since the full energy and environmental benefits of labels can only be realized through full compliance. Both Australia and some EU member states have designated budgets for monitoring and enforcement, which ranged from a high of nearly USD$1 million in Australia to less than 50,000 Euros in some EU member states (Ellis and Pilven 2010; Waide et al. 2011). Some EU member states such as Belgium and Portugal, have sizeable market surveillance staff and field inspectors. Of all the programs, Australia appears to have the most robust compliance budget with growing funding allocation to support verification testing and a team of 15 staff (Ellis 2011). Australia is unique in that its programmatic budget is divided between the Commonwealth of Australia and its state and territories, with states and territories contributing as much as 25 % of the programmatic budget. In contrast, the European Commission does not provide systematic financial support for the energy label program with the primary enforcement responsibilities laying with member states, although EU funding has been provided on EU-wide compliance and verification projects as previously discussed. This is different from the U.S. ENERGY STAR program, which is funded and administered entirely by the federal government, with some states playing minor roles in administering complementary or supplementary programs such as promotional and customer awareness campaigns, ENERGY STAR program rebates and testing. The existence of local support – either monetary or through other mechanisms (e.g., marketing) – helps bolster the national financial and human resources dedicated to label implementation and enforcement.

Energy efficiency labels inherently have economic externalities given their environmental and economic benefits to the public, and therefore often receive financial resources from governments in developed economies to support standards and labelling development and implementation. Australia and the U.S. ENERGY STAR program are two prominent examples, both of which have substantial labelling program budgets and in Australia's case, a designated budget for enforcement.

TECHNICAL CAPACITY

The technical capacity supporting the four regional labeling programs includes the development of test procedures and specifying testing laboratory requirements. While test procedures and methods found in the four selected countries and region vary in their degrees of international harmonization, a common guiding principle that has emerged over time is that test procedures should be harmonized to the extent possible while still reflecting national conditions and actual usage. This can be considered a success factor since harmonized test procedures can help facilitate information sharing and knowledge transfer between countries with the same test procedure, makes it easier to compare product performance on an international level, and reduce costs for manufacturers operating in more than one market (Nadel, 1997; Turiel, 1999; Wiel and McMahon, 2003; Mahlia and R. Saidur, 2010). For accrediting testing laboratories, the ENERGY STAR program has the most rigor-

3. There are usually two stages of testing: screening tests, which are preliminary assessments of products likely to fail a full verification test, and full verification tests, which are carried out in support of subsequent enforcement action (Carreño, 2015).

ous requirements for accreditation, followed by Australia with a preference but not requirement for nationally accredited labs. The EU and Japan do not have laboratory accreditation process or requirements, although Japan uses industry associations' accredited laboratories to conduct its limited verification testing. Rigorous accreditation requirements are a success factor because they help ensure the quality and capabilities of testing laboratories, thereby validating the energy performance test results of products to be labelled.

INFORMATION SHARING

In terms of information sharing, both the US EnergyGuide, US ENERGY STAR and Australian Energy Label use a centralized national certification database to compile and share information on which products qualify for the label and their energy performance levels. Systematic information sharing on tested compliance levels is also built into the ENERGY STAR third-party certification bodies' relationship with the EPA. Japan also publishes participating models of both the Top Runner and Uniform Energy-saving Labelling programs and their energy performance information online. The EU Labelling Directive requires information sharing between national surveillance authorities, and this has been demonstrated in practice recently between Sweden and Denmark, as well as promoted through a common database covering several key regulations and planned registration database of all energy labelled products.

These experiences show that there are different successful methods of information sharing, ranging from centralized databases to informal collaboration and information exchanges between regions. They also highlight the importance of sharing label compliance results with the public, since public access to compliance information help incentivize manufacturers to comply with labelling requirements and naming and shaming has proven to be an effective deterrent to non-compliance.

PROGRAM EVALUATION

The ENERGY STAR program stands out as having conducted the most consistent program evaluations over time, with annual surveys on labelling awareness and influence since 2001 and regular bottom-up modelling of annual energy savings for ENERGY STAR products. Australia and the EU have also conducted program evaluations including market impact analyses and bottom-up modelling of energy savings, but these were done as major one-time projects rather than on a consistent basis. Instead of comprehensive program evaluations, the primary method for evaluating the Top Runner program has been to track changes in the sales-weighted efficiency of all products and comparing the actual efficiency improvement achieved with the original Top Runner target.

Consistent evaluation is an important success factor for monitoring and improving labelling programs as they not only help quantify the actual benefits achieved by the labelling program, but also provide continual feedback on programmatic weaknesses and areas for improvement. Similarly, program evaluations which compare projected energy and environmental impacts before label implementation and the actual impacts realized after implementation is another important success factor. The comparison of predicted and actual impacts helps inform the label's overall effectiveness in achieving its intended goals and identifies the need for change if goals are not met.

STAKEHOLDER PARTICIPATION AND INVOLVEMENT

In all regions considered in this paper except China, stakeholders are invited to participate in the different stages of the label development process include industry/manufacturers, academic experts and consultants, trade associations, environmental and consumer advocates, and various levels of government officials. From the experiences of the U.S.A, Australia, EU and Japan, the two key forms of stakeholder involvement and public participation are

- formal membership in committees and forums that inform the standard setting and regulatory decision-making processes and
- participation in informal stakeholder meetings or comment periods.

All four of these regions are required to offer at least one open comment period for stakeholder input to the formulation of standards and labelling requirements, with Japan, EU and Australia offering public comment periods after an initial proposal or preparatory study for a standard is released in addition. The U.S. ENERGY STAR program – and the Japanese Top Runner program to a lesser extent - is unique in formally involving stakeholders such as industry associations and third-party certification bodies in its label implementation and enforcement process.

China gap analysis

Based on a collaborative effort with CNIS, a detailed analysis of existing barriers and challenges in the CEL program is provided in a complementary paper, Li et al. 2015, and the key findings from that paper are summarized below to provide context for existing barriers in the CEL program and remaining areas for improvement.

Legal basis and institutions: the CEL has a strong legal basis in several national laws, but these laws are outdated and do not reflect rapid changes in the market, technologies or the CEL program. The legal foundation also lack specific guidance and requirements for label development, implementation and enforcement, and divide enforcement and supervision responsibilities between multiple agencies, making coordination difficult.

Label technical specification and development: China links its label specification process exclusively to its mandatory standards development, which limits the flexibility for revisions. Analyses conducted for standards and labelling are also more limited due to resource constraints.

Enforcement and penalties: Label enforcement responsibilities lie with the administrative departments responsible for overall product quality supervision and management, which are focused more on long-term planning and priorities. Local governments conduct market surveillance activities, but efforts have historically been limited due to budget constraints and a focus on product safety, with very low penalties for non-compliance and lack of national guidance or requirements for market surveillance. This has resulted in inconsistent national product inspections and testing, large variations in compliance and no ongoing verification testing.

Financial and human resources: China has over 20 staff members working on the CEL program but lacks a consist-

ent national designated budget from the state. Severe budget constraints have resulted in limited public awareness, absence of consistent market surveillance activities and uneven local enforcement. Local enforcement agencies also lack funds to conduct testing.

Technical capacity: The majority of China's test procedures are harmonized to international standards and China has developed strict lab qualification controls, but faces a much larger volume of registered test labs (over 500 registered manufacture testing labs and nearly 300 third-party testing labs) than other countries and limited resources for conducting on-site inspections and round robin testing.

Information sharing: The CEL website publishes manufacturer reported energy performance results, which are accessible to consumers, but lacks a unified information collection and sharing system for check-testing results among different provinces and cities.

Program evaluation: The CEL lacked systematic program evaluation in its earlier years. It is beginning to conduct consumer awareness survey and modelling to roughly estimate the program's impacts and benefits but still faces limited capacity and resources for further evaluation.

Stakeholder Participation and involvement: China currently does not actively involve different types of stakeholders in its label development and implementation process, with participation largely limited to manufacturers and some industry associations. The lack of involvement of a wide range of stakeholders in either a formal or informal manner hampers public awareness. Low acceptance of the labelling program remains a barrier. Given China's presently limited resources and capacity for enforcement, not involving stakeholders such as third-party laboratory accreditation bodies in the implementation and enforcement process also represents a missed opportunity in tapping into additional technical capacity and resources.

Policy recommendations based on international experiences

Based on comparative analysis of the success factors and best practices identified from the experiences of Australia, the U.S., the EU and Japan as well as the current barriers and gaps remaining in the CEL program, key areas for improvement and specific policy recommendations are outlined below.

LEGAL BASIS AND INSTITUTIONS

The CEL Management Law which was revised and went into effect on June 1, 2016 address the issues with outdated laws and regulations related to the CEL. The revised law includes new language intended to help strengthen CEL and MEPS supervision and compliance oversight. It also introduced the addition of the QR code and launch of a comprehensive platform for consumers to access information related to a specific product and available results on compliance. Further linking the revised or new law or policy to recent air quality laws and policies could provide a stronger legal foundation for ensuring compliance, and including broader stakeholder participation in the label setting and implementation process could also help build greater market acceptance and thus a higher degree of compliance.

TECHNICAL SPECIFICATION AND DEVELOPMENT

Although China has continually improved the underlying technical and economic analyses supporting its development of MEPS levels and label thresholds, these analyses are often still relatively limited in scope and rigor due to human and financial resource constraints. As a result, more budget, funding and training need to be provided to help CNIS refine the technical analyses conducted to support MEPS and energy label development and revisions, especially in manufacturer impact, employment and environmental impacts analyses. As part of this capability building, resources could also be dedicated to establishing fundamental data collection channels and incorporating international exchanges and collaboration in supporting the development of technical specifications for MEPS and labelling requirements.

Given the benefits that a decoupled MEPS development and ENERGY STAR label development have demonstrated in the U.S., China may also want to consider changing its regulatory framework to separate its MEPS and label efficiency requirement setting processes. This greater flexibility and shorter turnaround time for label revisions would be especially beneficial to ensuring that the label efficiency grades are appropriate and representative of the market for products with rapid turnovers, such as consumer electronics. Moreover, adding average cost savings data to the label may also make it more influential to consumers' purchase decision-making process.

IMPLEMENTATION, VERIFICATION AND COMPLIANCE

In terms of label implementation, China has already adopted some of the success factors identified including a rigorous product label registration process before market distribution and additional registration and verification requirements for testing laboratories. In addition to testing laboratory registration and screening, China could go a step further in validating the laboratory test results and information shown on the China Energy Label by adopting a mandatory third-party certification process similar to that of ENERGY STAR's. This third-party certification process can ensure that laboratory data matches the product specification or information being shown on the label by independently certifying that the label information is accurate and consistent with actual test results. This process, run by accredited certification bodies, could then further improve the compliance rates for China's standards and labelling programs before products go to retail stores, reducing the need for market surveillance. An additional verification process could be standardized for random or targeted check-testing of products by third-party certification bodies, as is currently required under the ENERGY STAR process. Implementing a third-party certification process could not only reduce the burden and necessity of testing laboratory oversight for CNIS while increasing the reliability of manufacturer self-reported energy performance information, but could also strengthen enforcement and compliance, with complementary verification testing done by certification bodies. In addition, current regulations could also be improved to provide a stronger legal basis for improving the quality and capabilities of testing laboratories. This could be done by requiring national round-robin testing, and specifying fines and penalties (including revocation of laboratory registration) for testing laboratories that provide false or inaccurate testing reports.

Another policy recommendation for improving the China Energy Label implementation is to develop comprehensive recognition and marketing programs for promoting the label, such as the manufacturer and retailer awards program for U.S. ENERGY STAR and the Nordic Swan label[4]. Developing a comprehensive manufacturer and retailer recognition program could provide many benefits to implementation of the China Energy Label, and setting aside a specific budget and allocating sufficient financial and human resources to develop and implement a systematic communications and awareness framework is needed.

Given China's disjointed institutional framework for enforcement and lack of coordination between different levels of government for enforcement activities related to the China Energy Label program (national General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (AQSIQ) departments, the local quality supervisory departments and the China Energy Label Center in CNIS), a more structured framework is needed to improve coordination and provide clearer division of responsibilities between them. One possible method for providing this structure is to develop a policy document that clearly identifies the different responsibilities and the lead versus supporting roles for each institution. This was demonstrated by the recent U.S. MOU signed between EPA and DOE for the ENERGY STAR program, setting a clear framework could eliminate duplicative efforts and improve the overall effectiveness of the labelling program (US EPA, 2016). At the national level, more consistent and systematic enforcement activities such as a national check-testing program with targeted testing are also needed to bolster compliance verification.

At the local level, more training and capacity building are needed in order to raise the awareness and compliance verification and enforcement capabilities of local product quality supervisory departments, particularly in less developed regions where non-compliance has been a greater challenge. This could be done by promoting information sharing and training within national government institutions like CNIS, and supporting and promoting collaboration between regions on developing and enhancing the capacities for conducting local check-testing. For example, the pilot provinces that have participated in the pilot check-testing program organized by CNIS could serve as role models and trainers for other provinces that have not had any experiences with conducting check-testing.

ENFORCEMENT AND PENALTIES

The revised 2016 China Energy Label law included new language to strengthen responsibilities of compliance oversight and sanctions. However, the legal and financial sanctions for non-compliance could be further strengthened in terms of severity in existing regulations, as well as in practice.

FINANCIAL AND HUMAN RESOURCES

Nearly all of the policy recommendations for improvements to the other labelling program components discussed also need additional resources to be carried out and implemented. For example, on the label development and management side, more resources are needed to help build and enhance human and technical capacities, strengthen the technical basis for the label development process, and to increase marketing and public awareness efforts. This suggests that consistent funding is needed to support the continuous growth and maintenance of the CEL program. On the program implementation and enforcement side, a designated annual budget to specifically support national enforcement efforts by the AQSIQ such as a regular, annual national verification check-testing program is needed. This budget could be used to support the improvements that are needed in the label implementation and enforcement as discussed in previous sections. In addition to the national budget, financial resources also need to be allocated to local quality supervisory departments to support local check-testing and enforcement. Sufficient resources for enforcement at the local level will help deter local governments from only collecting fines to generate income and ensure that non-compliant products are taken off the market.

TECHNICAL CAPACITY

Learning from international experiences, China has taken steps to bolster the management and oversight of energy efficiency testing laboratories to ensure that the lab results are accurate. However, the large number of registered testing laboratories suggest that there continues to be a need for greater emphasis on on-site inspections and round-robin testing to verify lab testing capabilities. Given the limited resources, targeted selection and possibly tapping into resources from the existing national laboratory accreditation process could help.

INFORMATION SHARING

The fragmented institutional framework for label registration and enforcement makes information sharing much more critical in China. In order to maximize the usefulness of the energy label information to consumers and improve consumer trust, information about a product's claimed energy performance and label efficiency rating and check-testing results should be made publicly available in the same location or at least, provide links from one website to another. Records of market surveillance and verification (e.g., check-testing) efforts could be made publicly available to make stakeholders more aware of the range and frequency of enforcement activities and to highlight the risks of non-compliance. The highest authorities of CEL and market surveillance could take the lead in building a platform for information sharing, focusing especially on label compliance information, with CNIS's input and support. The platform for information sharing could include information sharing between the different regulatory agencies well as to facilitate communication and information sharing with external parties such as manufacturers, testing laboratories, retailers, consumers and other stakeholders. The CEL website could provide a good basis for the development of this centralized platform. There also needs to be greater policy emphasis through policy directives or formal meetings and workshops for instance, on promoting both formal and informal collaboration and information sharing between the different market surveillance institutions and enforcement efforts.

4. Another voluntary eco-product endorsement label that includes energy efficiency amongst the criteria for product qualification used in the Nordic countries.

PROGRAM EVALUATION

Program evaluations can provide important feedback on the CEL both from a process and impact perspective. The U.S. ENERGY STAR's consistent program evaluation conducted over time, including on consumer awareness, provide important metrics for measuring the program's success and for estimating the program's impact. Because program evaluation is still relatively new to China, promoting formal and informal collaboration and information sharing across institutions and regions, and beginning conducting retrospective program evaluations by learning and building capacities in advanced modelling and evaluation methodologies could be a good starting point for building up more regular program evaluations for the CEL.

STAKEHOLDER PARTICIPATION AND INVOLVEMENT

Expanding participation to more stakeholders in the label development and implementation process could help ensure there is not only broad awareness and understanding of China's Energy Label program amongst local regulatory agencies, manufacturers and industrial partners, retailers, and consumers, but also continuous support and feedback to the programs. This could be done by expanding the technical committees involved in developing MEPS and labelling efficiency requirements to more stakeholders including non-government organizations, environmental and consumer groups, or holding regular workshops and stakeholder comment periods to enable broad stakeholder participation and involvement. For example, the Nordic Swan label has become one of the most recognized labels in Scandinavia as a result of its successful marketing strategies as well as collaboration with stakeholders and interest groups to promote label by raising the overall budget for marketing activities, broadening the marketing approach with many different messengers, and by improving the creditability of the marketing activities with multiple stakeholders involved (Nordic Ecolabel, 2012). Although label recognition may be easier for an endorsement label, the strategies of stakeholder involvement can nevertheless apply to raising awareness and understanding of mandatory energy information labels as well.

Conclusions

The international technical review of the Australian, U.S., EU and Japanese energy labelling programs illustrate that while no single country represents best practice in all programmatic elements, there are many region-specific examples of success factors as well as common themes that prevail across programs. While all four regions' programs conduct similar types of analyses to determine the technical specifications for different product labels, the U.S. ENERGY STAR program as a voluntary endorsement label provides added flexibility in more frequent updates to reflect rapid market changes and even introduced a new Most Efficient designation to further distinguish the most efficient products. Similarly, all four regions' programs use manufacturer self-certification as the primary means of implementation but varying degrees of validation and market supervision through regular or one-time verification check-testing exist across the programs.

After ten years of experience, China's CEL program has expanded and evolved and already begun to address barriers and concerns that have emerged. For example, the CEL Management Law was revised in 2016 to strengthen supervision responsibilities and redesign of the CEL has enabled new information sharing through the use of the QR code. Nevertheless, there are still fundamental challenges such as insufficient resources and lack of stakeholder participation, technical capacity limitations, and persistent enforcement and compliance issues that can be addressed by tailoring international success factors to China's specific conditions. Based on the international experience and identified success factors, some specific policy recommendations for further improving the CEL program include:

- Considering expanding stakeholder involvement for broader support.
- Providing more budget, funding and training to expand data collection and strengthen current technical analyses and consider separating MEPS and labelling requirements for greater flexibility in updates.
- Considering introducing mandatory third-party certification of CEL test reports and conducting additional third-party verification testing.
- Conducting more consistent national check-testing with targeted sampling as well as additional training and capacity building at local levels.
- Placing greater emphasis on on-site inspections and round-robin testing to verify lab testing capabilities, possibly with targeted selection.
- Providing public access to market surveillance results, ideally in a centralized platform.
- Promoting formal and informal collaboration and information sharing across institutions and regions, and begin conducting retrospective program evaluations through capacity-building.

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