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POST KYOTO SECTORAL AGREEMENTS: A CONSTRUCTIVE OR COMPLICATING WAY FORWARD?

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12-13 March 2009

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1. Background and Motivation

1. Time and again the idea of "sectoral approaches" has been put forward in the context of a post-Kyoto agreement on climate change. The motivation is understandable: we need action now, we know where most of the emissions are, so why not focus on the source – the key emissions-intensive sectors? However, the term "sectoral approach" could be used to describe any action on climate change differentiated by economic activities, suggesting there are as many different kinds of sectoral approaches as there are economic activities or dimensions to climate policy.

2. It is widely accepted that measures to combat climate change are likely to be least cost and most effective if they are applied on an even-handed basis throughout the world.[1] But countries are not equal and, in support of the principle of common but differentiated responsibilities, parties to the UNFCCC have agreed that it is for developed countries to take the lead in pursuing emissions reductions.

3. The historical legacy of developed country emissions and the widely divergent resources available to reduce them has meant that while creating emissions on the same basis wherever they occur in the world would be the most 'efficient' approach, this is not compatible with an acceptable burden-sharing formula. Developing countries have to date insisted that their development priorities are not consistent with economy-wide emissions caps. Even if there was a desire in those countries to take on economy-wide emissions reduction targets, it is unlikely that they would have the capacity to meet them in the near term.

4. The absence of global caps on emissions undermines the objective of securing a global reduction in greenhouse gases through:

Concerns about competitiveness

- Binding caps on developed country industries confer competitive advantages on their counterparts in developing countries not subject to such caps.
- Competitiveness concerns give rise to intensive lobbying in Annex I countries and resistance to policies that seek to reduce emissions of GHGs – reducing domestic action and the degree of ambition in international negotiations in this area.

Leakage

- The environmental counterpart of competitiveness concerns. Without truly global constraints on emissions, the environmental pay-off to action in developed countries is likely to be reduced as production and demand which creates emissions migrates from countries with caps to countries without them.
- The dilution of environmental impact legitimises resistance to effective action and ambitious emissions reduction objectives in Annex I countries.

Insufficient ambition and the costs of delayed action

- On their own, emissions caps in developed countries cannot hope to prevent "dangerous anthropogenic interference with the climate system" (Article 2, UNFCCC). The IEA has estimated that 97% of growth in energy-related emissions between now and 2030 will come from non-OECD countries (IEA, 2008c).

- Mitigation options outside Annex I countries are reportedly some of the lowest cost and most effective mitigation options available. Effective action on climate change requires a global least-cost approach. As costs rise, so too does resistance to ambitious actions.
- The Clean Development Mechanism (CDM) may have helped to mobilise funding and encourage emissions reductions in developing countries, but the scale of the financial flows is insufficient to meet the challenge of addressing climate change (Doornbosch et al, 2008). Moreover, the CDM is a currently a substitute for emissions reduction in developed countries and thus cannot seen as additional to developed country caps.
- The slower the action the greater the challenge and cost to control the stock of GHG emissions, especially due to "lock-in" of emissions-intensive technologies that are hard to retire or policy path dependence (Ellis and Baron, 2005).

5. To help resolve deficiencies in current arrangements and to mobilise emissions reductions in developing countries it is necessary to:

- Scale up finance and investments to reduce emissions.[2]
- Set emissions reduction objectives that are demonstrably achievable.
- Build institutional capacity to implement emissions reduction policies and measures, e.g. in measuring, reporting and verifying emissions and emissions reductions.

6. Sectoral approaches appear to be a favoured approach to controlling GHG emissions. While international instruments have been based on economy-wide approaches, domestic actions have typically had a sectoral or selective flavour. Even the most comprehensive emissions trading scheme in the world, the EU ETS, has been selective in its application on a cross-sectoral basis. This raises the question: is a sectoral approach necessary if we are serious about reducing emissions in practice?

7. Sectoral agreements are one application of the more general concept of "sectoral approaches". The use of the term "agreement" implies entrenching sector-specific objectives and instruments within a post-Kyoto agreement on climate change. These should not be confused with process-oriented "sectoral approaches" such as using sector-specific analyses to inform negotiations and construct quantitative emissions targets, or using sector-specific policies and measures for reaching national or international climate change objectives.[3] The idea of a sectoral agreement is the creation of sector-specific objectives rather than processes.

8. But sectoral agreements are likely to be complicated (Sawa, 2008). Focussing on a sector in some detail may provide confidence about how and where emissions reductions will take place – thus making targeted reductions seem more achievable – but considerable amounts of information and detailed decisions need to be negotiated and implemented.

9. A number of dimensions common to any sectoral agreement can be identified and are described in Appendix A. The objective of this paper is to elaborate two prototype sectoral approaches and consider the costs and benefits each represents.

1) Sectoral Crediting Agreements (SCAs)[4], to:
   - Scale up financial flows.
   - Incentivise reductions that are additional to those made under Annex I caps.
   - Link reductions in developing countries to (more) specific abatement opportunities.

2) Sectoral Emissions Agreements (SEAs), to:

- Scale up ambition to reduce global emissions.
- Address competitiveness issues.

10. Each prototype has been designed to provide what might be an environmentally and economically effective agreement and is assessed in terms of its capacity to address the issues discussed above.

11. The focus when considering these approaches is on international arrangements within the context of the post-2012 UNFCCC architecture.[5] While domestic implementation issues are important, this paper considers only policies that are complementary to or integrated with other existing or potential UNFCCC instruments.[6]

12. Implementation issues and economic and environmental implications of each prototype are then discussed using examples of an SCA in the electricity generation sector and an SEA in the cement sector. To provide each prototype with a 'real-world' dimension, the analysis is related to real geographic and economic situations. The SCA is discussed with reference to China on account of the scale and carbon intensity of that country's likely future emissions trajectory, but could equally apply to any developing country. The impact of an SEA in the cement sector is illustrated using results from a model of international cement production developed by a significant group of transnational companies.

13. The choice of electricity generation and cement reflects the strength of research in these sectors around GHG abatement potentials and the applicability of sectoral agreements, though there are other good reasons to consider them. Sectoral agreements are potentially useful in sectors with some or all of the following attributes (Bradley et al, 2007):

- Substantial GHG emissions and likely growth.
- Exposed to international competition.
- Majority of production controlled by a few actors.
- Uniformity of products or processes.
- Existing regulatory presence or government involvement.
- Ease of monitoring and measuring attributable GHG emissions.

14. The prototypes analysed are but two approaches to sectoral agreements amongst many possibilities. The paper concludes with a discussion about whether a slightly different agreement or application of the agreements to a different sector would increase their effectiveness.

2. A Sectoral Crediting Agreement in the Electricity Sector

2.1 The need to mobilise emissions reductions in the electricity sector

15. The electricity sector is a significant and growing contributor to global GHG emissions. Electricity and heat make up around 25% (Bradley et al, 2007). The IPCC has said that limiting global average temperature increases to between 2.3 to 2.8 degrees Celsius means cutting GHG emissions by 30 to 60 percent in 2050 compared to 2000 levels.[7] The arithmetic of this is clear: to be effective, international action on climate change must address emissions in the electricity sector.

16. Just as important as the scale of the challenge is the fact that the power sector is also home to a large proportion of the available technical potential for emissions reductions and some of the lowest cost emissions abatement opportunities (IEA, 2008b, McKinsey 2009).

17. Containment of emissions in the power sector in developing countries will be crucial, as developing countries represent almost half of the expected growth in global CO_2 emissions on a business-as-usual basis (IEA, 2008c). Scenario modelling suggests potential for 1700 Mt CO_2 of emissions reductions in 2020 in the world's two major emerging regions (Asia and Latin America). The Chinese power sector makes up 53% of this total and the Indian power sector would contribute 22%.

18. At the same time, these figures are linked to the need for large scale capital investment on the order of 1000 GW in 2020 for China and India alone to meet increased energy demand and economic development objectives.

19. Effective emissions reductions in developing countries require the pursuit of increased efficiency in existing plants and, more importantly, containing increased power demand through end-use efficiency (particularly in the built environment). Significant changes from business as usual are required both from public and private entities. Comprehensive measures are required that can drive investment in electricity sector transformation and institutional and behavioural changes amongst key governmental and private sector actors. An SCA could offer one means of creating incentives for such change.

2.2 A Prototype Sectoral Crediting Agreement

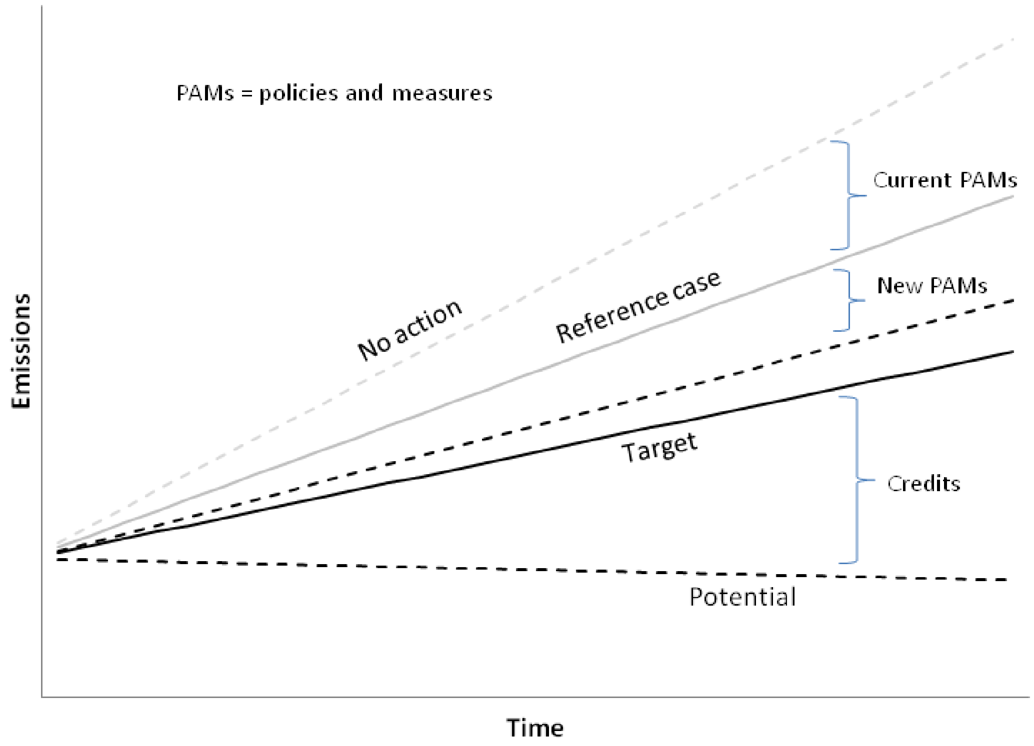
20. A Sectoral Crediting Agreement is similar in concept to the Clean Development Mechanism (CDM) but focuses on an entire industrial sector rather than individual projects. The advantage that an SCA could offer is its scale, a possible reduction in transaction costs, and potential for improved environmental integrity.[8]

21. Features of the prototype SCA for the electricity sector are:

- Sectoral definition: All grid-connected electricity generation. Includes cogeneration/CHP plants if grid-connected.
- Legal instrument: Amendment to Kyoto Protocol or inclusion in any successor arrangement.
- Contracting parties: Non-Annex 1 countries or countries without emissions caps. All parties to the overarching post-Kyoto agreement will need to agree to the use of SCA credits, but they will not need to be signatories to the SCA itself.
- Participation: Voluntary.
- Timelines:
  - In principle agreement: 2009.
  - Negotiated targets: 2012.
  - Entry into force: 2013.
  - Reporting: Every [2] years.
  - Credit issuance: Every [2] years.
  - Credit expiry: All SCA credits expire in [2030].
- Tradable units: Sectoral emissions reduction (SER) credits equivalent to CER and AAU.

- Verification and administrative body: CDM board or similar body yet to be established.
- Target: intensity-based, determined by negotiation.
- Gasses: All GHGs covered by the Kyoto protocol.

Figure 1. Stylised illustration of sectoral crediting under an SCA



22. An agreement would involve setting country-level emissions targets for sectors and rewarding those participating countries whose sectors outperform their targets with tradable emissions reduction credits. Targets would be built up from: a reference case incorporating current policies and measures (PAMs); new pledged or planned PAMs; and an extra margin to help ensure crediting occurs for truly "additional" emissions reductions (see Figure 1). The agreement would be a "no-lose" one: i.e. failure to meet targets would not result in penalties or requirements to purchase credits from other countries.

23. The prototype SCA elaborated here is a negotiated instrument.[9] The targets could be different for each participating country, or could be the same for a group of countries or all participating countries. Targets might also differ for new or established plants. Establishing different targets would be a core part of any negotiations on an SCA.

24. Schmidt et al (2008) propose a three-stage process for establishing targets:

1) Experts assess and define energy intensity best practice benchmarks in each sector to use as a starting point for discussions.
2) Non-Annex I countries pledge a carbon intensity level that they can meet without assistance.

3) Annex I countries negotiate with developing countries on specific financial and other support – through a Technology Finance and Assistance Package – to encourage non-Annex I countries to commit ultimately to stricter 'no-lose' emissions targets.

25. The last step would need to be focussed on funding towards reaching rather than exceeding a no-lose target to avoid duplication of funding for reductions beyond the no-lose target which receive credits.

26. During negotiations only the no-lose target would have to be agreed. However, at least four other pieces of information are likely necessary to reach an "informed" agreement over the no-lose target:

- A reference projection of emissions (and emissions intensity as appropriate) which estimates likely future emissions taking into account current policies and measures to reduce them.
- A projection of emissions (and emissions intensity as appropriate) incorporating estimates of the effects of new or planned policies and measures pledged unilaterally by parties.[10]
- Estimates of funding requirements and pledges (by Annex I countries) for new policies and measures pledged by developing countries.
- Estimates of the potential for emissions reductions which, in conjunction with bullet 2 above, could be used to assess (roughly) the financing implications of the target – i.e. the potential reduction "wedge" that will yield credits under the SCA (see Figure 1).

27. Each country's government or designated authority would be free to use credits as it wished; perhaps distributing them to individual companies in the sector or selling them for general revenue.

28. The saleability of credits and their value would depend on:

- Volumes of emissions credits created.
- Stringency of commitments taken on by developed countries.
- Whether credits are recognised in international carbon markets.

29. The volume of credits created could be very large depending on the precise design of the agreement and other international arrangements (Bosi and Ellis, 2005). In order to preserve the environmental integrity of post-Kyoto arrangements, the level of stringency and detail of SCA-related principles, modalities and procedures would depend on whether or not credits could be used for compliance purposes by industrialised countries.

30. A sectoral agreement would not necessarily, in and of itself, ensure that credits are fully fungible on the international carbon market used for compliance by industrialised countries. Such schemes are a matter of domestic policy and may not fully recognise international (Kyoto) instruments for domestic compliance.

31. There are good reasons for ensuring that credits are fully fungible with domestic entity-based emissions trading schemes such as the EU ETS. This would provide an incentive for the private sector to actively engage in the mechanism prior to the credits being generated. Activating investment flows in this way would help provide up-front financing for technology.

32. On the other hand, a link between a sectoral crediting agreement and domestic emissions trading schemes could undermine carbon prices and the environmental effectiveness of those schemes if credit volumes were very large. One way to prevent this would be for developed countries to take on stringent emissions caps. However, developed countries would likely be cautious given uncertainty about whether such credits would actually be delivered to the market.

33. Furthermore, to be fungible with domestic carbon instruments under emissions trading schemes, sectoral credits might well be subject to additional measurement, verification and regulatory requirements.

34. If credits could be used to offset developed country obligations there might well need to be a negotiation between developed and developing countries to ensure that credits could command a market with a reasonable price and developed countries could achieve some reassurance that credits would be forthcoming.

2.3. An evaluation of an SCA in the electricity sector in China

35. To determine if a sectoral crediting agreement could deliver in a practical sense, one needs to consider:

- Whether there are sufficient incentives to persuade a country to join an SCA.
- What would need to be done to implement an agreement.
- The likely economic and environmental consequences.

36. China provides a useful case study for considering such questions as it will be a key player in any effective post-Kyoto arrangement, and because electricity is an important component of its economic development and emissions reductions strategies.

37. In just a few decades, China has moved from being a minor and self-sufficient energy consumer to the world's second largest. Around 17% of China's final energy demand is consumed as electricity; equal to the global share of electricity in final energy consumption but higher than the comparable non-OECD figure of 14% (IEA, 2008b). Unprecedented economic growth has led to rapid growth in electricity demand, with consumption increasing five-fold between 1990 and 2006 (IEA, 2008b). This has created a near five-fold increase in CO_2 emissions in the sector, compared with an approximate 80% increase in GHG emissions across the entire economy.

38. China's demand for electricity is expected to continue to grow rapidly in the future. Without significant further action to address the emissions intensity of electricity supply, CO_2 emissions from China's power sector are expected to rise by around 3.4 Gt — around one quarter of the expected global increase in energy-related CO_2 emissions between 2006 and 2030.[11]

39. Much of the increase in GHG emissions in the power sector can be attributed to the structure of electricity production rather than a simple increase in generation. While China's share of electricity from renewable sources is above the global average (Höne et al (2008)) most of the growth in supply has come from increased coal-fired generation dominated by relatively inefficient emissions-intensive (subcritical) plants. This means that despite substantial renewable generation, the emissions intensity of China's electricity, at 0.8 kg of CO_2 per kilowatt-hour of electricity, is above the non-Annex 1 average of 0.5 kg/kwh and significantly above the world average of 0.7 kg/kwh.

40. Clearly there is technical potential for China to reduce emissions by reducing reliance on fossil fuel and increasing the efficiency of fossil fuelled plants, particularly coal fired power plants.

41. As discussed, the target is the most critical part of an SCA. Following the approach of Schmidt et al (2008), a technical exercise could be conducted to determine benchmarks on a global scale. These benchmarks could be used to suggest the technical mitigation potential that could be achieved in China's power sector by adopting more fuel efficient technologies and exploiting opportunities for increasing the share of generation from low emission or zero emission technologies. Undertaking such an exercise would benefit from work already undertaken by organisations such as the IEA but would still take quite some

time to complete, as there would be some disagreement amongst experts and constantly changing opinions as new information came to light.

42. Reaching an understanding on the technical reduction potentials also means, at least implicitly, agreeing on a “reference case” for future emissions and emissions intensity. One of the more delicate aspects of this process would be taking account of the effects of current and planned policies, including deciding which to include and evaluating their impact of on future emissions.

43. China has many different policies and plans affecting emissions from the electricity sector (see first column of Table 1). In the context of an SCA it is unclear which policies and measures might be included in a reference case. A key question in this regard would be how to treat policies that are aspirational versus those that are concrete.

44. Many of the initiatives mentioned are clearly concrete, such as a “feed-in tariff” or subsidy to wind generation schemes. For others it is less clear whether the policies or their effects could reasonably be counted in a reference case scenario or even as pledged additional measures. For example, renewable energy targets may be aspirational, setting the objective for policy with highly uncertain prospects for success. Such targets may be instituted as a first step to articulating a policy goal for which external funding and implementation assistance is necessary – precisely the kind of assistance that an SCA could provide. Thus to include such targets in the reference projection for an SCA could be to preclude the very means with which to meet them.

45. Furthermore, how does one account for efforts that have uncertain but potentially large impacts on emissions? Should a no-lose target take into account, for example, current research and pilot projects in the field of carbon capture and storage? Current policy has clearly put China on track towards mobilising CCS. Should CCS therefore be included in the calculation of the no-lose target to avoid crediting action that is not additional? No amount of expert judgement is likely to resolve these matters. The answers to questions about policies and measures would almost certainly come down to compromise and political agreement.

46. In addition to a discussion about the reference case, a dialogue would also be needed to determine the feasible mitigation potential in China taking account of economic, social, and political constraints. Again, technical analysis can only take the discussion so far.

47. The need for political discussion is unavoidable and introduces substantial uncertainty into any evaluation of the potential impacts of an SCA. Still, one can sketch these potential impacts by analysing what a likely reference projection might look like and evaluating its mitigation potential. With this information it is possible to construct a “landing zone” for an agreed no-lose target.

Figure 2. China electricity sector emissions
(Mt CO_2)

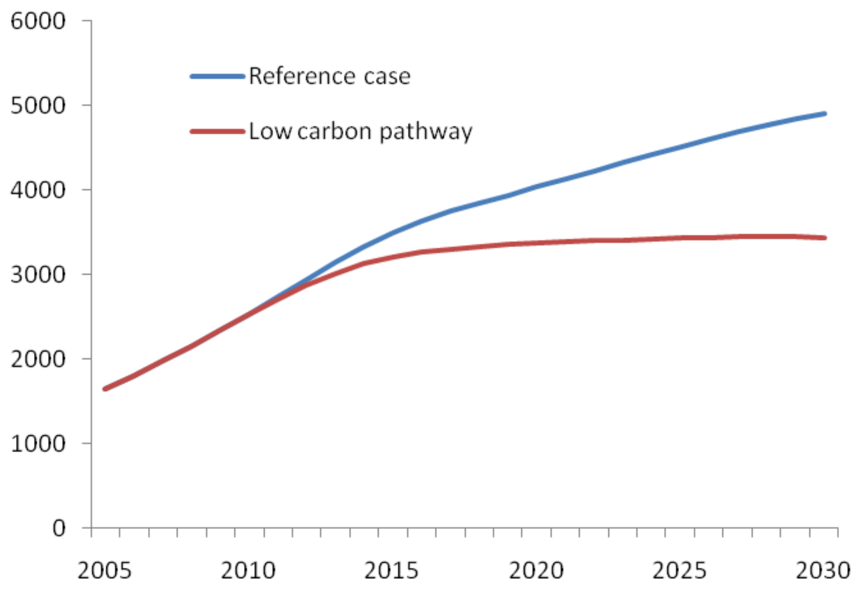
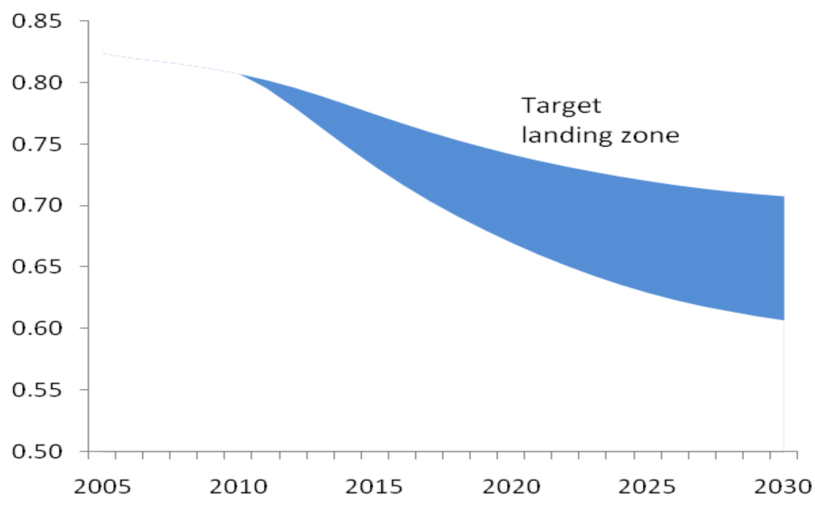
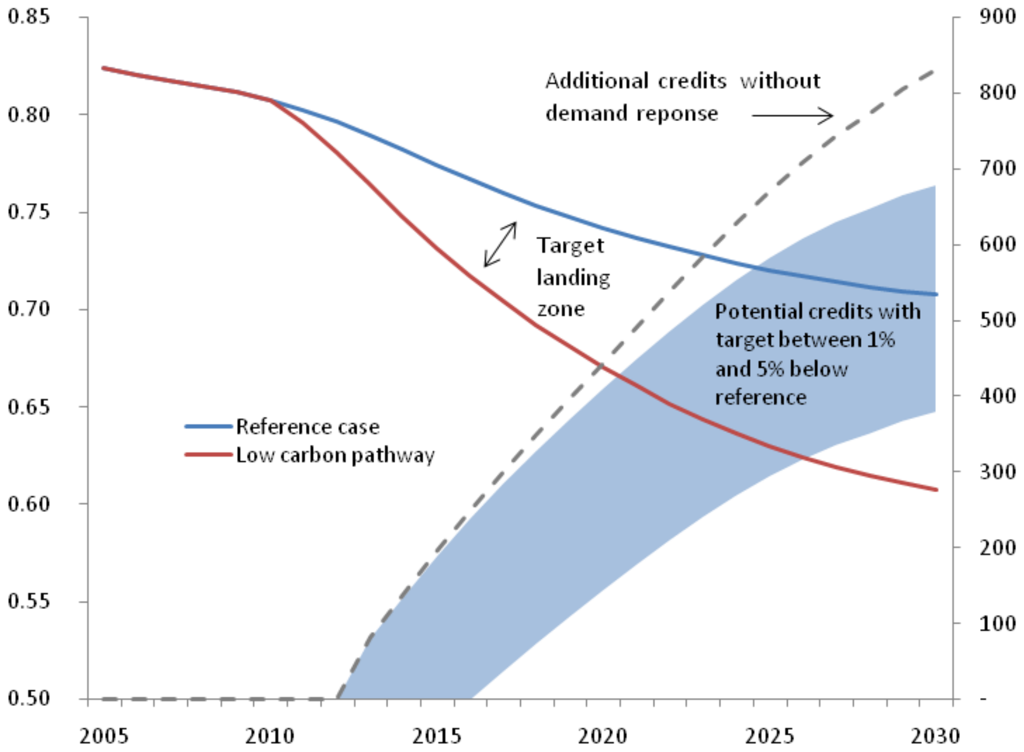


Figure 3. Emissions intensity potential
(tonnes CO_2 per MWh)



48. Figure 2 shows emissions from China's electricity sector under a reference scenario and low carbon growth pathway reflecting the deployment of "economic" mitigation opportunities when carbon is priced at $100 per tonne. The projections are based on IEA (2008c) estimates of recent activity in the Chinese electricity sector and mitigation potential from the Centre International de Recherche sur l'Environnement et le Développement (CIRED).[12] In the reference case emissions almost double between 2010 and 2030. The low carbon pathway sees emissions decline by 30% in absolute terms. Around half of this is due to improved emissions intensity and the other half to reduced consumption.

Figure 4. Potential credit volume from an SCA
(left axis CO_2 per MWh, right axis Mt CO_2)



49. Figure 3 charts the area for improvement in emissions intensity in the power sector; i.e. the "landing zone" within which an emissions intensity target might be set. The upper boundary on the target landing zone represents projected emissions intensity under the reference scenario. Note that the reference scenario includes substantial improvement in emissions intensity between now and 2030 as older coal plants are replaced with more efficient ones and government policies drive increased investment in renewable and other low(er) emission technologies.

50. Figure 4 considers the volumes of credits, measured in mega-tonnes of CO_2 avoided, that could be generated depending on how far a target is set below the reference case scenario. If the target is set at 1% below reference intensity there is potential for 500 million credits to be created in 2020 and a potential cumulative 3 billion credits between 2012 and 2020.

51. By 2030 the potential for credit creation grows to 700 million per annum and the cumulative flow of credits is 7 billion. However, the credit potential declines rapidly as the intensity target increases. A target 5% below reference halves the amount of credits created in 2012-30 and reduces credits created during the period 2012-20 by nearly two-thirds. At 10% below reference no credits are created in 2012-30.

52. These results are merely indicative, but the orders of magnitude are instructive. The figures suggest that an SCA could make a substantial contribution to the investment costs of a low carbon growth pathway in China. The UNFCCC (2007) has estimated that investment in power generation in China in 2030 would have to increase by around US$25 billion (compared to a reference case) to facilitate necessary emissions reductions. Based on the CIRED results a target around 8% below reference intensity could raise the necessary capital.

53. The low emissions growth pathway includes substantial demand reductions. The dashed line in Figure 4 shows how much larger credit volumes might be if demand was not reduced by higher energy prices.[13] An emissions intensity target on its own may not incentivise such reductions depending, for example, on whether price signals are passed on to consumers of electricity. Furthermore, new policies to improve energy efficiency and reduce demand may be discouraged by the fact that they would reduce credit revenue. This suggests a need for additional arrangements to complement an emissions intensity target.

54. The magnitude of credits suggested by the CIRED results is similar to those from other studies for the period to 2013-20. This reflects a reasonable degree of agreement amongst researchers about short to medium term reduction potentials and therefore potential credit volumes. However, estimates of mitigation potential out to 2030 vary considerably due to assumptions about the costs, availability, and uptake rates of technologies, particularly CCS.

55. The CIRED results include almost no CCS used in the Chinese power sector by 2030. By comparison, the Foundation for Sustainable Development and International Relations (FONDDRI) has produced projections that assume significant use of CCS in China beyond 2020, drastically reducing emissions intensity in the power sector and increasing the potential for credit creation. Under their scenario, the potential for credit creation by 2030 is projected to be up to 2.5 billion per annum. A substantial volume of credits is created even with much more stringent targets. In the FONDDRI scenarios, a target of 25% under reference intensity generates 900 million credits in 2030. This illustrates the extent to which uncertainty around potential credit volumes increases over longer time horizons.

56. Over a shorter horizon to 2020, an SCA is likely to produce substantially fewer credits under most scenarios. This mainly reflects the impact that demand growth has on credit volumes and the slow speed with which new plants are built and existing ones are replaced. It may seem to suggest that an SCA should have a short life span, perhaps ending in 2020 to avoid excessive creation of offsets. However, if the objectives of an agreement are to scale up finance and mobilise emissions reductions it may be counter to those objectives to curtail such an agreement just as it starts to make a real impact. Furthermore, many of the credits created in the period 2020-30 are likely to be the result of actions taken in 2012-20 in anticipation of resulting credit revenue streams in the future. An inability to create credits in 2020-30 would undermine the incentive to take action in 2012-20.[14]

57. It is important to take a long-term perspective when considering the role of credits in incentivising structural changes in electricity generation. Costs of electricity investment, or indeed any infrastructure investment, are typically recovered over long periods of time (20-50 years). This is desirable in that it spreads the costs of such investments over the succeeding generations who will benefit from the assets. In the absence of such long periods for recovering investment costs, the price of electricity would have to rise significantly to cover them. Similarly, for credit revenue to incentivise low carbon investment either the revenue stream needs to be long lived (large predictable volumes into the future) or the price of credits high in the short term.

58. The potential creation of 2.5 billion offset credits in 2030 (the FONDDRI scenario including substantial CCS) also raises the question of who would be in the market to buy them. Such a quantity amounts to around one quarter of the abatement potential in developed countries (McKinsey, 2009), close to 15% of projected developed country emissions in 2030, and could have a massive impact on the global price of carbon and substantially undermine climate stabilisation objectives if it became a pure offset for GHG abatement in developed countries. Thus, developed countries would have to take such potential offsets into account when committing to emissions caps and reduce them accordingly. The fundamental difficulty in this regard is that an SCA is no-lose, while emissions caps are binding. This would leave

developed countries with substantial uncertainty about whether they could meet their commitments – a political problem that has plagued signatories to the Kyoto Protocol.

59. There is uncertainty about the potential for credit-based financing to drive low carbon investment in China. The effectiveness of financing and price signals from an SCA will depend on how the electricity sector is regulated in the future and whether adequate incentives are passed through to investors and operational decision-makers in the industry. These incentives may or may not need to be based on prices or financial signals depending on the regulatory framework in place. If the Chinese power sector was entirely government-controlled the government could use credit revenue to recoup the cost of infrastructure investment. Political fiat could do the job if central government power were sufficient. If the Chinese power sector were dominated by private investors and had a wholesale market with economically efficient pricing signals it would be necessary to pass on the financial incentives from emissions reductions to ensure investment in low emission technologies.

60. In reality, the Chinese power market sits between these two extremes. While significant steps have been taken towards liberalising the power system – including breaking up state monopolies and allowing private and limited foreign investment – there are no effective market-based price signals that could be used to incentivise investment in low emission technologies. At the same time, policy directives from Beijing remain an important tool for driving change in the sector but any such directives must compete with other national, local, and community priorities including economic development and job creation. That is not to say that the Chinese government would not pursue and exceed a no-lose target, but it does raise questions about the usefulness of a notionally market-based mechanism for driving emissions reductions in an industry that is not based on market fundamentals.

61. A market-based instrument alone is unlikely to provide the necessary impetus for China to reach and exceed a no-lose target under an SCA. Rather, a series of policies and measures would need to be put in place, all of which will have uncertain impact. Table 1 summarises one possible package of measures across a range of specific objectives.

62. Note that within the package of measures summarised in Table 1, energy efficiency measures are an important component. The IEA (2007) estimates that demand-side efficiency measures could reduce electricity demand in 2030 by 12% from what it might otherwise be. Under an intensity-based target in an SCA such measures would not be incentivised. This illustrates the extent to which an SCA would only address a part of the emissions reduction possibilities in the power sector.

63. Amatayakul et al (2008) suggest that incentives to control demand might be introduced by introducing a cap on growth in emissions from electricity generation on a per capita basis. If emissions lift beyond a target of 3t CO_2 per capita, for example, the number of emissions reduction credits would be reduced accordingly. This could prove useful, although it introduces a further degree of uncertainty about the volume of credits created by an SCA when negotiating or discussing its merits.

64. Whether steps toward a no-lose target are driven by incentives to private sector investors or government policy does not much affect the uncertainty developed countries would face were they to take on stringent caps in the anticipation of offsets from China or another country participating in an SCA.

Table 1. Examples of current and possible policies and measures to reduce power sector emissions in China

<table>
<tr><th>Approaches</th><th>Existing measures</th><th>Additional measures and tools</th></tr>
<tr><td>Energy efficiency</td><td>- Energy conservation Law
- Target in 2010
- Closure of inefficient manufacturing plants</td><td rowspan="7">- Increase energy conservation and end-uses efficiency through more cost-reflective pricing
- Further regulation and incentives for enforcing standards and meeting targets
- Efficient metering of consumption
- Crediting mechanism for some actions
- Improved investment environment (e.g. for joint ventures) for enabling improved systems and technology for e.g. through technology transfer
- North-south cooperation
- Adoption of standards based on best available technology
- Review and update targets and standards (current wind and nuclear targets, for e.g. could be exceeded).
- Improving distribution and transmission systems to reduce losses, support use of renewable generation and improve access to energy from renewable or low emission sources.
- Continue to pursue and strengthen R&D especially on collaborative basis to promote diffusion of knowledge and technology transfer</td></tr>
<tr><td>Efficient coal</td><td>- Supercritical is the new standard
- closure of inefficient plants</td></tr>
<tr><td>Wind</td><td>- Renewable energy law
- Target in 2020 (30 GW)
- Feed in tariff
- All the wind turbines originate from developed countries</td></tr>
<tr><td>Hydro</td><td>- Renewable energy law
- Ambitious target in 2030
-Large potential of small hydro</td></tr>
<tr><td>Nuclear</td><td>- Target : 40 GW in 2020</td></tr>
<tr><td>Transmission</td><td>- Plan to strengthen the inter and intra regional transmissions systems</td></tr>
<tr><td>CCS</td><td>- Research and development partnerships and pilot schemes (for e.g. EU-China Near Zero Emissions initiative)</td></tr>
</table>

65. In addition to the policies and measures outlined in Table 1, there would also need to be an improvement in data collection and monitoring of power plant emissions. Existing information is not totally reliable (Steinfeld et al, 2008). National statistics are typically based on surveys which are biased towards large entities. In the power sector this is likely to mean a bias towards less emissions-intensive production given the tendency for large plants to operate with greater efficiency. In China this bias may be large, as in the past the power sector has had a large number of small plants (in 2003, 4000 units under 50 MW accounted for 20% of the total capacity). Information gathered in China is also not usually subject to third party verification and there is evidence of inappropriate data aggregation (values with different units being summed together).

66. All this points to a further source of uncertainty when assessing the prospects for an SCA. Data gathering efforts would need to improve considerably to provide confidence in verified emissions

reductions before parties to an SCA would sanction the issuance of credits. This kind of uncertainty is of course systemic in global climate policy and is not specific to SCAs. For any post- Kyoto arrangement to be effective, financial assistance and capacity building will be needed to facilitate rapid improvement in emissions information systems in China and other developing countries.

67. Data problems, forecast accuracy, and policy effectiveness all add to the uncertainty that developed countries would face were they to take on stringent caps in the anticipation of offsets from developing countries such as China. At the same time, developing countries would face the risk that if developed country commitments were not stringent enough, funding from an SCA might not be commensurate with the cost of the actions needed to reduce emissions. They would not know whether funding would be adequate until after action had been taken to meet the SCA target. Of course, developed countries providing up-front financing would shift the risk from developing to developed countries (but would not eliminate it).

68. The chances of achieving a perfect balance between adjustment to Annex I commitments and stringency of no-lose targets – giving just the right amount of funding and offsets – are miniscule. Under certain circumstances this may not matter, such as in the case of an SCA for a small sector or country. In the case of large countries such as China, where the reductions sought are likely to be in gigatonnes, any errors could be of consequence.[15]

2.4. Preliminary conclusions

69. It would seem that an SCA in the power sector could certainly scale up financial flows and link emissions reductions in developing countries to specific abatement opportunities by focussing attention on sector-specific opportunities and information. However, the impact is highly uncertain, with the potential for offset credits to be generated in such quantities that effective global action could be undermined. The question is whether decision makers are willing to take that risk.

70. Any decision to pursue an SCA as a complement to post-Kyoto arrangements will have to be based on political judgement about whether such an approach is necessary. The risks inherent in an SCA will reduce incentives to participation for both developed and developing countries. Nevertheless, given the risks and costs of climate change, the most appropriate question to ask is: are there less risky or more effective alternatives?

3. A Sectoral Emissions Agreement in the Cement Sector

3.1. Emissions reduction potential in the cement sector

71. The cement sector is a substantial contributor to global GHG emissions, producing around 4% of global GHG emissions and 5% of global CO_2 emissions (Bradley et al, 2007).

72. The IEA has identified cement as one of the industrial sectors requiring substantial new investment to upgrade old and emissions-intensive technologies (along with steel and pulp and paper production) (IEA, 2008b). This reflects the fact that a substantial proportion of total global cement production uses older, more energy and emissions-intensive production technologies.

73. Table 4 summarises the emissions intensity of cement production amongst the major cement producing countries in the world. It reveals substantial differences in emissions intensity with emissions per tonne of product ranging from 0.6 to 0.9 tonnes of CO_2.

Table 2. Cement production, blending practices and CO_2 emissions

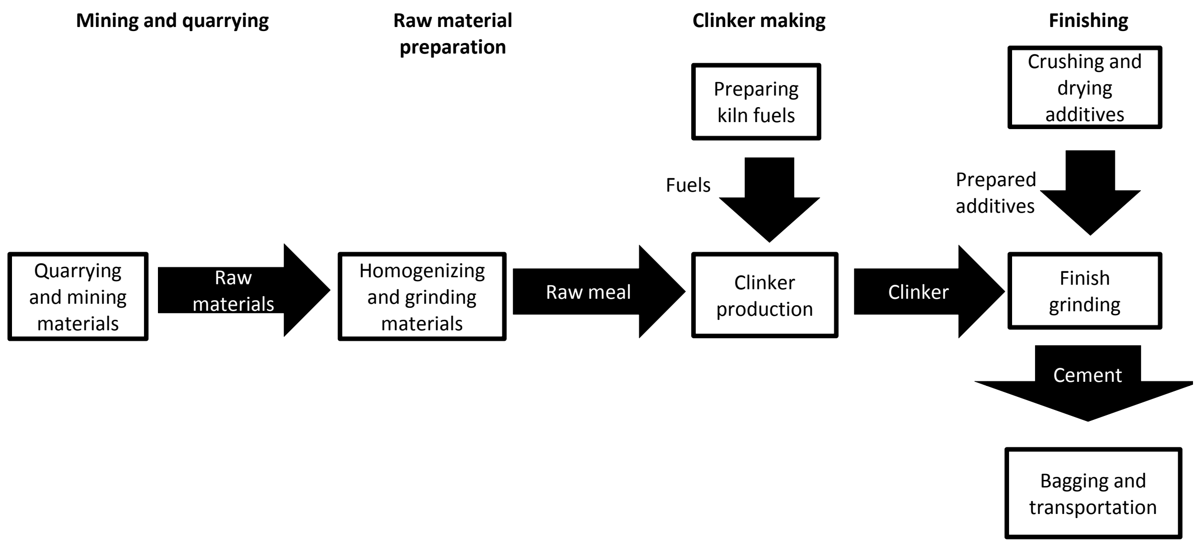
(*Höne and Ellerman, 2008 p.5)*

	Production	Clinker/ cement ratio	Primary intensity	Primary energy	Process carbon emissions	Carbon emissions energy use	Total carbon emissions	Emission intensity	Share of world total
	Mt		GJ/t cement	PJ	MtC	MtC	MtC	tCO2/t	%
China	1200	75%	5.7	6,840	128.9	177.8	306.7	0.937	54.05%
India	155	88%	4.6	713	19.5	18.5	38.1	0.901	6.7%
Brazil	40	81%	3.6	144	4.6	2.9	7.5	0.689	1.3%
Mexico	41	86%	4.5	185	5.0	3.5	8.6	0.765	1.5%
South Africa	13	90%	4.6	60	1.7	1.6	3.3	0.928	0.6%
Korea	55	89%	3.6	198	7.0	4.2	11.2	0.744	2.0%
USA	98	90%	5.6	549	12.6	11.5	24.2	0.904	4.3%
Japan	70	90%	3.6	252	9.0	5.0	14.1	0.737	2.5%
Russia	55	80%	6.0	330	6.3	6.9	13.2	0.882	2.3%
Europe (27)	245	76%	3.8	931	26.7	17.8	44.5	0.666	7.8%
WORLD TOTAL	2550	80%	4.5	11,475	292.1	275.4	567.5	0.816	100.0%

74. Emissions intensity and mitigation potential in cement production is primarily a function of the production and use of clinker – the principal ingredient in cement (see Figure 5). The production of clinker is emissions-intensive with emissions resulting from chemical reactions as well as energy and fuel use during production.

Figure 5. Schematic representation of cement production

(Adapted from Höne and Ellerman, 2008)



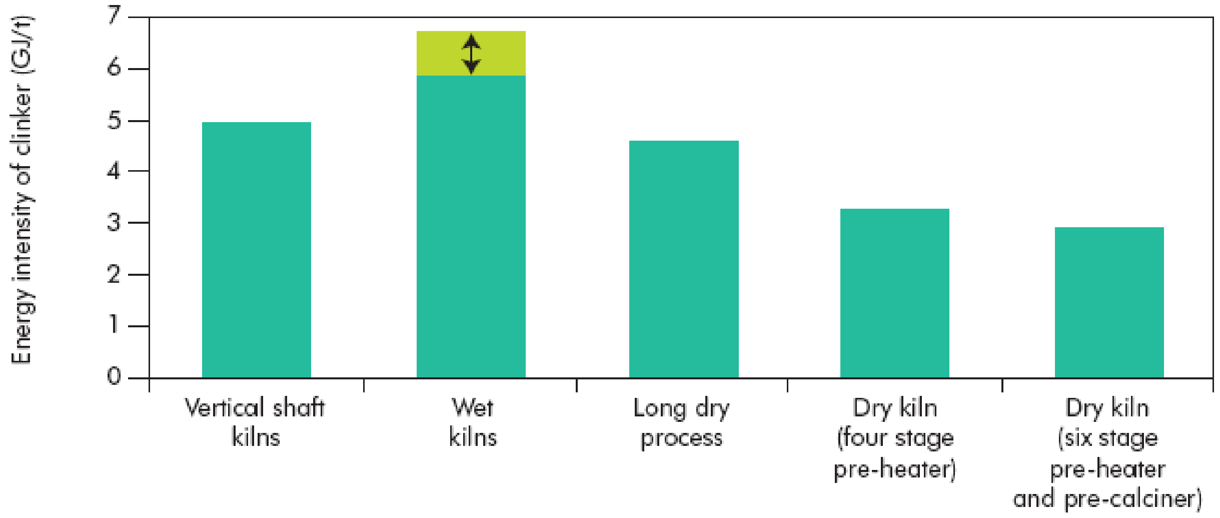
75. The main emissions reduction potentials in cement production are in the clinker making and finishing process, e.g.:

- Installation of more energy efficient kilns.

- Substitution of waste or biomass for fossil fuels during clinker production.
- Reduction of clinker use in cement by blending with alternative cementitious substances.

76. In terms of technology there are substantial global emissions reduction gains to be achieved through a shift away from wet kilns and vertical shaft kilns (see Figure 6). These technologies are widespread in the three countries representing more than 50% of global cement production: China, India, and the United States (see Table 3).[16]

Figure 6. Energy intensity of clinker production technologies
(IEA 2008b, p.492)



Note: For wet kilns, the arrow represents the range of energy consumption for different wet kiln types.
Source: FLSmidth, 2006.

77. Use of alternative fuels can also lead to substantial emissions reductions, although their use is somewhat constrained by local availability. Alternative fuels include tyres, plastics, and biomass. The IEA (2008b) estimates that around 2% of fuel used for clinker production in 2005 was from such alternative sources and that increased use of those fuels could reduce CO_2 emissions by around 100Mt to 200Mt per year – around a third of global cement sector CO_2 emissions reduction potential excluding carbon capture and storage. Reducing emissions in areas with a ready supply of alternative fuels is much less costly than in other areas.

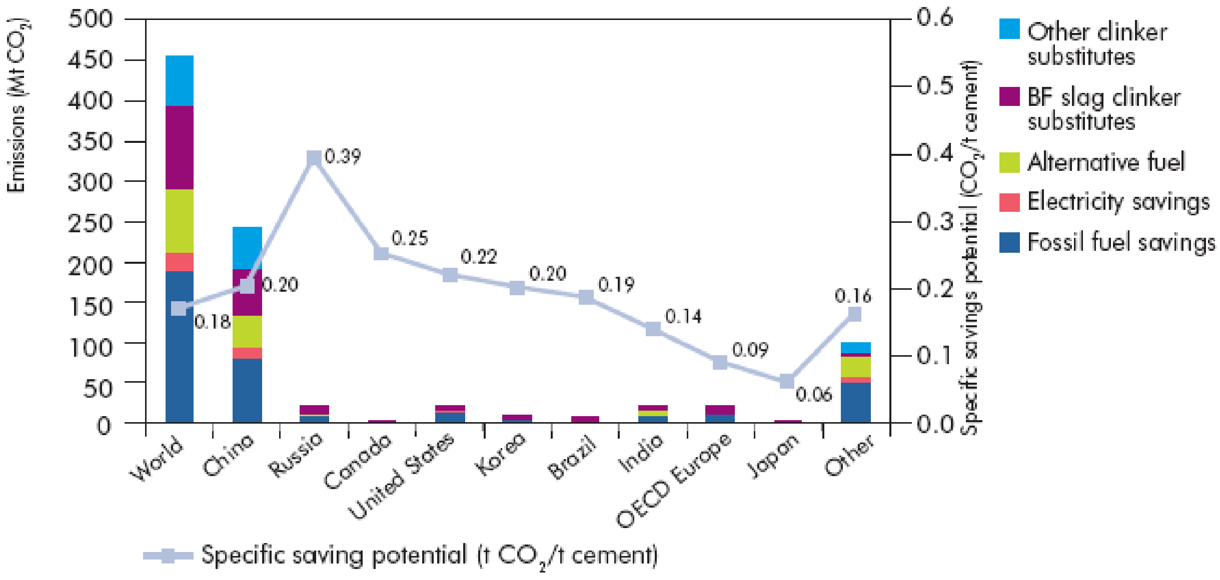
78. The reduction in energy costs that flows from using alternative fuel sources can yield a competitive edge to firms with access to such materials. Further incentivising such practices through a sectoral agreement may well put some firms in resource-constrained countries at a competitive disadvantage, thus discouraging participation and emissions reductions.

79. Similarly, blending clinker with other materials to reduce the use of emissions-intensive clinker relies on a low cost local supply of such material such as blast furnace slag from steel production and fly ash from coal plants.[17] As a bi-product such materials are limited in their availability by the output of other industries. This being so, mitigation potential varies. It is precisely this kind of variation which commends high-level economy-wide caps and tradable permits.

80. Technological innovation could offer new emissions reduction opportunities by providing abundant and cost competitive alternatives to conventional blending materials or a cost competitive and technically acceptable non-limestone based binding agent. Despite many years of research neither have emerged (IEA, 2008b; Humphreys and Mahasenan, 2002). A properly structured sectoral agreement could increase the returns to R&D and improve the prospects of a breakthrough.

81. The capacity to use such emissions reduction strategies also depends on the regulatory environment and knowledge of how to use such fuels or blending. Regulatory authorities often limit the use of blending and limitations vary from authority to authority. Reducing emissions can confer a competitive advantage by reducing costs, so it may not be in the interests of firms to share such knowledge.

Figure 7. ***CO_2 reduction potentials in cement in 2006 based on best available technology***
(IEA, 2008b p.491)



82. The potential for emissions reduction also depends hugely on the initial emissions intensity of production before abatement takes place. While this idea may be simplistic, it is instructive to observe what it means in practice. According to the IEA (2008a), potential improvements in the emissions intensity of cement production based on current available technologies are more than six times greater in Russia than in Japan (see Figure 7).

83. Mitigation potential does not necessarily decrease according to level of development. Mitigation potentials in terms of emissions intensity are 16% higher in the United States than in Brazil, reflecting the former's comparatively higher emissions technologies and practices in cement production.

84. As noted earlier, blending clinker with other materials reduces the use of emissions-intensive clinker. Depending on the local availability of blending materials and local cement and building codes, reductions can be significant in some regions. For example, the variation in clinker to cement ratios in Table 4 suggests that if blending ratios in Europe or China could be replicated in other parts of the world the reduction in emissions could be substantial.

85. The technical mitigation potential in the cement sector is not trivial, amounting to a 20-25% reduction in emissions intensity globally based on established technologies (IEA, 2008b). Use of CCS, for which the cement sector is a candidate, would lift the stakes much higher.

3.2. Suitability of cement for a sectoral agreement

86. It is clear that achieving meaningful reductions in cement sector emissions will not be possible without securing the participation of developing countries. Over 80% of global cement production is already outside Annex I country caps. That share is expected to rise so that less than 10% of production will be accounted for by Annex I countries in 2030. Indeed "Over 90% of all new plants will be built in emerging and developing countries in the coming 40 years." (Ecofys, 2008 p.6).

Table 3. Global cement production, 2006

(IEA, 2008a, p.33)

	Production Mt/yr	Production Share (%)	Cumulative Production Share (%)	Process Type			
				Dry (%)	Semi-dry (%)	Wet (%)	Vertical (%)
China	1 200	47.1	47.1	50	0	3	47
India	155	6.1	53.1	50	9	25	16
United States	100	3.9	57.0	82	0	18	0
Japan	70	2.7	59.8	100	0	0	0
Republic of Korea	55	2.2	61.9	93	0	7	0
Russia	55	2.1	64.1	12	3	78	7
Spain	54	2.1	66.2	92	4.5	3.5	0
Turkey	48	1.9	68.1	-	-	-	-
Italy	43	1.7	69.8	-	-	-	-
Mexico	41	1.6	71.4	67	9	23	1
Other	730	28.6	100.0	-	-	-	-
Total	**2 550**	**100.0**	**100.0**	-	-	-	-

Sources: United States Geological Survey, 2008a; Batelle, 2002; PCA, 2005; Price, 2006; JCA, 2006; CEMBUREAU, 2006; Siam Cement Industry Company Ltd, 2005.

87. Expansion of constraints on emissions is also vital in preventing emissions leakage from production migrating from regions with carbon constraints to regions without carbon constraints. While large quantities of cement are not currently traded internationally (compared to industrial commodities such as steel or aluminium), the sector is still very exposed to changes in the relative competitiveness of international firms. This is because the embodied emissions in cement are very high relative to the value of the product. A carbon price of US$30/t of CO_2 would add 15-30% to the price of a tonne of cement if that cost could be passed through to consumers.[18] Such a large cost increase would substantially increase the competitiveness of internationally-traded cement (currently constrained by the weight of the material and costs of freight relative to product prices) and would most likely lead to relocation of production outside of Annex I countries and a consequent leakage of emissions.[19] Furthermore, there are localised examples of significant trade under existing economic conditions, for example between the EU and neighbouring Mediterranean countries. Competitiveness impacts are likely to be felt more strongly in such markets than for international trade as a whole.

88. Given the forecast substantial increase in global cement sector emissions and the potential for competitiveness and leakage issues, the cement sector provides a useful basis for examining the workability of a sectoral emissions agreement aimed at expanding emissions control measures globally while addressing competitiveness issues to control the risk of leakage.

89. While global cement production includes a very large number of different operators, international production and trade is dominated by a comparatively small number of multinational firms.[20] Many of these firms already measure and report their emissions and cooperate to reduce emissions within the Word Business Council for Sustainable Development's (WBCD) Cement Sustainability Initiative (CSI).[21] The existence of such an initiative provides a further reason to examine the workability of a sectoral approach.

3.3. A Prototype Sectoral Emissions Agreement

3.3.1 Choosing between possible versions of an SEA

90. The prototype cement sector emissions agreement (SEA) is just one possible version that could be imagined. It seeks to advance two objectives: widening the geographical scope of action to reduce emissions and minimising competitiveness issues and leakage while respecting the principle of common but differentiated responsibilities on the part of developed and developing countries. It is important to spell out clearly the motivation behind this or any other proposed design. In the real world, any agreement will reflect the motivations of those who design and then seek to negotiate it. Clearly the design chosen may be contentious. A 'straw man' scenario is a useful way to highlight some of the issues that may arise.

91. The simplest approach to a sectoral cement agreement would be to cap global cement emissions. This would entail the same process as the negotiation of Annex I quantitative emissions caps, only would do so at the level of a sector rather than an economy. Countries would have to negotiate a global limit on the sector's emissions, negotiate their respective shares of this global limit, and would be allocated emissions permits accordingly. Such permits are referred to in this paper as sector emissions units or SEUs.

92. SEUs would ideally be fungible with economy-wide emissions permits such as those created under the Kyoto protocol: assigned amount units (AAUs), certified emissions reductions (CERs) and emissions reduction units (ERUs). If not, the emissions agreement could be unnecessarily costly by forcing participant countries to address emissions in the cement sector even if it turned out to be more effective to focus on others.

93. Such a scheme would make little difference to the nature of the obligations already faced by Annex I countries under the Kyoto Protocol but would amount to an extension of emissions caps to developing countries with respect to the cement sector (and any other sector subject to a similar agreement). Clearly this would be highly contentious. Developed countries would benefit from reduced concerns amongst domestic industry about lost competitiveness and emissions leakage. The benefits to developing or non-Annex I countries could include:

- Revenue from sales of emissions permits, depending on the stringency of cement sector emissions caps.
- Building institutional capacity to implement nationally appropriate emissions reduction policies and measures, including expertise in measuring, reporting and verifying emissions and emissions reductions.

94. From a process and confidence-building perspective, the idea of a sector-specific emissions cap could be more attractive than an economy-wide cap to the extent that negotiations over the size of the cap and the allocation of permits would be informed by "concrete" examples and demonstrably achievable emissions reduction opportunities.

95. The main difficulty with a sector specific emissions cap is that there is no flexibility for countries that outgrow their emissions caps due to rapid or unpredictable economic development, even if a country has improved its performance in terms of reduced emissions intensity. This could be a distinct problem in

the case of cement given its fundamental role in infrastructure development. If set too low, an absolute cap on emissions in the cement sector could inhibit economic development in developing countries. On the other hand, if the cap proposed were set too high, competitiveness concerns would remain and there might be very little incentive to reduce the rate of emissions growth.

96. Given that cement demand in developing countries is expected to grow by around 150% in the next 20 years, it seems reasonable that the objective of any cement sector agreement should be less about constraining absolute emissions and more about incentivising improved performance in terms of the amount of emissions associated with a tonne of cement. For that reason, a more reasonable and politically acceptable emissions intensity performance target was adopted.

97. It should be recognised from the outset that the choice of an intensity target may undermine the objective of minimising competitiveness issues and leakage if those targets are employed in parallel with national absolute emissions caps in Annex 1 countries. Under absolute caps, firms face the full cost of carbon. Under an intensity approach, carbon costs vary and can be much higher or even become negative – i.e. provide a production subsidy. It all depends on the targets that are set. In theory, the target could be set so that it mirrors the effect of an absolute target, but if that were the goal then it would be simpler to introduce an absolute cap. The point being that firms facing intensity targets will face different production costs to firms under an absolute emissions cap. Cost differences are precisely what drives competitiveness concerns and risks of leakage (see Appendix B for a brief discussion of how intensity targets affect production decisions).

3.3.2 A prototype intensity-based SEA

98. For discussion purposes an intensity target measured in terms of CO_2 per tonne of cement produced is proposed. The agreement would include explicit penalties for not meeting the target as well as benefits if the target were surpassed. Countries that bettered the target would be allocated emissions permits on the basis of their production (tonnes of cement) multiplied by the distance between their emissions intensity and the target. For example, if the target is 1 tonne of CO_2 per tonne of cement and a country which produces 1000 tonnes of cement achieved a performance of 0.9 tonnes of CO_2 per tonne, the country would receive 100 SEUs. The SEUs could be sold to other governments to assist them in meeting their emissions reduction obligations and possibly on other international and national markets depending on how those markets develop in the future. Countries that failed to meet their intensity target would have to purchase permits to the extent of the shortfall.

99. For countries that bettered the performance target the creation of credits would differ depending on whether or not a country had an economy-wide emissions cap. For those with an economy-wide emissions cap under a post-Kyoto arrangement, the SEA agreement would effectively be “no-win” at the level of the country. Permits generated under the SEA would need to be “retired” rather than used as economy-wide emissions permits or on-sold unless another emissions permit such as an AAU were retired in its place. Unless this happened, permit creation in the cement sector could end up increasing a country’s cap.

100. But it is important to stress that any “retirement” of permits occurs at the level of national accounts. It does not mean that governments could not reward firms for reaching or surpassing a domestic performance target by passing on the benefit of the permits they had created. Governments would simply have to retire one of their economy-wide emissions permits to account for any SEU passed down to industry. International performance targets could be taken into account when considering the allocation of domestic emissions permits to the sector. Countries with emissions caps but lacking a domestic economy-wide emissions trading scheme might wish to replicate on a domestic basis the international sectoral SEA so as to create incentives for firms to reduce emissions. Countries with economy-wide trading schemes could also replicate the SEA domestically for the cement sector. This would help to offset some of the

competitiveness issues that arise when intensity targets are used in parallel with absolute caps. It could be difficult to manage, however, if the existing domestic scheme were based on an absolute cap (cap and trade schemes like the EU ETS). Schemes with intensity targets are usually preferred by industry so other sectors are likely to seek to be included in such a scheme – undermining support for the cap and trade scheme.

101. In order to avoid double counting of emissions reductions, countries without economy-wide emissions caps would not be able eligible to register projects under the Clean Development Mechanism (CDM).

102. The SEA as proposed would be subordinate to the Kyoto-Protocol or any such successor arrangement in all respects except where CDM is concerned. The SEA would be devised as a protocol to the UNFCCC. [22]

103. The intensity target proposed here would be calculated using a percentage improvement in emissions intensity relative to a base period, but there are other possibilities. For instance, a target could include a performance benchmark based on current best practice instead of an improvement rate. Choosing a percentage improvement in emissions intensity does make heavy demands on data because of the need to establish historical performance, but it has the benefit of making the magnitude of required change very clear.

104. Improvement targets would be the subject of negotiation. The process might be:

1) Experts to assess and define emissions-intensity global benchmarks (best practice intensity) as a starting point for discussions.

2) Countries to provide information on base year emissions intensity and propose rates of improvement based on their assessment of the feasibility and cost of meeting best practice.

3) Final targets to vary by country or region.

105. Allowing targets to vary by country would be a concession to the variation of abatement opportunities and costs that exist across countries. The rationale for such a move would be essentially political. It would not be easy to justify from an environmental point of view because one of the benefits of placing a cost on emissions is to encourage their reduction, which may in some cases mean relocating production to locations where it is inherently less emissions-intensive. Balancing the need for development and ambitious environmental objectives is likely to be difficult, as political imperatives will typically pull in the opposite direction from strong environmental discipline and environmental outcomes.

106. Thresholds for critical mass and entry into force would apply. The agreement would enter into force with the ratification of countries responsible for 75% of emissions in the sector according to emissions data held by the UNFCCC for a base year date of 2005. Around 75% of existing cement sector emissions could be covered within the agreement if only nine countries were included in any cement sector agreement, e.g.: China, India, Brazil, Mexico, South Africa, Korea, USA, Japan, and Russia.[23, 24]

107. Under the SEA countries would be obligated to report on their cement sector emissions on an annual basis. However, a formal determination of whether a country would either receive permits or have to purchase them would be based on three-year assessment periods. This would permit some uncontrollable short-term fluctuations in performance to be taken into account while not constraining liquidity and unnecessarily delaying access to financial returns for countries that bettered their targets.[25]

108. Other specific aspects of the prototype for the cement sector include:

- Sectoral definition: Cement production is defined by the following activities:
  - Clinker production
  - Raw material quarrying
  - Grinding of clinker, additives and cement substitutes such as slag, both in integrated cement plants and stand-alone grinding stations
- Gasses covered: All GHGs produced directly by the activities within the sectoral definition if, and only if, they do not fall within the boundary of another agreement.26
- Contracting parties: Any party to the UNFCCC. Compliance of obligations rest with governments.
- Accession/joining the agreement is voluntary.
- Compliance after joining the agreement is mandatory.
- Timelines:
  - In principle agreement: 2009
  - Negotiated benchmarks: 2012
  - Entry into force: 2013
- Verification and administrative body: Industry organisation.
  - WBCSD GHG protocol to be used for emissions measurement and verification
  - Policies and practices of the Industry group to be approved by the CoP

3.4 Impacts of a cement sector agreement: modelling results

109. The CSI has constructed a model to evaluate likely impacts of different policy options including a sectoral agreement in the cement sector. The modelling remains very much a work in progress, but some preliminary simulations enable us to provide an interpretation of the potential impacts and issues associated with an SEA of the type described above.[27] A description of the model and the CSI's modelling work is contained in Appendix C.

110. In 2005 the CSI covered 28% of global cement production, with high data coverage for Europe (73%), North America (75%), Latin America (65%) and India (57%), but low for Asia (11%), especially China (5%).

111. Reference case projections from the model are challenging in terms of emissions growth in the cement sector if no action is taken to reduce emissions. Emissions from cement production are expected to grow by over 100% by 2030, from around 1600 Mt in 2005 (4% of global emissions) to 3500 Mt (6% of global emissions).[28] This result is due largely to expectations of continued robust growth in demand for cement. Global average emissions intensity of cement production is expected to improve in the future as old plants are replaced with newer less emissions-intensive technologies and as producers increase blending and alternative fuel use. Improvements in emissions intensity are expected to be largest in non-Annex I countries where most new cement demand will be located and most new cement capacity put in place.

112. Three global policy scenarios are referred to below: 1) Annex I country emissions are capped while other countries face no carbon cost (Annex 1 caps); 2) all countries engage in an SEA as outlined above (Sectoral agreement); and 3) all countries take on emissions caps in the cement sector (Absolute caps).

Although the focus is an SEA it is useful to consider how modelling results vary according to each scenario.[29]

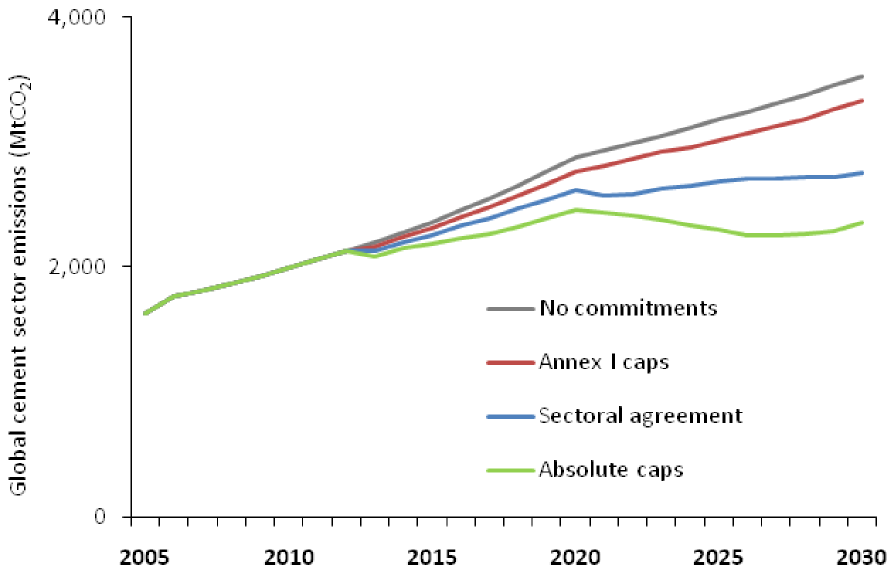
113. When only Annex I emissions are capped, global emissions from cement production are reduced by around 5% in 2030.[30] The cost of carbon faced by Annex I producers drives substantial improvement in emissions intensity (approximately 50%). The largest improvement is in North America, where emissions intensity is currently high by world standards. However, as Annex I producers are a relatively small part of global production, impacts on global emissions are small.

114. The Annex I caps scenario assumes that capped countries do not allocate emissions permits to domestic producers free of charge. Under these conditions the increase in production costs in Annex I countries leads to an approximate one-quarter reduction in cement production in 2030 and a corresponding increase in cement imports to meet domestic demand. This result illustrates the sort of effect that industry and policy makers are concerned about when they refer to competitiveness issues and potential for leakage. If permits were allocated free of charge to firms in Annex 1 countries this result could be less pronounced, but this is uncertain. While free allocation may compensate firms for lost competitiveness it would not change the economics of decisions to reduce investment or relocate production over the longer term.

115. A sectoral agreement based on intensity targets extended to all countries nearly quadruples emissions reductions in the cement sector, from an approximate 5% reduction in 2030 with Annex I caps to over 20% reduction with intensity targets. In this respect the sectoral agreement is a certain improvement in terms of an emissions reduction objective.

116. The modelling also shows reduced distortion to production compared with the Annex 1 caps scenario, but this result cannot be taken at face value. In the modelled SEA scenario Annex I countries implement absolute emissions caps while non-Annex I countries introduce domestic intensity improvement targets replicating the design of the prototype.[31] It is assumed that improvement targets are the same for all non-Annex I countries, so the "playing field" in terms of international competitiveness and costs of carbon is still uneven. In the modelling results, production distortions are a fraction of what they are in the case of the Annex I caps scenario. For example, Annex I production contracts by around 5% in 2020 relative to the base case, as opposed to around one-third in 2020 in the Annex 1 caps scenario.[32]

Figure 8. Projected cement sector emissions under different international policy scenarios
(Source: Cement Sustainability Initiative)



117. As noted earlier, the impact of intensity targets on competitiveness and leakage depends crucially on the chosen targets. Therefore, the magnitude of production distortions found in the modelling cannot be generalised to the real world because they presuppose agreed improvement targets. However, it is useful to consider why the production distortions were reduced under the sectoral agreement scenario.

118. The short answer is that the targets were stringent enough to prevent large scale (net) financial transfers to some countries which, under an intensity target, could operate like production subsidies. Indeed, in the modelling results non-Annex I countries are net purchasers of permits. The net purchase position is not large, however, and the effective price of CO_2 paid by non-Annex 1 countries equates to less than $1 per tonne of cement. This aggregate result obscures the fact that some developing country regions receive permit revenue (in net) but it does explain why there is a reduction in distortions. It also demonstrates that a sectoral agreement can reduce competitiveness problems – even if it cannot be guaranteed to do so.

119. In any event, a sectoral agreement based on intensity targets will not, on its own, fully address competitiveness issues. This raises the prospect that alternative measures for addressing competitiveness might be employed to counter any potential distortions, such as carbon taxes at the border.

120. Absolute caps would of course be more effective in addressing competitiveness issues and come with the benefit of much deeper emissions reductions incentivised by higher carbon costs in non-Annex 1 countries. In CSI's absolute caps scenario, the higher cost of carbon lifts emissions reductions to over 30% compared with the base case. However, the carbon cost that non-Annex 1 countries would face would rise to reflect the cost in Annex 1 countries (assumed in some cases to be $100/t CO_2 in 2013-20 and rising to $150/t in 2020-30) and would be in direct conflict with the core UNFCCC principle of common but differentiated responsibilities. The scenario is included simply to illustrate the foregone abatement opportunity.

121. One of the most important results is the extent to which the model chooses to use carbon capture and storage as a mitigation tool that ends up dominating the mitigation scenarios (see Figure 9). While established mitigation approaches offer material opportunities for reducing emissions, CCS not only

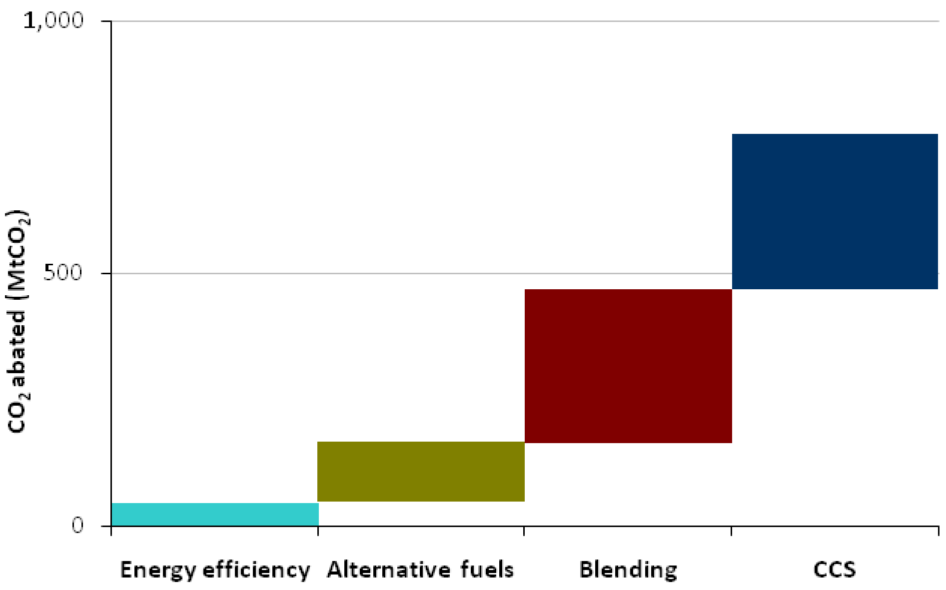
dominates abatement opportunities but would need to be deployed very widely (more than half of all plants) for the absolute level of cement sector emissions to be controlled at current levels.

122. The viability of CCS as a widespread abatement technology is uncertain in the cement sector. Its technical feasibility is yet to be proven in the cement industry and economic barriers are high. The IEA estimates that CCS would raise cement production costs by 40% to 90%. Further, the economics of CCS, with high fixed capital costs, would favour deployment in large plants. This is problematic given the large number of small plants that operate in the industry, especially in emerging and developing economies.

123. Raising the prospects for widespread use of CCS requires increased investment in research and development of new technologies and up-front finance capital. An SEA on its own is unlikely to incentivise CCS given the immaturity of the technology and the potential for spillovers from commercial research and development. This being so, a counterpart arrangement to an SEA may be in order which could provide up-front funding from Annex I SEA parties to their non-Annex I counterparts.

Figure 9. Potential contributions of different abatement options[33]

(Source: Cement Sustainability Initiative)



124. Financing the development and deployment of CCS may have additional benefits in the context of an SEA beyond mobilising a crucial abatement technology. Distortions to trade competitiveness could be minimised if climate policies were focussed on the uptake of CCS or by directing funding towards CCS technology. This is because most technologies for reducing emissions confer a competitive benefit by reducing energy intensity or otherwise lowering input costs. Thus a credit creation process may not only tip the balance of decision making in favour of lower emission technologies and practices (such as blending and alternative fuel use) but those subsidised decisions will also reduce operating costs and boost competitiveness. However, CCS is quite different in this regard. CCS is an abatement technology that has no complementary cost-saving purpose beyond avoiding costs of carbon. Indeed, CCS would add to the energy requirements of a plant and thereby increase not only capital costs but also operating costs, which impact on competitiveness. Thus CCS is not only the most crucial technology for reducing CO_2 emissions but it is also the one for which there is the least distortion.

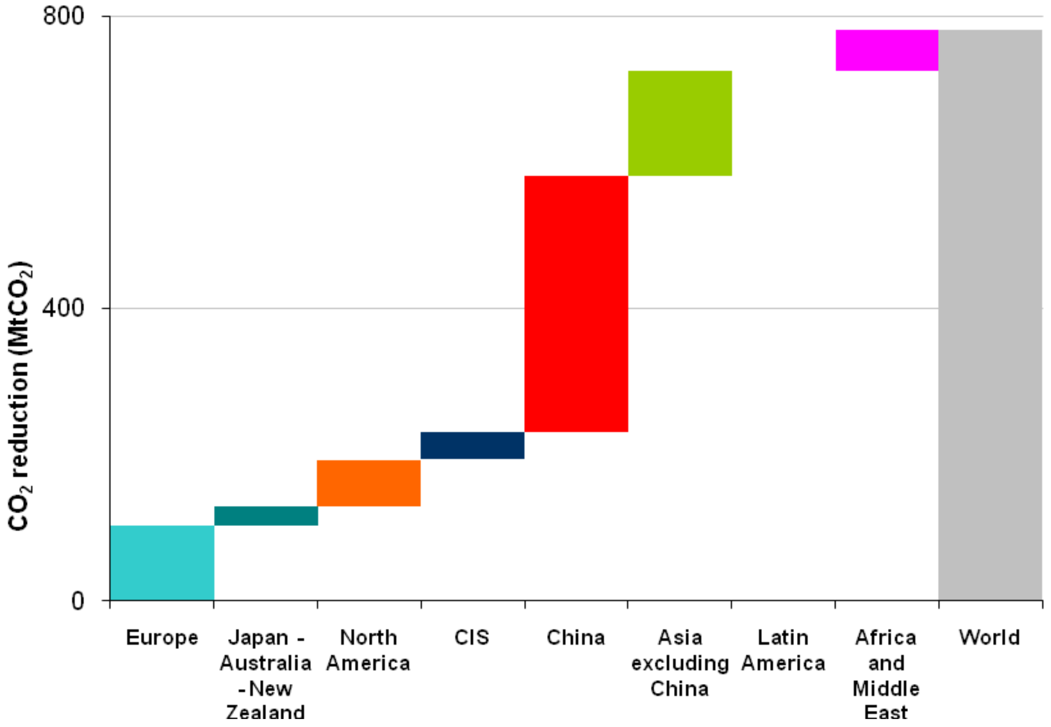
3.5 Ensuring the agreement works on the ground

3.5.1 Data issues

125. One of the most important and immediate challenges to a sectoral agreement in the cement sector is increasing the coverage of programmes for monitoring and reporting on GHG emissions and verifying emissions reductions. Accurate and timely information is a prerequisite to any effective sectoral agreement, but current measurement and reporting initiatives have incomplete coverage across all developing countries. This is especially the case in China, the largest source of CO_2 emissions in the cement sector.

126. Increasing coverage in China is particularly important. CSI modelling suggests that nearly half of the abatement potential in the cement sector resides in China, making Chinese participation in a sectoral agreement indispensable (see Figure 10). This result is not surprising given the large role China plays in cement production and the numerous outdated manufacturing technologies still used there today.

Figure 10. Location of reduction potential under a sectoral agreement
(Source: Cement Sustainability Initiative)



127. Current initiatives to measure GHG emissions from the cement sector include national GHG inventories (under the UNFCCC and Kyoto Protocol) and CSI's "Getting the Numbers Right" initiative. Country-wide emissions inventories are perhaps not well suited to the kind of sectoral agreement envisaged here; use of more detailed protocols such as the CSI initiative should be increased.

128. Increasing coverage of monitoring and reporting in China is a difficult task, as production is dispersed and a large number of small cement plants exist in the poorer regions. However, this situation is changing. Large-scale consolidation has taken place in recent years and is expected to continue; the number of cement plants in China decreased from around 8,000 in 1994 to 5,200 in 2007. Consolidation has also coincided with the closure of many of the more emissions-intensive plants. This kind of

restructuring could slow the implementation of monitoring schemes, but with fewer plants to cover ongoing monitoring and reporting would be simplified.

3.5.2 Incentives for industry

129. Governments will need to come up with schemes that pass incentives down to industry. Otherwise, agreements will be unable to create a level playing field, abatement actions may not be taken where they are most needed and technologies may not be diffused as widely as they need to be.

130. For countries with existing or planned emissions trading schemes some changes may be implemented to ensure that domestic regulation is consistent with the international design of an SEA.

131. For countries without a domestic trading scheme new regulations would have to be put in place to ensure that domestic incentives reflect those in the international arrangement. Candidate solutions are many, but the most obvious approach would be to replicate the intensity-based baseline and credit design of the SEA in domestic regulation.

132. Instituting a baseline and credit scheme (or similar) introduces an added complication in terms of the domestic policy and regulatory matters that SEA participants would have to address. Setting up a domestic baseline and credit scheme could be a useful learning curve for systematic climate regulations. Hurdles would need to be overcome, however, such as resistance from domestic constituencies on the grounds that they are being “singled out” when other industries are not subject to regulations. In the cement industry concerns might be raised that product substitution at the expense of cement could take place if equivalent regulations were not extended to other industries. Taken to its logical conclusion, such concerns suggest that domestic schemes covering multiple sectors would be necessary, increasing the complexity of implementing an SEA in practice.[34] It also suggests that SEAs in sectors other than cement would be important to help offset potential inter-industry distortions. This would raise the complexity of a cement SEA still further.

133. Governments would need to give serious consideration to linking domestic schemes to the wider international carbon market. Linking would ensure a reasonable degree of correlation between the domestic carbon costs firms will face and international prices faced by governments in terms of credit revenue or purchasing. This is needed to ensure a general match between the aggregate value of industry liabilities or credit revenue and government liabilities or credit revenue.

134. Policies and regulatory changes will be needed to achieve the mitigation potential demonstrated in the CSI modelling, especially in terms of blending and alternative fuels. For example, the IEA (2008b) notes that “blended cements offer a major opportunity for energy conservation and emissions reductions, but their use would in many cases require revisions to construction standards, codes and practices”.

135. If governments were to pass on the incentives from an SEA to industry then a constructive co-dependence would be created between industry and government which should help to mobilise emissions reductions. Under an SEA governments would face liability to other governments if firms did not act, and firms would face a liability to governments if they did not – incentive for both to act.[35] In this way an SEA might help to focus the minds of industry and government on barriers to abatement, for example from established policies and practices.

3.6 Prospects for SEA membership

136. It is not clear that the incentives in the prototype cement SEA would be enough to attract a sufficient number of countries (representing 80% of production) for it to enter into force. Adequate incentives for developing countries would be the determining factor.

137. It is reasonable to expect that major cement producing Annex I countries would join such an agreement. Annex I countries face resistance to their domestic emissions regulations and policies from industries who fear a loss of international competitiveness. While an SEA would be unlikely to completely resolve these issues, it would at least go some way towards addressing them.

138. That said, an SEA would add an additional layer of complexity to climate policies. Annex I governments would have to weigh whether the benefits of any such agreement compensated for the added complexity.

139. For non-Annex I countries, concerns about the impacts of any SEA on economic development would need to be addressed. Intensity targets and differential benchmarks would go some way toward addressing such concerns, though they are unlikely to be sufficient.

140. Intensity targets are a double-edged sword. Countries that bettered their targets would receive credit revenue in relation to output. Thus countries experiencing rapid development and growth in cement output would receive increasing amounts of credit revenue. On the other hand, countries that did not meet or exceed their targets would face liabilities to pay that are proportional to cement output. It is possible to remove any chance of liabilities by adopting a no-lose target (as discussed for the electricity sector) but this would also dilute incentives to reduce emissions and would not help to reduce the risk of leakage.

141. Concerns around the size of potential liabilities could be addressed by setting targets based on clear implementation plans or "road maps" for reaching them.[36] In the cement sector, where many abatement opportunities reduce production costs, technical implementation plans should be able to be created which are quite attractive and achievable. This being the case, one important incentive to participate would be the reasonably assured prospect of revenue from credit sales.

142. Implementation plans would need to be linked to a financing mechanism to provide up-front capital for some aspects of implementation including building institutional capacity for any necessary policy or regulatory changes. As discussed earlier, a cement sector agreement could not be separated from a more general need to improve emissions-related information systems and institutional and policy capability. Thus the financing necessary for an SEA would most likely need to be delivered by a more broadly based fund or funding mechanism.

143. In summary, it is possible for membership of a cement SEA to reach a critical mass, but the incentives to make it happen are just as likely to lie outside an SEA as inside it.

4. Prospects for sectoral agreements

144. Sectoral agreements could be a useful part of any post-Kyoto arrangement on climate change but are unlikely to deliver on their promise without significant practical effort, political will and supplementary measures outside such agreements.

145. A sectoral crediting agreement could certainly scale up carbon finance as promised. If applied to the electricity sector, significant financial flows could be generated – so significant, in fact, that there is a risk that the supply of offsets generated would drastically depress international carbon prices. This would mean a substantial devaluation of emissions reductions – precisely the opposite effect that any post-Kyoto agreement needs to create.

146. While there are many design choices available for sectoral crediting agreements, there is no reasonable way to avoid this risk. The best risk management technique would be to strike what is believed to be an ambitious agreement with stringent emissions reduction targets for both an SCA and Annex I emissions caps.

147. Similarly, a sectoral emissions agreement could help reduce competitiveness issues and address leakage but only as far as ambition and political feasibility allow. The kinds of design choices deemed feasible only go some way towards addressing competitiveness issues. As such, they may be supplemented by unilateral actions to help level the playing field.

148. Any sectoral agreement needs to be considered within the context of a package of measures. It cannot be a stand-alone solution. Complementary measures include:

- Other sectoral agreements to prevent intra-industry distortions.
- Demand-side measures, especially energy efficiency measures.
- Reviewing and adjusting a range of policies and standards.
- Financing arrangements to kick start necessary changes.
- Improved information systems and institutional capacity.
- Continued emphasis on research and development for crucial mitigation technologies.

149. Research and development appears to be a crucial aspect, especially in the context of carbon capture and storage.

150. All of these issues will need to be addressed in the context of a sectoral agreement. Irrespective of the agreement design, considerable amounts of detail would need to be worked through to strike a functional agreement.

151. The complexity of sectoral agreements is by no means a mark against their usefulness. There are not likely to be any simple solutions for a post-Kyoto agreement and any that are proffered will have to be scrutinised for their practical effectiveness. Beyond the political acceptability of any implied burden-sharing, the workability of any sectoral agreement will depend upon the detail. This may prove to be the single biggest advantage of sectoral approaches: the opportunity they provide to focus the minds of governments and industries on the practicality of emissions reduction in some of the most emissions-intensive sectors.

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1 See Barker et al (2007) for examples of research supporting this claim.

2 The UNFCCC's technical report on Investment and Financial Flows to Address Climate Change (2007) reviews and analyses investment and financial flows relevant to the development of an effective and appropriate international response to climate change, with particular focus on developing countries' needs, including their medium-to long-term requirements for investment and finance. An updated version was released on 26 November 26. The investment needs for climate change mitigation have been significantly revised, especially regarding the energy sector. The secretariat relied on IEA scenario and estimates. And between the 2006 and 2008 editions of the WEO, estimations for the investment needs to reach to stabilise atmospheric concentration at 450 ppm case have increased by no less than 170%. As estimates regarding the baseline emissions have not been significantly revised (0.2%), this increase is mainly due to an increase of the capital cost of energy facilities. The secretariat did not calculate the updated figure of the overall investment needs for climate change mitigation on this basis. But as it was estimated around 200- 210 USD billions in 2030 in the previous paper, and as energy related investment needs for climate change mitigation represent around 70% of the overall figure, it would sum up to around 440-450 USD billion. Half of the additional global investment and financial flows needed would occur in developing countries due to rapid economic and population growth.

3 See Egenhofer and Fujiwara (2008) for a typology of sectoral approaches including "bottom-up country commitments."

4 The Sectoral Crediting Agreement (SCA) is essentially the same as approaches referred to in the literature as, inter alia, Sectoral No-lose Targets (Ward et al., 2008) and Sectoral Crediting Mechanisms (SCM) (Baron and Ellis, 2008).

5 Domestic implementation could follow a range of options tailored by parties to a sectoral agreement to suit their specific circumstances or institutional capabilities. For example, some countries may wish to use finance from a sectoral agreement to fund publicly controlled infrastructure rather than pass such finance/revenue through to plant-level operators. This would have implications for the effectiveness of an agreement and is discussed further? but a prototype for domestic implementation is not developed in this paper.

6 Following the language of Bradley et al (2007). Alternative options include: carve-out, addition, or sector only options.

7 Barker et al (2007), based on stabilising GHG concentrations at between 490-535 ppm CO_2 eq.

8 Improvements over the CDM are not assured and depend on the design of the SCA and how it is implemented. In fact transaction costs could increase given the increased scale of monitoring reporting and verifying emissions under an SCA compared with CDM. However, the replicability of measurement and monitoring processes suggests that economies of scale should reduce costs (relative to the amount of emission reductions achieved). Environmental integrity should be improved thorough SCAs, compared to CDM, but that will depend on the outcome of negotiations on reduction targets.

9 Following Ward et al (2008) and Höhne and Ellerman (2008), the prototype is a negotiated instrument rather than the more technical exercise typified in CDM or as proposed by Schmidt et al (2008). The need for a negotiated outcome is due to the complexity of the process of setting targets and wide differences in the specific situations of developing countries (Baron, et al 2007). It also reflects the unavoidably political nature of striking a balance between the acceptability of SCA targets and the stringency of developed country emission reductions.

10 Incorporating additional unilateral pledges will enhance the effectiveness of the SNLCAs by retiring the associated reductions from the atmosphere rather than creating offset mechanisms that can substitute for Annex I reduction efforts.

11 Reference scenario in the IEA's *World Energy Outlook 2008* (IEA, 2008c).

12 A description of the model used by CIRED, called IMACLIM'R, can be found at http://www.centre-cired.fr/spip.php?article544. The numbers used here incorporate the most recent IEA estimates of historical emission and power generation in China with the IMACLIM'R demand growth rates and technological improvement rates used to assess mitigation potential. IMACLIM'R has also been used as one of two modelling platforms used to create the FONDDRI scenarios discussed below.

13 These estimates are only for illustrative purposes. Forecasts of energy demand and emissions in China move around substantially from year to year. This is unavoidable when projecting growth in developing economies because of, inter alia, the potential for rapid substantial increases in economic growth and changes to industrial structures.

14 If the credits created under an SCA were project related it would be possible to peg reduction credit volumes to projects initiated prior to 2030. In an economy-wide crediting environment this is not possible.

15 It may be that making SERs fungible with AAUs is not a good idea given the potentially serious consequences of getting the target wrong. Discounting credits is one option that has been put forward. For one avoided tonne of CO2 equivalent, less than one credit would be issued. This would shift the problem from striking a balance between no-lose targets and Annex I commitments to striking a balance between discount rates and Annex I commitments. The potential margin for error would not be avoided.

Another alternative might be to create an SCA fund for which developed countries pledge contributions that can be used to "pay" for reduction credits. Such a mechanism would not escape any of the problems of uncertainty that exist in an SCA. In fact, uncertainty would be compounded. Not only would likely volumes of reductions be part of the discussion in setting up such a fund, but projections of the cost of reductions would also need to be decided upon. But at least such an approach would reduce the risk of large volumes of offsets undermining efforts to reduce emissions in developed countries. Some have suggested that it may also be possible to sidestep some of the uncertainty that exists in projections by adopting a target for the uptake of particular generation technologies rather than a target for emissions; i.e., setting a target for new coal plant installed in China to be supercritical or ultra-supercritical. This kind of approach is not fundamentally different to an emissions or emissions intensity target. A technology target would have to include either an implicit or explicit agreement about the potential for improved emissions intensity. Such an agreement would of course have to include an assumption about whether or not such technology would be installed without a target or associated incentives. Further, agreement would be necessary on the value of any funding to assist with or incentivise reaching such a target. As such the implications of this are not fundamentally different from the idea of an SCA, whether funded through trade in credits or via an SCA fund. A technology standard would be even more prescriptive than a sector target, further reducing the flexibility to reduce emissions at low cost compared with an SCA.

16 The IEA (2008b) notes that the situation in China is changing as a result of government policies.

17 The availability of such material comes at an environmental cost, with both steel production and coal-fired electricity generation producing GHG emissions, but these materials are typically waste products.

18 Based on a CO_2 ‘content’ of 0.9 tonnes per tonne of cement (Ecofys, 2008) and a market price (without carbon of US$50-$100.

19 Under current circumstances (costs and prices) the low value to weight ratio of cement means transporting cement long distances over land is very costly. Sea freight is, however, more viable.

20 Around 25% of global cement production capacity is controlled by 16 companies (Vieillefosse, A. (2007).

21 One major gap in the CSI’s coverage is China. Expanding coverage to include China would be an important prerequisite to an effective sectoral agreement for the cement sector. This could be facilitated by external funding to Chinese government or industry to expedite the roll out of the WBCSD GHG protocol for measuring cement sector GHG emissions. Working with the Asia Pacific Partnership, the CSI has already conducted two workshops with China’s cement sector.

22 Baron et al (2008, p. 26) find that “Were transnational sectoral agreements to be incorporated into the UNFCCC regime in the near future, they would likely be negotiated under the auspices of the Convention, not the Protocol, given the more limited focus of AWG-KP negotiations. This could change, however, were future versions of the Protocol to include a more nuanced form of division among Parties (beyond simply Annex I and non-Annex I). For now, BAP paragraphs 1(b)(i) and (ii) provide a potential negotiation mandate for transnational sectoral approaches and paragraph 1(b)(iv) may also be relevant.”

23 It is likely to be impractical and very costly if all parties were to ratify the agreement. While partial coverage would come with costs – introducing the possibility of substantial increases in cement sector emissions in the future in areas outside the agreement – it would most likely be less costly than ensuring all parties to the UNFCCC had sufficient capacity to implement such an agreement.

24 Alternatively, a specific number of countries could be considered. Schmidt et al (2008) suggest that an effective sectoral agreement might include “…the ten highest-emitting developing countries in electricity and other major industrial sectors…”. An agreement which covered the G8+5 would also achieve coverage of around 80% of global production.

25 In this regard there is a trade off to be made between the benefit of long periods between reconciliation, which helps to smooth short term fluctuations, and the financial cost of delaying the creation of credits. Choosing a relatively short reconciliation period (every three years) puts more weight on liquidity. The actual payment or receipt of credits (i.e. settlement) would take place initially four years after entry into force (2017) with reconciliation relating to the first three years (2013. 2014 and 2015). Thereafter settlement would take place every three years (for e.g. 2020) covering the subsequent three-year reconciliation period (for e.g. 2016, 2017, and 2018).

[26] The sectoral definition would cover all direct emissions including from stationary power sources such as on-site electricity generation not connected to a grid (i.e. there is no possibility of export or import of electricity). GHGs associated with any other electricity consumption – sourced from the grid or from an on-site grid connected installation for which import and export of electricity is possible – fall outside the terms of the agreement unless no other agreement exists which covers such electricity generation. The reason for this is that including all electricity consumption in the cement sector agreement would almost certainly lead to double counting.

[27] Modelling studies, while useful, are not predictions of the future. They can, however, help improve 0understanding of trends and relative changes in trends under different scenarios.

[28] Assuming growth in CO_2 equivalent emissions of GHGs from approximately 44 Gt in 2005 to 60 Gt in 2030 (IEA, 2008c) if no action is taken to address growth in emissions. While this assumption is purely hypothetical, it clearly demonstrates the extent to which cement emissions are expected to become a proportionately larger share of global GHG emissions in the future.

[29] The relative impacts are more instructive than absolute impacts under each scenario because those impacts are quite sensitive to a large number of assumptions about technology and the final shape of any negotiated SEA (including the number of countries participating).

[30] The caps or absolute emissions targets used in this scenario vary by region and are relative to a 1990 base year. The targets are: Europe, -20% by 2020, -30% by 2030; Japan, Australia, New Zealand and North America, -10% by 2020, -15% by 2030; CIS 0% in 2013-30. The price of carbon is assumed to be $100/t$CO_2$ in 2013-20 rising to $150/t$CO_2$ in 2020-30.

[31] In this scenario Annex I countries employ domestic emissions caps as for the Annex I cap scenario. Non-Annex 1 countries face improvement targets of -10% by 2020 and -20% by 2030 relative to a 2005 baseline.

[32] It is difficult to be precise about where production will increase or decrease on country by country basis. The modelling results are sensitive to assumptions about agreed intensity targets and abatement potentials in each country, making specific results on leakage highly speculative. Other estimates of potential changes and potential leakage from the cement sector vary widely and studies are not always directly comparable. For example: Demailly and Quirion (2005) report an estimated 16% leakage rate in the OECD cement sector in 2030; Szabo et al (2006) suggest an EU-only (EU-15) emission cap and a CO_2 price of €40/t would produce an approximate 30% leakage rate in cement production (assuming a constant emission factor across regions, i.e. the leakage in question is production leakage rather than emission leakage and the estimated impact is for the short run and it is not clear if the research suggests the leakage rate would grow); Demailly and Quiron (2006) find an EU-only emission cap producing leakage of 50%, in the most extreme case; Ponssard and Walker (2008) find a similar result to the CSI model with leakage around 70% under some scenarios with a EU-only cap on emissions; OECD (2008) estimates 20% leakage for EU only caps estimated for emissions across the entire economy, not just cement.

[33] The CSI note that individual contributions are not necessarily directly cumulative.

[34] Accepting that deciding to join an SEA would be voluntary (but with obligatory compliance) so that only those parties capable of (or capable of being assisted into) economy-wide or industry-specific emissions trading schemes would need to overcome these issues.

[35] The existence of an incentive (the avoidance of liability) is no guarantee of action but incentives would be roughly aligned.

[36] The IEA has considerable expertise in creating such road maps and is working with industry to develop and refine their road map for the cement sector. Thus, any process for creating road maps would not be starting from “square one”.

APPENDIX A

COMMON ASPECTS OF ANY SECTORAL AGREEMENT

1. Any sectoral agreement needs to:

- Define a boundary around the emissions source (whose emissions?).
- Define the unit of measurement (what emissions?).
- Reflect an understanding about expected emissions with and without action.
- Set out a performance target of some kind.
- Provide incentives for taking action to reduce emissions.
- Specify institutional arrangements for measurement, reporting, verification and technical guidance.
- Specify time frames for entry into force, evaluation, and cessation.

A.1 Boundary issues

2. A sectoral agreement must clearly define the activities which fall within its reach. While this may seem straightforward, boundaries can create incentives to include or exclude activities in a way that can undermine integrity. Three common risks in this regard include:

> *Threshold risk*: Where a threshold for coverage is used in terms of defining the size of an activity or inclusion in a sector according to "principal activity" wherever multiple activities take place. This may incentivise patterns of production that are not otherwise ideal but secure either inclusion or exclusion from an agreement.
>
> *Diversion risk*: Where production activity and emissions increase in a sector not covered by an agreement. Conversely, where production and absolute emissions in an activity covered by a sectoral agreement increase beyond what they would otherwise have been given new incentives to invest in that sector.
>
> *Double-counting risk*: The risk that multiple climate policy measures do not have consistently defined sectoral boundaries so that emissions or emissions reductions may be counted twice.

3. Boundary issues can have very real implications. However, these can, for the most part, be resolved through systematic and consistent technical rules or guidelines, as have been used in the construction of

GHG inventories in Annex I countries. These can be the subject of considerable discussion and negotiation.[1]

A.2 Units of measurement

4. Unit of measurement is perhaps the most difficult to negotiate because of its impact on an agreement. The unit of measurement must address whether all GHGs are measured (i.e. CO_2, CO_2 equivalents) and whether or not the emissions of interest are per unit of output (i.e. intensity), absolute emissions or some other proxy. In addition, each unit of measurement could, in theory, be applied in a dynamic fashion – with targets updated or refined over time. The choice of unit of measurement will have an impact on the nature and stringency of a performance target, how success is measured (benchmarks), the incentives created, the degree of difficulty in measuring and verifying emissions, and emissions reductions. The choice of unit of measurement may also affect perceptions about the effects of a target irrespective of its stringency.

A.2.1 Absolute emissions

5. Using absolute emissions as the unit of measurement has the benefit of linking action to the principal objective of climate policy: reducing overall emissions. It is transparent and relates action and targets to all aspects of GHG emitting activities, whether from demand for goods and services or production techniques.

6. Absolute emissions are a function of both technical factors and economic activity. Thus measuring performance or targets in terms of absolute emissions brings economic growth to the fore of any discussion. This can create nervousness about whether performance targets adequately account for future economic growth and economic development needs, especially for developing countries.

7. Similarly, developing countries may be resistant to agreements focussed on measuring absolute emissions, as they could be construed as a step toward economy-wide binding caps.

8. From a practical perspective it is difficult to choose sectoral performance targets measured in terms of absolute emissions, as this requires an assessment of future technological potentials for controlling emissions and associated costs. It also requires a judgement about how much economic activity is desirable in a particular sector. These information requirements are usually bound up in projections of future emissions and the potential for absolute emissions reductions. Projections are likely to be inaccurate, and as a result the targets could prove to be "wrong". This matters less when setting global emissions targets because they can be set based on working back from "what needs to be done". On a strictly sectoral basis it is much more difficult to identify the optimal reduction.

A.2.2 Emissions intensity

9. Industries often argue for measuring performance and targets in terms of emissions intensity on the grounds that they are more favourable to economic development. This is not accurate, as intensity targets can constrain development by more than absolute emissions targets. Impacts on economic development are determined by the stringency of targets, not the units of measurement.

10. Using emissions intensity as a unit of measurement avoids having to make up-front judgements about economic development. The weight of discussion, in terms of performance and targets, is focussed on technical factors. Future economic growth can be relegated to a second order question about the impacts of these targets. However if targets are set without an absolute emissions cap in mind it could lead to more

[1] See Ellis and Baron (2005, p.16) for a useful discussion of this issue.

emissions than is desirable. In that respect, intensity-based measurement does not avoid the practical problems associated with absolute emissions.

11. Setting targets using emissions intensity can be complicated, however, because there may not be a single appropriate or obvious target to use. An international best practice intensity target is one option, but such a target is not sensitive to regional or local resource constraints. It may not reflect all interpretations of "common but differentiated responsibilities" and may also discourage countries from improving the emissions intensity of their production if the international best practice is impossibly hard to reach.

12. There may be a presumption that an international best practice benchmark is appropriate in the case of a sectoral agreement because production within a sector can more or less be treated on a like-with-like basis. This presumes a degree of similarity that may not be appropriate in reality – although inappropriate assumptions about similarity may emerge whatever the unit of measurement for the target.[2]

13. The very practical nature of sectoral agreements makes them appealing. Considering emissions on a sector-by-sector basis at the international level provides a window on effective action and the steps that need to be taken in practice to reduce emissions. In principle, this provides focus and a greater degree of certainty about what can be achieved compared to more theoretical approaches such as cap and trade.

14. However, sectoral agreements present in microcosm many of the difficulties that arise in a more generalised and flexible economy-wide cap-and-trade scheme. In negotiating emissions caps, Annex I countries have appealed, whether in the Kyoto Protocol or in the EU under burden-sharing arrangements, to their individual circumstances and resources to argue why they are constrained in their abatement opportunities – or at least why they face very high abatement costs. Digging down into a particular sector does not resolve this sort of problem.

15. For example, it is well known that there are wide geographical differences in the availability and cost of renewable and low emission energy. In some geographical settings there are rivers amenable to hydro schemes, wind-swept areas for wind power or a surplus of biomass waste for fuelling distributed generation. Others have easy access to gas, while others rely primarily on coal for their energy.

16. The existence of variations in mitigation potentials raises an important issue of ambition for any agreement seeking to reduce emissions – whether through comprehensive caps or a more narrow sectoral approach. Parties to any such agreement will invariably try to preserve existing industry and the policy space to encourage expansion. Governments are likely to argue that they cannot be held to the same mitigation objectives as parties with abundant low emission opportunities. For example, if alternative fuels are not available locally, the argument might be that a target reduction objective should be set which reflects such a constraint. Any such accommodation would, however, increase the cost of global emissions reductions and impede the objective of controlling climate change. In a world that is serious about constraining emissions, the ability to produce low emission products should confer a comparative advantage which lifts production in low emission locations and reduces production in high emission locations. To loosen constraints where emissions intensity is inherently higher can eliminate benefits from production shifting to wherever emissions are lowest.

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2 The concept of a "sector" is simple in the abstract but practical difficulties in setting sectoral boundaries suggest that it is not. In the negotiating space there has also been "an expectation that breaking the challenge of climate policy down on a sector-by-sector basis will present a more manageable task for negotiators – either by removing difficult aspects of climate mitigation from discussion altogether, or by allowing them to be addressed separately" (Bradley et al (2007), p.2). This is not necessarily so, because in practice the heterogeneity of country mitigation potentials is also reflected in industrial sectors so splitting up discussions replicates or magnifies the kinds of difficulties and complexities that exist at the economy-wide level.

A.2.3 Multiple or composite units of measurement

17. A final option for units of measurement might be composite targets based on a combination of intensity-based and absolute emissions and variations that can account for regional and local resource constraints. In the case of electricity generation this could mean measuring emissions intensity of generating plants depending on fuel type while also measuring emissions intensity or emissions from the entire electricity system. For example, a target might be created on the basis of the best 10% of emissions intensities globally for a given fuel type. The target would not create any incentive to use demand-side initiatives (e.g. smart metering or improved transmission) or to adjust the generating portfolio in favour of renewable or low(er) emission fuels. Incorporating a second target based on average global emissions intensity would take account of those incentives. The weights given to each could vary across countries to reflect local resource constraints.

A.3 Incentives

18. The issues discussed above are largely ones of implementation that can be generalised from one sectoral agreement to another. The nature of incentives, however, is the dimension that distinguishes most proposed sectoral approaches or agreements from one another. Key issues here are:

- Whether tradable permits are part of the agreement.
  - Incentives such as taxes could be used instead of permits.
  - Would permits be fungible with other international carbon instruments?
  - Would permits be held by or given to firms?
- Whether incentives are attributed to actions (installing a particular technology) or to outcomes (verified emissions reductions below target).
  - Policies and measures or the installation of particular technologies that create credits rather than verifiable and specific emissions reductions would avoid problems with data collection.
- Whether the agreement includes explicit penalties and explicit rewards.
  - A no-lose target sets explicit rewards but not penalties, although the implicit cost of not bettering the target is foregone rewards.
  - A baseline and credit scheme has an explicit (permit purchase requirement) penalty for emissions above target (i.e. baseline) and explicit rewards (permit creation/credits) for bettering the target.

19. Tradable permits are likely to be a distinguishing feature of international sectoral agreements. The capacity to generate tradable instruments is what distinguishes a sectoral approach from a simple funding initiative targeted at a particular sector, the latter being potentially ad hoc while the sectoral agreement provides a systematic framework for scaling up finance and crediting or incentivising action to reduce emissions. A sectoral agreement would most likely be additional to any directly-funded emissions reduction policies and actions.

20. Incentivising actions rather than emissions is appealing because it could reduce monitoring costs compared with crediting outcomes. However, it would require a de-facto/ex-ante measurement of emissions reductions to know how much an action would be "worth". The question is whether the errors implicit in this measurement are more or less acceptable than the errors and costs associated with monitoring emissions reduction outcomes.

A.4. Institutional arrangements

21. Any sectoral agreement would have to include institutional arrangements and protocols for monitoring and advising on measuring, reporting and verifying emissions and emissions reductions. Such arrangements might also include advice on appropriate benchmarks and technical standards. At the multilateral level such arrangements might include:

- Establishment of a new sectoral monitoring and technical body under the UNFCCC;
- Expansion of existing institutional arrangements such as those associated with the CDM;
- Recognition of a third party (perhaps an industry body) as the principal technical body for administering standards, providing guidelines and monitoring and collecting information; or
- A combination of all three.

22. The "right" approach will vary by sector depending on the presence and strengths of third party groups such as industry associations. It will also depend on the extent to which countries wish to treat sectoral agreements as primarily a technical exercise (as for CDM) or a more political construct which may well introduce the need for an entirely new institutional framework within the UNFCCC architecture.

23. Measurement protocols will also need to be established detailing what to measure and how to measure it. This includes accounting frameworks, data collection guidelines, data compilation tools and data reporting, verification, security and validation (i.e., credibility development) processes and institutions. The measurement protocols that underlie performance assessment programmes and statistics compilation are very technical and can be difficult and time consuming to develop – however, there are already some examples of successful experiences in the design of accounting frameworks, data collection guidelines and data compilation tools. Many existing statistical, analysis and voluntary reporting programmes are based on the accounting frameworks and data tools and guidelines developed under the WRI/WBCSD GHG Protocol Initiative.

24. Different countries show a wide range of characteristics, making a unique solution for developing industry benchmarks unlikely. Industry structures vary widely and the boundaries and processes that make sense in one place may fit poorly in another. This can be further complicated by the differing availability of data for constructing performance indicators among countries and sectors. As a consequence of this industry variation, performance metrics are expected to vary by country and sector.[3]

A.5. Time Frames

25. A sectoral agreement will need to be clear about the timing for:

- Negotiation.
- Entry into force.
- Evaluation:
  - Reporting

3 Availability and reliability of data is a very important matter and a prerequisite to sectoral approaches. However, it should be recognised that virtually no emissions inventory is perfect. Bosi and Ellis (2005, p.11) cite that "IPCC estimates that there is an uncertainty range of ±5% on energy-related CO_2 emissions in countries with good energy data collection systems. The uncertainty range may be on the order of ±10% in countries with less well-developed energy data collection systems (IPCC 2000)".

– Compliance

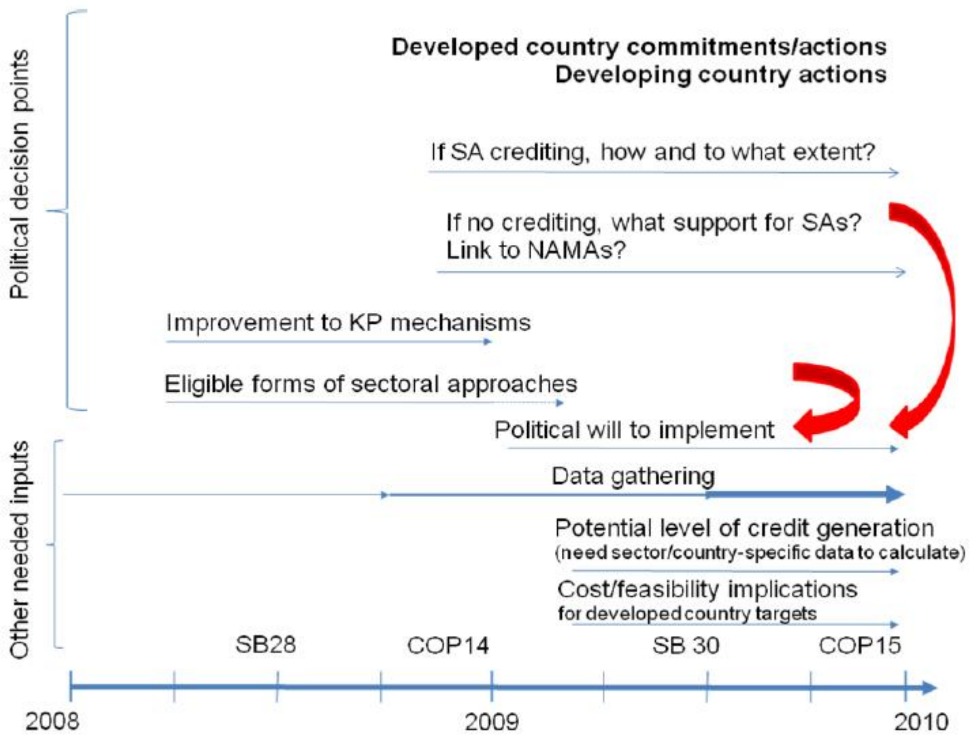
– Creation or submission of tradable instruments

- Termination of the agreement (if any).

26. It is most likely that negotiations on a sectoral agreement would have to be completed in phases, with initial phases used to establish the core parameters or modalities for establishing sectoral agreements including benchmarks and perhaps a short list of eligible sectors.

27. Figure 11, from Baron et al (2008), summarises the kinds of staging, decisions, and information that might be needed in the short term for sectoral agreements to be included in the post-2012 international climate policy architecture.

Figure A.1 Possible timelines of key elements for international sectoral agreements



28. Agreement on modalities could be followed by or parallel to a process for collecting the necessary information to inform negotiations on specific elements of a sectoral agreement – especially decisions on targets or benchmarks.[4]

29. The timing for entry into force is 2013. However, entry into force may, as a matter of practicality, be contingent on whether the necessary information has been gathered to agree on targets and benchmarks and whether parties to an agreement are in a position to perform the measuring and reporting necessary to implement it.

4 The degree of difficulty of this task will vary considerably by sector and by country. While some sectors will have very limited information, others such as the cement sector may be in a much stronger position in terms of information and information systems.

30. Baron et al (2008) point out some important in principle decisions that would need to be taken at COP 15 to facilitate the inclusion of sectoral agreements in any post-2012 international climate arrangement:

- The relationship between sectoral goals, nation-wide commitments by developed countries and other mitigation actions by developing countries.
- The use of sectoral expertise, information and institutions.
- Decisions on core elements of the negotiation, which could include: technology co-operation, common methodology for GHG baselines, and types of targets.
- Whether the agreements would be voluntary, and if so whether a critical mass is necessary to bring the agreements into force.
- Identification of a short list of possible sectors.
- A decision on how to move forward with addressing data gaps in identified sectors.

31. Time frames for evaluation of an agreement include frequency of reporting. In addition, the point at which credits would be issued or supplied (if any) would need to be decided. In general, more frequent crediting (say once every one to two years) would result in greater liquidity, financial incentives and transparency in carbon markets. However, more frequent credit issuance or settlement would reduce the time available to verify reductions. It may therefore be seen as desirable to have credit issuance or settlement to coincide with the end of a commitment period.

32. Finally, it will also be important to consider the lengths of time that an agreement remains in effect or for which credit rights or obligations remain “valid”. This will depend on whether the agreement is seen as a stepping stone to a more comprehensive international agreement capping global emissions or as an end in its own right.

APPENDIX B

INTENSITY TARGETS, PRODUCTION DECISIONS, AND COMPETITIVENESS CONCERNS

1. The impact of an intensity target on firms' decisions varies depending on whether the firm is making decisions about production volumes or about emissions intensity (i.e. production technologies and processes). It will also vary by the distance between a firm's emissions intensity and the intensity target. This is summarised in Table 4.

2. For a "poor performing firm" which has not reached its intensity target the decision to increase production by one tonne increases emissions by one tonne, but the additional cost of that additional tonne is only $1 compared to the market price – assumed here to be $10/t. This is because the price paid for that tonne is the market price multiplied by the distance between the target and the firm's emissions intensity, i.e. $10 x 1 x (1 – 0.9) = $1. Under an absolute emissions cap or target, the cost of that extra tonne of emissions would be $10. This means there is an incentive to produce in locations with intensity targets rather than absolute caps, although in this case the size of this incentive is smaller than if the "poor performing firm" faced no emissions regulations whatsoever.

Table B1 Permit cost with an intensity target

	Production Tonnes (t)	Intensity t CO_2/t	Target t CO_2/tonne	Emissions t CO_2	Permits No.	Permit cost (1 permit = $10)
Poor performing firm	100	1	0.9	100	10	$100
Increase production	101	1	0.9	101	10.1	$101
Change	1	--	--	1	0.1	$1
Increase intensity	100	1.01	0.9	101	11	$110
Change	--	0.01	--	1	1	$10
High performing firm	100	0.8	0.9	80	-10	-$100
Increase production	101	0.8	0.9	80.8	-10.1	-$101
Change	1	--	--	0.8	-0.1	-$1
Reduce intensity	100	0.79	0.9	79	-11	-$110
Change	--	-0.01	--	-1	-1	-$10

3. For a "high performing firm" the intensity target implies that increased production results in revenue rather than cost. In Table 4 the firm receives additional revenue (shown as a negative cost) of $1 by increasing production. In this respect, the imposition of an intensity target creates a larger incentive to relocate production away from locations with absolute emissions caps than would be the case if the alternative location had no emissions regulations.

4. The stringency of the target plays a crucial role in determining whether or not an intensity-based scheme would minimise competitiveness and leakage issues. In Table 4, if the intensity target were reduced to 0.8, the poor performing firm would face a cost of $2 for increasing production by 1 tonne. In the extreme, if a firm's emissions intensity were more than twice the target that firm would face a larger cost than one under an absolute emissions cap.

5. In summary, the use of intensity targets in parallel with absolute emissions caps can either reduce or increase competitiveness problems and leakage risks. The outcome depends on the stringency of the target. In theory, targets could be set to mirror the effect of absolute emissions caps, but in that case it would be simpler to introduce absolute caps.

6. While competitiveness and production decisions may be distorted when an intensity target is introduced alongside an absolute emissions cap, the incentive to reduce emissions by changing emissions intensity is the same under an intensity target as an absolute cap – i.e. $10 for every tonne of emissions. This means that an absolute cap and an intensity target should have the same effect in terms of incentivising the use of technologies or processes to reduce emissions. In this respect, intensity targets in parallel with absolute caps will not undermine emissions reduction objectives in the way they may undermine competitiveness and leakage objectives.

APPENDIX C

SUMMARY DESCRIPTION OF THE CSI CEMENT SECTOR MODEL

1. The CSI has worked with the international consultancy ERM to develop an economic model of the global cement business. The model separates the world into eight different regions and calculates regional production and interactions between regions to meet a predicted global cement demand (forecast by the International Energy Agency). Each region has a mix of cement-kiln technologies, costs, and materials availability which are combined to meet the fixed global cement demand at minimum cost. The model calculates cement production, trade and CO_2 emissions in each region over the period 2005 – 2030.

2. Carbon policies and emissions targets can be set across regions (and over time). The model incorporates the goals and costs associated with different carbon management approaches into its analysis. In this way, the impacts of different carbon policy choices can be analysed and compared on a consistent basis. For example, it is possible to see how changing cement demand is met through a dynamic combination of regional production, imports and exports. These comparisons can be used to help inform decision-makers about the relative merits, costs and impacts of different carbon and trade policy choices.

3. To insure fair and accurate treatment of the many different variables involved, the CSI requested and received formal peer review of its model by several organisations, including:

- Lawrence Berkeley National Laboratories (USA)
- The International Energy Agency (Paris)
- Research Institute of Innovative Technology for the Earth (RITE), (Japan)

4. Informal comments were also received from a number of other organisations during the course of the model development and included in revised model calculations where necessary to meet the reviewers' concerns. A detailed set of specifications for the model, and a summary of how the different elements are assembled are available at www.wbcsdcement.org.

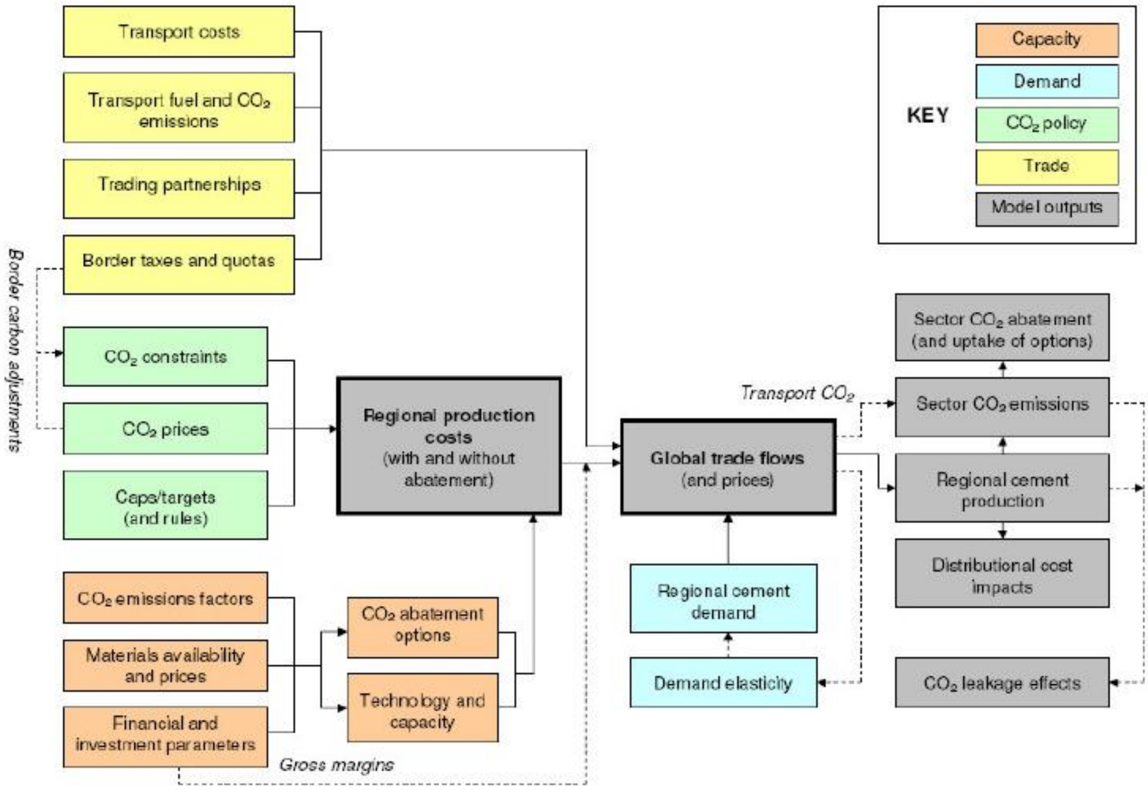
5. The model is bottom-up, based on eight world regions and seeks to meet global and regional demand for cement at least cost. It determines cement production costs by region over time, resulting international trade flows and regional production volumes.

6. Key model principles include:

- World cement demand is always met.
- Regional cement demand is met at lowest cost, through domestic production and/or imports.
- Investment decisions are made in the year when capacity is needed – i.e. the model does not look ahead.
- Profit maximisation behaviour is assumed (as opposed to, for example, market share maximisation behaviour).
- Production costs (including increases in costs over time and the cost of CO_2) are fully passed through to the user via the cement price.

- The highest marginal cost producer in each region sets the region's cement market price.
- Regions seek to meet domestic demand and may then export to other regions where it is profitable to do so (subject to cost of production, price in export market, transportation and tax costs, and any defined trade restrictions).
- Only the cement sector is modelled; where carbon prices exist they are user-defined and the cement sector acts as a price taker. At these prices there is always demand for any carbon allowances/credits sold by the sector.

7. A schematic flow diagram of the CSIM3 model is shown below, illustrating the key model inputs and outputs.



8. Key model data inputs include:

- Technology and capacity details of existing and new cement production facilities by region, over time (energy and electricity use, fuel mix, blending rates, process emissions, phasing out of shaft kilns etc).
- Production and investment cost data, by kiln type and region over time.
- Cement demand by region over time.
- Values for the price-elasticity of cement demand can also be entered but this has been assumed to be zero in the current scenarios.
- Transportation costs by region (shipping and road transport).
- Availability and cost of blending materials and fuel/electricity by region over time.

- CO_2 emissions factors for fuels, electricity and raw materials.
- Availability, costs and technical details of CO_2 abatement options and how they can be applied to existing and new facilities over time and by region (energy efficiency, blending, alternative fuels, carbon capture).

9. The majority of model data inputs are retained throughout all policy scenarios as 'key assumptions'. These key assumptions and datasets have been developed through consultation with CSI members and stakeholders and draw on information from various published sources (e.g. CSI's Getting the Numbers Right (GNR) database and Reporting Protocol, IEA data, cement trade and market analysis data, regional academic studies etc.). Policy scenarios are developed by introducing various data and assumption changes across regions over time. Any model input data can be changed to define a specific scenario. However, in order to focus on the impacts of different carbon policies being introduced, policy scenarios are defined principally in terms of carbon constraints applied to regions – or groups of regions - over time. A wider range of data changes can then be applied to these base policy scenarios as model sensitivities.

10. The key data inputs (or 'scenario assumptions') which define carbon policy scenarios are:

- Type and depth of commitments (i.e. absolute CO_2 caps or intensity-based targets and their stringency).
- Regional CO_2 prices (defining the price at which carbon is traded in capped regions or credited/sanctioned in intensity-based target regions) by region and over time.
- Availability of CO_2 abatement options available to the cement sector by region and over time.
- Cement sector CO_2 emissions - $MtCO_2$ (world and by region)
- AF and blending uptake - % (world average and by region)
- CO_2 intensity - tCO_2/t cement (world average and by region)
- Global trade flows - Mt cement (net cement imports by region)
- Cost, price and revenue data, including net carbon costs/revenues (world and by region)

11. To date the CSI has chosen to look at a suite of reasonable options from literally an infinite number of policy possibilities. A number of sensitivity studies have also been made to look at the effects of different parameters such as carbon price, emissions goals, etc. The specific scenarios evaluated include:

- No Commitments Post 2012. Used as a base case to see the changes in global emissions and trade. No specific commitments are made by governments or industry. However, small energy efficiency improvements continue to occur in the cement sector as older, more energy intensive plants are replaced with newer equipment. In addition, as production continues to shift to developing markets to meet local demand, new, more efficient cement plants grow to dominate the sector's performance.
- European Caps. Europe continues to develop and use the EU Emissions Trading System (ETS), with a cap on absolute CO_2 emissions as a primary mechanism to control emissions. For modeling purposes, a 20% decrease in emissions has been assumed to be reached by 2030, based on 1990 baseline emissions. The scenario assumes that no other countries adopt carbon restrictions.
- Annex I Caps. An extension of Scenario 2 to include strict limits on CO_2 emissions in other Annex I countries: Japan, Australia, New Zealand, the United States, Canada, and the CIS countries. The European target increases to -30% between 2020 and 2030 (from a 1990

baseline). For model calculations, most Annex I regions are assumed to adopt caps of -10% and -15% in the time periods 2012-2020 and 2020-2030 respectively. Again, the scenario assumes that no developing countries adopt any carbon limiting policies.

- Global Intensity Targets. In this scenario, intensity-based targets (a specified % reduction in the number of tonnes of CO_2 per tonne of cement product) are adopted in each region. Several choices for targets were considered, including: an identical target for all regions globally; i.e. initially differentiated targets based on current regional performance which converge on a common target over time. For modelling purposes, these targets were chosen as a 10% intensity reduction by the end of the 2012-2020 period, with a further 10% reduction by the end of the 2020-2030 period.
- Sectoral Approach. A sectoral approach involves a mix of carbon policies, differentiated by region, applied to the major producers and producing countries in an industrial sector with a goal to mitigate climate impacts of the sector. A wide range of different climate policies might be used. The scenario is modelled assuming a mixture of absolute caps on emissions in Annex I countries (as per the Annex 1 caps option, above) combined with intensity-based targets in developing countries, using the same values outlined for global intensity targets. The latter improve emissions efficiency without limiting the absolute volume of emissions.
- Global Caps. An extension of Annex 1 caps to include strict limits on CO_2 emissions in all regions. Developing country caps are set at 0% change from a 2005 baseline.

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