Driving market transformation and international collaboration through the super-efficient equipment and appliance deployment (SEAD) initiative

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Abstract

The Super-efficient Equipment and Appliance Deployment (SEAD) initiative facilitates collaboration, coordination, and information sharing on appliance and equipment energy efficiency policies and programs among sixteen participating governments to accelerate our transition to a clean energy future. Using the Bottom-Up Energy Analysis System (BUENAS) developed by Lawrence Berkeley National Laboratory in collaboration with the Collaborative Labeling and Appliance Standards Program (CLASP), we show that SEAD activities cover end-uses representing approximately 50 % of the estimated technical potential energy savings in the residential sector and 77 % of the technical potential energy savings in the industrial and commercial sectors. We describe how SEAD partners are working together to achieve these potential savings through activities designed to: (1) "raise the efficiency ceiling" by pulling super-efficient appliances and equipment into the market through cooperation on measures like awards, procurement, and incentives; (2) "raise the efficiency floor" by working together to bolster national or regional policies like minimum efficiency standards and labeling programs; and (3) "strengthen the foundations" of programs through coordinated cross-cutting technical analysis work to support these activities. Thirteen standards or policies that directly advance the energy efficiency of lighting, televisions, and ceiling fans have either been adopted or proposed as a direct result of the SEAD initiative and the peer-to-peer exchange fostered by the Clean Energy Ministerial.

Introduction

Adopting smart energy efficiency policies is an essential strategy for achieving a sustainable future. At the First Clean Energy Ministerial (CEM) in Washington, DC in July 2010, energy ministers from fourteen major economies pledged to join efforts to dramatically improve the energy efficiency of appliances and equipment – cutting energy waste, creating jobs, reducing pollution, and saving money for consumers around the world. The fourteen ministers plus two additional ministers renewed their pledge to work together and with the private sector to accelerate the global pace of progress on improving the energy efficiency of equipment and appliances at the Third CEM in London in April 2012.

The Super-efficient Equipment and Appliance Deployment (SEAD) initiative is the result of this pledge: a five-year, US$20 M initiative under the CEM and also a task group under the International Partnership for Energy Efficiency Cooperation (IPEEC). SEAD fosters collaboration among its 16 participating governments to strengthen their standards and labeling programs to more quickly keep pace with technology innovation, as well as work together on incentives, prizes and procurement programs that can spur the development of super-efficient devices. Information on SEAD activities and resources are available at www.superefficient.org.

SEAD is a multilateral, voluntary effort among Australia, Brazil, Canada, the European Commission, France, Germany, India, Japan, South Korea, Mexico, Russia, South Africa, Sweden, the United Arab Emirates, the United Kingdom, and the United States. SEAD participating governments account for over 60 % of global primary energy demand. The Collaborative Labeling and Appliance Standards Program (CLASP) is the operating agent. Lawrence Berkeley National Laboratory (LBNL) provides technical analysis.

SEAD has collaborative relationships with the International Energy Agency (IEA) Efficient Electrical End-use Equipment (4E) Implementing Agreement and its annexes, the United Nations Secretary General's Sustainable Energy For All initiative, and the Asia Pacific Economic Cooperation (APEC) Expert Group on Energy Efficiency and Conservation. SEAD also is partnering with the United Nations Environment Program (UNEP) en.lighten initiative.

Employing current best practices in the 16 participating SEAD economies could by 2030 reduce annual electricity demand by over 1,900 billion kilowatthours (TWh), equivalent to electricity delivered by 650 mid-sized power plants, and annual fuel demand by 65 million tonnes of oil equivalent. These measures would decrease carbon dioxide emissions over the next two decades by 12 billion tonnes. These results would account for 50 % of the reductions in global electricity consumption in the buildings sectors called for in the IEA's World Energy Outlook 450 Scenario (IEA, 2012).

Since SEAD's launch in 2010, participating governments have implemented, issued, or begun development of efficiency requirements that are sufficient to achieve more than one-fourth of this estimated electricity savings potential, 16 % of the projected fuel savings potential, and 40 % of potential cumulative CO_2 emissions reductions (about 4 billion tonnes). Credit for most of these savings goes to national and regional programs, for example Ecodesign in Europe, Top Runner in Japan, and minimum standards adopted by national programs in other SEAD participating governments. However, several policies have been adopted or strengthened as a direct result of the information exchange, analysis, and activities supported by SEAD. These include India's becoming the first country in the world to comprehensively regulate the performance, safety, and quality of light-emitting diodes (LEDs). The newly published standards will help ensure quality and avoid market-spoiling effects from poorly performing products in this critical global market for highly efficient lighting. As described below and in Ravi et al. (2013), India added LED televisions to the top category of their 5-star energy efficiency ratings and is increasing the overall stringency of the star rating criteria for color televisions as a result of their participation in the first SEAD Global Efficiency Medals, which recognized the world's most energy-efficient televisions. In addition, based on SEAD analysis, Korea revised its television efficiency standards to be the most stringent in the world.

Accelerating Progress through International Cooperation

The sixteen governments participating in SEAD recognize the value of promoting energy efficiency as part of a strategy to "bend the curve" of growing global energy demand while improving energy access, reducing pollution and reducing energy costs for consumers and governments. Most of the energy growth in the buildings sector is occurring in emerging and developing economies. According to the International Energy Agency's 2012 World Energy Outlook (IEA, 2012), energy consumption in the buildings sector in non-OECD countries was 32 % greater than for OECD countries in 2010, and expected to grow at 1.8 % compound annual average rate over 2010–2035 in the current policies scenario, which is twice the projected growth rate for the OECD. Household surveys for emerging and developing economies show a clear S-shaped ownership curve for refrigerators (Wolfram et al., 2012). As household incomes increase, so will first-time purchases of refrigerators, TVs, etc. For these first-time buyers, the price elasticity of product purchases is low, and hence the direct rebound is expected to be small. Indirect rebound effects may be large, especially if there is significant unmet demand for energy services (e.g., Roy, 2000). For comparison, analysis of energy efficiency rebound for appliances in developed countries has been found to be on the order of 10 to 30 % (Davis, 2008; Sorrell et al., 2009).

SEAD facilitates collaboration, coordination, and information sharing on appliance and equipment energy efficiency policies and programs among participating governments. If there are beneficial standards and labeling policies and programs that are not being implemented either due to a lack of information or resources, then an initiative like SEAD can help. Indeed, empirical evidence suggests the existence of an "efficiency gap" resulting from market failures and behavioral anomalies that could be addressed by energy efficiency policies (Gillingham and Palmer, 2013). As described below, SEAD activities include both regulatory mechanisms and market-based mechanisms, such as incentives, awards, and procurement, to address these market failures.

One of the first activities undertaken by the SEAD initiative was an assessment of the savings potential of efficiency policies and programs at a global scale. SEAD used the Bottom-Up Energy Analysis System (BUENAS) policy impact assessment model for this work (McNeil et al., 2012). This assessment determined that there is likely to be as much as US$1 trillion in net financial savings globally (energy savings less equipment cost increases), establishing that even small efforts at addressing resource and information barriers in ways that can accelerate adoption of best-practice efficiency policies and programs could be highly beneficial (Letschert et al., 2012b). Given this potential, SEAD has been focusing on facilitating communication between key policy and program development practitioners in participating governments. This communication has helped facilitate information sharing, the demonstration and evaluation of program best practices, and it has supported several efforts to enable greater international comparability, transparency, inter-operability and exchange of test methods, product standards, and product efficiency performance ratings data. All of these activities should make it cheaper and easier for more countries to implement those best-practice efficiency policies and programs that are appropriate to their national, social and economic conditions.

But making it cheaper and easier to implement standards, labeling and efficiency promotion programs may not be the biggest impact that SEAD may have over the long term. To the extent that global harmonization of test procedures, metrics, and levels as appropriate, and trade of efficient product technologies helps build global markets for high efficiency technologies, SEAD may help accelerate technological learning and innovation rates for energy efficient products and technologies in global markets.

To the extent that efficient products become more affordable because of technological learning, then an increase in the global market share of more efficient products during the early stages of their market introduction can further accelerate affordability.

Because technological learning is directly related to cumulative experience (which is usually measured by cumulative product sales; Desroches et al. 2013), any acceleration in global market adoption of high efficiency products should result in a proportional decrease in the time it takes for the product to become affordable to a larger population of global consumers.

This dynamic can be active even when different countries are operating under different economic conditions. Because of technological learning, when countries with high energy prices adopt high efficiency products first, their production and sale allows their price to drop due to "learning-by-doing." If prices drop sufficiently, then the efficient products become affordable and economical in countries with lower prices of electricity, with a lag equal to the time necessary for technological learning to achieve the necessary price decrease. This creates a virtuous cycle of adoption, technological learning and further adoption that can continue from one economy to the next. To the extent this dynamic can be instigated through international trade and policy collaboration facilitated by an initiative like SEAD, consumers in nearly all economies can benefit.

Potential Savings

BUENAS OVERVIEW

We use the Bottom-Up Energy Analysis System (BUENAS) developed at LBNL with support from CLASP and the U.S. Department of Energy (U.S. DOE) to calculate the national energy savings and carbon emission reductions that would be possible under different policy scenarios. BUENAS is a multi-appliance (Table 1) stock accounting energy demand model for which several scenarios have been developed (McNeil et al., 2008, 2012; Letschert et al., 2012a, 2012b). BUENAS models multiple end uses in the residential, commercial and industrial sectors at the same time, allowing for comparison among them. BUENAS includes demand scenarios for all SEAD participating governments, and has also been adapted for some non-SEAD countries and regions.

Energy demand and emission are calculated for each of five scenarios:

1. Business As Usual Scenario (BAU): Projects growth in energy demand as a function of activity (appliance ownership rates, industrial production and commercial floor area) and intensity (annual unit energy consumption).
2. Recent Achievements Scenario (RA): Includes unit energy savings resulting from Standards and Labeling programs recently implemented by SEAD participating governments.
3. Best Practice Scenario (BP): Includes a hypothetical standard in 2015 based on current most stringent standards globally or regionally, as well as an update to higher efficiency in 2020.
4. Best Available Technology Scenario (BAT): Models a 2015 minimum energy performance standard (MEPS) based on highest-efficiency technologies currently available, or which could be constructed from currently available components.
5. Cost-Effective Potential Scenario (CEP): Uses cost vs. efficiency curves in the Global Energy-Efficiency Cost (GEEC) database (McNeil and Bojda, 2012) to construct a 2015 MEPS corresponding to the maximum efficiency improvement found to be cost-effective from a consumer perspective.

Impacts of potential efficiency improvement are calculated by comparing each high-efficiency scenario to the Business As Usual scenario. The major impacts modeled are:

- National Energy Savings – Projected energy savings in each year over the forecast period allows for prioritization of target appliances and evaluation of overall program impacts, both ex-ante and ex-post. Greenhouse gas mitigation is closely related to NES, and also provided by BUENAS.
- National Financial Impacts – National net present value (NPV) of financial impacts, when available, represent one form of the 'bottom line' of program benefits and provide a concrete way to value policy efforts.
- Peak Load Impacts (in development) – In environments where power system capacity is strained and capital resources are scarce, peak load impacts can be at least as important as overall energy savings.

The Recent Achievements, Cost-Effective Potential, and Best Available Technology scenarios are compared in a companion paper (Letschert et al., 2013). For the purposes of this paper, we focus on the Best Available Technology scenario to capture the full energy savings potential for each end use across SEAD economies, including savings that are not cost-effective today, but may still be targeted by labeling, incentives, and awards programs.

BUSINESS AS USUAL (BAU) SCENARIO

The Business As Usual (BAU) scenario is described fully in McNeil et al. (2012). Briefly, the BAU scenario projects the growth in energy demand as a function of growth in both activity and intensity. Activity is defined as the overall level of energy services provided driven by residential appliance ownership rates, commercial floor area and end-use intensity or industrial activity. Intensity is the level of energy service provided per unit of equipment, per unit floor area or per unit of industrial output. Activity and intensity projections are assumed equal for all scenarios, which implies that scenarios differ only by the efficiency of products – changes in stock of equipment and usage patterns are not included as effects of policy.

In addition to growth in activity and intensity, the BAU case also includes a specific assumption of efficiency performance for each end use in each economy. By default the BUENAS BAU case assumes "frozen efficiency" from 2010 forward. This means that while usage may evolve over time, the efficiency of new products remains constant. Exceptions to this arise when projections are available that include "market-driven" efficiency improvements, which are then included in BUENAS. The assumption of frozen efficiency is a consequence of the absence of systematic estimates of market-driven improvement by end use.

BEST AVAILABLE TECHNOLOGY (BAT) SCENARIO

The total technical potential for energy savings can be estimated assuming adoption of the most efficient products, or combination thereof, that are commercially available. The BAT scenario

Table 1. Comparison of end-use and regional scope of the BUENAS BAU and BAT Scenarios.

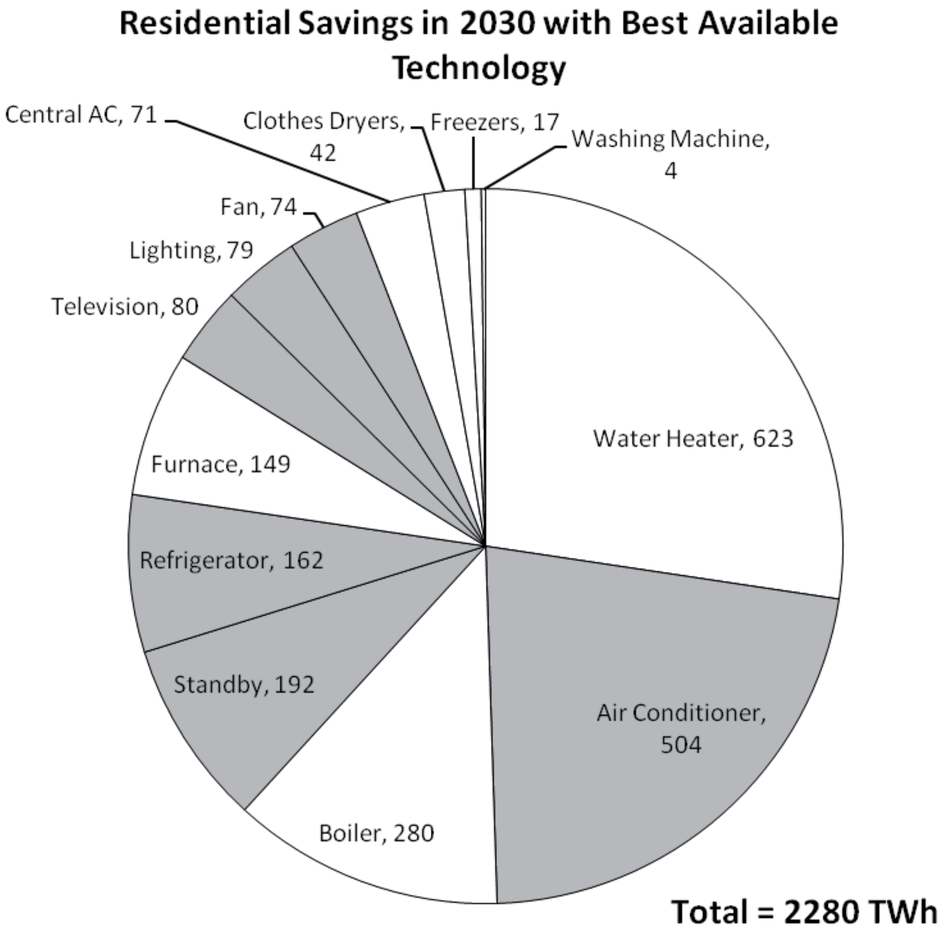
	Appliance	AUS	BRA	CAN	EU	IND	JPN	KOR	MEX	RUS	USA	ZAF
Residential	Air Conditioner	X	X	X	X	X	X	X	X	X	X	X
	Central AC	X		X					X		X	
	Cooking Equip.											
	Fans	X	X	X	X	X	X	X	X	X	X	X
	Laundry				X			X	X			
	Lighting	X	X	X	X	X	X	X	X	X	X	X
	Freezers				X						X	
	Refrigerators	X	X	X	X	X	X	X	X	X	X	X
	Boilers			X	X						X	
	Furnaces			X							X	
	Space Heating											
	Standby Power	X	X	X	X	X	X	X	X	X	X	X
	Televisions	X	X	X	X	X	X	X	X	X	X	X
	Water Heaters	X		X	X				X		X	
Industrial	Distribution Transformers			X		X					X	
	Electric Motors	X	X	X	X	X	X	X	X	X	X	X
Commercial	Lighting	X	X	X	X	X	X	X	X	X	X	X
	Space Cooling	X	X	X	X	X	X	X	X	X	X	X
	Refrigeration	X	X	X	X	X	X	X	X	X	X	X
	Commercial AC						X					
	Commercial Clothes Washers										X	
	Space Heating										X	

Shaded cells = regions covered in BAU scenario; X = regions covered in BAT scenario; AC = air conditioning; AUS = Australia; BRA = Brazil; CAN = Canada; EU = European Union; IND = India; JPN = Japan; KOR = South Korea; MEX = Mexico; RUS = Russia; USA = United States of America; ZAF = South Africa. The United Arab Emirates participate in SEAD, but have not yet been incorporated into the BUENAS model.

efficiency targets represent the maximum achievable energy-efficient designs, based on emerging technologies that are commercialized (or will be soon) but have a small market share, or designs that combine the most efficient currently available components (Letschert et al., 2012a). In cases where neither of these options is available, the analysis uses an aggressive target from an existing efficiency program. BAT targets exclude promising technologies that are in development but are several years away from commercialization. In addition, large-scale production of products or technologies that meet the BAT targets must be feasible by 2015. BAT targets are determined according to the above criteria using a variety of sources, including: technical analysis studies performed by LBNL in support of the SEAD initiative, the *Max Tech and Beyond* study (Desroches and Garbesi, 2011), technical support documents (TSDs) developed for the U.S. DOE standards programs, preparatory studies from the European Commission Ecodesign program, and the Japanese Top Runner program's target definitions.

Coverage of End-uses by SEAD Activities

Governments participating in SEAD work together to create and exchange knowledge, develop tools, and engage in activities to drive our transition to a clean energy future through appliance and equipment efficiency. As shown in Figure 1, SEAD activities cover end-uses representing approximately 50 % of the estimated technical potential in the residential sector and 77 % of the technical potential calculated for the industrial and commercial sectors. To tap this potential, SEAD partners are working together in activities designed to: (1) "raise the efficiency ceiling" by pulling super-efficient appliances and equipment into the market through cooperation on measures like **awards**, **procurement**, and **incentives**; (2) "raise the efficiency floor" by working together to bolster national or regional policies like minimum efficiency **standards and labeling** programs; and (3) "strengthen the foundations" of programs through coordinated **cross-cutting technical analysis** work to support these activities.



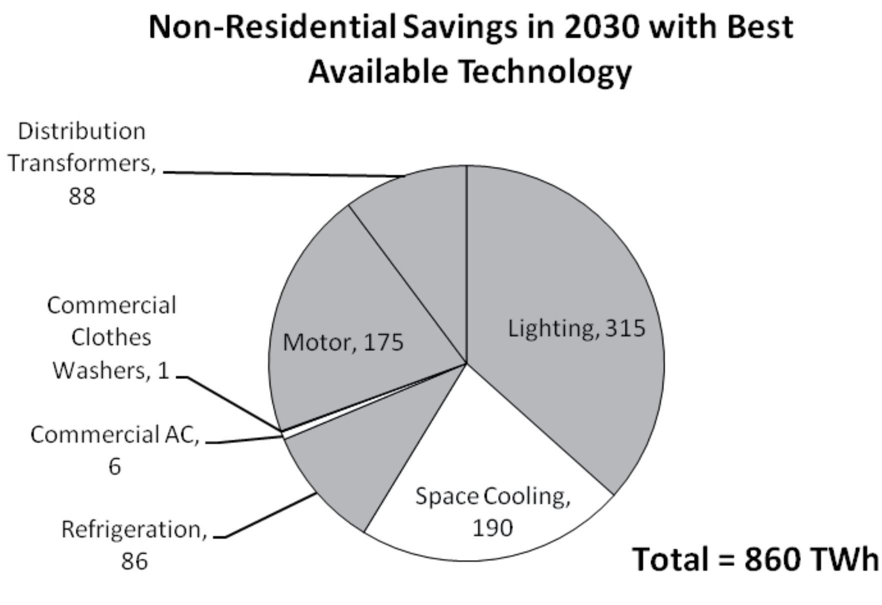


Figure 1. Technical potential savings in 2030 by end use. Under the BUENAS Best Available Technology scenario, SEAD participating governments could save over 1,750 TWh/yr in 2030 (Letschert et al., 2012a). Shaded end-uses are those for which SEAD has activities underway or planned (note: SEAD is indirectly supporting work on water heaters as part of an APEC EGEE&C project).

Table 2. SEAD Accomplishments to date.

IMPACTS	ACTION	POTENTIAL SAVINGS
Nine performance, safety, and quality standards for LEDs in India	Standards Adopted	277 TWh of energy savings and 254 MT CO_2 emissions reductions cumulatively between 2015–2030 (compared to 5 year delay)
Inclusion of more efficient LED TVs in 5-star energy efficiency ratings in India	Standard Adopted	If all TVs sold were as efficient as the SEAD award-winning LED TV models, electricity savings globally would be more than 84 TWh annually by 2020
Increased TV efficiency label standards in Korea	Standard Adopted	To be determined
Increased stringency of energy efficiency star rating criteria for color TVs in India	Standard Proposed	To be determined
Selection of ceiling fans as first product to be promoted under India's new Super Efficient Equipment Programme (SEEP)	Policy Proposed	By 2016–17, annual electricity savings of 2 TWh and 24 million tonnes of CO_2 avoided emissions (assumes 15-year fan lifetime)

To date, thirteen standards or policies that directly advance the energy efficiency of lighting, televisions, and ceiling fans have either been adopted or proposed as a direct result of the SEAD initiative and the peer-to-peer exchange fostered by the Clean Energy Ministerial (Table 2).

RAISING THE CEILING: AWARDS, PROCUREMENT, AND INCENTIVES

SEAD participating governments are working to bring the best available technologies to market by recognizing top performance and creating competition among manufacturers through the SEAD Global Efficiency Medal, as well as stoking demand through dissemination of best-practices in public procurement and incentive program design.

SEAD Global Efficiency Medal: Televisions, Displays, and Motors

The SEAD Global Efficiency Medal is a winner-takes-all competition that seeks to advance efficiency improvements by: recognizing products with the best energy efficiency, guiding early adopter consumers who want to purchase the most energy-efficient models, and demonstrating the levels of efficiency that are achievable with commercially available and emerging technologies.

SEAD launched its first Global Efficiency Medal competition in January 2012 at the Consumer Electronics Show in Las Vegas, NV. The first product category was flat-panel televisions, and was divided into three size categories and four regions: Australia, European Region, India, North America, and an international award. Manufacturers of winning products are being recognized at an awards ceremony at the Fourth Clean Energy Ministerial in New Delhi, India in April 2013. A companion paper (Ravi et al., 2013) describes the development and implementation of the European Regional TV awards, with a discussion of key lessons learned for policymakers who wish to promote highly-efficient products through awards programs or other voluntary schemes.

Televisions account for more than 3–4 % of global residential electricity consumption. The SEAD winning models use 33–44 % less energy than televisions with comparable technology. If all televisions sold were as efficient as the SEAD award-winning models, electricity savings globally would be more than 84 TWh annually by 2020, enough to power New York City for nearly a year and a half or avoid the need for 28 mid-sized coal fired power plants (Rosenfeld; Koomey et al., 2010). In addition to recognizing top performing products, the competition influenced policy outcomes in India and Korea, and led to improved test lab capability in India and the Philippines.

In April 2012, SEAD announced the next two Global Efficiency Medal competition categories: displays (desktop computer monitors) and electric motors. The displays competition was launched on January 7, 2013. The competition will recognize the 12 most energy-efficient commercially available displays in three size categories across four regions. The competition will also give international awards to the top model in each size category and to an emerging technology with the greatest potential to reduce display energy consumption.

Procurement: Street lighting and best-practice guide

Policies that mandate procurement of energy efficient products by public and private institutions are an effective means to “pull” super-efficient products into the market by stimulating demand from large purchasers (e.g., national/local governments, universities, and global retailers). Public procurement accounts for between 10 and 15 % of national GDP worldwide (WTO, 2013), a large fraction of which is spent on energy-consuming products. Private sector companies also purchase large numbers of energy-consuming devices and can benefit from procurement policies that minimize life-cycle energy costs. Both public and private procurement offer opportunities to generate market-transforming demand for high efficiency products.

The SEAD Procurement Working Group is engaged in a variety of activities, including development and deployment of a Street Lighting Evaluation Tool, a Procurement Best Practices Guide, and a Procurement Specification Catalog.

Street lighting is typically one of the largest sources of energy consumption under a municipality’s direct control. A rapidly changing product market, including the introduction of light-emitting diode (LED) fixtures and other advanced technologies, allow for significant energy savings, but also make proper lighting design and careful evaluation of fixture choices all the more important. The SEAD Street Lighting Tool provides a quick and easy way for government procurement officials and lighting specialists to evaluate the light quality, energy consumption, and life-cycle cost of efficient street lighting options. Municipalities in Armenia, Canada, India, South Africa, Sweden, and Togo have expressed interest in using the tool in their efforts to upgrade to energy efficient street lights.

Incentives

Financial and non-financial incentives aim to "raise the ceiling" and increase the market penetration of energy efficient appliances by encouraging manufacturers to produce and consumers to purchase highly efficient products. Properly designed incentives and increased awareness of the full life-cycle costs of appliances can also help support stronger efficiency standards. The SEAD Incentives Working Group aims to support the development and implementation of energy efficiency incentive programs globally by facilitating peer-to-peer information sharing on the effectiveness of technical resources, best practices on incentive program design, and incentive policies.

Many of SEAD's incentives-related activities are organized under the Efficient Product Promotion Collaborative (Collaborative), a public-private partnership under the incentives working group launched at CEM3 in April 2012, which aims to strengthen programs targeting efficient and super-efficient products. The Collaborative connects international stakeholders throughout the energy efficiency value chain to inform program design and maximize efficiency benefits at least cost. For example, India is working with Collaborative partners to develop a unique upstream incentive program, the Super Efficient Equipment Programme (SEEP), whereby manufactures would bid on financial incentives to develop and produce more efficient products. Initially SEEP will focus on ceiling fans, though other products are also under consideration. While SEEP has not yet launched, project performers have already learned a number of key lessons for incentive program design broadly and have developed some relevant tools. SEAD Collaborative partners are developing a "SEEP roadmap" to allow countries that are considering implementing incentive programs of their own develop the appropriate analytical tools and determine the type of program (e.g., upstream versus downstream) that would be most relevant to their circumstance.

Additional tools and resources to support incentives program design and implementation are being developed, including the LBNL Energy Efficiency Revenue Analysis (LEERA) model, which estimates the appliance energy savings that can be achieved by the revenue neutral financing of incentive programs from avoided electricity subsidies (Gopal et al., 2013).

RAISING THE FLOOR: STANDARDS AND LABELING PRODUCT-SPECIFIC COLLABORATIONS

SEAD is demonstrating the value of international cooperation by bringing together like-minded partner governments to tackle technical projects that will help accelerate standards and labeling efforts for all. SEAD partners are working together on 11 projects totaling approximately US$700,000, including about US$200,000 in partner in-kind and financial contributions (Table 3). Projects range from an effort to revolutionize access to product energy efficiency data to a multi-national effort to improve policies to minimize the energy use of network-connected products in standby modes. These projects are expected to result in policy-ready outputs for SEAD partners to use in advancing their domestic programs.

Technical information exchange that delivers more comparable and transparent test methods, efficiency metrics, and energy performance standards level definitions can provide

Table 3. SEAD Product-Specific Projects.

Product Category	Project Description	Timeline
Cross-cutting	Standards to Improve Access to Energy Efficiency Data and Product Information	Aug 2012 – Jul 2013
Cross-cutting	Promotion of International Energy Efficiency Standards	Aug 2012 – Apr 2013
Commercial Refrigeration	Evaluation of International Test Methods and Level Definitions	Sep 2012 – Apr 2013
Computers	Development of Globally Applicable Test Standard for Computer Energy Efficiency	Nov 2012 – Sep 2013
Distribution Transformers	Evaluation of Internationally-comparable Test Methods and Efficiency Class Definitions	Aug 2012 – Aug 2013
Electric Motors (APEC EGEE&C)	Best Practice for Energy Efficiency in Motor Repair	Aug 2012 – Aug 2013
Electric Motors	Evaluation of International Standards for Compliance, Certification, and Enforcement	Dec 2012 – Sep 2013
Heat Pump Water Heaters (APEC EGEE&C)	Evaluation of International Test Methods	Oct 2012 – Nov 2013
Network Standby	Standardized Definitions for & Application to Televisions	Sep 2012 – Aug 2013
Network Standby	"Real World Usage" Study	Nov 2012 – Nov 2013
Televisions	Evaluation of Energy Consumption Impacts of TVs Displaying 3D Content	Sep 2012 – Apr 2013

myriad benefits to the global energy efficiency community. One of the primary objectives of the SEAD initiative is to help strengthen participating governments' standard-setting work and facilitate technical harmonization through government-to-government collaboration and information-sharing for product categories that offer the greatest potential benefits.

Based on an assessment of energy savings potentials and government interests, the Standards and Labels Working Group established product-specific collaborations for six product categories, including commercial refrigeration, computers, distribution transformers, motors, lighting and televisions; and one energy use mode, network standby. Groups convene approximately every other month and are staffed by international policy-makers and technical consultants. Each collaboration group is chaired by a representative from a SEAD participating government.

Several SEAD product-specific collaborations have in place mechanisms to ensure coordination with IEA 4E activities, these include: the SEAD Efficient Lighting collaboration which includes a formal liaison with the IEA 4E Solid State Lighting Annex, the Network Standby collaboration which has adopted a statement of cooperation with the IEA 4E Standby Annex, and the Motors collaboration which has put in place a "bridge" document with the IEA 4E Electric Motor Systems Annex.

STRENGTHENING THE FOUNDATION: TECHNICAL ANALYSIS

SEAD Technical Analysis is primarily undertaken by the Lawrence Berkeley National Laboratory (LBNL). There are two main analytical products generated for SEAD: BUENAS potential savings estimates under different policy scenarios (described above) and techno-economic analyses of specific products to reveal technical potential. Letschert et al. (ECEEE 2013) presents a comparative review of three BUENAS scenarios.

Techno-economic Analysis

Televisions

SEAD commissioned an analysis of techno-economic energy savings potential for televisions from LBNL (Park et al., 2011). The analysis estimates a significant decrease in on-mode energy consumption for newly sold TVs globally, because of the large-scale transition toward LED-LCD TVs and rapid efficiency improvement in TVs, in spite of the projected growth in screen size and TV sales. In a business-as-usual case, considering only LCD TV efficiency improvement, global TV electricity consumption from annual TV shipments is estimated to decrease by about 47 %, from 36 TWh per year in 2010 to 19 TWh per year in 2015. Although rapid TV technology transitions are likely to reduce the consumption of a TV unit, it can be further reduced by about 20 % to 40 % cost effectively (cost of conserved electricity per unit < 8–10 cents) with a global economic saving potential of 18 TWh per year in 2015.

Ceiling fans

Results from the recently completed SEAD Ceiling Fan techno-economic analysis performed by LBNL indicate that ceiling fan efficiency can be cost effectively improved by about 50 % using commercially available technology, specifically DC motors and aerodynamic fan blades (Sathaye et al., 2013). If these efficiency improvements were implemented in all ceiling fans sold by 2020, 70 TWh/yr could be saved and 25 million metric tons of carbon dioxide (CO_2) emissions per year could be avoided, globally. This analysis has been used to inform the selection of ceiling fans as the first product to be promoted under India's new Super Efficient Equipment Programme (SEEP).

Displays

In support of the SEAD Global Efficiency Medal competition for displays (desktop computer monitors), LBNL completed an analysis of market trends and potential energy efficiency savings for displays (Park et al., 2013). Market trends in the energy efficiency of displays suggest that display efficiency will likely improve by over 40 % by 2015 compared to today's technology without any additional policy intervention. An additional 20 % efficiency improvement is available with cost-effective technology. Recent development of universal serial bus (USB) powered liquid crystal display (LCD) monitors has the potential to further deeply reduce energy consumption by as much as 50 %. Accelerated adoption of these efficient technologies has the potential to capture global energy saving from PC monitors of up to 9.2 TWh per year in 2015.

In progress: Room Air Conditioners and Domestic Refrigerators

Two additional studies on Room Air Conditioners (RAC) and Domestic Refrigerators are in progress.

In SEAD economies, the market penetration of RACs is growing rapidly. Split Room AC sales are expected to reach 87.5 million per year in 2014 and these sales are dominated by 5 economies: China, India, Brazil, Japan and the EU, which represent 90 % of the RAC market (Shah et al., in prep). In India, China, and Brazil alone, electricity demand to power RACs is expected to equal the output of five Three Gorges Dams by 2020 (Figure 2). Air conditioning also often accounts for a significant portion of peak electricity demand – nearly 40 % to 60 % in the summer months in many Indian cities – exacerbating chronic electricity shortages in many parts of the country (Garg et al., 2010). Adopting best available technologies for room air conditioners in SEAD economies and China could reduce electricity demand by 220 TWh/yr in 2020, avoiding the need for 73 mid-sized coal plants and reducing annual carbon emissions by 150 MT CO_2e.

Conclusions

The peer-to-peer exchange and technical analysis support enabled by SEAD is helping to drive market transformation by making it easier for participating governments to advance their respective goals on energy efficiency policy. As market penetration rates of new appliances and equipment increase and as technological learning drives down the cost of efficient technologies, the energy savings potential from appliance and equipment efficiency will continue to increase. While SEAD participating governments have made significant progress over the last two years implementing new standards, meeting energy access and climate targets will require accelerating the pace of progress.

Going forward, SEAD will continue to expand on its current range of activities, including a new SEAD Global Efficiency Medal for electric motors, which are responsible for 40 % of all global electricity (about 6,000 TWh in 2005; CLASP and Navi-

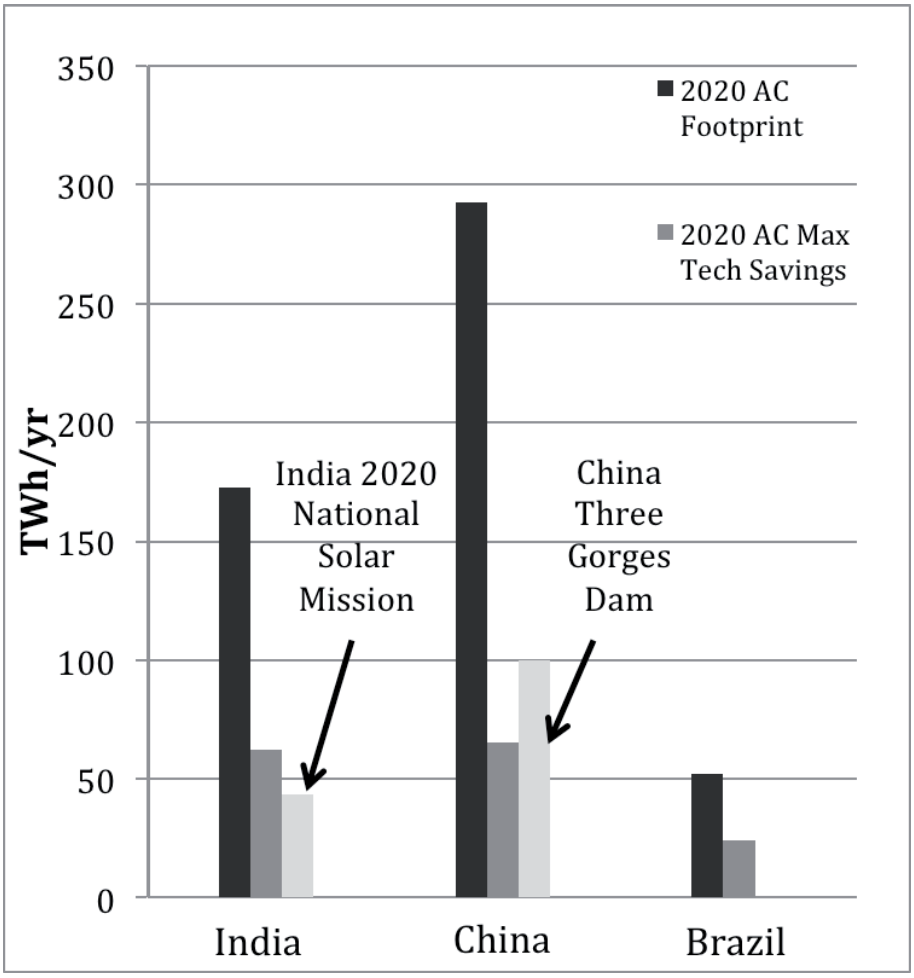


Figure 2. Potential savings from widespread adoption of highly efficient room air conditioners could save more electricity annually in 2020 than is expected to be produced by India's ambitious Jawaharlal Nehru National Solar Mission to deploy 20,000 MW of grid connected solar power by 2022. Estimated 2020 AC Footprint and Savings from Efficient ACs (Shah et al., in preparation; AC footprint and max tech savings estimated from Letschert et al, 2012a).

gant, 2011). In addition, SEAD is developing a strategy to focus on reigning in the rapidly growing electricity demand from air conditioners (Figure 2).

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