Policy Pyramids: An Evaluation Framework for Industrial GHG Mitigation Policies

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This paper proposes an innovative methodology to evaluate whether policy packages provide the necessary impetus to achieve ambitious improvements in energy savings and emissions reductions in industry. The paper uses the "policy pyramid" methodology, which distinguishes among three levels of policy making: effort-defining policies; supporting measures (or complementary policies, either carrots or sticks) that help deliver that effort and address specific barriers identified; and tools, guidelines or mechanisms that help define and establish the policy implementation framework.

The paper analyses and evaluates the industrial energy efficiency policy packages of two countries (China and the United States) using this policy pyramid methodology. It sheds light on how to evaluate the effectiveness of existing policy packages focusing on the consistency of policy objectives and approaches and whether policies are mutually supportive. The paper argues that an effective policy approach requires a policy package consisting of all three policy levels. These countries' policy packages are surveyed and used as case studies to demonstrate the approach and methodology in two diverse countries in terms of size, economic structure, level of development, culture and policy approach.

Introduction

While recognition that energy efficiency is a powerful tool to cut operating costs, improve the economy and reduce environmental pollution have never been greater, the implementation of energy efficiency measures is slow to materialise (IEEFP, 2009). This is because of a range of barriers including insufficient information, competing priorities within the company and the lack of commercially viable financing options.

In both developed and developing countries, a large number of policy measures targeting industrial energy savings and GHG emissions has been introduced with the aim to overcome these barriers. With more measures designed and implemented at different times, there is a constant need to look at the interaction effects (or lack thereof), both positive and negative, of different policies.

Key questions can be asked in order to explore policy interactions and the effectiveness of the overall policy package: Are the policy measures in place aiming to achieve the same goal? Have policymakers given tools and guidelines to help companies implement the policies? Are policies targeting the same group of actors who will implement or assist with the implementation of energy savings or GHG mitigating measures?

This paper will address several of these questions by exploring the packages of policies in the United States and China. The policy pyramid methodology enables an evaluation of the countries' policy mixes and policy interactions, in terms of whether the policy packages enable and motivate companies to realise the full range of energy efficiency actions, which would otherwise be neglected. The focus throughout the report is on the industrial sector. Small and medium size enterprises (SMEs) as well as larger industries, are included although energy saving and GHG emission targets are generally applied to large companies.

Section 1 of the paper briefly argues that a package of policies is needed to provide the drivers that stimulate, and, address the barriers that hamper energy efficiency and GHG mitigation decisions in manufacturing companies. In Section 2, the policy evaluation and classification framework is presented. In Section 3, the classification method (according to the policy pyramid) is applied to the set of policy measures at the national and federal levels in China and the US. In section

4, the report then provides a high-level evaluation of the policy packages focusing on their capacity to provide the necessary impetus to investment decisions and whether the policy measures are mutually reinforcing. Conclusions and policy observations follow in the final section.

Policy Packages for Addressing Barriers and Drivers

Undertaking energy efficiency actions often makes economic sense, but are often still not adopted. Although studies have shown that investing today in energy efficient technologies will generate fuel savings that significantly outweigh the initial investment cost over the lifetime of the purchase, companies often do not make investments that improve their energy efficiency levels to their maximum potential.

Investments that maximise energy efficiency are not undertaken due to economic, behavioural, technical and organisational barriers, or because companies prefer alternative investments in growth or business development above these. For example, when companies replace technologies, while some technology options may bring additional benefits in terms of energy savings at small incremental cost, companies often forego these options.

Barriers refer to all obstacles that prevent financially and technically feasible energy efficiency measures from being implemented (IPCC, 2001).[1] For example, organisational barriers need to be overcome enable management and staff to put energy efficiency high on the company agenda. The extent and magnitude of barriers will depend on the market, the industrial sector, and the company size and energy intensity (Reinaud and Goldberg, 2011b).

On the other hand, numerous *drivers* also exist for companies to invest in energy efficiency projects. A driving force is defined in this paper as a mechanism that influences (either positively or negatively) a company's decision to invest in the most energy efficient practices or technologies (Reinaud et Goldberg, 2011a). Examples of significant energy efficiency drivers include direct cost savings and productivity improvements, policy obligations and public reputation for corporate sustainability.

When companies do not maximise energy efficiency levels as they make investment decisions because of barriers (e.g., limited access to technical know-how) and a lack of drivers (e.g., low energy prices) to stimulate a change in their investment priorities in favour of an investment that carries more energy efficiency benefits than another, there is often a role for government policy. Typical policies that target industrial energy efficiency include regulations and energy saving agreements that directly compel actions; economic policies such as taxes, directed financial support (*e.g.* subsidies and loans) and differentiated energy prices that seek to influence the cost-effectiveness of technical actions; and informational policies, which help to establish a favourable environment for industry to implement EE actions. Yet, a single policy is not likely to be sufficient. Only a package of policies can strengthen incentives and overcome barriers for all the actors in the market (Irrek, W. and Jarczynski, L., 2007), with different policies within the package targeting different barriers and/or drivers. The specific composition of the policy package will depend on the types of barriers and drivers identified within the country context (Reinaud et Goldberg, 2011b).

While several policies may be necessary to address barriers and drivers, a policy should only be implemented when it is complementary to another policy in that no two policies address the same aspect of the barrier and to address incomplete coverage, infrastructure lock-in, financing, cost containment, policy uncertainty and wider policy integration (Hood, 2011).2 For example, an energy

[1] There is an extensive body of empirical evidence on the existence of barriers, providing insights into the drivers for implementing energy efficiency measures. Example literature includes: Rohdina *et al.*, 2007; de Groot *et al*., 2001; Masselink, 2008; de Beer *et al*., 2000; Anderson and Newell, 2004; Harmelink *et al.*, 2010; Tanaka, unpublished 2009; Sorrell et al 2004; Sorrell et al, 2011, Reinaud and Goldberg, 2011a and 2011b.

[2] Sorrell, Mallett and Nye (2011, p. 27) define a barrier to industrial energy-efficiency investment as a "mechanism that inhibits a decision or behaviour that appears to be both energy and economically efficient."

audit programme may co-exist with an energy taxation policy: the former will help reduce the information barrier while the latter will help reduce financial barriers. This in line with the literature (see Ryan et al., 2011; Hood, 2011; CoA, 2008; Jaffe and Stavins, 1994).

Different combinations of instruments, or the introduction of a new instrument to an existing policy mix, could have a variety of effects, not all of which are positive (Gunningham et Sinclair, 1999). To help estimate – at a high-level - the effectiveness of policy packages, this paper proposes the "policy pyramid concept', which is described in further detail in the following section. By effectiveness, it is implied that the policies enhance the likelihood of achieving their objectives (Oikonomou and Jepma, 2008). We do not discuss cost-efficiency (i.e., do the interacting policies achieve GHG abatement/ energy conservation at least cost following a cost and benefit assessment).

Evaluation Framework: the Policy Pyramid

The authors of this report propose a simplified and transparent classification method for exploring the wide range of industrial efficiency policies that have been introduced in all countries. These multiple policies can be analysed through a policy framework that distinguishes among three policy levels consisting of:

(i) Sufficiently ambitious effort-defining policies (such as cap-and trade or EE targets) to outline energy efficiency and GHG reduction goals;

(ii) Supporting measures (i.e. in the form of carrots and sticks) that address the different barriers (if any barriers have been identified) and that are mutually reinforcing and encourage action both by industry itself and energy service companies or financial institutions that can help with the implementation of energy efficient technologies and behaviors.[3] These measures are needed to increase the effectiveness of the effort-defining policies and, as such, should be consistent with the direction of the effort-defining policies; and

(iii) An implementation toolbox (supporting mechanisms, guidelines, tools and templates) to support the execution of effort-defining policies and supporting measures in a transparent and efficient way.

This approach corroborates with other research on the subject including Irrek and Jarczynski (2007), Ryan et al. (2011), Hood (2011), Mallet et al. (2011) and Boonekamp (2005), Irrek, W. and Jarczynski, L. (2007).

The policy pyramid serves as an important method to analyse the effectiveness of a country's policy package. It can help in analysing the policy package of a given country, especially regarding completeness and internal consistency. It also facilitates cross-country comparisons and sharing of lessons learned across countries. Relevant questions include:

- Are the policy measures in place aiming to achieve the same goal?
- Does the policy framework adequately address all relevant barriers by using the three parts of policy framework?
- Do the supporting measures reinforce the goals and approach of the effort-defining policies?
- Have policymakers given tools and guidelines to help companies implement the policies?
- Are policies targeting the same group of actors who will implement or assist with the implementation of energy savings or GHG mitigating measures?

The next section provides an overview of the policy pyramids of China and the United States. These case studies are used to demonstrate the approach and methodology. The analysis only covers national and federal measures in the China and the US although it is important to note that provincial

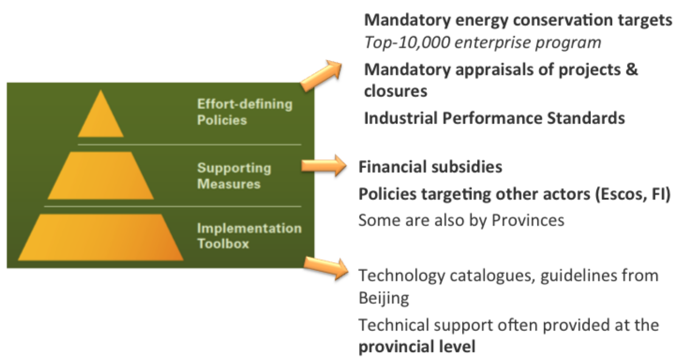
[3] Energy management programmes that encourage the implementation of energy management systems (EnMS) – a collection of procedures and practices to ensure the systematic tracking, analysis and planning of energy use in industry -, if cohesively linked to effort-defining policies and supported by training and incentives, can be very effective as supporting measures (see Reinaud et al, 2012).

and state level policies are as important, if not more important, than national policies. The sample of countries is intended to be illustrative and covers a wide range of industry sectors (e.g., iron and steel, cement, pulp and paper) that are the focus of this report, sizes of firms (large and SMEs) as well as actors in the market that either host energy efficiency investments (industrial companies) or support their materialisation (energy service companies (ESCOs) and financial institutions).[4]

An Overview US and China's Policy pyramids

China

As industrial energy use accounts for approximately 70% of national final energy use, strong efforts are made in China to address the high energy-intensity and outdated technology in the industry sector. Economy-wide targets under the Central Government's Five Year Plans (FYPs) are a key driving force in all industry-related policies and measures.



According to the 12th FYP goals (2011-2015), China's mandatory energy and carbon targets are:

- Energy intensity (energy consumption per unit of GDP) reduction of 16% below 2010 levels by the end of 2015; and
- Carbon intensity (carbon emissions per unit of GDP) reduction of 17% below 2010 levels by the end of 2015.

Effort-defining policies

To meet 12th FYP plan targets, the State Council has released a comprehensive work plan, which details 50 specific measures that are to be carried out in support of the energy intensity target. Many of these measures are devolved to provincial governments.

The major effort-defining policy in the industry sector that supports the achievement of China's 12th FYP targets is the Top-10,000 Enterprise Program. This Top-10,000 Enterprise Program, introduced under the 12th FYP, is an expansion of the successful Top-1,000 Enterprise Program that ran during the 11th FYP period (see Levine et al, 2010 for an evaluation).[5] The Top 10,000 Program, which sets EE targets, aims to cover two thirds of China's total energy consumption, and will include 15,000 industrial enterprises[6] that use more than 10,000 tonnes of coal equivalent (tce) per year.

[4] An energy service company (ESCO) is an organisation that delivers energy services and/or other energy efficiency improvement measures in a user's facility or premises, and accepts some degree of financial risk in so doing. The payment for the services delivered is based (either wholly or in part) on the achievement of energy efficiency improvements and on the meeting of the other agreed performance criteria (Bertoldi et al, 2007) http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/7668/1/22827%20esco%20report-edition%20paper%20version%20.pdf The US National Energy Service Company Association (NAESCO) describes an ESCO as a business that "develops, installs, and arranges financing for projects designed to improve the energy efficiency and maintenance costs for facilities".

[5] The Top-1000 Program, the key policy for the largest energy-intensive industries, has been successful in achieving, and even surpassing, the program goal of achieving energy savings of 100 Mtce over the 11th FYP period.

[6] The total number of enterprises covered by this program may reach up to 16,000 to 17,000 and will include transportation and buildings.

China has also introduced regulatory backstops to improve minimum performance at the bottom-end of the market, which can also qualify as effort-defining policies. These include industrial energy performance standards introduced in 2008 and covering over 20 industrial products[7] as well as regulations that mandate small plant closures and phasing out of outdated capacity. The EE appraisals for new large industrial projects (fixed asset investments) address infrastructure lock-in (introduced late in 2010). All new investments must undergo independent assessments and government reviews on their energy-saving status before being approved by regulators. Projects that pass will be subject to government supervision and managers are required to submit energy-reports (Xinhua, 2010).

Supporting policies

To underpin the Top-1,000 and Top-10,000 Programs (and provincial policies that target "key enterprises"[8]), a number of mandatory supporting measures include:

- Assignment of energy managers, implementation of energy conservation plans and implementation of energy management systems (under the Top-10,000);
- Reporting of energy consumption data to the government;
- Energy audits according to the Chinese audit standard GB/T 17166-1997; and
- Energy efficiency benchmarking (under the Top-10,000).

Several other supporting measures that encourage industrial energy efficiency and supplement the effort-defining policies include:

- The use of differentiated electricity pricing within the same industry subsector, in which electricity prices are higher for companies with higher electricity intensity;
- Measures not targeted specifically at the industry sector but aimed to facilitate industrial EE include fiscal incentives for qualifying ESCOs, demand-side management for utilities, EE financing regulations and instruments targeting financial institutions;
- Financial rewards for energy-saving technical retrofits. The program supports boiler/furnace retrofitting, waste heat and waste pressure utilization, motor system energy conservation, energy system optimization, green lighting, and energy conservation in buildings (MOF, 2010; NDRC, 2010). Under the 12th FYP, this program has been extended to qualifying ESCOs in order to promote the ESCO market and achieve greater savings. Under the 12th FYP, the value of the reward has increased from RMB 200 to at least RMB 240 per ton of coal equivalent energy (tce) saved (the middle and west regions can receive rewards of RMB 300).

Implementation toolbox

China's implementation toolbox contains a range of guidelines and tools such as training programs, standards for energy management and audits, lists of closure thresholds, efficiency standards for various industries, and eligibility criteria for ESCOs to receive fiscal incentives. These

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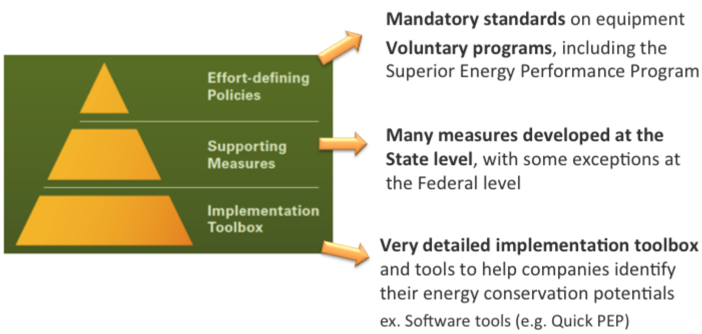
[7] Materials covered include: cement, crude steel, caustic soda, copper, ferroalloy, coke, calcium carbide, ceramics, zinc, lead, yellow phosphorus, synthetic ammonia, flat glass, magnesium, copper-alloy, nickel, electrolyzed aluminium, tin, antimony, carbon materials, and wrought aluminium alloy, and electricity from coal-fired power stations.

[8] China's energy conservation law and many subsequent regulations employ the term "key enterprises" which include all industrial enterprises with annual energy consumption of over 10,000 tons of coal equivalent (tce), and, if also so designated by provincial/local governments, enterprises with annual energy consumption of over 5000 tce. All Top-1000 enterprises and all Top 10,000 enterprises are key enterprises.

tools and guidelines are distributed to companies through the provincial government agencies and/or industry associations, among other channels.

United States (Federal)

Energy production and transport represent a large share of total GHG emissions in the United States, and overall energy intensity is higher in the US in comparison to other OECD countries (although the energy intensity of the manufacturing has been falling and is now comparable to that in the EU-12 see IIP's IEPD database, and Mulder and de Groot, 2011).



Effort-defining policies

The major US effort-defining policies at the federal level include the GHG permitting and new source performance standards[9] under the Clean Air Act (CAA), and three voluntary programs: the Better Buildings, Better Plants program (formerly Save Energy Now), Superior Energy Performance (SEP), and the Energy Star Program for Industry. [10]

The CAA is the only federal policy with a mandatory element. From 2011, it requires selected installations to obtain a permit for polluting emissions to air and to install the Best Available Control Technology (BACT) to limit GHG emissions. The BACT requirements were defined by US Environmental Protection Agency (EPA) late in 2010 and provide guidance on technologies to be employed.[11] The BACT specify a maximum amount of GHG emissions allowed by the specific technology under the CAA.

Except for the upcoming mandatory requirements under the Clean Air Act (CAA), other effort-defining policies have a purely voluntary character.

A new certification program that relies on voluntary company participation, the Superior Energy Performance Program (SEP), will be launched nationally in 2012. SEP will provide companies with a framework for implementing the international standard for energy management systems (EnMS) ISO 50001 and for achieving awards (silver, gold or platinum) based on a set of predetermined performance criteria. Participating companies' performance can be recognised according to two "energy pathways": 1) a pathway for companies new to energy management requires that they demonstrate savings of at least 5% over a three-year period; and 2) a mature pathway for companies with longer experience that requires these companies demonstrate at least 15% savings over the last ten years and receive a minimum score according to the "Best Practice Scorecard" (SEP, 2012).

The Government will leverage the SEP to deploy other federal programs such as the Better Buildings, Better Plants program (formerly Save Energy Now program) since participants of the federal programs are given priority access to energy assessments and other resources.

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[9] The new source performance standards only apply to fossil fuel-fired power plants and refineries.

[10] Climate Leaders ended in September 2011 and between 2011 and 2012, Save Energy Now transitioned to Better Buildings, Better Plants.

[11] Phase 1 began in January 2011 for sources emitting at least 75,000 tons of carbon equivalent/year and already subject to the CAA permitting program covering other pollutants. In July 2011, Phase 2 began for new sources emitting at least 100,000 000 tons of carbon equivalent /year and modified installations emitting at least 75,000 000 tons of carbon equivalent /year due to the modification. http://www.epa.gov/nsr/ghgdocs/ghgpermittingguidance.pdf New source performance standards for power generators are also being implemented.

Also voluntary programs, Better Buildings - Better Plants and the Energy Star Program target industry. The former is a comprehensive energy efficiency program that includes a 10 year 25% energy-intensity improvement target and reporting progress to the Department of Energy (DoE). Partners who wish to pursue more extensive EE activities or exercise leadership in their field can be recognised as "Challenge Partners" (whilst companies who meet the requirements are recognised as "Program Partners").[12]

The Energy Star Program, administered by the U.S. EPA, encourages organizations to improve their environmental and energy performance by developing Energy Performance Indictors to score plant performance and establishing Best in Class recognition (certification) for plant performance. Energy guides help improve companies performance by identifying and sharing best practices and projects.

Supporting policies

At the federal level, supporting measures include a tax credit scheme, an accelerated depreciation scheme, and a loan guarantee program. SME manufacturers are also eligible to receive a free energy assessment provided by DOE Industrial Assessment Centers (IACs), which are conducted by universities around the country. A greater number of programs occur at the State or regional level (Elliott and Taylor, forthcoming).

Implementation toolbox

Underpinning the U.S. voluntary effort-defining policies and supporting measures, extensive implementation tools are provided by the government: calculation tools, monitoring formats and free energy management support. The U.S. DOE's Advanced Manufacturing Office (formerly Industrial Technologies Program) provides many software tools for assessing energy efficiency of motors, pumps, compressed air systems, process heating and steam systems.[13] The U.S. DOE also provides case studies that describe energy-efficiency demonstration projects in operating industrial facilities in many industrial sectors and sourcebooks, tip sheets, technical fact sheets and handbooks, and market assessments.

High-level Assessment of Case Studies

This section addresses some of questions outlined above (i.e. has a country developed an effective and comprehensive policy package) using a qualitative approach. It does not focus, however, on whether the level of ambition of such policies is appropriate, or on the cost effectiveness of policies and policy packages. We start by introducing some general "rules" that we consider are international best practices and then provide a first order evaluation. We also support our conclusions by presenting a number of considerations that have emerged from our literature review.

Capacity to establish a coherent set of effort-defining policies

Effort-defining policies should ideally be composed of GHG mitigation and/or energy efficiency targets, either voluntary or mandatory, supplemented in certain cases by standards. Policies that specifically target long-lived assets will also drive energy efficiency performance. For example, a regulatory backstop such as an energy efficiency or GHG emission performance standard for new industrial facilities (or retrofits) is a preventive measure to guard against the lock-in of inefficient high-energy consuming investments.

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[12] **Program Partners** pledge energy savings goals consistent with national targets and agree to report progress annually to DOE. Program requirements largely match those of the Save Energy Now LEADER initiative. **Challenge Partners** agree to transparently pursue innovative approaches to energy efficiency, and make a significant, near-term investment in an energy saving project or set of projects.

[13] See http://www1.eere.energy.gov/industry/bestpractices/software.html

In the two countries, both targets and standards have been implemented.[14]

- The BACT standards under the Clean Air Act in the United States,[15] in combination with the targets within voluntary programmes;
- The definition of industrial efficiency performance standards in China, in combination with a more ambitious voluntary ("reach") standard, energy efficiency appraisals for new large industrial projects, and the company-level targets under the Top-10 000 Enterprise Program.

In China, administrative measures that define the level of EE effort, such as mandatory targeting and regulations, codes, and standards play a prominent role in China's policy package and are defined in prescriptive terms. These top-down measures have certainly played a key role in the energy efficiency gains achieved in the 11th FYP and will continue to do so during the 12th FYP. A report by Tsinghua University and the Climate Policy Initiative has estimated that China basically met its 20% energy intensity target the achievement of a 19.1% improvement (CPI, 2012).

Company reporting and verification of these effort-defining policies is an issue though. Companies report directly to the government, and there is no transparency regarding the data, even in aggregate form. In addition, third party verification is absent at enterprise level, as well as provincial and national levels (Price et al., 2011) leading to uncertainty as to whether implementation is being fully undertaken in spite of stringent provisions.

In comparison, until 2011, the United States had only a very limited focus on mandatory GHG emission or EE effort-defining policies, which hampered the effectiveness of its policy packages. Today, the CAA policy works on the bottom-end of the market limiting GHG emission levels, while the voluntary targets encourage companies go beyond these actions and aim for higher ambition levels. The voluntary programs have assisted firms in identifying and realizing energy savings through project implementation and technical and educational. Another recognised benefit of these programs is the opportunity to network and share EE-related information among peers. Awards, letters and certificates recognising achievement are provided as incentives for participation.

However, no penalties are given in case of non-participation in the voluntary agreements. Furthermore, it is not clear whether these voluntary programmes are complementary or competing, and institutional coordination could be improved (e.g. EPA's Energy Star for Industry is similar to DOE's Better Building, Better Plants or Save Energy Now Programs). The programs do not appear to have been properly integrated or linked, although there is evidence that the SEP will become a subset of the Better Buildings - Better Plants.

Another issue is whether and how should the two major types of effort-defining policies, targets and standards, be combined? In general, targets and standards can be complementary (i.e. synergistic and hence desirable) as long as they differ in scope, i.e. if the total amount of energy use and/or emissions that are affected by the instruments is different, or if they affect energy use and/or emissions from different sources. When the scope is similar between targets and standards, the added value of combining both instruments becomes limited and can lead to effects such as reduced support for either instrument, increased transaction costs or duplication of efforts, negatively affecting both effectiveness and efficiency (Reinaud et Goldberg, 2011b). This is supported by Duval (2008) and Tinbergen (1952) in Hood (2011), who note that there should be no more than one policy instrument for each policy goal because where policies overlap, interactions can be complex, may be constructive or damaging, and imply loss of flexibility and higher administrative costs. Instrument combinations can be desirable if they address different barriers or different target groups.

There may be two reasons for this depending on the design details of each of the policy types. In the first case, where targets are combined with pricing mechanisms such as tradeable permits, economic theory, as widely discussed in the literature, suggests that this is an inherently

[14] Standards, here, are defined as minimum efficiency standards (or maximum energy consumption or emission standards), defined either at the level of equipment (motors and drives or steam boilers) or processes or products (production of cement and steel).

[15] The recent BACT requirements under the Clean Air Act have the potential to drive efficiency improvements and reduce emissions; however, the political will and the resources to deploy the new CAA provisions at the State-level are still uncertain.

cost□effective method, as it encourages abatement to be made first where it is cheapest (see Hood, 2011). If standards were to be applied to the same scope and target group as the targets-and-trading mechanism, then the target group would be obliged to implement mitigation options to meet the standard, regardless of the cost of those options. This would thus offset the effect that the flexibility of targets-and-trading provides to participants to choose abatement within their own facility or through trading. In the second case, where there is no trading coupled with targets, then the standard would simply be a direct overlap (i.e. to drive abatement within the target facility) of the taregt. This would therefore duplicate efforts and increase administrative burden of having to demonstrate compliance with the two instruments.

In the Chinese context, while no analysis exists to date, the combined application of performance standards on industrial processes/products with the Top-1,000 targets target the same group and scope. Nonetheless, the interaction between both mandatory policies would not seem to be negative, as the former prevents lock-in of inefficient installations, while the latter encourages performance beyond the standard. Similarly, in the US, the interaction would not seem to be negative, since the mandatory BACT standards would apply to specific technologies whereas the targets are voluntary programs for the companies who wish to go over and above the minimum standards.

Capacity to define mutually reinforcing supporting policies

Beyond this core set of effort-defining policies, further measures to address the need for increased investment capital and to better inform companies of their energy efficiency opportunities are likely to be desired. However, before implementing such policies, their costs, benefits and interactions with the effort-defining policies needs to be assessed. As mentioned by Hood (2011), even though there is a justification for policy intervention does not mean that the benefits outweigh the costs.

In China, a wide array of measures supporting the mandatory EE targets have been implemented in recent year including financial support and rebates as well as electricity pricing mechanisms, an ESCO programme and energy management requirements under the Top-10,000 programme (as discussed in previous section). The ESCO program, financing regulations, and energy management requirements will likely help to reduce information and financial barriers, and electricity pricing and rebates will give added incentives to meeting energy efficiency targets and standards. Nonetheless, some particularly important areas that could be improved include energy auditing and energy management. Energy auditing in China currently is more focused on accounting (how much energy is used where) with less emphasis on assessing energy saving potentials (Bo et al, 2011). Energy managers are also required, and new energy management system requirements have been mandated but these have not yet been adequately implemented with appropriate training and technical assistance.

In the US, as mentioned above, there are only a small number of federal supporting measures that are linked to energy efficiency and/or emission reductions. One of the exceptions are the in-depth plant assessments facilitated by the government. For large companies, these free assessments are now tied to companies' participation in the Better Buildings, Better Plants program and are considered to be relatively successful[16] considering that the lack of skilled industrial engineers is one of the major barriers in the US context and that the IACs have helped to significantly train and produce adept engineers (Chittum et al, 2009).

The US SEP has the potential to overcome barriers present in the US, including misunderstanding of business value, lack of staff and management awareness, lack of cross-departmental cooperation, outdated accounting techniques, restrictive budgets and fiscal criteria, lack of management accountability, lack of external technical expertise (see Brown et al., 2011, Chittum et al. 2009). However since SEP is currently voluntary, it is not clear whether the market uptake will

[16] For the largest, most energy-intensive plants a three-day system assessment can be received from a DOE Energy Expert. Small- and medium-sized plants can apply to receive a one-day assessment from one of DOE's university-based Industrial Assessment Centers.

be large enough to realise the potential across US industry. Additional supportive measures could be tied to it to promote its widespread adoption. Based on the analysis of EE barriers in U.S. industry, to help accelerate market transformation for facilities and service providers, Brown et al (2011) suggest the design of several new federal supporting measures. One of their recommendations includes a federal policy to promote the adoption of the SEP program that would link SEP certification to tax credits or other financial incentives. [17]

Detailed and comprehensive implementation toolbox

As well as ensuring that a country has an ambitious effort-defining policy in place with supporting measures, an implementation toolbox is a key element for ensuring an effective policy package. These tools are the instruments that assist the target group in meeting the requirements of policies effectively and efficiently. The tools may be definitions, standardised methods, lists of eligible technologies or practices, information on options for meeting obligations, training, or guidelines for how to monitor and report data. The implementation toolbox may be either developed within the regulations of an effort-defining policy or a supporting measure, or may underpin them as separate tools.

For example, international best practice is to set specific standards or guidelines for conducting energy audits that clearly outline the scope and procedures to be used to conduct an assessment. Standardized methodologies, auditing tools, training for energy auditors, and reports that provide detailed recommendations are key elements of a high-quality auditing program (Levine et al, 2010).

The US has a relatively elaborated toolbox, with well-defined rules and modalities and many different tools, guidance documents, etc. This is an area where much more attention is needed in China, where such support is often either largely missing or developed too late. More guidelines and tools to help implement its supporting programs (e.g. energy auditing, benchmarking, information dissemination) could be designed. For example, the Top-10,000 program currently has not developed a systematic means for gathering or disseminating energy efficiency information sources to the participating enterprises. Energy auditing standards, guidebooks, tools, and training should also be developed and disseminated to enterprises, sector associations, universities, energy conservation centers, and any other entities involved in energy auditing in China (Levine et al, 2010).

It is also critical to develop appropriate training materials that will assist companies in identifying their energy saving opportunities. For example, in China, at the national level, trainings on energy audits are less regular and focus largely on providing enterprise managers and outside auditors with instructions on making preparation for the mandatory audits and understanding the government requirements for reporting energy audit results. At the provincial and local level, local energy conservation/supervision centers have been providing training to enterprises on energy audits. But these trainings have focused largely on laws and regulations, energy-reporting procedures, as well as data collection for reporting rather than on deepening enterprises' understanding of technical and economic potentials of energy-efficiency measures. (Bo et al, 2011). To the same extent, the competence of energy managers must be improved.

Conclusion

This paper has proposed a classification method to analyse the ability of a country's policy mix to define and meet energy saving and GHG reduction goals in the industrial sector. This "Policy Pyramid" methodology forms the basis from which policy interactions can be analysed, providing

[17] Incentives would include 1) a federal production tax credit for energy efficiency savings of facilities that become SEP certified; 2) the ability of verified energy savings to be counted as an energy-efficiency credit in compliance with meeting energy-efficiency or renewable energy portfolio requirements; 3) an energy-efficiency grant for 30% of eligible certification costs; and 4) recognition programs (Brown et al, 2011).

further insights into policy overlap (such as redundancy or competition), the absence of drivers that motivate companies to undertake EE actions, or the lack of measures to address or reduce barriers.

Based on a high-level assessment of the national and federal policy packages in China and the US, the report concludes that there are certain minimum elements critical to the success of a policy package, which should be tailored to specific industrial and national circumstances. Firstly, effort-defining policies are the most important driver that governments can provide. Mandatory approaches usually work best, although voluntary approaches can also be effective if tied to incentives such as tax rebates and external recognition programmes. China has clearly been able to design mandatory targets and standards to drive EE levels and avoid inefficiency lock-in. The combination of minimum standards and targets can be beneficial in some but not all circumstances, depending on whether targets and mandatory or voluntary, and the scope/system boundary of each. Further research into these interactions is necessary.

In the US, several voluntary effort-defining policies have been implemented. However, even though implementation tools are comprehensive and proactive companies are likely to have benefited significantly from the program, their lack of link to incentives and drivers are likely the cause of limited uptake. The BACT standards hold a more promising role for wider coverage although it is not clear which of the policies (standards or voluntary agreements) would result in higher EE levels at the individual company-level.

Secondly, effort-defining policies need to be underpinned by supporting measures that reinforce drivers or remove or reduce barriers. The newly developed financing incentives and regulations, and promotion of ESCO services are positive signs that China is considering how to reduce barriers to EE financing. However, it still has a way to go to implement supporting measures that will reduce the informational, organisation and institutional barriers that seem to be widely prevalent. Now that China's 12 FYP action plan is in place, national supporting measures should be designed to guide local governments in providing adequate implementation support and in improving technical capacity and expertise.

Finally, the success of energy/GHG goals relies on the ability of companies of implement EE actions. A comprehensive implementation toolbox is therefore critical to the success of a policy package as it equips companies with practical methods of improving their EE. In the US, the success of it voluntary schemes and targets are owed to the tools, case studies, industrial system assessments, an energy management advice that are provided to companies. In China, it is of great importance that the government steps up its efforts to provide tools, training, technical expertise and energy management advice.

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