The problem of creating an appropriate domestic sectoral climate policy by emerging economy governments is examined through the case study of India’s iron and steel sector. Unique circumstances and patterns exist in different sectors of emerging economies so a single international policy may be unable to reconcile subtle yet important country-specific drivers. Shortcomings in the form of distortions could arise if policies are designed with a short time horizon. A fully integrated, long-term and well-planned domestic policy is required. The emergence of a strong domestic carbon price to guide sector expansion is identified as a key feature for such a framework. Additional support through international cooperation would help to gain the necessary political support while stabilizing the policy environment and facilitating substantial sectoral abatement.

Policy relevance: Fuel savings and emissions reductions in India’s steel sector can be delivered firstly by improving energy efficiency in existing and new plants, secondly by shifting to efficient production processes, and thirdly by using steel more efficiently as a component or by substituting low-carbon alternatives. The CDM only supports energy savings and emissions reductions from efficiency improvements in the production process, but cannot target the other two opportunities. Domestic policies, including improved product standards and carbon pricing, can create broader benefits for the Indian economy and global climate. However, to achieve domestic support for these measures, international cooperation and coordination are necessary. A key question is how support can be structured without providing subsidies for the production of a carbon-intensive commodity.

Keywords: CO₂ reductions; domestic policy options; India; iron and steel; sectoral approach
Indian steel production is expected to triple by 2020, with significant implications for coal consumption and carbon emissions. The opportunities are being explored to enhance energy efficiency and reduce carbon emissions by: (1) increasing the efficiency of existing and new plants, (2) the shifting of investment from the inefficient coal-based direct reduced iron (DRI) process to the blast furnace basic oxygen furnace (BF-BOF) process, and (3) creating incentives for efficient steel use. Different policy instruments are available to realize these opportunities, including Clean Development Mechanism (CDM) credits, carbon taxes, incremental carbon emission taxes, and administered standards. This article analyses the implications of these policies on the sector’s efficiency improvement and carbon emission reduction. The ultimate challenge is to gather political support for the implementation – linking domestic benefits such as reduced coal consumption and upgrading of technology with potential support from international cooperation.

The Indian iron and steel sector grew at over 7% per annum in 2005–2007 (MoS, 2008) and accounts for nearly 10% of country’s carbon dioxide (CO₂) emissions (Garg et al., 2006). Growth has been driven primarily due to a surge in demand for steel from the rapidly expanding infrastructure, housing and manufacturing segments. The country exported 10% of its steel output, but was essentially a net importer during this period. The nominal import tariff for crude steel has been fixed at 5% (MoS, 2009).¹

The analysis of primary steel production in India shows that energy efficiency and CO₂ emission intensity levels are still 50–75% behind the OECD average (IEA, 2007). The major reasons are small plant size, the emergence of small-scale coal-based DRI units, and a large contribution from old public-sector units (see Figure 1). A unique feature of the Indian scenario is that the

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¹ Figures and percentages are rounded for simplicity.
coal-based DRI process requires a significantly lower capital investment and exploits the local advantage of cheaper low-grade raw materials while employing unskilled labour. It accounted for 26% of country’s crude steel production in 2007, with over 350 small units, and the output was growing at 15% per annum (MoS, 2008). The other uncommon route, natural-gas-based DRI, is not expected to increase its share in India due to fuel availability and price constraints (MoS, 2008).

Despite significant performance differences between different primary crude steel-making routes (see Figure 2), firms in India continue to invest in the inefficient coal-based DRI process and are averse to taking up many of the potential energy efficiency measures. An industry survey (Sreenivasamurthy, 2008b) suggests that this is due to the high rate of return required by investors, which energy efficiency and modernization measures may not always deliver. While existing CDM schemes encourage some project-based efficiency improvements that result in reduced CO₂ emissions, they do not guide the sector towards low-carbon production processes. It was also found that limited data are available on the performance of the sector, which hinders the mainstreaming of climate mitigation into periodic planning guidelines for sector expansion.

The Bali Roadmap (UNFCCC, 2008) makes reference to ‘consideration of cooperative sectoral approaches and sector-specific actions’ and ‘various approaches, including opportunities for using markets to enhance the cost effectiveness to promote nationally appropriate mitigation actions (NAMAs)’ in order to enhance implementation of the Convention’s objectives. In line with these recommendations, this article evaluates various domestic policy options for intervention to lower the rising GHG emissions trajectory of the Indian steel sector.

![Figure 2: Primary steel-making performance comparison with OECD countries](Source: Planning Commission, 2006; IEA, 2007)
2. Existing policy ideas

In the post-2012 international climate cooperation talks, a number of schemes have been suggested to support specific actions in developing countries. While some researchers are investigating transnational technical cooperation (Baron, 2006; APP, 2008a), others propose a no-lose sectoral crediting mechanism (Schmidt et al., 2008) and best practice adoption (Japan, 2008). However, given the particular dynamics of a fast-growing sector in a free market with numerous players, these approaches may not be able to address the most fundamental concern: lack of factoring CO₂ externality costs into decisions at the levels of every firm (including small units) and of government. If initiatives by firms and governments continue to be voluntary, without specific objectives and time-lines for abatement, climate benefits will remain an afterthought in investment decisions.

A submission to the UNFCCC by South Africa (2008) points to the importance of sustainable development policies and measures (SD-PAMs) (see also Winkler et al., 2007). Their application to the Indian steel sector from the policy context is explored in this article. The analysis points to the importance of such bottom-up policies, which are able to influence every relevant decision made and are ambitious and long term.

3. What should the sectoral policy objective be?

The manufacture and use of steel is a resource-intensive and socio-economically complex activity, creating a deeply entrenched supply chain system in India. This implies that a holistic consideration of both production and consumption is required when proposing any climate policy for the sector. The broader policy objective should clearly be to help integrate climate mitigation into the decision-making stage and enable energy efficiency improvement of all production units.

Figure 3 illustrates three mechanisms that can contribute to reduced energy demand and carbon emissions relative to the business-as-usual (BAU) scenario for 2020. First, policies focusing on efficient technologies alone, such as waste energy recovery under CDM, typically help promote specific abatement projects while leaving the key drivers of emissions growth unchecked.

Second, an additional effort of ‘process shift’ could help divert new investments from the intrinsically less efficient coal-based DRI process to the large BF-BOF process. This is because climate protection effort eventually calls for progressively greater abatement from the steel sector, and policies should evolve to enable step-changes towards the most efficient metallurgical processes. The project-based mechanism fails to limit proliferation of inefficient processes and does not promote modernization of entire industrial units, both of which could deliver maximum climate benefits.

Third, the end-user requirement could also be partly met by more efficient material use (Worrell, 2007) and by substituting steel with other less carbon-intensive materials. Acknowledging that steel is inherently a carbon-intensive material, policies in the long term should promote material efficiency and substitution.

In summary, an energy efficiency improvement policy could deliver noteworthy emissions reductions by 2020. However, the inefficient coal-based DRI process would continue to contribute a disproportionately higher share of sectoral emissions (39%) than output (30%; tonnes of crude steel). Looking forward to 2030 and beyond, achieving additional sectoral abatement could well lead to tougher bargaining positions due to lock-in effects from the coal-based DRI process. On the other hand, shifting the structure to the most efficient large BF-BOF units would allow the industry to meet the same market demand and yet achieve further emissions reductions by 2020.
FIGURE 3 Different outcomes possible (represented progressively) from climate policies in the Indian steel sector (assuming that steel substitutes have limited emissions and a conservative production forecast from MoS, 2008) (for detailed assumptions, see the original source, Sreenivasamurthy, 2008a)
Finally, any additional efforts through material efficiency and substitution could help achieve substantive emissions reductions.

The costs involved for such a transition could be high. Capital expenditure for establishing a coal-based DRI induction furnace unit is around $200 per tonne crude steel (tcs) per annum, which is one-quarter of the expenditure for a large BF-BOF unit (Sreenivasamurthy, 2008b). However, the higher investment costs for the BF-BOF units result in subsequent savings in operating costs, and are thus profitable in the long term. Furthermore, large BF-BOF units require imported high-grade coking coal, making those units less competitive during periods of high global demand for the fuel (Sreenivasamurthy, 2008a) but, conversely, improve the competitive situation in times of declining commodity prices, as witnessed in early 2009. For detailed information on the latest steel technologies and their abatement costs see the APP handbook (APP, 2008b), IEA (2007) and Oda et al. (2007).

Nonetheless, certain co-benefits from such long-term integrated planning can be expected. These include reduced demand for coal (a primary energy source in India); lower local pollution levels, especially from coal DRI units; increased firm competitiveness; and the stimulus for local research and development activities in the steel supply chain.

4. How can this objective be met?

The broader policy objective should clearly be to help integrate climate mitigation into the decision-making stage for all production units. An important feature of the Indian business system is that private companies, and an increasing number of public firms, are largely dynamic and entrepreneurial in nature. If policies are enforced with clear guidelines, then firms tend to innovate and maximize individual benefits; as the example of the success of CDM in India illustrates (CII, 2008). This article now discusses how tailored domestic policies could help address domestic climate actions by creating appropriate economic incentives.

Existing Clean Development Mechanism

Although CDM incentivizes project-based initiatives, due to the inherent complexities of determining a baseline, satisfying additionality criteria, extensive monitoring and verification requirements and high transaction costs, most industrial firms are not motivated enough to apply for this scheme, especially when considering new builds or modernization (Hayashi and Michaelowa, 2007; Parthan and Bachhiesl, 2007). Thus, while CDM promotes easy-to-monitor project activities, it does not encourage abatement through complex modernization activities, choice of plant size, or the type of process adopted. Developing new sector-wide baseline methodologies under CDM would require redefining the existing guidelines and procedures.

Conversely, providing project-based incentives makes climate policies politically acceptable while generating minimum opposition from governments and industrial lobbies. This play-it-safe position is further reinforced by the urge to meet end-user demand through a metallurgical process which requires a short lead time and low capital costs. A lack of comprehensive technology cost curves to guide policy design for sectoral mitigation also adds to this complexity. Despite its political convenience, policies that achieve marginal abatement through energy efficiency improvement alone will have to be re-evaluated in order to avoid incentivizing suboptimal processes or plant sizes.

Proposed Policy 1: Harmonized carbon tax

Under this scheme, the government levies a charge to the firm for every unit of carbon emission (tonne of CO₂). In response to the tax imposed, firms then seek opportunities to minimize their
overall current and future tax liabilities by investing in cleaner technologies or extensive modernization plans. For new builds, firms would evaluate their carbon tax liability during the design stage itself on process type, plant size and choice of technology.

**Proposed Policy 2: Incremental emissions carbon tax or intensity-based rewards**

Firms prefer to avoid the imposition of taxes in the political process and subsequent implementation (Smith and Vos, 1997; Wallart, 1999). To reduce this opposition, another policy option is to charge for the incremental emissions alone, i.e. the tax is only levied on emissions over and above a specific emissions limit (see Figure 4). A corollary would be intensity-based rewards, as discussed by Schmidt et al. (2008), advocating a no-lose crediting policy. The proposed scheme under India’s national action plan (NAP) for climate change also has a similar intensity-based design whereby energy efficiency levels are to be benchmarked and subsequent trading of certificates permitted (NAP, 2008).

The benchmarks can be determined based on ambitious targets agreed by stakeholders. The benchmarks could also be seen as providing a new technical guideline for technology providers, new entrants and plant designers.

However, such a scheme has some drawbacks. Defining benchmarks is quite complex, given different process types, plant vintage and size, type of raw materials, scrap volume used, and choice of system boundaries (Eichhammer et al., 2002; Tanaka et al., 2006). Setting of standards also has an arbitrary nature and can be influenced by stakeholders. As a result, there may be a risk of two or more process-wise or vintage-wise standards emerging from the political process, thus undermining a shift towards the most efficient production process.

**FIGURE 4** Incremental carbon tax: in this scheme, tax is levied only above the specified emissions level (‘X’ tCO\(_2\)/tcs). This policy is similar in design to other intensity-based approaches, where producers below the specific emission level are rewarded.
Proposed Policy 3: Administered standards
Regardless of imposing any of the above market-based policies, highly inefficient processes such as coal-based DRI and old and/or small BF units may still continue to operate, given the domestic demand for iron and steel products. These units have inherent advantages such as being flexible, requiring low capital investment, and using low-quality raw materials. Providing market-based incentives for such units to improve energy efficiency may only help to achieve minor abatement results and may not be adequate to guide the sector to an overall lower carbon production path in the medium to long term. Hence, it may be necessary to incorporate and enforce certain standards for plant sizes and limits on capacity addition in inefficient processes. Norms can be stipulated and revised over time, making firms aware of the minimum plant performance levels required for sectoral expansion. The Asia–Pacific Partnership Steel Task Force (APP, 2008a) and the World Steel Association (WSA, 2008) discuss such an approach, where inefficient plants are identified through benchmarking and are eventually phased out.

5. Criteria for policy selection
The major criteria for suitable policy choice would be effectiveness and governance. Effectiveness can be understood as the ability of a policy to limit the growth of sectoral GHG emissions below a BAU scenario, not only in the short term, but also in the long term.

Governance relates to simplicity and transparency in administration and interpretation by various stakeholders. Governance requires periodic monitoring, reporting and verification (MRV) systems to be put in place, which are lacking at present. In particular, since there is a significant presence of public-sector units in the Indian steel industry, private firms may be concerned about distortions created by climate policy. Hence, the policy should be designed to create a level playing field for both private- and public-sector players.

Existing CDM policy is least likely to encourage process shift, as it continues to provide project-based incentives to inefficient processes such as waste energy recovery projects. Furthermore, creating process-wise intensity-based incentives may allow the continuation of inefficient processes. A harmonized tax, on the other hand, targets the total emissions of all units, including those which are below standard emission intensity levels, and hence can help in enhanced efficiency. On governance, it is expected that an intensity-based policy is likely to involve more complexity than other options. A summary of policy evaluation criteria is presented in Table 1.

The analysis in this table shows that, although schemes such as CDM and Policy 2 (incremental emissions tax, or the proposed NAP scheme) can deliver marginal emissions reductions in the short term, they do not tend to strongly promote the move to more efficient plant configurations in the longer term. Policy 3 (administered standards) would, on the other hand, allow the gradual incorporation of the goal into national planning mechanisms. Policy 1 (harmonized tax) appears to be a good option to tackle sectoral emissions with varying advantages at all stages and also goes well with the free market nature of the Indian business environment. Enhanced abatement could further be achieved by combining Policies 1 (harmonized tax) and 3 (administered standards), which could provide the dual effect of price-based incentives and minimum performance standards for existing and planned capacities.

Although the above policy analysis is not complete in itself, it highlights the kind of distortions that different policies could deliver by considering a short time horizon (such as 2020). Climate change concerns require urgent action; however, it is crucial that these policies evolve in the right direction and avoid the locking-in of carbon-intensive processes and technologies. Therefore, it is
vital to have a fully integrated, long-term and well-planned domestic policy approach which can take into account the aforementioned implications.

6. Barriers for policy implementation

The major difficulty for implementation of the policy framework in India is the fundamental issue of accepting mitigation responsibility by both government and industry. It can be argued that in line with this national position, the policies discussed above do not require any national or sectoral emission caps (or reductions in steel output), but would nevertheless show the country’s commitment to act earnestly on climate mitigation.

Some concerns may arise that the implementation of such policies would affect the operational viability of many steel units and reduce supply during periods of higher demand for steel. The government could also be concerned about inflationary pressures from carbon prices. However, a detailed analysis of the sector's operating costs (Sreenivasamurthy, 2008a) shows that carbon emission liability costs are insignificant compared with production costs. Furthermore, it can be argued that as long as steel prices are determined by free market principles, an increase in production cost due to carbon pricing would not completely feed through to product prices.

### TABLE 1 Policy evaluation criteria

<table>
<thead>
<tr>
<th>Criteria for policy evaluation</th>
<th>Existing CDM</th>
<th>Proposed Policy 1: Harmonized tax</th>
<th>Proposed Policy 2: Incremental emissions tax or intensity-based rewards&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Proposed Policy 3: Administered standards</th>
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<tbody>
<tr>
<td>1. Short term: Improve efficiency and CO&lt;sub&gt;2&lt;/sub&gt; intensity of coal DRI and BF-BOF units against business-as-usual (BAU)</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>2. Medium term: Encourage shift from coal DRI and small BF to large efficient BF units</td>
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<td>+</td>
<td>—</td>
<td>+</td>
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<td>3. Long term: Encourage substitution of steel with low-carbon-intensive materials</td>
<td>—</td>
<td>+</td>
<td>—</td>
<td>NA</td>
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<tr>
<td>4. Overall effectiveness</td>
<td>—</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>5. Ease of implementation</td>
<td>+</td>
<td>+</td>
<td>—</td>
<td>+</td>
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<tr>
<td>6. Ease of monitoring and verification</td>
<td>+</td>
<td>+</td>
<td>—</td>
<td>+</td>
</tr>
</tbody>
</table>

Notes:

<sup>a</sup>The intensity-based rewards proposed in India’s NAP (2008) have a similar policy design.

+++ = very good; —— = worst; NA = not applicable.
Finally, because the medium- and small-scale firms in the steel sector employ a large semi-skilled and unskilled workforce in India, any threat to their survival could have serious political repercussions, thus directly forcing the government to reconsider any ambitious policies. One solution could be the provision of capacity building in order to enhance the skills of unskilled and semi-skilled workers to enable their employment at larger, more efficient plants. However, given the entrenched socio-economic implications, further detailed research is required in this area.

7. How can this be anchored through international cooperation?

Even though the policy would essentially be nationally driven, close international cooperation from Annex I Parties will be required to support policy implementation and deliver enhanced emissions reductions. One such area is technology transfer and cooperation, where domestic policies need to be complemented by increased access to technology. Examples of the latest technologies include larger-volume blast furnace units, enhanced coal injection, thin slab casting, and improved coal washeries. The APP (2008b) handbook provides detailed information on the technology solutions required. Financing these efforts can be linked to input-based metrics (such as carbon price, choice of process in new build) and outcomes (such as sector-wide emissions). Furthermore, capacity-building programmes for low-skilled workers can help to increase their employability in larger and more efficient steel-making units. Nevertheless, further research is required on how international financing and technology support could balance the social concerns while implementing ambitious domestic climate policies.

If future international mitigation commitments require India to enhance its contribution, then the domestic sectoral policy can progressively be ramped up to raise the domestic carbon price, tighten new-build design norms, and further encourage low-carbon alternative materials.

8. Conclusions

This article analysed the feasibility of a domestic climate policy framework for the Indian steel sector. It shows that distinct circumstances prevail in emerging economy sectors and a single international policy may not be able to address subtle yet important country-specific drivers. The article therefore discussed the need to set up a domestic regulatory framework with a suitable climate policy to target the specific drivers. Based on the analysis of different policy outcome scenarios for the steel sector, it is concluded that an effective policy should be consistent in limiting emissions at all stages of its implementation.

The recent economic downturn of late 2008 showed that, at times of lower steel demand, the coal DRI process is largely uneconomic. In the longer term, promoting such inefficient steel making could therefore prove costly for the economy as well as for the climate, thereby reinforcing the argument for a shift towards more efficient routes. Implementing such policies is also likely to deliver significant co-benefits such as lower pollution levels to the surrounding communities, a reduced demand for coal, and stimulation of local research and development in low-carbon technologies.

As emerging economies continue to expand, a key criterion to measure policy effectiveness would be the emergence of a domestic carbon price to guide future sector investments. Ultimately, policies should seek to achieve the twin objectives of enhanced abatement and sustainable production. Further research is required on policy implications and the international cooperation mechanisms required to support an appropriate domestic policy. To conclude, it is possible to...
carefully design an ambitious domestic sectoral policy that lowers emissions and costs, delivers benefits to the economy and the community, while addressing the larger global objective of climate mitigation.

**Note**

1. Although a slowdown in the Indian steel sector was seen from October 2008 onwards due to the global financial crisis and the associated fall in international steel demand, this article looks at long-term demand and capacity addition scenarios in India, where the policy analysis could be an important consideration.

**References**


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