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Integrating Industrial Efficiency Measures into Air Quality Plans

Christopher James and Bob Taylor¹

Executive Summary

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 to 50 percent during each episode.⁴ Long-term adverse health effects and risk from exposure to high pollution levels will place further high costs on China's society and healthcare system. According to China's Ministry of Environmental Protection, during 2014 only eight of 74 major cities met the PM_{2.5} annual ambient emission standard.⁵

Coal combustion from industrial production is a chief contributor to China's air pollution and rising greenhouse gas emissions. Despite this known linkage, there is no guide for China's air pollution officials to assess the degree to which clean energy policies and reduced energy consumption could help improve air quality and reduce greenhouse gas emissions. China's Top 1,000 and Top 10,000 programs, implemented during the 11th and 12th Five-Year Plans, respectively, saved about 420 million tons of coal.⁶ But how do these coal savings relate to reducing air pollution?

The Regulatory Assistance Project (RAP) and the Institute for Industrial Productivity (IIP) recently completed a project aimed at answering this question and equipping China's air regulators with the tools necessary to include clean energy and energy efficiency (EE) programs in their air quality plans. The project team evaluated 84 energy savings projects, all part of the Top 10,000 program, completed in eight industrial sectors across China to identify energy savings, coal savings, and avoided emissions of both greenhouse gases and other air pollutants. In collaboration with the Clean Air Alliance of China (CAAC), the team is developing process templates for each of the industrial categories evaluated so that air officials can use the same "plug and play" process that they use for other control measures in their air quality plans.

¹ Graphics by Gu Junchao.

² The Lancet (2012). *Global Burden of Disease Study 2010*, 380, n 9859.

³ The World Bank (2007). *Cost of Pollution in China: Economic Estimates of Physical Damages*. Beijing, China. 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.

⁵ Meng, C. (2015). *Enforcement of strictest environment laws 'key to reducing pollution'*. Global Times. Retrieved from <http://www.globaltimes.cn/content/905521.shtml>.

⁶ China tracks coal consumption in terms of "tons of coal equivalent" (tce), which has a heating value of 7,000 kcal per tce. Raw coal has a heating value of 5,000 kcal per ton. The actual quantity of raw coal saved is greater than that of the tce.



The Regulatory Assistance Project (RAP)[®]

Beijing, China • Berlin, Germany • Brussels, Belgium • Montpelier, Vermont USA • New Delhi, India
北京市朝阳区建国门外大街19号国际大厦2504室 • phone: + 86-10-85262241

CITIC Building, Room 2504 • No 19 Jianguomenwai Dajie • Beijing 100004 • phone: +86-10-85262241

www.raponline.org

Industrial Efficiency Programs Reduce Emissions

The highest savings occurred at one district heating boiler project, which saved more than 177,000 tons of coal. Twenty-one projects saved more than 50,000 tons of coal at each enterprise, with many more saving more than 10,000 tons of coal.

Table 1 below reflects the average coal saved, and the NO_x, SO₂, and CO₂ emissions avoided for the 84 projects in the eight industrial categories. Coal savings were obtained directly from each project. NO_x and SO₂ emissions are calculated using national figures. The data reflects emission control equipment where applicable, also using national average values. Actual data may be different.

Table 1: Annual Energy and Emissions Savings for 84 Industrial Projects

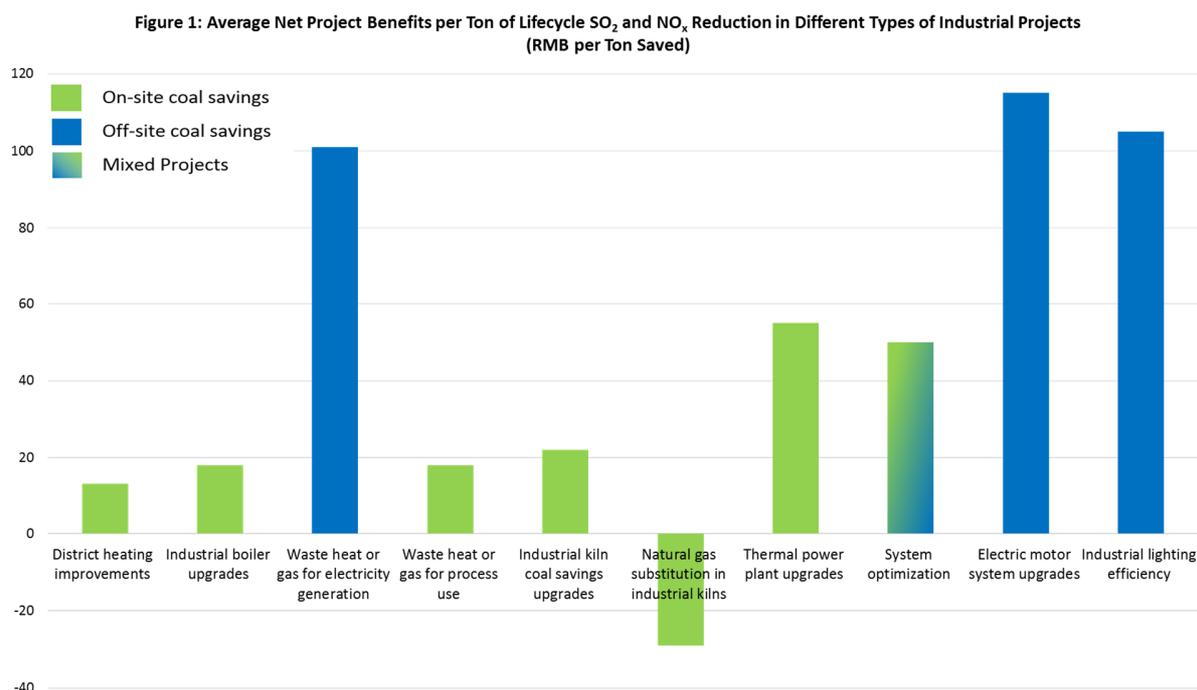
Industrial Category	Number of Projects	Average Annual Energy Savings per Project (tce)	Average NO _x (tons) Avoided	Average SO ₂ (tons) Avoided	Average CO ₂ (tons) Avoided *
District heating	19	40,000	310	780	100,000
Industrial boilers	4	13,000	170	410	32,500
Projects capturing and using waste heat or gas	16	23,000	160	290	57,500
Industrial kiln energy efficiency upgrades	2	15,000	160	390	37,500
Power plant efficiency improvements	6	25,000	90	100	62,500
Industrial system optimization	16	25,000	150	350	62,500
Lighting and motor system upgrades	16	10,000	70	70	25,000
Substitution of natural gas for coal	5	17,000	280	690	42,500

*Converted from tce at 2.5 tCO₂e/tce

Some of the 84 individual enterprises reduced SO₂ and NO_x emissions by as much as 1,000 tons (for each pollutant), with many enterprises reducing such pollutants by more than 500 tons each. While these values are significant, it is even more important to recognize that these pollutant reductions are also highly cost-effective. Life-cycle costs reflect that, in all cases, the costs to reduce air pollution (and greenhouse gases) are in fact negative. This result is significant in two key ways. First, enterprises save money and are more profitable by completing these energy savings projects. Second, any air quality plan that does not include energy savings as a control measure imposes higher costs on businesses and consumers to achieve the same air quality objective.

As Figure 1 shows, each of the ten different types of industrial energy efficiency projects analyzed show substantial net financial benefits for enterprises for each ton of SO₂ and NO_x reduced, with the exception of projects that involve substitution of natural gas for coal. Energy cost savings more than pay for all of the project investment costs. Projects that save electricity provide the greatest financial benefits to enterprises, as electricity is more valuable than raw coal.

Figure 1 shows private benefits, which accrue directly to the industrial enterprises where the energy savings projects were implemented. The societal benefits from these projects are estimated to be 260 RMB per ton of coal saved—these benefits are in addition to those shown in Graph 1. RAP’s “Layer Cake” analogy for assessing the benefits of energy efficiency describes more than two dozen energy and non-energy benefits that occur from the implementation of energy savings projects.⁷ While this work focuses on the U.S., we expect a similar outcome in China with respect to the direction and degree of the societal benefits, relative to the private benefits and to the cost of electricity. The Layer Cake reflects total societal benefits that are many times greater than the cost of electricity.⁸



Incorporating Energy Efficiency as a Control Measure into Air Quality Plans

Energy efficiency projects yield energy savings and air quality improvements for society, as well as energy cost reductions for users. In addition to these benefits, energy efficiency projects also yield supplementary energy system benefits, such as reducing peak load demands, easing energy transmission and distribution system congestion, and reducing transmission and distribution losses. Energy efficiency projects also yield additional environmental benefits, such as reductions in water use and wastewater discharge, as well as land quality benefits, such as reduced needs for ash disposal.

State Council guidance, regulations, and the recently adopted Air Law recognize these benefits and have required multi-pollutant and clean energy policies to be part of any air quality plan developed by China’s

⁷ Lazar, J. and Colburn, K. (2013). *Recognizing the Full Value of Energy Efficiency*. Montpelier, VT: The Regulatory Assistance Project. Retrieved from <http://www.raonline.org/document/download/id/6739>.

⁸ Natural Resources Defense Council (2015). *China’s National Coal Cap Policy Could Save Nearly 50,000 Lives and \$6.2 billion Every Year by 2020*. Retrieved from <http://www.nrdc.org/media/2015/150408.asp>.

338 most polluted cities. Yet, to date, there has been little effort to integrate energy savings as an air quality control measure. This is because there has been no proper assessment of the possible air quality benefits that would result from China's air quality agencies adopting control measures that capture the energy savings potential in the industrial sector.

Air quality plans are developed to yield tons of emissions reduced and micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) of ambient air quality improvement, while efficiency programs are developed to produce megawatts and tons of coal equivalent saved. To put the energy savings projects on an equal footing with other control measures that air officials evaluate, the energy savings need to be converted to tons of emissions avoided. Then air officials can input these values into their air quality models to determine the ambient air quality improvements that can be achieved. Tons of emissions avoided from energy savings projects can also be compared to the total tonnage that must be reduced in a particular jurisdiction to meet the required air quality objectives.

To ensure that energy savings projects are fully exploited by air quality officials, the process and detailed steps required must be explained. Simply saying that energy savings occur and significant pollutant reductions can be achieved is insufficient. An air quality management plan may have dozens of discrete control measures. Each of these measures has a process template and guidance for officials to follow. Agency resources are stretched, and unless the process is simple and easy to follow, a control measure will not be considered. In collaboration with the CAAC, the project team is developing templates that describe the process for assessing emission savings for each of the eight categories. Each template will allow a user to input their own emissions data, if available, in lieu of the default data. When complete, air officials will be able to use the same "plug and play" process that they use for other control measures in their plan.

Recommendations to More Effectively Include Industrial Energy Efficiency Projects as Air Quality Control Measures

1. Incorporate industrial EE projects as control measures in local and regional air quality management plans

EE projects that reduce on-site emissions through direct coal and energy savings should be included as specific control measures in all air quality management plans. Locality-specific factors are important when choosing project sites, especially where the industry location influences local and regional air pollution. For example, the industrial site may be in the central city or located in an area where prevailing winds transport pollution into the central city. The location of thermal power plants in relation to project locations is another important factor. If the project results in both direct coal savings *and* reduces electricity consumption, these results produce additional air quality benefits by reducing the coal used to generate electricity. Other factors to consider when evaluating project locations include coal quality, inter-coal substitution options, and the status of industry emissions controls.

Electricity conservation has many benefits, even if the effects are not local. Air pollution transport from one province to another is a serious problem in China. Projects that reduce generation, even if from distant thermal power plants, can produce regional air quality benefits. The cost savings -effectiveness attributes of energy savings projects may free up funds for investment in complementary projects that

further improve their profitability and energy savings, such as on-site fuel efficiency improvements and improved process design.

2. Improve coordination between air pollution control and energy efficiency stakeholders both in government and in technical and service institutions

As in many other countries, authorities tasked with promoting environmental protection and energy efficiency operate largely in separate, vertically-integrated institutional hierarchies that lack not only official coordination between agencies, but also coordination between experts working in the field. Concerted efforts to develop and coordinate the implementation of regional and local air quality management plans are vital. Specific recommendations for improving coordination between regulators follow under 3 and 4 below.

3. Recommendations for local and regional air pollution control authorities and experts on including EE projects in air quality control measures

- Recognize the potential role of industrial EE projects as air quality improvement measures in air quality plans. Seek consensus on a plan to identify, quantify, and realize that potential where possible. Given their potential to reduce greenhouse gas emissions, industrial energy efficiency can also be included in the national greenhouse gas cap-and-trade program announced by the Chinese government.
- Work with government energy efficiency authorities to develop a portfolio of the most important industrial energy efficiency projects for air pollution control. Gather data about the number and types of projects and their location, in order to calculate and analyze emissions reductions for different groups of projects under various scenarios. Compare the costs and benefits of coordinating energy efficiency and air quality control projects with other methods of air quality improvement, and assign priorities accordingly.
- Calculate the forecasted contribution of the prospective energy efficiency/air quality control projects to the achievement of air quality goals, including PM_{2.5}, if the appropriate modeling capacity is available. While not required, if available, modeling can support an aggressive timeline for implementing the energy efficiency projects.
- Work with government energy efficiency units to finalize and obtain approval of concrete annual goals for implementing specific energy efficiency/air quality control projects.
- Work with government energy efficiency units to identify and implement specific environmental regulations and incentive measures to encourage enterprises to implement the planned energy efficiency projects, in addition to the regulatory and incentive measures already used to promote the projects.

4. Specific recommendations for energy conservation authorities, supervisory bodies, and experts on contributing to the local air quality improvement agenda

- Review prospective industrial energy efficiency projects for the relevant region and assess the potential of different types of projects to improve local air quality. The methodologies could be similar to the simple approach outlined in the forthcoming technical report from this project. It is important to analyze the different types of energy to be saved, in order to differentiate between on-site air pollution reductions versus off-site power plant pollution reductions.
- Work with government environmental authorities and associated experts to develop a portfolio of the most important industrial energy efficiency projects for air pollution control. Gather data about the types of projects, number of projects, and their location, in order to calculate and analyze possible emissions reductions for different groups of projects under various scenarios. We recommend refining the over-simplified methodology used in this study with more location-specific data and assumptions on fuel quality, as well as reviewing the existing and prospective air pollution control equipment in the factories under consideration.
- Work with government environmental officials to finalize and obtain approval of concrete annual goals for implementing specific energy efficiency/air quality control projects. Although they comprise part of the standard overall energy efficiency program, these specific projects can be highlighted and prioritized in local energy efficiency plans as key contributions to achieving local air quality improvement goals.
- Proceed with existing incentives for energy efficiency projects to support the implementation of the energy efficiency/air quality control project portfolio. Seek regulatory assistance and support from government environmental authorities where needed and possible.