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Capturing Win-Win Energy Efficiency and Air Quality Improvement Projects

Combining Two Communities of Practice for Mutual Benefit

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August 2016

Introduction

Energy efficiency projects are typically financially attractive and often have significant air pollution benefits (including greenhouse gas emissions impacts), either by reducing fuel combustion on site or by reducing thermal electric power generation requirements. Still, capturing the large remaining potential for attractive energy efficiency remains a tough challenge in all countries because of institutional barriers, split incentives, transaction costs, needs to bring technical expertise to bear for project identification, lack of understanding of financial benefit streams or perceived risks, and other problems.[1]

Poor air quality is a serious health and economic problem in many regions, especially in many developing countries such as China and India, but also in parts of the developed world. Energy efficiency projects can play an important and highly cost-effective role in reducing air pollution, but they often are not included in local air quality improvement plans prepared by local-, regional-, or national-level authorities.

How can energy efficiency projects be better included as control measures in local air quality improvement plans? What are the costs of energy efficiency projects as air pollution control measures, and which types of projects have the largest air quality benefits for the lowest cost? How can energy efficiency and air pollution control practitioners better coordinate and integrate their planning and implementation efforts to capture the most attractive opportunities? These are the topics this paper explores.

The paper draws on a recent study of the costs and benefits of industrial energy efficiency projects as air pollution control measures in China, and the implementation steps needed to better capture the most attractive opportunities. China both suffers from severe air pollution problems and operates a sophisticated set of nationwide energy efficiency programs. Despite the need for synergy between these two, much still needs to be done to combine the efforts of the two communities of practice.

Air Quality in China

China's air pollution is extensive, persistent, unhealthy, and causes significant economic harm. Pollution is responsible for an estimated 1.2 million excess deaths each year,[2] and a three percent loss of GDP.[3] To date, air pollution has erased more than 2.5 billion years of life expectancy in China. Pollution also strains China's medical system, as emergency room visits spike 30–50 percent during each episode.[4] Long-term adverse health effects and risk from exposure to high pollution levels will impose further high costs on China's healthcare system and society. According to China's Ministry of

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1 See Taylor et al. (2008). *Financing Energy Efficiency: Lessons from Brazil, China, India and Beyond.* World Bank. Retrieved from http://siteresources.worldbank.org/INTEAPASTAE/Resources/FinancingEnergyEfficiency.pdf

2 The Lancet. (2012). *Global Burden of Disease Study 2010, 380, 9859.* Retrieved from http://www.thelancet.com/global-burden-of-disease

3 The World Bank. (2007). *Cost of Pollution in China: Economic Estimates of Physical Damages.* Beijing. Retrieved from http://siteresources.worldbank.org/INTEAPREGTOPENVIRONMENT/Resources/China_Cost_of_Pollution.pdf

4 Chen, R. et al. (2010). Ambient Air Pollution and Hospital Admission in Shanghai, China. *Journal of Hazardous Materials,* 181, 234-240. Retrieved from https://www.researchgate.net/publication/44663286_Ambient_air_pollution_and_hospital_admission_in_Shanghai_China

Environmental Protection, during 2015 nearly 80 percent of China's 338 major cities failed to meet the PM2.5 annual ambient emission standard.[5]

Premier Li Keqiang has declared "war" on air pollution, announcing that the government will levy higher fines on those who violate air quality laws. Premier Li also acknowledged that China's progress so far to improve air quality has failed to meet public expectations.[6] Both central and provincial governments have significantly invested in new air pollution control measures. In Hebei Province alone, more than $1 billion was invested in anti-pollution measures during 2014.[7] And the World Bank has approved $500 million in loans to support new control measures for the Jing-Jin-Ji region that includes Beijing and its surrounding provinces.[8]

Several comprehensive and detailed policies and laws have been implemented since 2010 to improve air quality:

- Joint prevention and control guidance that requires regional multi-pollutant planning;
- Adoption of $PM_{2.5}$ as an ambient air quality standard, installation of more than 1,000 $PM_{2.5}$ monitors, and real-time transparent hourly reporting of air quality data;
- State Council "Ten Measures" Law requiring up to 25 percent reduction in PM2.5 by 2017 for key cities and regions; and
- Revised and strengthened Air Law (effective January 1, 2016), which includes requirements for clean energy policies and green dispatch of generation to be part of air quality plans.

Energy Efficiency Efforts in China

With its economic development driven by industrial growth, China is now the largest energy consumer of any nation. For cost-competitiveness, energy security, and environmental reasons, China also now operates one of the world's most extensive energy efficiency promotion programs. Specialized government departments in central, provincial, municipal, and county governments operate, supervise, and enforce a series of nationwide initiatives including mandatory local and enterprise energy savings targeting, promulgation and enforcement of a wide range of process and equipment minimum energy performance standards, promulgation and enforcement of building codes, and technology promotion efforts. Market-based mechanisms also have been widely developed, including a range of commercial financing mechanisms and development of the world's largest energy performance contracting industry.

In large and medium-sized industry, the various elements of the government's program have been brought together under the Top-10,000 Energy-Consuming Enterprises Program. This program includes mandatory energy saving agreements and their annual supervision, a variety of technical and financial support programs, and initiatives to improve factory energy management. Air pollution reduction is one broad objective of the program. However, operational coordination of the program with local air quality improvement planning and implementation is poor, largely for institutional reasons.

The China Industrial Energy Efficiency and Air Quality Improvement Study

Study Objective

The Regulatory Assistance Project and the Institute for Industrial Productivity (IIP) completed a small empirical study of the costs and benefits of industrial energy efficiency projects in China in 2015, supported by the ClimateWorks Foundation.[9] The study evaluates the

5 Zheng, J. (2016, February 5). Most Cities Report Poor Air Quality in 2015. *China Daily.* Retrieved from http://www.chinadaily.com.cn/china/2016-02/05/content_23402446.htm (citing data from the Ministry of Environmental Protection).

6 Wong, E., & Buckley, C. (2015, March 15). Chinese Premier Vows Tougher Regulation on Air Pollution. *The New York Times.* Retrieved from http://www.nytimes.com/2015/03/16/world/asia/chinese-premier-li-keqiang-vows-tougher-regulation-on-air-pollution.html?_r=0

7 Spegele, B. (2015, July 15). China War on Pollution Benefits from Economic Slowdown. *The Wall Street Journal.* Retrieved from http://www.wsj.com/articles/china-war-on-pollution-benefits-from-economic-slowdown-1437410558

8 The World Bank. (2016) *World Bank to Support China's War on Air Pollution* [Press release]. Retrieved from http://www.worldbank.org/en/news/press-release/2016/03/22/world-bank-to-support-chinas-war-on-air-pollution

9 James, C. & Taylor, B. (2015). *Integrating Industrial Efficiency Measures into Air Quality Plans.* Beijing, China: Regulatory Assistance Project. Retrieved from http://www.iipnetwork.org/Integrating_Industrial_Efficiency_Measures_into_Air_Quality_Plans.pdf

economics of the energy efficiency projects as air quality control measures, and develops simple measures to help Chinese air quality planners include the most attractive projects in their air quality improvement plans.

Study Description

The study evaluated the investment costs, verified energy saving results, and sulfur dioxide and nitrogen oxide emissions abatement from 84 projects completed during 2008–2014 in some of the top 10,000 energy-consuming enterprises in China. Industrial energy efficiency projects were classified into nine categories:

- Urban district heating system reconfiguration and efficiency improvements;
- Industrial coal-fired boiler upgrades;
- Projects capturing and using waste heat or gas for on-site electricity generation or industrial process use;
- Industrial kiln efficiency upgrades;
- Thermal power plant efficiency improvements;
- Industrial system optimization, with packages of measures in integrated approaches;
- Electric motor system efficiency improvements;
- Industrial lighting efficiency improvements; and
- Substitution of natural gas for coal.

Project-specific data included investment costs and energy savings by fuel type, while energy price, project lifetime, and emission-fuel coefficient assumptions were nationwide estimates.

Results of the Study

Table 1 shows the energy savings (measured in tce—tons of coal equivalent)[10] and air pollution emissions avoided every year through investment in the different types of industrial energy efficiency projects. All of the project groupings have significant air pollution reduction impacts, although the impacts vary substantially. Several of the leading energy efficiency projects in terms of pollution reduction impacts are well known to Chinese air quality regulators, such as urban district heating reconfiguration, coal-fired industrial boiler upgrades, and substitution of natural gas for coal (where gas is available and affordable). However, some key project groupings such as industrial system optimization are less well known to air quality regulators.

On-Site Versus Off-Site Air Pollution Reduction Impacts

Local air pollution reduction impacts vary substantially between projects that reduce fuel combustion at industrial sites and projects that reduce electricity purchase requirements and hence emissions from electricity power generation plants, however much

10 One ton of coal equivalent equals 7 million kilocalories (29.3 GJ). The heat value of electricity saved is calculated at the primary energy value in coal-fired power generation plus transmission and distribution losses.

Table 1

Annual Energy and Emissions Savings for 84 Industrial Projects

Industrial Category	On-Site or Off-Site Avoided Emissions	Number of Projects	Average Energy Savings Per Project (tce)	Average NO_X Avoided (tons)	Average SO_2 Avoided (tons)	Average CO_2 Avoided* (tons)
District heating improvements	On-site	19	40,000	310	780	100,000
Industrial boiler upgrades	On-site	4	13,000	170	410	32,500
Waste heat or gas for electricity generation	Off-site	9	20,000	150	160	50,000
Waste heat or gas for process use	On-site	7	25,000	180	460	62,500
Industrial kiln upgrades	On-site	2	15,000	160	390	37,500
Power plant efficiency upgrades	On-site	6	25,000	90	100	62,500
Industrial system optimization	Both	16	25,000	150	350	62,500
Motor system and lighting upgrades	Off-site	16	8,000	50	50	20,000
Natural gas substitution for coal	Off-site	5	17,000	280	690	42,500

**Converted from tce at 2.5 tCO_2e/tce*

and wherever those may be. Projects that reduce coal combustion on-site, or close to or in urban areas, are clear air quality control winners. For example, the average on-site emissions avoided from the sample of 19 district heating improvement projects amounted to 310 tons of NO_X and 780 tons of SO_2 every year.

For local air quality control planners, the attractiveness of projects that reduce electricity generation needs off-site varies by the situation and air pollution issues being considered. Electricity savings may not be very relevant if air quality control planners are chiefly concerned with reducing ambient $PM_{2.5}$ concentrations in their city and the affected power plants are mainly non-fossil fuel plants or are thousands of kilometers away. However, if thermal power production within the airshed under review can be reduced through electricity savings, or medium-distance air pollution flows from power sector emissions are substantial, electricity-saving projects could be important air quality control measures even for local planners. For example, in Chongqing Municipality, where a significant portion of electricity is produced from local power plants using high-sulfur coal, an electricity-saving project can be quite important as long as power plant dispatch protocols also consider air pollution effects. Moreover, if long-distance air pollution control is of concern (e.g., for acid rain issues) or greenhouse gas emissions control is the issue of focus, off-site impacts may be just as important as on-site impacts.

Because of on-site versus off-site impact differences, it is important to separate on-site fuel combustion savings and electricity savings when analyzing energy efficiency projects from an air pollution control perspective. For example, in this study, projects where power was generated by factories from waste heat or gas to reduce purchase requirements were separated from projects where waste heat or gas was used to reduce fuel combustion in the on-site process because of the different local pollution impacts of each (see Table 1).

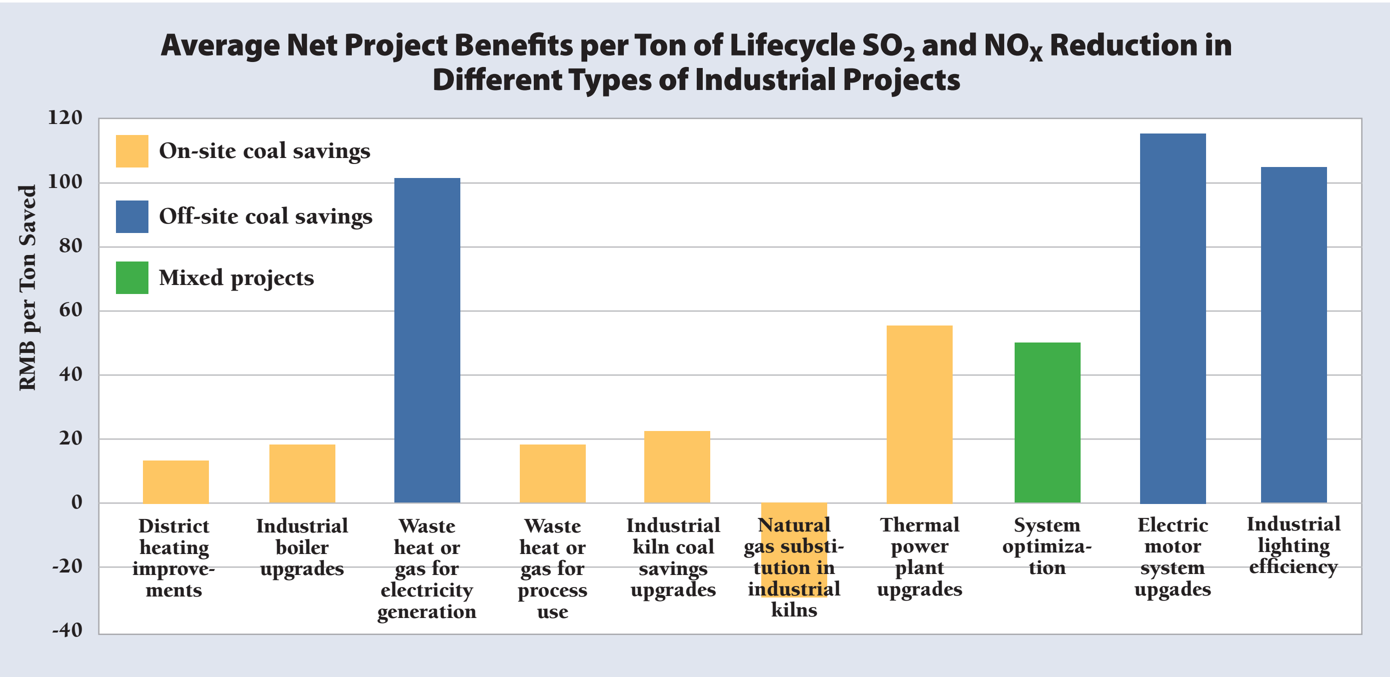
Net Costs of Energy Efficiency Projects as Air Pollution Control Measures

The energy efficiency projects reviewed generate financial benefits from energy cost savings that far exceed total project costs. Thus, the net costs of these projects as air pollution control measures are negative. Stated another way, these air pollution control measures generate net benefits to their investors without considering air pollution at all.

The net financial benefits to investing enterprises per ton of SO_2 and NOx pollution reduced are shown in Figure 1 for each energy efficiency project grouping. The natural gas substitution projects show net costs, as the price of natural gas is so much higher than the price of coal in China. All of the energy efficiency projects, however, result in strong net financial benefits.

The projects that save on electricity purchases (shown in blue) generate substantially higher financial benefits to enterprises per ton of pollutant reduced than the

Figure 1



projects that reduce fuel consumption on site (shown in green). This is because the price of electricity is much higher than the price of coal, and therefore projects that save electricity generally yield substantially higher cost savings benefits. In cases where reduction in electricity generation requirements can play an important part in achieving air pollution reduction goals, air quality regulators can expect enterprises to be enthusiastic about the financial benefits that electricity-saving projects might bring. In cases where the focus needs to be placed more squarely on on-site fuel combustion reductions, air quality regulators can expect enterprises to still derive good financial benefits from fuel-saving projects, but at lower levels.

In sum, the issue that needs to be overcome to ramp up implementation of energy efficiency projects as pollution control measures is not project economics. Rather, the issue is how to overcome a variety of other implementation barriers, such as organizational blockages, split incentives, transaction costs, the need to bring technical expertise to bear for project identification, and lack of investor understanding of financial benefit streams or perceived risks.

Recommended Implementation Steps

The RAP/IIP study recommended that Chinese air quality planners and regulators undertake the following steps to better incorporate attractive industrial energy efficiency projects in local or regional air quality improvement plans:

1. Identify the key control region for planning and implementation of air quality improvement measures. Set air quality improvement goals.
2. Identify and analyze prospective energy efficiency project development plans among key energy consumers in key control regions. Categorize these projects by technology grouping or by key industrial subsector.
3. Analyze the investment, energy savings, and air pollution impacts of typical projects within the prospective energy efficiency project development plan. Energy savings must be broken down into on-site fuel savings and purchased electricity savings.
4. Compare the benefits and costs of the energy efficiency projects with other air quality improvement measures under consideration. Select energy efficiency projects to include in models to assess the aggregate air quality improvement impacts of the different air quality control strategies.
5. Complete the local/regional air quality improvement plan for implementation, including energy efficiency air quality control measures.
6. Implement energy efficiency project promotion and support measures to ensure implementation of priority energy efficiency air quality control measures based on specific annual plans.

Combining Communities of Practice

The implementation of efforts to better capture energy efficiency projects as air quality improvement measures requires close coordination between the energy efficiency project development and implementation community and the air quality planning and regulation community. Viewing the steps recommended above for Chinese localities, for example, Step 1 (initial air quality planning) must be undertaken by the air quality community; Steps 2 and 3 (efficiency project identification and analysis) by the energy efficiency community; Step 4 (selection of efficiency project types for inclusion in the air quality plan) by both together; Step 5 (completion of the air quality plan) by the air quality community; and Step 6 (ensuring efficiency project implementation) by the energy efficiency community.

Combining the two communities of practice to work together effectively is not easy. In China, as in many other countries, environmental protection and energy efficiency promotion authorities operate in largely separate, vertically integrated institutional hierarchies. Official coordination between agencies does not come naturally, nor does coordination between experts working in the two fields. Special efforts need to be made.

Air Quality Community

Although their work units suffer from serious understaffing and lack of a sustainable mechanism for long-term funding, each of China's 338 key and county-level cities have some air quality staff in place. With only limited capacity available, these staff are currently under great pressure to develop plans and implementation solutions to address the acute, chronic, and accumulative effects of pollution, highlighted by China's leadership as an increasingly political issue.

In this situation, local air quality agencies often default to what they know, or what they have seen from Western countries: end-of-pipe emissions control devices (i.e., scrubbers). These technologies are well established, and flue gas emissions can be continuously monitored using in-stack instruments where collected data can be transmitted directly to the air quality agency. This default option ignores process changes and improvements that can be made upstream of the stack to reduce emissions. Such demand-side measures, as those discussed previously, are highly cost-effective, reduce multiple pollutants concurrently, and can either avoid the need for an end-of-pipe device or permit a smaller device to be installed. However, they are more difficult for the air quality agencies to handle by themselves.

Energy Efficiency Community

China operates a full system of specialized agencies at each level of government—central, provincial, municipal, and county—in charge of supervising the government's energy savings agreements with the main industrial enterprises, enforcing standards, and implementing enterprise support policies. The system reports to a different government line of departments unrelated to the environmental protection system. Authorities and experts in this industrial energy efficiency community are concerned with lowering total enterprise energy intensity and consumption (regardless of fuel type), checking compliance with China's many energy efficiency standards, helping to identify new energy-saving opportunities, and channeling incentives and technical support for energy efficiency project implementation.

China's system of energy efficiency agencies are not responsible for the enforcement of air pollution regulations and are rarely involved in air pollution control planning, except in occasional high-level, cross-department meetings. The energy efficiency and air quality communities have had some success working together on special, targeted initiatives, such as those relating to expansion and reconfiguration of district heating systems, improving efficiency and reducing pollution from industrial coal-fired boilers, and the substitution of natural gas for coal in certain urban areas. However, so far, there has been less evidence of successful, detailed cooperation in air quality improvement planning or systematic cooperation irrespective to certain specific technologies.

Adjustments Needed in Each Community to Make Energy Efficiency Projects a Standard Air Pollution Control Measure

Modest institutional adjustments are needed in the regular practices of both the air quality and the energy efficiency communities to achieve a mutually beneficial goal of systematically including more energy efficiency projects as air quality control measures in local air quality improvement plans. These adjustments are not exceptionally difficult, but require a concerted effort.

Adjustments in the Air Quality Community

Demand-side measures, such as energy efficiency projects, need to be included both conceptually and operationally as air quality control measures on par with other measures. They need to be characterized and their efficacy assessed in the same step-by-step manner as is done for end-of-pipe control measures. To achieve this, air quality control units will need to reach out to energy efficiency authorities and experts for the necessary data, project identification, and project assessment work. Once planning is completed, air quality control authorities then need to work with and through energy efficiency agencies for delivery of the key energy efficiency projects to achieve air quality improvements.

Adjustments in the Energy Efficiency Community

Energy efficiency proponents and practitioners can gain much additional public support for their efforts by helping the air quality community deliver on specifics in its critically needed and high-profile air quality improvement agenda. To help deliver energy efficiency projects as key air quality control measures in local plans, the energy efficiency community will need to incorporate new locational foci in its work, as directed by air quality experts. Project analysis must differentiate between on-site fuel savings and electricity savings, which is not often done today. The energy efficiency community will also need to learn to use environmental policy and support tools as means to help push energy efficiency project implementation, in addition to its regular tools.

Related Reading

The Future Electricity Grid: Key Questions and Considerations for Developing Countries

http://www.raponline.org/knowledge-center/the-future-electricity-grid-key-questions-and-considerations-for-developing-countries

Regulators around the world are faced with complex issues ranging from securing the supply of energy, to meeting public policy objectives and protecting the environment. Current developments in the energy sector present serious challenges for policymakers leading a vital transition—a rise in the deployment of cost-effective technologies, such as energy efficiency, renewable energy resources, and storage, coupled with a host of new market players and policies to ensure a fair playing field for all market participants. Ranjit Bharvirkar of the Regulatory Assistance Project teamed up with authors from the World Resources Institute, Prayas Energy Group, International Energy Initiative, and UnisonGroup to identify key issues and considerations for emerging nations as they develop their electricity grids. Drawing on experiences from Brazil, China, India, and Kyrgyzstan, the authors outline best practices for electricity planners and utilities faced with these current trends, in order to ensure clean, reliable, and affordable power to consumers.

Driving Energy Efficiency: Applying a Mobile Source Analogy to Quantify Avoided Emissions

http://www.raponline.org/knowledge-center/driving-energy-efficiency-applying-a-mobile-source-analogy-to-quantify-avoided-emissions

Energy efficiency is a cost-effective, multi-pollutant strategy for addressing air quality, but is rarely utilized to meet air quality standards in the United States. This policy brief provides state air quality regulators and the U.S. Environmental Protection Agency (EPA) with an innovative approach to quantifying efficiency-related emissions reductions with sufficient rigor to meet regulatory standards and without being so onerous as to discourage the use of efficiency in air quality plans. The 'mobile source analogy' suggests that the same approaches used to quantify emissions from the country's cars, buses, and trucks can also be used to quantify the emissions avoided by energy efficiency programs. In addition, the authors offer three complementary approaches EPA could take to connect the dots between energy saved and emissions avoided. Under a "deemed emissions approach", EPA would establish default emissions reductions for a host of well-established efficiency measures with well-documented outcomes. A second approach suggests that EPA extend its existing AP-42 approach for establishing acceptable emission factors to include acceptable emissions reductions from energy efficiency measures. A third approach would utilize modeling to determine location-specific emissions reductions when important for meeting ambient air quality standards. Regardless of the approach taken, the authors see great potential for energy efficiency as an air quality strategy and encourage EPA to provide the necessary guidance to states to maximize its use.

The Next Quantum Leap in Efficiency: 30 Percent Electric Savings in Ten Years

http://www.raponline.org/knowledge-center/the-next-quantum-leap-in-efficiency-30-percent-electric-savings-in-ten-years

Energy efficiency is a valuable, least-cost alternative to supply-side investments. States' recognition of this value has grown dramatically in the U.S. over the past ten years, with leading jurisdictions now acquiring more than twice as much electric efficiency savings as they did a decade ago. A new RAP study conducted by Chris Neme and Jim Grevatt of Energy Futures Group concludes that it should be possible to cost-effectively meet 30 percent of forecast electricity needs with new efficiency investments over the next ten years—a level of savings that is 50 to 100 percent greater than what leading states are acquiring today. The authors' recommendations for achieving 30 percent electric savings in ten years include increasing efficiency program funding to capture all cost-effective efficiency, eliminating utilities' financial disincentives to support efficiency, expressing goals in terms of lifetime savings generated over a multi-year period, setting long-term electricity sales goals, or electricity intensity goals, and fully valuing all of the benefits of efficiency. They also highlight the importance of encouraging and rewarding market transformation efforts, striking a better balance in the regulation of utility efficiency programs, exploring new regulatory approaches to the acquisition of efficiency resources, as well as broadening, accelerating, and improving the effectiveness of efficiency codes and standards.

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