# Proposed Framework: Design of a Pilot Tradable Intensity Standard System[1]

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## Background

The Cancun agreement made important progress in rebuilding confidence towards a global solution by advancing the issues around international finance for developing countries and monitoring, reporting and verification. Challenging issues pertaining to the form and ambition of developed and developing country commitments remain largely unresolved. The global community is particularly looking to the United States and China, as the largest emitters, to further develop their domestic plans of action, which in turn could enable others to accept tougher domestic obligations.

In China's case, the plan for climate action must coincide with current priorities to improve energy security, tackle local environmental issues and raise long-term industrial competitiveness, all of which are potentially consistent with China's efforts to control greenhouse gas emissions. At the same time, China's policies must be consistent with the notion of differentiated action as compared with developed countries. Against this backdrop, China's State Council announced at the end of 2009 that China is going to reduce the intensity of carbon dioxide emissions per unit of GDP in 2020 by 40 to 45 percent compared with the level in 2005. In March 2011, Premier Wen mentioned in his Government Work Report [1] that in the 12th Five-year plan period (2011-2015), China's carbon dioxide emissions per unit of GDP should decrease by 17%; the government plans to carry out research and then establish guidelines on how to place a price on pollution emissions and carry out emission permits trading. In the meantime, the twelfth National Economic and Social Development Five-Year Plan [2] also set up a separate chapter illustrating China's plan in coping with global climate change, in which "controlling greenhouse gas emissions from industry, building, transport and agriculture sectors" and "gradually setting up carbon emission trading market" are clearly written in the "to-do" list.

[1] These framework recommendations were developed following multi-stakeholder workshops on trading system design options. The workshops and framework recommendations were made possible with financial support from the UK Foreign and Commonwealth Office, Low Carbon High Growth Strategic Programme Fund China. Although the workshops and framework paper were carried out with support from the UK FCO, the views expressed are those of the authors and do not necessarily represent the opinions of the Authority.

China's expressed interest in carbon pricing mechanisms can drive achievement of the stated carbon intensity targets at the lowest cost. However, the design of the program will be very important to ensure the system also advances efforts to raise industrial competitiveness and economic growth. For example, a traditional cap-and-trade system that sets an absolute upper limit on emissions seems to be politically unpractical in large developing countries such as China where such a limit could stymie development priorities. It is also technically infeasible because developing countries' economic growth is less certain, making it more difficult to set an aggressive yet realistic emissions cap. Therefore, for developing countries such as China, intensity control seems to be more realistic at present. It is also in line with China's released intensity control targets.

Under these contexts, the Center for Clean Air Policy has developed the concept of "tradable intensity standard" as an alternative means to set a market price for reductions in emissions. With a Tradable Intensity Standard, each firm in the domestic industry sector (e.g., iron and steel) is required either to meet the intensity standard (expressed as emissions per unit output) or, if they exceed that intensity, to submit an allowance or credit to the government to cover the excess emissions; firms that beat the intensity standard earn tradable allowances or credits [3]. This new intensity-based trading system addresses concerns that an emission trading system would limit developing countries' room for development.

To explore the possibilities of implementing tradable intensity standards in China, Tsinghua University and the Center for Clean Air Policy held workshops to gather feedback from a range of stakeholders, including representatives from government, industry and research institutes. Based on feedback received, the following sections highlight the potential advantages and challenges with implementing such a program.

## Case Study: Applying Tradable Intensity Standards to China's Iron and Steel Sector

The iron and steel sector has been chosen as a potential case study to evaluate the implications of a Tradable Intensity Standard in China for the following reasons: (1) it is one of the biggest emission sources in China, accounting for approximately 15% of total national $CO_2$ emissions; (2) its industrial concentration level is high compared to the cement sector – another big GHG source that takes up about 10% of national emissions; at the same time, developing policies for the iron and steel industry is not as politically and economically sensitive as it would be to establish intensity limits in the power generation sector.

China has surpassed the rest of world in steel production for the last 15 years. In 2010, the steel production in China reached 627 million tons, as reported by China Iron and Steel Association [4], which is 10% more than the previous year. Figure 1 shows the development of crude steel production in China from 2000 to 2010. Except the year 2008 when the world was hit by the financial crisis, China's iron and steel production has been growing at an annual growth rate of 17%.

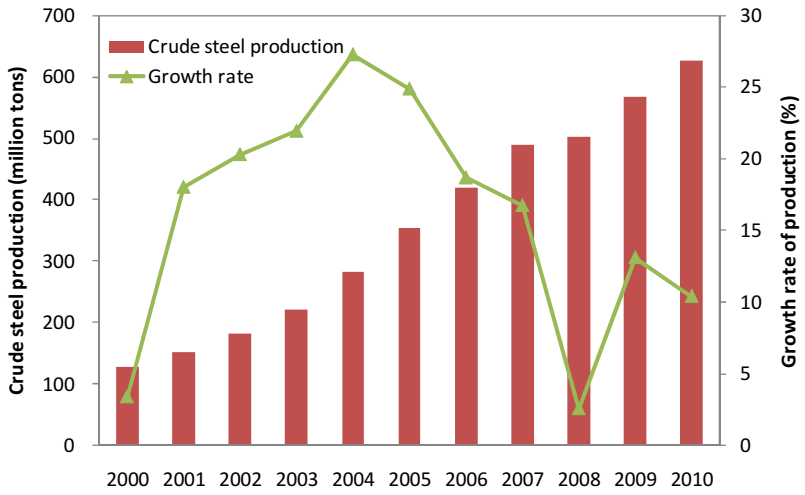


Figure 1. Crude steel production and its growth rate in China from 2000 to 2010

According to China's Energy Statistics Yearbook, the $CO_2$ emissions from industrial sectors can be roughly calculated based on energy consumption data. In 2008, the $CO_2$ emissions from the iron and steel sector were about 916 million tons, which corresponded to an emission intensity of 1.83 $tCO_2$/t-steel.

Importantly, China has already implemented a number of unilateral actions that are reducing greenhouse gas emissions in the iron and steel sector. Specifically, China's recent mitigation actions already include the following six aspects:

(1) *Shutting down small and inefficient plants*: During the 11$^{th}$ five-year plan, China's iron and steel sector had eliminated a cumulative total of 117 million tons of backward iron production capacity and 69 million tons of backward steel production capacity, which were 1.17 and 1.26 times the original elimination plan. In the Restructuring and Revitalization Plan of Iron and Steel Industry established in 2009, it was also planned to shut down 72 million tons of iron production capacity and 25 million tons of steel production capacity from 2009 to 2011, which would extend the shut-down scope from the original 300 $m^3$ or below blast furnace and 20 t or below BOF/EAF to 400 $m^3$ and 30 t.

(2) *Setting up clear energy intensity and emission intensity targets*: In the Restructuring and Revitalization Plan of Iron and Steel Industry, the industry enacted a nationwide limit on energy consumption per ton of steel produced by key big and medium-sized iron and steel plants (620 kgce), and a similar limit on the amount of $CO_2$ emissions per ton of steel produced (1.8 kg). Three energy intensity standards--a) the norm of energy consumption per unit product of major procedure of crude steel manufacturing process, b) the norm of energy consumption per unit product of coke making, (c) the norm of energy consumption per unit product of ferroalloy--have facilitated the realization of these plans. It was reported that the comprehensive energy consumption per ton of steel in China at year-end 2009 was 615 kgce, 11.4% lower than in 2005 [5].

(3) *Increase the level of industrial concentration*: The State Council had published several opinions on enhancing energy savings and emission reductions and speeding up structural adjustment in the iron and steel sector in 2010, in which it aimed to increase the production share of the top 10 iron and steel corporations from 44% in 2009 to 60% in 2015. In the Iron and Steel Industrial Development Policy established in 2005, the State Council also set out a goal to achieve a 70% concentration level in the industry by 2020.

(4) *Establish technology standards/thresholds*: The Iron and Steel Industrial Development Policy set out the minimum scale for various types of facilities in this sector, which included the minimum utilization area of a sintering machine, the minimum height of the carbonization chamber in a coke oven, the minimum effective volume of a blast furnace, as well as the minimum capacity of BOF and EAF units. It was also required that all new blast furnaces must be set up together with Top Gas Pressure Recovery Turbine (TRT) and Pulverized Coal Injection equipment; all coke ovens must have Coke Dry Quenching (CDQ) equipment; and all coke ovens, blast furnaces and BOFs must have gas recovery equipment. Combined cycle power plants (CCPP) were also encouraged for use in the iron and steel sector.

(5) *Differentiated electricity price*: Unfavorable electricity prices were imposed on the highly energy intensive iron and steel plants in China. Meanwhile, subsidies were rewarded to good performers in the areas of energy saving and emission reduction.

(6) *Export policies*: Feebate policies have been implemented to limit the export of low value added iron and steel products which are also energy intensive and resource intensive.

Even though China has implemented all the above energy saving and emission reduction policies, according to an officer in the Department of Industrial Policy from the Ministry of Industry and Information Technology in September 2010, backward production capacity still accounted for 20% of the total capacity in China's iron and steel sector [6]. The total production capacity in China's iron and steel sector was about 770 million tons at the end of 2010 [7]. Therefore, the backward production capacity is about 150 million tons. Based on this "production capacity mix" perspective, China's iron and steel sector still has considerable potential to yield additional emissions reductions. However, from a pure "technology mix" perspective, China's iron and steel sector is mostly based on BF-BOF technology. While many developed countries have a much lower energy intensity and emission intensity stemming from a large share of EAF technology, this is not practical for China at this stage due to a lack of scrap. Direct reduction iron (DRI), used extensively in Mexico and in some other countries, is a novel iron-making technology for China. This technology uses natural gas or coal as the reducer for iron ore or iron oxide to produce iron. Natural gas-based DRI is more energy and emission efficient than BF-BOF, however it is rare in China due to low historic levels of natural gas resources, particularly in relation to the very large domestic supply of coal. However, this could change quickly if the recently identified economic resource of shale gas is realized. Coal-based DRI is being tested in China, however the energy and emission intensity is even higher than for BF-BOF. Therefore in the short run, the potential for further emissions reductions still lies with use of more efficient BF-BOF technology. However, as China policy makers gain confidence in recent estimates of domestic natural gas resources stemming from shale gas deposits,

natural gas-based DRI may become more feasible as a means of reducing the carbon intensity of steel production in China.

With the establishment of the national economy-wide target at -40-45% below 2005 levels, the question was raised as to whether this target is directly applicable to the iron and steel sector. However, from Figure 2 [8] below, with the current technology mix in China's iron and steel sector, even if all the current BF-BOF facilities can be upgraded to advanced BF-BOF, the feasible target would be around -14% below 2005 levels. Therefore, the costs and limited reduction potential in the iron and steel sector suggest a less aggressive standard in the near-term.

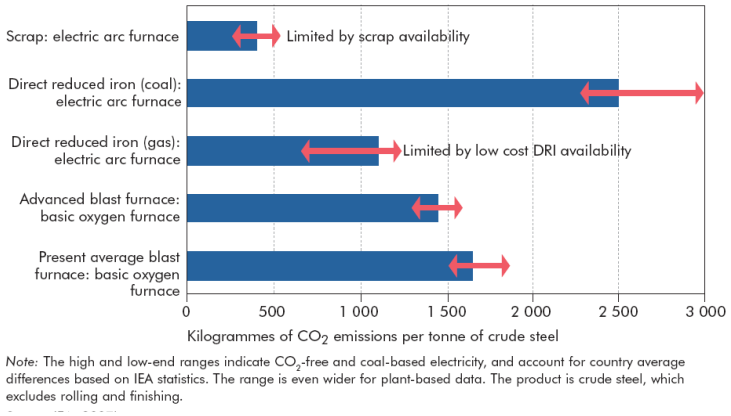


Figure 2. $CO_2$ emissions per tonne of crude steel produced

If trading is used to facilitate a more aggressive standard, whether based on more advanced BF-BOF technology or development of shale gas resources to support natural gas-based DRI, we suggest use of a tradable intensity standard (TIS). A TIS is a promising option for the iron and steel industry (and for other large industrial sectors such as electric power) as it allows for continued increases in production (whereas cap-and-trade establishes an absolute limit on emissions, which could mean a limit on production if forecasts are inaccurate or not adequately considered). Production will be higher under tradable intensity standards than with a cap-and-trade. This is even true with free allowances. (Free allowances provide a lump sum payment, but don't affect the marginal cost of production.)

A TIS also results in lower marginal costs than other options because it is not necessary to purchase allowances to cover every ton of emissions, supporting China's industrial competitiveness.

## TIS Program Description

In this section, we will be giving a brief introduction of a Tradable Intensity Standards (TIS) program, hoping that it could play some role in achieving China's emission intensity target in fast-growing, energy intensive and/or internationally competitive sectors, such as iron and steel.

As described in the background section, an intensity control target may be more realistic and feasible in developing countries than the cap-and-trade alternative. In a TIS program, each facility in the sector (or

subsector) faces a mandatory limit on emissions per unit output. The TIS program would not impose absolute limits on sectoral emissions, i.e. if output grows, emissions can grow. Facilities that reduce emissions below the standard earn credits from the government for each ton below; yet facilities with emissions above the standard must buy credits in the market for each ton above and surrender them to the government. The TIS could be unilateral (China only) or it could be linked to the international trading market.

## Linking to International Markets

We would not recommend rushing into a linked international market right away, because, first, an international market that is ready to accept sectoral credits is not yet well developed; second, keeping the program China-only gives China more control than in a linked market, and it ensures the use of low-cost measures to meet China's target. Third, even if an international market is ready, keeping it a China-only program could eliminate the possible situation that China would be a buyer rather than a seller.

However there are also disadvantages of a China-only TIS program. The biggest disadvantage is that net supply and demand could vary a lot. For example, it is possible that the carbon emissions reduced below the standard will greatly exceed emissions above the standard (net supply), or vice versa (net demand). The government will need to play a role to manage net supply/demand and prices. Specifically, it is desirable to set a more ambitious standard, so on net, there is more demand than supply. The government would then have the ability to regulate prices and facilitate compliance by selling extra allowances. We recommend setting a price floor, perhaps supported by the Green Climate Fund.

A linked program might work in this way: (1) First, a baseline intensity standard is set (through international negotiations) for international crediting, and both domestic and international credits may be used by covered facilities in China as a means of compliance; (2) Second, Chinese companies that purchase credits from the international market turn them in to the Chinese government to demonstrate compliance with the standard; (3) Third, the government gets credits from an international body if the sector as a whole beats the baseline standard, but if it fails, there is no penalty (i.e. no lose); (4) Finally, the government gives both the credits turned in for compliance purposes AND the international "overcompliance" credits to efficient facilities that beat the baseline. (The total credits would exactly equal the credits "earned" by winning firms that beat the standard.) Thus, the winning firms would get a credit for each ton by which they beat the baseline.

The result is that all firms in the sector—those that are above the standard and those that are below--would face the full international carbon price signal to motivate emission reductions. Each firm would have certainty about the amount of credits it would receive for beating the intensity standard, and that certainty would make it easier to secure up-front private financing for emission abatement projects.

In a linked program, as the market is larger and more liquid than a domestic one, it creates more stable prices and reduces uncertainty for investors, because they know they will get the international carbon price for each ton by which they beat the standard. It also provides good incentives for private

investment capital for mitigation investments. The domestic carbon price will be equal to the international one.

## Trading Within and Across Sectors?

We would recommend starting with the iron and steel sector only, on a pilot basis. Preferably, the pilot would be tested nationally and apply to all iron and steel plants. However, the pilot could also be done in a region where there is significant iron and steel production above a threshold.

Later, if the TIS program works well in the iron and steel sector, additional sectors could be regulated under a TIS, and trading across sectors could be planned, adding additional compliance flexibility. Different intensity baselines would be set for each sector. Instead of purchasing credits from plants within the same sector, in a multi-sector trading system, an iron and steel plant that needs to buy credits to continue its production can turn to facilities in other sectors which have surplus credits to sell. Ideally, in a multi-sector trading system, it further ensures that the emission reduction happens in the places where mitigation costs are the lowest. Instead of measuring whether one sector beats the baseline, the government would measure all sectors in this multi-sector trading system and get credits for the overall net deviation from baseline intensities generated by all sectors.

## Emissions Banking

Emissions banking is widely used in emissions trading programs to allow regulated entities to better manage their mitigation investments over time. Emissions banking should similarly be used under a TIS. The main challenges may relate to ensuring the value of banked allowances from one five-year period to the next, and determining the amount by which banked allowances should be discounted in the transition to a linked trading system.

## Offsets

Domestic offsets can provide an additional source of compliance flexibility to sources subject to a domestic (China-only) TIS and can help lower compliance costs. This could include domestic CDM projects or potentially development of a domestic offset program covering sectors and small sources that are unlikely to be regulated. In a linked market, Chinese sources would have the option to use international offsets for compliance.

## Compliance and Enforcement

Compliance is demonstrated through reports of emissions—including emissions reductions purchased/sold in trades—and production output. Given that both the measurement of emissions and the trading mechanisms would be new to the iron and steel industry, it may make sense to undertake these measures more on a trial basis in the first year or two. So long as the industry participates in good faith, penalties for non-compliance might be low in the initial one to two years to build experience and trust in the mechanism. After such a trial period, relatively high automated penalties would be adopted, as this is the major incentive for compliance. In other words, non-compliance must cost significantly more than compliance through purchase of allowances.

### Relation to the CDM

When implementing the TIS program, the relation to CDM projects in the iron and steel sector must be clarified. In the current China's CDM markets, most of the projects are in power generation sector, such as small hydro, wind, biomass and solar PV. In China's iron and steel sector, there are mainly two types of CDM projects, both in the energy saving and energy efficiency category: combined cycle power generation (CCPP), and coke dry quenching power generation (CDQ).

One option is to "wall off" CDM projects that are already "in the pipeline". Facilities that are already receiving or will receive credits from CDM markets that are already underway could not use the emission reduction to participate in TIS program, as this would result in double crediting. Essentially, the same emissions reductions would be used to take credit for emissions reduction in China AND in another country that purchases the CDM credits. Another option to prevent double counting would be to limit CDM opportunities to smaller facilities not covered by the TIS. These are just rough strategies to cope with double crediting issues. More nuanced partition methodologies should also be developed and evaluated.

## Program Impacts

Compared to the more common cap-and-trade market mechanism, a TIS will result in the following practical differences for affected sources.

Inefficient facilities do not need to purchase allowances to cover their total emissions; rather, they only pay for emissions in excess of the intensity standard. Therefore, their marginal production cost rises less compared to C&T. Consequently, their production falls less than with C&T.

Efficient facilities also do not need to purchase allowances to cover their total emissions. Rather, they receive credits—including allowances purchased by inefficient facilities and credits issued by foreign governments for any sector-wide over-compliance. These credits provide a marginal incentive for each unit of production. In addition, the TIS program, characterized by no control on absolute emissions and production, will provide an incentive for efficient facilities to produce more in order to have more emissions lower than the intensity standards, which translates to more credits earned.

It is anticipated under a TIS program that big steel manufacturers are likely to have an easier time meeting the standard and will serve as sellers to smaller firms. This would further advantage the larger manufacturers while disadvantaging the smaller ones (which represent about 20% of production). While some experts express concern about monopoly power, this policy seems directionally consistent with government policy supporting greater convergence in the industry.

## Key Technical Issues to Address

The following are some of the key technical issues that must be addressed to support use of tradable intensity standards:

1. **Considering the production technology in setting the standard.** A key question is whether a single intensity standard is set for the entire industry sector (advantaging the small number of existing EAF facilities and encouraging new cleaner forms of production), or whether standards are differentiated based on the main steel industry production processes (BF-BOF, NG-DRI, Coal-DRI, EAF). A representative from the steel industry confirmed the necessity of having separate standards. It may also be possible to begin with separate standards for the different production technologies, and move to a more unified standard over time, particularly if lower-emitting shale gas resources become a reality.

2. **Source boundaries.** The definition of a source within a sector is more important under tradable intensity standards than under a traditional cap-and-trade program. Under tradable intensity standards, the emissions from each covered source will be directly compared with a performance standard derived from a high performing source within the sector. As a result, it is important that each source has the same manufacturing processes included within the source boundary to ensure this comparison is fair. Concerns were raised about use of comparable boundaries in the iron and steel sector, where some facilities use an integrated manufacturing process that includes coke manufacture, whereas others purchase coke and do not produce it at their own facilities. This issue can be resolved by having separate standards for different steel industry configurations.

3. **Measurement methods.** Accurate measurement of emissions is critical under any type of emissions trading system. Questions were raised about whether such measurement is possible to do both accurately and economically in the iron and steel sector. The steel industry representative cited different methods used by different international associations. Therefore, further research is needed to assess and explain methods used under the European Emission Trading System, the U.S. reporting rule, and the Indian Perform, Achieve and Trade program, and then decide which method is most suitable for China and whether it is necessary to make adjustments to account for China's specific circumstances. The participant from Tianjin suggested it may be possible to improve MRV while simultaneously setting up a market. To implement even a pilot project on TIS, we need to greatly improve technical, operational, management and monitoring capacities.

4. **Double counting.** This is related to using which measure as the denominator of a performance standard. If using crude steel for BF-BOF, plants could manipulate intensity by altering scrap use in BOF. The ratio of using scrap could vary between 10% - 30%. That is why in EU, the allocation methodology uses liquid pig iron as the denominator. Liquid pig iron, or hot metal, is the hot, liquid, metallic iron product obtained upon reduction of iron ore. It is the primary input for production of steel in the integrated steel plants. However, the steel industry representative from China raised the issue of double counting in using hot metal as the denominator of a performance standard.

5. **How to convert from a domestic market to a linked market?** As a domestic intensity standard becomes more stringent, it may become desirable to take advantage of enhanced liquidity and lower price volatility offered by the international marketplace. The transition should be fairly straightforward, except for treatment of any allowances that were banked under the China-only program. These banked allowances are excess reductions that would have been made in past years, and may have been made at a lower allowance price. It would need to be agreed how these past emissions reductions would be recognized under a linked trading program. It would be possible to simply trade these allowances for international credits, but potentially not on a 1:1 basis. Precedents for this can be seen in the transition to the U.S. Clean Air Interstate Rule and the transition from the Northeast Ozone Transport Commission program to the NOx Budget Trading Program.

6. **Monitoring frequency and capacity.** It is also vital to decide when and how often facilities must report their emissions to the government, and the frequency with which the government should monitor compliance. Additionally, it will be necessary to ensure that regulated entities and government officials have the capacity needed to undertake these tasks. In terms of frequency, one option is to report and monitor performance at the end of each five-year plan. Another option is to monitor it at the end of each year. Of course even more frequent monitoring is also possible. Additional research is needed on how big these transaction costs are likely to be for industry and government, and how can they be minimized while still providing the data required to successfully implement the program. Capacity needs also must be evaluated. For example, do the current administrators and the plants have the enough capacity to carry out monitoring, measuring and reporting tasks? Are there necessary management rules and corresponding institutions? From the third workshop, designers of the $SO_2$ emission trading scheme in China emphasized the great difficulty to bring up the institutional and personnel capacity. And in terms of TIS policy, both emissions and output must be reported for the same source boundary.

7. **Other institutional and capacity barriers.** Concerns were raised by representative from environmental exchanges that under the current energy saving and emission reduction management system (characterized by provincial-level target decomposition, and the target responsibility system) in China, governors at the provincial level may not be willing to allow sales of their "surplus" credits in the middle of a five-year plan. Rather, they would be likely to wait to allow sales of excess reductions until the end of the five-year plan, when they are sure that the credits would not be needed. This would not be an issue for a provincial-level pilot, but it would affect the cost-effectiveness of a national-scale pilot program, and could result in provincial-level market prices, each with its own allowance supply-demand balance. Another concern raised at the third workshop (in the context of applying TIS regulation to the electricity sector) that under the context of "coal price decided by market but electricity decided by plans", a majority of generating units in China (nearly 73% of the total generating capacity) are actually losing money by operating. Many coal plants are still running right now, not because of economic benefit reasons but to fulfill social responsibilities (e.g., prevent electricity shortages

and unemployment). Therefore there is a possibility that a TIS program might not provide enough economic incentives for those generating units to start energy saving or technology upgrade work, and could drag them into even more disadvantage place and further reduce their motivation to generate electricity, risking the financial health of the industry and/or resulting in severe social problems.

## Political Challenges

The following political challenges were raised during the workshop discussions.

First, industries usually do not prefer to be targeted for TIS regulation (or any additional regulation), as expressed by the steel industry. There are various reasons for self-defense: the technical issues are too complex; the costs are too high; our international competitiveness is already low; we don't have enough capacity; etc. This is understandable because industry usually lobbies for exclusions, and short of that, easier targets. The real technical and other barriers to effective participation would need to be addressed. Many of these challenges were described earlier.

Second, some industries may be willing to participate but their reduction potential might be limited. The electricity sector in China is the case. This sector had already reacted positively to emission reduction, and saw some advantages to a TIS approach. They are reporting carbon emissions, and are conducting research on setup of MRV and analysis of targets. Due to the hard energy saving work during the 11$^{th}$ five-year plan, 60% of the current generation capacity is new and efficient, and much of the older capacity has been shut down. So there is quite limited potential for further emission reduction. However, a TIS design deserves more study to evaluate how this mechanism might be used to undertake additional efficiency improvements, additional shut downs of the least efficient plants, and support investments in new natural gas baseload capacity making use of (lower-emitting) shale gas resources.

### Incentives to Participate in a TIS Program

A key consideration is to ensure that both buyers and sellers have an incentive to participate in trading. An expert involved in $SO_2$ emissions trading design and practices mentioned a dilemma that happened in the $SO_2$ emissions trading market. The overall emission reduction target was allocated to provinces and then cities that were in the $SO_2$ control zone. As $SO_2$ emissions are mainly produced by the electricity sector, power plants were key to realizing the reduction target. However, as the credits for $SO_2$ emissions essentially represent room for development, and development brings in tax incomes, there were many active municipal government buyers yet many passive sellers. To solve this problem and to increase both sides' incentives to participate, in the 11$^{th}$ five-year period, NDRC decided to list out each province's emission reduction target for electricity sector separately and took that as the assessment indicator for the whole province (rather than having the province evaluate each city's performance in electricity sector's emission reduction), which greatly promoted inter-provincial $SO_2$ emission trading. This is a very good example of how policy design influences participation incentives. While a TIS does not create an absolute limit on growth (facilities may increase production as much as they want so long as they meet the emission standard, whether at their own facility or through purchases), the above-

mentioned factor should also be considered. Another $SO_2$ emission trading expert mentioned that an appropriate tax scheme will be very important. If high tax rates are imposed on the credit-selling income, this could greatly discourage facilities' motivation to participate.

Furthermore, a good external environment will also increase facilities' incentives to participate, such as media praise and good performance recognition from a higher-level government.

## Key Capacity Building Steps for Implementing a TIS

As stated above, the key institutional and capacity building points include the following:

First, accurate measurement of emissions and high-quality emission data gathering will be critical. These relate to drawing the right boundaries, choosing the appropriate methodologies to measure emissions, educating qualified people to report $CO_2$ emissions, installing advanced on-line monitoring equipments/sensors, selecting an appropriate frequency of emission/production data, training qualified institutions to verify these data, etc.

Second, capacity is needed to build an effective carbon trading system and compliance assessment system. This includes building up the management institution, trading institution and trading platform for intensity-based carbon emission trading, making sure they have the necessary knowledge and capacity to ensure the operation of the system, comparing accurately a facility's emissions (or emission intensity) against its standard and tracking allowances needed versus allowance held.

Third, planning will be needed to support a fluent conversion from a domestic market to an internationally linked market (if used). This will involve negotiating a conversion factor for banked allowances, preparing all stakeholders for the differences between a domestic market and an internationally linked market, training and educating about how to manage the international linking, how to register and sell emission reductions in excess of intensity standards under an internationally linked market, design of incentives to participate to make sure there is sufficient motivation to achieve intensity standard under a no-lose assumption, etc.

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