BEYOND THE BASELINE – LARGE SCALE CLIMATE FRIENDLY DEVELOPMENT

Draft

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A deep impasse has emerged between industrialized and developing countries on the task of reducing carbon--the former arguing that the task is essential, and the latter putting a higher priority on development. The compromise, so far, has been to focus carbon abatement in developing countries on marginal activities that reduce carbon below a "baseline." The extra cost is paid as compensation by investors, and the emission credits are traded in markets. We suggest a different strategy that integrates climate protection and economic development. We illustrate with two large-scale development programs--one in South Africa, the other in China--and demonstrate that there are significant quantities of emissions to be saved and that these do little harm to, and can even encourage, economic development. For these developing countries, we show that it is impossible to achieve these savings under current emissions mitigation mechanisms, and as such, they may not be realized until it is too late.

Introduction

The goal of climate action in developing countries should be simple: significantly lower the trajectories of greenhouse gas emissions growth. Eventually the aim is to reduce emissions in absolute terms, but actions should promote development rather than hinder it. To date, however, getting through the maze of political hurdles has eluded all multinational efforts. Under the Kyoto Protocol, the international community adopted the Clean Development Mechanism (CDM), which allows developed countries to invest in greenhouse gas mitigating projects in developing countries that would not have otherwise gone ahead—in other words, the projects must be "additional." This requirement precludes investments and policies which may significantly reduce emissions but could have gone ahead under different circumstances for other reasons.

This article investigates two cases of development-neutral projects that reduce emissions but which are not additional. In China we consider the effect of accelerating development of natural gas infrastructure and its effects on emissions from the power generation sector. In South Africa we consider the effects of an energy efficiency strategy rigorously pursued. Neither project is additional, both reduce emissions and both encourage sustainable development. Yet neither may go ahead without appropriate support, or under CDM. After discussing each case we draw implications for the effort to mitigate greenhouse gas emissions in developing countries.

Case Study: [Energy Efficiency in South Africa]

The Challenge

Perhaps the single largest challenge in meeting the goals for reducing emissions in developing countries is showing that greenhouse gas mitigation and development can be achieved simultaneously. Historically, developed economies have moved through phases of economic activity that were necessarily energy and CO_2 emissions intensive. Many developing countries are approaching or undergoing such industrialisation, and view the prospect of emissions reduction as a hindrance to economic development.

South Africa presents a good example of the challenge posed by simultaneously reducing greenhouse gases and promoting economic growth. The South African economy is emissions-intensive; seven hundred and seventy tons of CO_2 are emitted for every million international[1] dollars of economic output (WRI 2005). This is 27% more than in the United States. Emissions levels are high because of dependence on energy intensive industries and because of the low cost of coal. South Africa's electricity, over 90% of which is generated from coal, costs only 1USc to produce–the lowest in the world. South Africa is also the world's 3rd largest coal producer. And the country's development needs are stark. Unemployment[2] is near 40% and local environmental pollution caused by burning coal in inefficient domestic stoves is responsible for a significant proportion of death and disease[3]. However, industrial competitiveness—which is driven by the supply of cheap coal—is of the utmost importance in its open economy. To South African politicians, emissions reduction policies that could potentially reduce the country's competitiveness or cause job losses in heavy industry or fuel supply are anathema.

In many ways South Africa is an extreme case. However, unless emissions reductions on a relatively large scale can be achieved in a development-friendly way, it will prove difficult for any developing country to agree to take on an emissions target. Given that developing countries are likely to account for over 50% of emissions by 2020, any serious effort to meet the challenge posed by climate change must effectively include developing countries.

The opportunity

Improved energy efficiency has the potential to improve economic competitiveness while significantly reducing emissions per unit of economic output. Even in the absence of climate-specific policies, such improvements could have been implemented if their effects were understood and if the institutional capacity existed to carry them out. However, for various reasons this has not happened and effective government policy on energy efficiency has been limited. Our case study looks at the implications of an effective energy efficiency policy in South Africa. We focus specifically on electricity, which holds a key place in the economic mix because it affects employment both directly (in the power generation sector) and indirectly (from the competitive advantage low-cost electricity provides).

The South African government hopes to embark on an ambitious energy efficiency program motivated by a concern for the three dimensions of sustainable development: economic, social and environmental. (DME 2004) The strategy is to pursue energy efficiency not simply as a goal in its own right, but because it contributes to major energy policy objectives. (DME 1998 White Paper on Energy Policy) Here we consider the various environmental, social and economic effects of meeting government energy efficiency targets and compare them to a reference case scenario.

The extent to which the objectives are met depends to a considerable extent on the policy specifics and the vigor of its implementation. At present the government has neither allocated the necessary funds or institutional capacity to implement the policy.

The Department of Minerals & Energy (DME) recently published a 'draft energy efficiency strategy'. The strategy sets the goal of a 12% improvement in energy efficiency by 2014 relative to consumption. (DME 2004) The rationale behind the target is that increased energy efficiency will help the country meet a series of development goals. Presently, the emphasis is on national rather than global goals (such as GHG mitigation), but according to the draft strategy carbon funding should be taken advantage of when it can be used to encourage energy efficiency. This underscores the need for GHG mitigation regimes to be consistent with development goals if emerging nations are going to be engaged (Winkler et al. 2002c; Heller & Shukla 2003). The goals South Africa hopes to meet through the adoption of energy efficiency measure can be grouped according to the following sustainable development themes: social, environmental and economic. Specific goals are reported in table 1.

Previous work has taken estimates of the energy savings derived from historical evaluation of other national energy efficiency policies and adapted the results to South Africa. (Hughes et al. 2003) Here we simply further develop the analysis to model other attributes associated with the DME's stated development goals, as specified in Table 1.

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[1] We quote purchasing power parity exchange rates and emissions levels for the year 2001.
[2] Which includes those who have given up looking for work
[3] Domestic use of coal is the source of 25% of the total annual particulate emissions in South Africa

Table 1: Goals to be met by energy efficiency

Goals	Metric / proxy for this goal in the analysis here
Social sustainability **Goal 1: Improve the health of the nation** **Goal 2: Job creation**. **Goal 3: Alleviate energy poverty**	 **Goal 1**: Tons of sulphur dioxide, nitrogen oxides and total suspended particulates **Goal 2**: Thousands of jobs created **Goal 3**: NA
Environmental sustainability **Goal 4: Reduce environmental pollution** **Goal 5: Reduce CO_2 emissions**	 **Goal 4**: Tons of sulphur dioxide, nitrogen oxides and total suspended particulates And specific water use **Goal 5:** Tons of CO_2 emitted and abatement cost (R / t CO_2)
Economic sustainability **Goal 6: Improve industrial competitiveness** **Goal 7: Enhance energy security** **Goal 8: Defer the necessity for additional power generation capacity**	 **Goal 6**: Cost of energy supply in millions of South African Rands **Goal 7:** Level of energy imports in rand and per unit of energy[4] **Goal 8:** Power station investment timing expressed as MW of supply avoided

Source: DME (2004)

Using a previously developed model we show how the adoption of these measures affect different development goals. (Howells & Laitner, submitted) We develop a reference scenario reflecting the continuation of current development trends, and an electrical energy efficiency policy scenario which we refer to as the "efficiency scenario". The difference between the two shows the impact that energy efficiency can have on local sustainable development and on emission reductions. The model uses the MARKAL (short for market allocation) energy model generator.[5] A full description of the model is contained in Howells (2005). This model incorporates various macro-economic[6] aspects such as economy wide employment and rebound effects, which are unusual[7] to standard MARKAL models. To do this, we consider the effect that improved competitiveness due to increased efficiency has on increased economic growth[8]. The increase in economic activity results in an "indirect" increase in fuel consumption (and therefore emissions). This is known as the "rebound effect". While emissions are reduced, there is a rebound in emissions due to the positive economics of the measure. These emissions are generally less than 5% of the direct emissions saving, assuming that the structure of the economy does not change significantly (Howells 2005). Similarly, we determine the effect on employment that results from increased economic growth (due to more cost effective energy use).

[4] This result is however not reported as we consider only the displacement of locally mined coal, which is used to generate the electricity saved. Nor is this policy likely to increase volumes of electricity exported as a results of reduced local demand, as regional demand is limited.

[5] ETSAP (Energy Technology Systems Analysis Program). 2005. www.etsap.org

[6] These are incorporated from an input-output analysis (see also Spalding Flecher et. al.). The interventions considered are based on limited technological changes at the margin of relatively intensive industry. We do not, and cannot, consider changes in the structure of the economy as mitigation options.

[7] See Sato et. al. for an example of a standard MARKAL generated model.

[8] There are two effects that we consider. The first is a general lowering of the cost of industry's energy bill and the second are the effects associated with implementing the measure.

We calibrate the model using detailed sector-by-sector demand projections (Howells 2004b), emissions and economic data[9] and identify a limited set of power investments based on recent electricity sector planning (NER 2004).

The **reference scenario** is a business as usual scenario, without the energy efficiency policies described in the DME's draft energy efficiency strategy. It takes assumptions on electricity demand growth from the recent National Integrated Resource Plan (NER 2004) of the National Electricity Regulator. These assumptions are consistent with the previous Integrated Energy Planning exercises of the Department of Minerals and Energy (DME 2003)[10].

Next we consider an **efficiency scenario** that adopts the policies listed earlier. To realise the goals, we consider the specific technological measures to be implemented and the amount of electricity savings that would accrue to each given the policies and targets chosen.

The specific measures we consider are described by Howells and Laitner (2003) and Trikam (2002) and listed in Table 2 below. Assumptions related to the characteristics of these options including aspects such as economics, job creation potential, rebound effects and cost differences associated with local content, are described in Howells and Laitner (2005)[11].

The savings accruing from each measure to meet the efficiency scenario are adapted from Hughes et al (2003) and summarised in Table 2. We compute the effects of this scenario in terms of the development goals listed in Table 1 and compare these to the base case.

Table 2: Savings by measure for the policy scenario

Technical energy efficiency saving measure							
Steam system	Other thermal measures	Efficient motors	VSDs	Efficient lighting	Compressed air saving	HVAC	Refrigeration
Percentage of industrial electricity saved to meet DME targets by 2014							
0.16%	1.26%	2.21%	2.21%	1.89%	3.16%	0.63%	0.47%

Source: adapted from Hughes et al. (2003)

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[9] Gaseous emissions per unit of fuel consumed are taken from IPCC (1996) and van Horen (1996), water emissions data from van Horen (1996), particulate emissions from Howells and de Villiers (1999), and indicators for the "difficulty of implementation" from Howells and Laitner (2003).

[10] The "primary planning assumptions" are summarised as follows:

- A net discount rate of 10% is assumed
- An average medium term economic growth rate of 2.8% is expected
- A low penetration of DSM is expected and this is in line with current commitments
- The horizon of the scenarios is from 2005 to 2020

Structural changes from energy intensive industry continue at historical rates

[11] Technical measures include:

a. Variable speed drives: These drives reduce unnecessary power consumption in electrical motors with varying loads

b. Efficient motors (ERI 2000a): These motors are available at higher cost. Efficient motors can reduce power consumption, but may require modifications because running speeds are generally higher than for inefficient motors.

c. Compressed air management (ERI 2000a): This measure is easily achieved and often results in significant savings at low cost.

d. Efficient lighting (ERI 2000a): These measures take advantage of natural lighting, more efficient light bulbs and appropriate task lighting.

e. Heating, ventilation and cooling (ERI 2000b): These measures are for maintaining good air quality and temperature and can commonly be improved through better maintenance and the installation of appropriate equipment.

f. Thermal saving (ERI 2000b): Thermal saving refers to more efficient use and production of heat. For steam systems in particular we consider condensate recovery and improved maintenance.

Next we show the effects on the system by comparing the efficiency scenario to the reference case. Firstly we report on the system costs, a measure of competitiveness. These decrease over the scenario period by about 8.3 billion South Africa Rand[12] at the discounted rate. This is due to two factors. The first is fuel savings in industry itself and the second is the postponement and reduction of new investment in the power sector. By the end of the scenario period approximately 4GW of electricity generating capacity is displaced by energy efficiency measures. (Power station investment in coal baseload plants are delayed by approximately three years.) Along with decreased electricity generation due to more efficient use of electricity, there are reductions in local emissions from the power sector. Recall that we account for rebound effects, and these offset savings only slightly. (Less than 5% of savings are lost due to increased economic activity due to the efficiency scenario's negative cost nature).

During 2014, when the energy efficiency target is reached, significant inroads have been made in terms of meeting the stated local development goals. Four hundred million litres less water is used and there are reductions of 200,000 tons of SO_2, 23,000 tons of particulates and 80,000 tons of nitrogen oxides. About 40,000 new jobs are created.[13] For comparison, the entire coal mining industry in South Africa in 2000 employed approximately 51,000 people, and over time employment in this sector is dropping.

Table 3: Impacts of industrial energy efficiency on costs, pollutants and jobs

	2014	*% saving in total energy system*	*2020*	*% saving in total energy system*	*Units for absolute numbers*
Annual energy savings	76	3%	93	3%	PJ
Annual cost savings	4.1[14]	est. 8%	1.2	est. 2%	Billion Rand
Avoided investment in power stations	3600	est. 7%	4400	est. 7%	MW saved
Pollutants avoided					
Carbon dioxide	20	est. 4%	24	est. 5%	$MtCO_2$
Oxides of nitrogen	84	est. 5%	102	est. 5%	kt NOx
Sulphur dioxide	204	est. 6%	252	est. 6%	kt SO_2
Total suspended particulates	23	est. 4%	28	est. 4%	kt TSP
Water savings	455	est. 5%	558	est. 5%	Gl (10^9 litres)
Additional jobs created	40 000		60 000		Jobs
Cost of abatement	-34[15]		-8		$ / tCO2-eq

Note: the 'cost of abatement' is a benefit, since efficiency measures have negative cost over the life of the intervention.

[12] One dollar is equal to approximately six South African Rand.

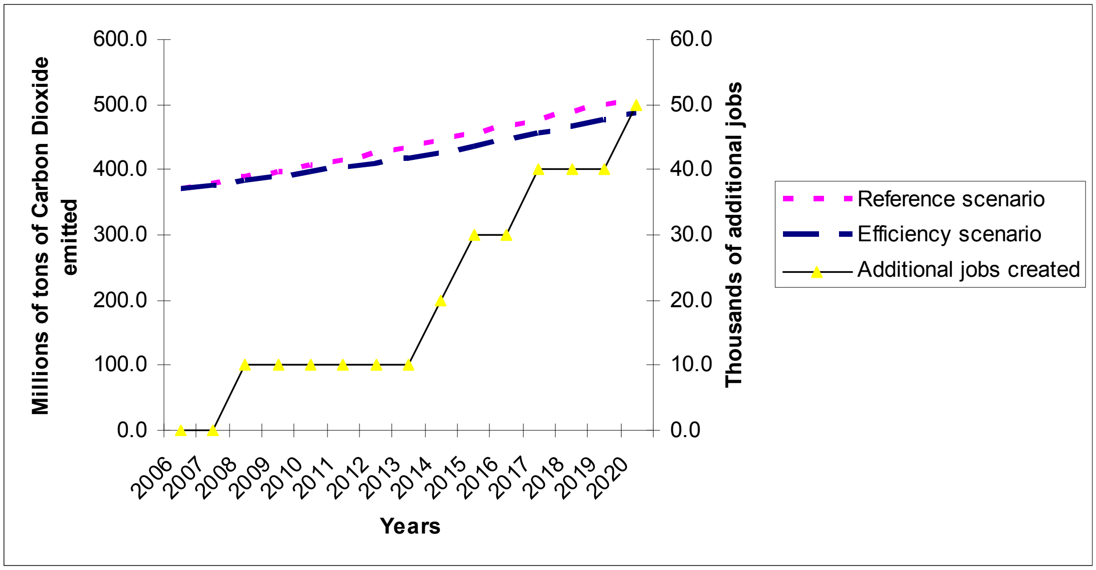
[13] These are for only electricity consumption within industry and do not include the savings that would accrue to other fuel use and to mining. The economy (and all fuel) wide effects of these measures are hundreds of thousand of jobs created.

[14] Of which approximately three hundred million is attributed to a reduction in fuel costs.

[15] Cost savings are great in this year due to the postponement of investment in new baseload power stations which are expected to be invested in at this time.

Co-benefits of realizing these policy goals include significant greenhouse gas mitigation. In Figure 1 we show the CO_2 savings relative to the reference case as well as the extra jobs created.

Figure 1: CO2 savings by scenario and jobs created[16] through industrial electrical energy efficiency



Over the whole scenario period, there is a reduction of approximately 230 million tons of carbon dioxide at a negative cost per ton of CO_2. Were all sectors and all energy carriers to be considered, the total saving would be close to a billion tons of CO_2 – and this done at a net benefit to society. This represents a change in the CO_2 development trajectory of the country that could not be achieved by project specific activities. At present, a total 21million tons of CO_2 are expected to be mitigated in South Africa under climate-motivated mechanisms such as CDM (DNA 2005), and these at net positive costs.

Barriers

Even though these policies pay for themselves, some form of energy efficiency policy is required as its autonomous uptake has proven to be slow. The government cites several reasons for this (DME 2004): the lack of information about energy efficiency costs and benefits, lack of investment confidence in related technology and practice as well as institutional barriers. The latter relates to a mismatch between key performance indicators and accounting for changes in energy bills. There are also market imperfections, in particular tariffs that do not reflect the marginal price of fuel supply (NER 2005).

Standard policy measures (described in detail in DME 2004) being considered as part of the South African policy to meet the 12% target include:

1. Energy efficiency standards
2. Appliance labeling
3. Education, information and awareness

[16] Note that these are extra jobs created that result from cash flows through the economy as a result of lowered energy costs and new investments in energy efficiency. In some cases there are net job losses from the implementation of certain energy high cost efficiency measures, we do not consider these measures in this analysis, nor are they a part of government policy. As a result, the overall effects are positive.

4. Research and technology development
5. Support of energy audits
6. Monitoring and targeting
7. Green accounting

By definition, energy efficiency measures like those described above are not "additional" in an economic sense because at some point in the future they begin to save money. And while South Africa has the institutions and finances to support such policies, there are other arguably more urgent requirements for the government. Domestic resources are limited, needs are great. As such energy efficiency policies may not receive appropriate levels of funding and support. But as we have shown above, there are enormous climate and development benefits to be gained through such policies.

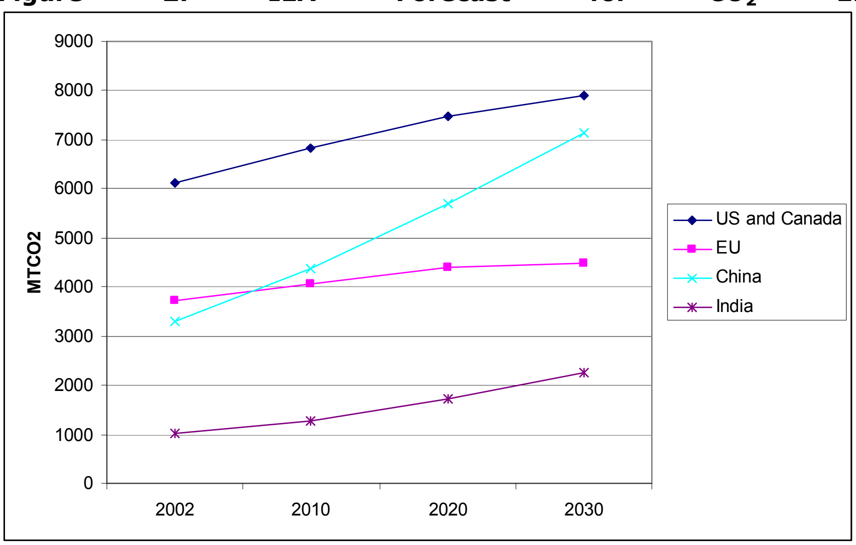
The use international donor funding to support energy efficiency policy initiatives is not uncommon in developing countries. However, as yet, there is little incentive to be gained by donors for the emissions that might be mitigated as a result.

Case Study: CO_2 Mitigation in the Chinese Electric Power Sector

The Challenge

Perhaps the single largest threat to the ongoing effort to reduce greenhouse gas emissions is the use of coal for electric power generation in China. In absolute terms, China is already a major contributor to global warming. In 2002, China emitted 3.32 billion tonnes of CO_2, or 13.5% of the world total, making it the second largest emitter of CO_2 (IEA 2004). In relative terms, however, China more closely resembles a developing country; per capita emissions of carbon dioxide in China are about one-tenth the level found in the U.S. Figure 1 below shows the growth in emissions forecast over the next 25 years.

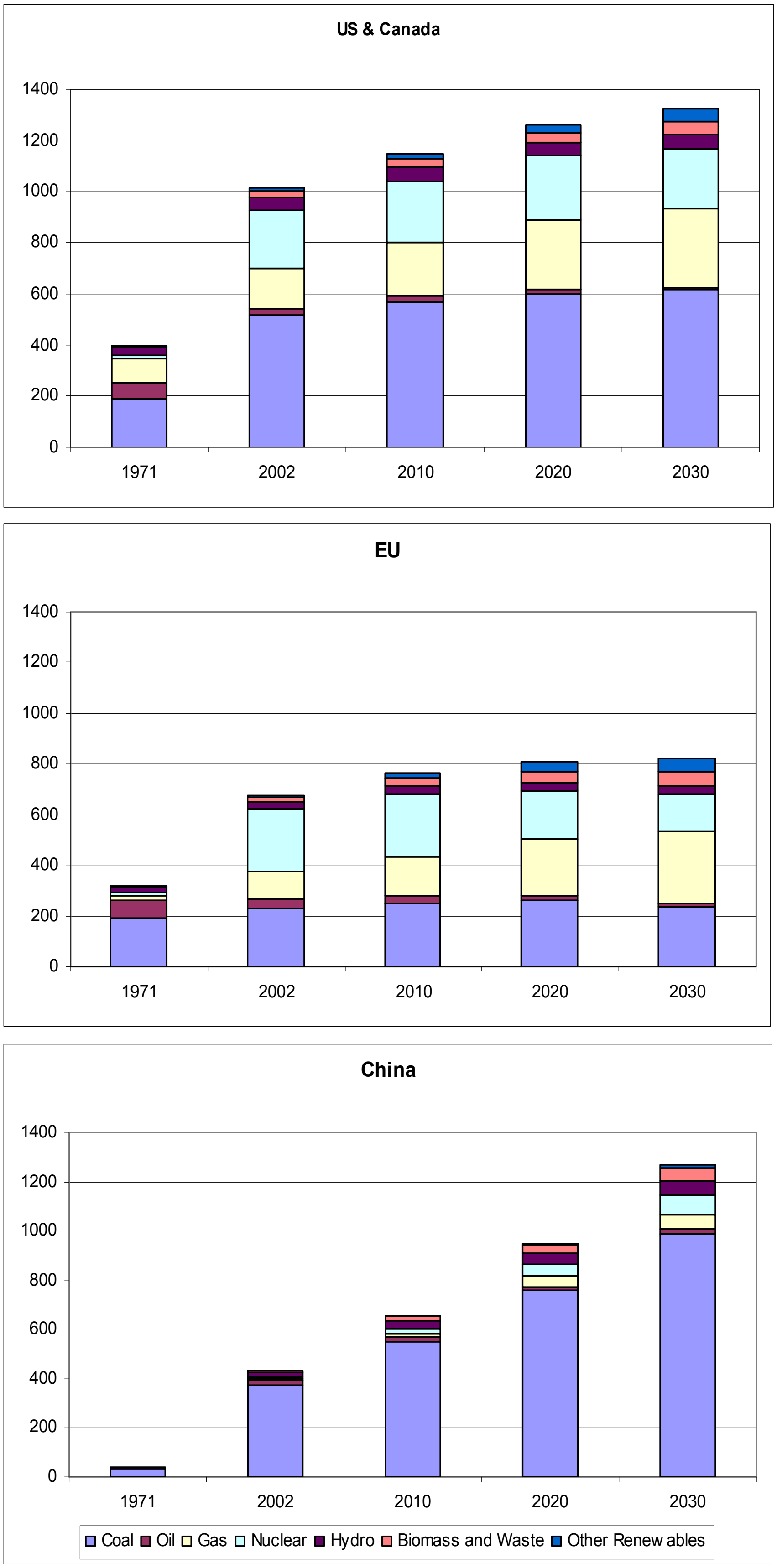
Figure 2: IEA Forecast for CO_2 Emissions Growth



Source: IEA World Energy Outlook 2004

Any truly serious effort to meet the challenge posed by climate change must focus on the electric power sector in China. In 2002, power and heat generation accounted for around 48% of the country's total CO_2 emissions; to put this into perspective, if the emissions from the electricity and heat generating sector were those of a single country, that country would be the world's third largest emitter of carbon dioxide behind the U.S. and Russia. Figure 2 shows the explosive growth that is forecast in primary energy demand by the electric power sectors of the U.S. and Canada, the EU, and China over the next 25 years. Two observations stand out: first, primary energy demand by the electricity industries of the U.S. and Canada and China will be roughly the same in 2030. Second, the amount of coal burned to generate electricity in China will be equal (in energy equivalents) to the total energy used for electric power generation in the European Union by 2020.

Figure 3: Historical and Forecast Energy Demand (Mtoe) for Electricity Generation



Source: IEA World Energy Outlook 2004

While the threat to the climate posed by coal use in China is huge, there is an equally large opportunity to lock in emissions savings in the electric power industry by substituting natural gas for coal. In several provinces this process is underway and in most cases it is being driven by factors wholly unrelated to climate change. For example, rapid economic development in the coastal provinces has increased demand for natural gas as citizens begin to desire less air pollution and as the electricity load exhibits more of a peak. But the gasification of China is not proceeding as quickly as is possible nor as might be desired by countries keen to prevent dangerous human interference with the climate. For this to happen, it is likely that China will need more than simple compensation for the incremental cost of the more climate-friendly technology (natural gas), which is essentially the current strategy for engaging developing countries on climate change. What will be needed is a broader approach that gives incentives for countries to choose climate-friendly development pathways.

What follows is an attempt to quantify the greenhouse gas emission reduction opportunities available by strengthening the trend toward gasification in the Chinese electric power sector. This exercise is necessary before beginning discussion of an alternative approach to engage developing countries, the subject of the final section.

The Opportunity

The IEA's forecast for the status-quo evolution of the Chinese electric power generation sector is presented in Table 1 below. Total electricity generation and the carbon dioxide intensity of the different technologies (which is expressed in grams of CO_2/ kWh) determine the emissions from the Chinese electric power sector. In turn, total electricity generation is a function of the installed capacity of the different technologies and how often they are used.

Table 4: IEA Forecast for Electricity Generation in China

	2002	**2010**	**2020**	**2030**
Total Electricity Generation (TWh)	**1675**	**2653**	**4018**	**5573**
Coal	1293	2030	2910	4035
Gas	17	55	196	315
Oil	50	59	65	53
Nuclear	25	82	180	280
Hydro	288	383	578	734
Renewables	2	44	89	156

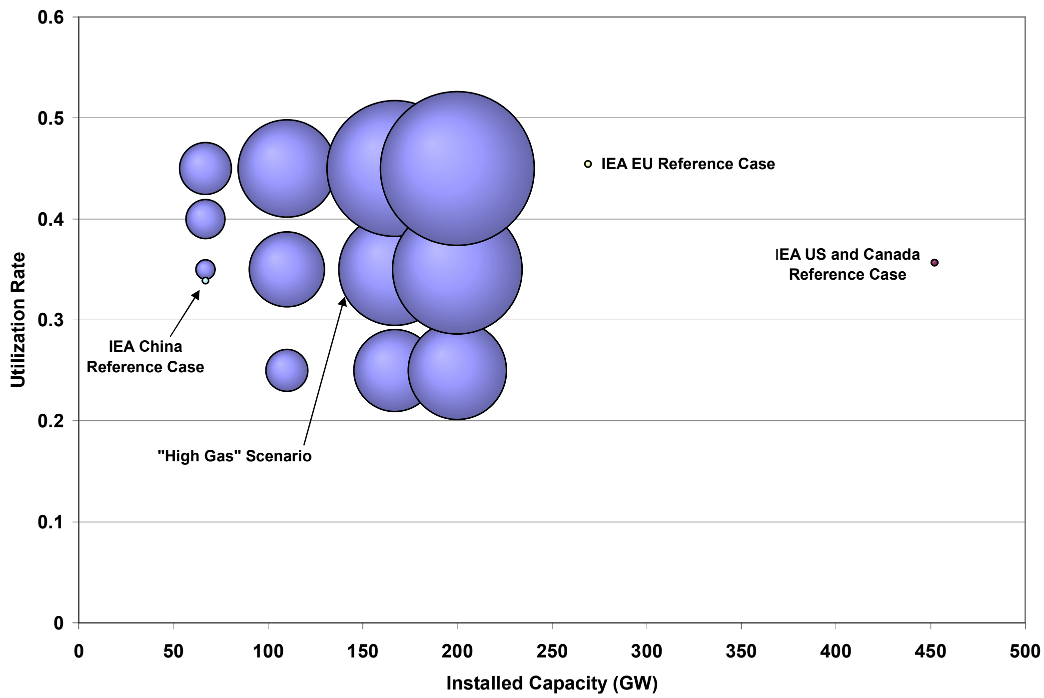
Source: IEA World Energy Outlook 2004

What we have done is create a simple model that allows us to calculate the magnitude of emissions avoided when combined cycle gas turbine technology (CCGT) replaces conventional coal technology. Using the IEA's forecast for installed capacity and actual generation (TWh) as a "baseline" against which we can compare alternative scenarios, we calculated the implied utilization rates of the different primary fuels (coal, gas, nuclear, hydro, etc.). We then created a separate scenario where we input values for the installed capacity and utilization rate of natural gas greater than what the IEA has forecasted. For simplicity, we held constant total forecast electricity generation (TWh) and the capacity and utilization of oil, nuclear, hydro and renewable energy so that any increase in natural gas capacity or utilization came at the expense of coal. We also assumed modest increases in the carbon intensity of CCGT technology (from 400 g CO_2/kWh in 2010 to 350 gCO2/kWh in 2020).

The results are striking: under a scenario where by 2020 China has an installed capacity of 167GW of natural gas-fired generation (and where there is no change in the utilization rate implicit in the IEA baseline), the emissions savings for that year amount to 130 million tonnes of carbon dioxide. This "high gas" scenario is no fantasy—the only difference from the IEA forecast is that 100GW of capacity has changed from coal to gas. As a comparison, 110GW of CCGT capacity was constructed in the U.S. between 2000 and 2003. (EIA 2004) These emissions reductions are not trivial either—they equal more than half of year 2000 emissions from cars in California, and almost 200 times the annual reductions from the first CDM project ever registered. It is also important to remember that emissions savings do not begin in 2020, but occur every time natural gas replaces coal at the margin.

Figure 3 shows the relationship between installed capacity, utilization rate, and the size of emissions reductions in 2020 below the baseline case for several different scenarios. Each sphere represents a different level of installed capacity and utilization, and the size of the sphere denotes the relative emission reductions below the baseline. For illustrative purposes, we have also included points representing the IEA's forecast for natural gas capacity and utilization in 2020 for China, the EU, and the U.S. and Canada.

Figure 4: Natural Gas Scenarios and Corresponding Year 2020 Emission Reductions



If natural gas were to play the same role in the Chinese electric power sector as it is forecast to do in the EU (269 GW installed capacity and 45% utilization), the corresponding emissions reductions would be 388 million tonnes annually beginning in 2020. An American level of installed capacity and utilization would secure 535 million tonnes of reductions annually.

There is an enormous potential for reducing emissions below the status quo scenario for growth in the Chinese electric power industry. The potential reductions will not require radical changes to the existing capital stock. The necessary technologies are widely used and have been bolted to the ground at rates much faster than required by the above scenarios. What are the barriers, then, and what would it take to remove them? This is the question the next section discusses briefly.

The Barriers

There are myriad development friendly policies that, if implemented, would push China towards an energy future resembling the scenarios discussed above. For example, financial reforms that raise the cost of domestic capital would favor relatively less capital-intensive natural gas generation, and an appreciation of the Chinese currency would lower the price of imported natural gas as compared to domestic coal. Alternatively, China could, through central control over capital allocation, systematically give preference to funding for natural gas infrastructure projects such as pipeline distribution networks and LNG import facilities.

This state-driven "creation" of a natural gas market through the provision of up-front capital has several historical precedents, including the Italian government's successful effort to gasify southern Italy by funding construction of a pipeline from Algeria and expansion of the regional distribution network. (Hayes 2004) The Italian government enlisted the European Investment Bank to provide approximately half the funding, some $1.8 billion (Y2000 dollars), to complete the project, and gas consumption rose quite markedly after construction was complete and gas began flowing.

What would it take to "create" a natural gas market in China? The IEA World Energy Investment Outlook reports that China will need approximately $3 billion annually between 2011 and 2020 to finance the planned increase in natural gas consumption. A large percentage of the planned investment, and a large fraction of the eventual end-user cost of natural gas, comes from pipe transmission and distribution networks and gas storage. Complementing this is the fact that the most inexpensive users to connect to the grid are the generally the largest gas users that have the longest capital life spans and who are the biggest emitters. Subsidization of the construction of the needed infrastructure earlier rather than later will lock a large portion of the Chinese economy into a lower-carbon growth path. The question, then, is whether or not there is a role for outside parties to play in this process.

Potential developed nation interventions and incentives

Under the current regime for engaging developing countries on climate change—the Clean Development Mechanism (CDM) —there is no incentive for developed countries to push China towards policies that lock-in natural gas for electricity generation or to persuade South Africa to an aggressive yet development friendly energy efficiency policy. This is because it is impossible to determine the "additionality" of emissions reductions created through policies such as subsidization of infrastructure that locks in the incentive to use natural gas or policies that improve industrial productivity.

But there are potential ways for developed nations to give incentives for low-carbon development paths outside of the CDM. For example, the World Bank, or a similar institution like the Asian Development Bank could provide subsidized loans for the capital costs of low-carbon infrastructure, efficient appliances or policy support. Or the export credit agencies of developed countries (U.S. Export-Import Bank, etc.) could subsidize export of low carbon energy and infrastructure technology. If emissions baselines are altered by foreign assistance, perhaps approximate savings may be used as "soft" credits. These credits would have limited application. Perhaps they could be used for setting mitigation targets, or as a "safety valve" to reduce the excessive pressure exerted by meeting mitigation targets.

While discussed only notionally, such real emissions reductions could help encourage flexibility in the multinational process and accelerate technology transfer. The reductions would not retard, but likely encourage development in the host country. However, if a pre-condition of climate change assistance to developing countries is that assistance must create discrete, identifiable emissions reductions, investments that fundamentally shift the emission baseline and lock-in lower carbon growth paths won't see the light of day until it's potentially too late. It is therefore necessary to consider new mechanisms or change existing ones.

Conclusion

Using two case studies, we show that greenhouse gas emissions can be reduced in a manner that does not retard development. In the case of South Africa, development is encouraged, and in the case of China large quantities of greenhouse gas are mitigated.

While the Kyoto Protocol may have been hailed as "*a historic step forward in the world's efforts to combat a truly global threat." (Annan 2004)* we have shown that it may miss important opportunities to reduce emissions and promote development. On examination of the two case studies, it is clear that neither would be encouraged by current mechanisms such as CDM.

There are incentives that could encourage the GHG mitigation we describe. These incentives are currently outside of the CDM[17]. We conclude that it is necessary to urgently review CDM or develop new mechanisms to accommodate such non-additional, large scale, development friendly mitigation.

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[17] From a donor, or developing country stand point, they may act to encourage exports and increase flexibility in emissions targets.