Asia-Pacific
Economic Cooperation

2007/ASCC/2.2
Session: Energy and Climate Change in APEC

2.2.3

What Can Technology Deliver?

Purpose: Information

Submitted by: Dr Margo Thorning
International Council for Capital Formation, London

APEC
AUSTRALIA 2007

Annual Conference of APEC Centres
Melbourne, Australia
18-20 April 2007

Technology Transfer: Impact on Energy Security and GHG Emission Reductions

Background

As the International Energy Agency noted in its 2006 World Energy Outlook, the world is facing twin energy-related threats: (1) not having adequate and secure supplies of energy at affordable prices and (2) the potential for environmental harm due to increased energy use and higher levels of greenhouse gases in the atmosphere. High energy prices and recent geopolitical events remind us of the essential role affordable energy plays in economic growth and human development, and of the vulnerability of the global energy system to supply disruptions. Safeguarding energy supplies is once again at the top of the international policy agenda. Yet the current pattern of energy supply carries the possibility of environmental damage - including changes in global climate. The need to slow the growth in fossil-energy demand, to increase geographic and fuel-supply diversity and to mitigate climate-destabilizing emissions is more urgent than ever. The transfer of existing technologies for electricity production, manufacturing , transport and buildings and structures from developed to developing countries can have a powerful effect on both economic growth and the goal of slowing GHG emission growth.

Fossil energy will remain dominant over next 25 years

According to the IEA report, global primary energy demand is projected to increase by an average annual rate of 1.6% between now and 2030 in the base case scenario. Over 70% of the increase in demand over the projection period comes from developing countries, with China alone accounting for 30%. Their economies and population grow much faster than in the OECD, shifting the centre of gravity of global energy demand.

Globally, fossil fuels will remain the dominant source of energy to 2030, absent sharp changes in consumption and technological breakthroughs. Fossil fuels are likely to account for 83% of the overall increase in energy demand between 2004 and 2030. As a result, their share of world demand edges up, from 80% to 81%. Coal sees the biggest increase in demand in absolute terms, driven mainly by power generation. China and India account for almost four-fifths of the incremental demand for coal. It remains the second-largest primary fuel, its share in global demand increasing slightly. The share of natural gas also rises. Hydropower's share of primary energy use rises slightly, while that of nuclear power falls. The share of biomass falls marginally, as developing countries increasingly switch to using modern commercial energy, offsetting the growing use of biomass as feedstock for biofuels production and for power and heat generation. Non-hydro renewables - including wind, solar and geothermal - grow quickest, but from a small base, the IEA states.

The threat to the world's energy security is real and growing

Rising oil and gas demand, if unchecked, would accentuate the consuming countries' vulnerability to a severe supply disruption and resulting price shock. By 2030, the OECD as a whole will import two-thirds of its oil needs in the IEA's base case scenario compared with 56% today. Much of the additional imports come from the Middle East, along vulnerable maritime routes. The concentration of oil production in a small group of countries with large reserves - notably Middle East OPEC members and Russia - will increase their market dominance and their ability to impose higher prices. An increasing share of gas demand is also expected to be met by imports, via pipeline or in the form of liquefied natural gas from

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The International Council for Capital Formation (www.iccfglobal.org) is a non-profit, Brussels-based think tank promoting a nurturing climate for business expansion, cost-effective regulatory policies and job growth.

increasingly distant suppliers. The share of transport demand - which is relatively price-inelastic relative to other energy services - in global oil consumption is projected to rise. Current subsidies on oil products in non-OECD countries are estimated at over $90 billion annually. Subsidies on all forms of final energy outside the OECD amount to over $250 billion per year - equal to all the investment needed in the power sector each year, on average, in those countries.

Oil prices still matter to the economic health of the global economy. Although most oil-importing economies around the world have continued to grow strongly since 2002, they would have grown even more rapidly had the price of oil and other forms of energy not increased. Most OECD countries have experienced a worsening of their current account balances, most obviously the United States. The recycling of petro-dollars may have helped to mitigate the increase in long-term interest rates, delaying the adverse impact on real incomes and output of higher energy prices. An oil-price shock caused by a sudden and severe supply disruption would be particularly damaging – for heavily indebted poor countries most of all.

Investment needed to promote energy security

Meeting the world's growing hunger for energy requires massive investment in energy-supply infrastructure, according to the IEA report. The IEA base case calls for cumulative investment of just over $20 trillion (in 2005 dollars) over 2005-2030. The power sector accounts for 56% of total investment – or around two-thirds if investment in the supply chain to meet the fuel needs of power stations is included More than half of all the energy investment needed worldwide is in developing countries, where demand and production increase most quickly. China alone needs to invest about $3.7 trillion - 18% of the world total. There is no guarantee that all of the investment needed will be forthcoming. Government policies, geopolitical factors, unexpected changes in unit costs and prices, and new technology could all affect the opportunities and incentives for Private and publicly-owned companies to invest in different parts of the various energy-supply chains.

The investment decisions of the major oil- and gas-producing countries are of crucial importance, as they will increasingly affect the volume and cost of imports in the consuming countries. There are doubts, for example, about whether investment in Russia's gas industry will be sufficient even to maintain current export levels to Europe and to start exporting to Asia. The ability and willingness of major oil and gas producers to step up investment in order to meet rising global demand are particularly uncertain. Capital spending by the world's leading oil and gas companies increased sharply in nominal terms over the course of the first half of the current decade and, according to company plans, will rise further to 2010. But the impact on new capacity of higher spending is being blunted by rising costs. Expressed in cost inflation-adjusted terms, investment in 2005 was only 5% above that in 2000. Planned upstream investment to 2010 is expected to boost slightly global capacity. Beyond the current decade, higher investment in real terms will be needed to maintain growth in upstream and downstream capacity.

Impact of global energy demand on carbon dioxide emissions

Global energy-related carbon-dioxide (CO_2) emissions increase by 55% between 2004 and 2030, or 1.7% per year, in the IEA's base case scenario. Power generation contributes half of the increase in global emissions over the projection period. Coal overtook oil in 2003 as the leading contributor to global energy-related CO_2 emissions and consolidates this position through to 2030. Developing countries account for over three-quarters of the increase in global CO_2 emissions between 2004 and 2030 in the base case scenario. They overtake the OECD as the biggest emitter by soon after 2010. The share of developing countries in world emissions rises from 39% in 2004 to over one-half by 2030. This increase is faster than that of their share in energy demand, because their incremental energy use is more carbon-intensive than that of the OECD and transition economies. In general, the developing countries use proportionately more coal and less gas. China alone is responsible for about 39% of the rise in global emissions. China's emissions more than double between 2004 and 2030, driven by strong economic growth and heavy reliance on coal in power generation and industry. China overtakes the United States as the world's biggest emitter before 2010. Other Asian countries, notably India, also contribute heavily to the increase in global emissions.

Bringing modern energy to the world's poor is an urgent necessity

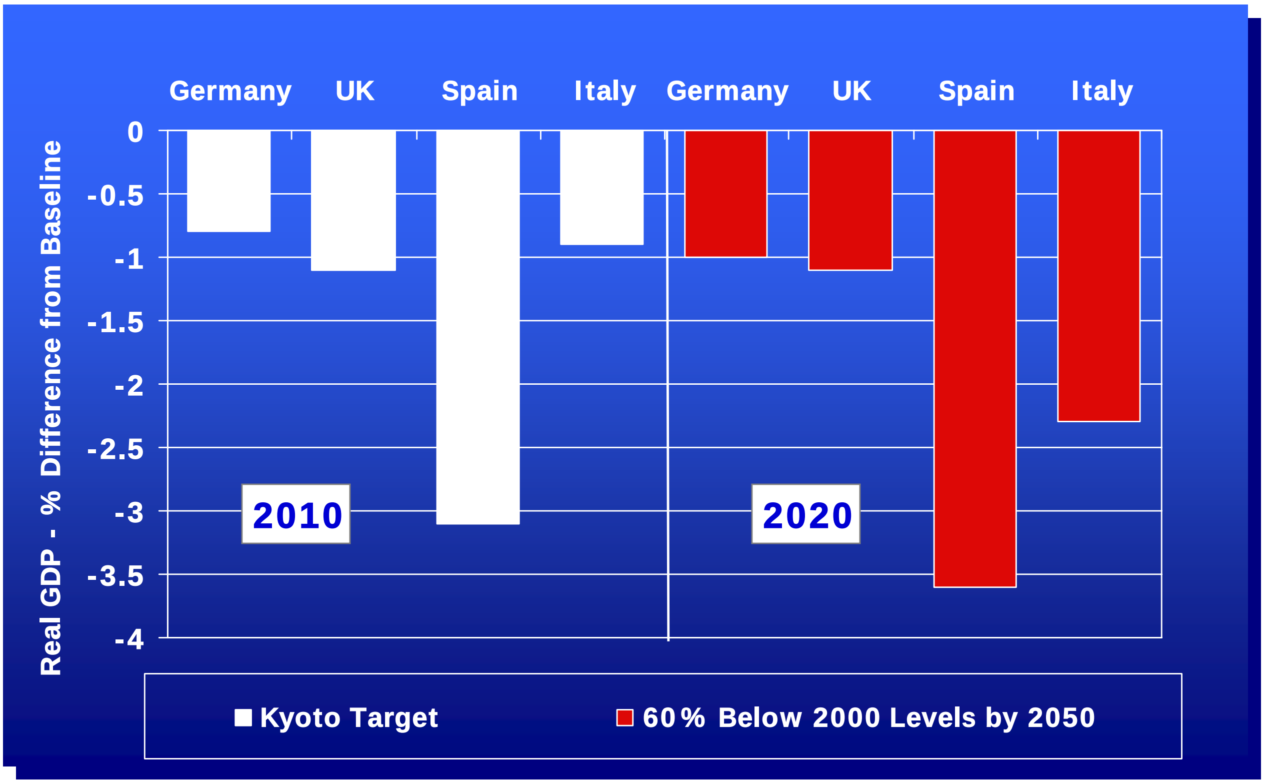
Although steady progress is expected to be made in the IEA base case scenario in expanding the use of modern household energy services in developing countries, many people still depend on traditional biomass in 2030. Today, 2.5 billion people use wood, charcoal, agricultural waste and animal dung to meet most of their daily energy needs for cooking and heating. In many countries, these resources account for over 90% of total household energy consumption.

The inefficient and unsustainable use of biomass has severe consequences for health, the environment and economic development. Shockingly, about 1.3 million people - mostly women and children - die prematurely every year because of exposure to indoor air pollution from biomass. There is evidence that, in countries where local prices have adjusted to recent high international energy prices, the shift to cleaner, more efficient ways of cooking has actually slowed and even reversed. In the IEA’s base case scenario, the number of people using biomass increases to 2.6 billion by 2015 and to 2.7 billion by 2030 as population rises. That is, one-third of the world's population will still be relying on these fuels, a share barely smaller than today. There are still 1.6 billion people in the world without electricity. Action to encourage more efficient and sustainable use of traditional biomass and help people switch to modern cooking fuels and technologies is needed urgently. The appropriate policy approach depends on local circumstances such as per-capita incomes and the availability of a sustainable biomass supply. Alternative fuels and technologies are already available at reasonable cost. Halving the number of households using biomass for cooking by 2015 – a recommendation of the UN Millennium Project – would involve 1.3 billion people switching to liquefied petroleum gas and other commercial fuels. This would not have a significant impact on world oil demand and the equipment would cost, at most, $1.5 billion per year. But vigorous and concerted government action – with support from the industrialized countries – is needed to achieve this target, together with increased funding from both public and private sources. Policies would need to address barriers to access, affordability and supply, and to form a central component of broader development strategies.

Further, several different economic analyses show that if the EU were to actually meet its emission reduction targets under the protocol the economic costs would be high. For example, new macroeconomic analyses by Global Insight, Inc. show the cost of complying with Kyoto for major EU countries could range between 0.8% of GDP to over 3 % in 2010.

(See Figure 1 overleaf)

Figure 1: *Impact of Purchasing Carbon Emission Permits on Gross Domestic Product Levels under the Kyoto Protocol and under More Stringent Targets on Major Industrial Economies*



Source: International Council for Capital Formation "The Cost of the Kyoto Protocol: Moving Forward on Climate Change Policy While Preserving Economic Growth," November, 2005, (www.iccfglobal.org) and unpublished estimates for the U.S. prepared by Global Insight, Inc.

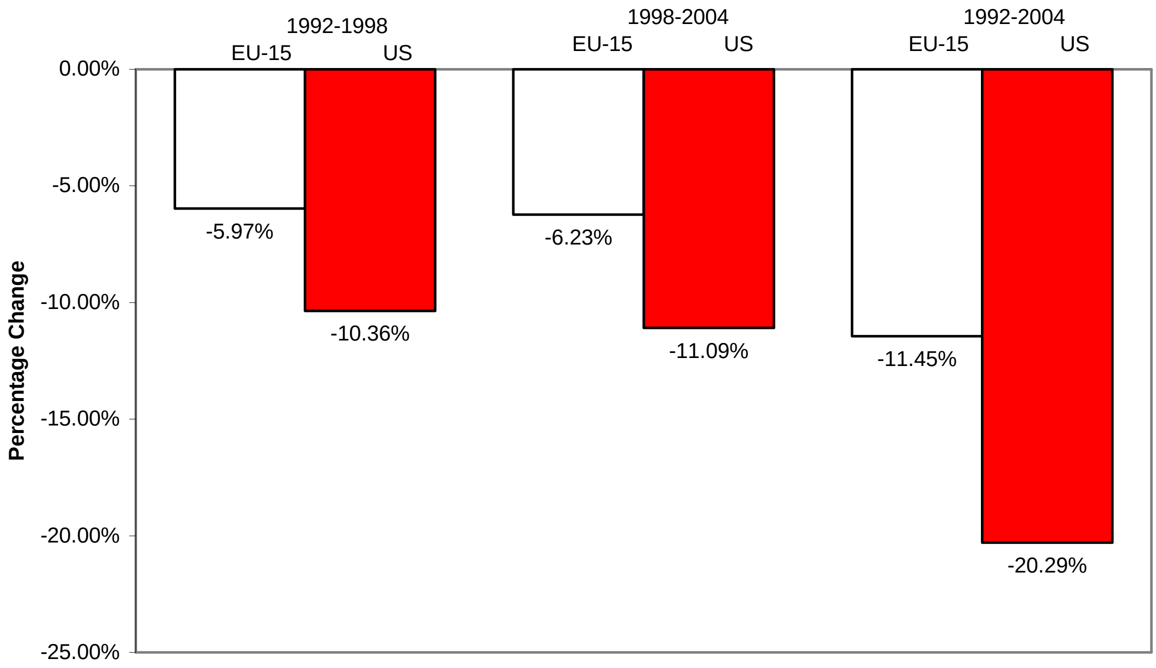
According to Global Insight, the reason for the significant economic cost is that energy prices, driven by the cost of cap/trade emission permits**,** have to rise sharply in order to curb demand and reduce GHG emissions. The Global Insight report also estimated the cost to EU countries of getting on a trajectory to reduce emissions to 60% below 2000 levels by 2050. Such targets could cost losses ranging from 1 % to 4.5% of GDP in 2020(see Figure 1). Even the EU Commission for the Environment admits that emission reductions could cost as much as 1.3% of GDP by 2030.

In January, 2007 the European Council endorsed new GHG emission reduction targets for the post 2012 period. The targets include a 20 % reduction in CO2 emissions, a 20% renewable target, and a target of 10% biofuels. These new EU targets will require emissions reductions in all sectors, not just the 40 percent currently covered by the Emission Trading System. The fact that the European Environmental Agency projects that the EU 15 will be 7% above 1990 levels of emissions in 2010 (instead of 8% below) demonstrates that the mandatory ETS system as currently structured is not working and that further costly mandates will be required. In fact, a new European Commission Green Paper(March 2007) calls for the use of new energy taxes(based on BTU content) on sectors not covered by the ETS to encourage cut reductions in energy use to curb emissions.

The role of economic growth and technology in GHG reduction

Many policymakers overlook the positive impact that economic growth can have on GHG emission reductions. For example, the US, with its voluntary approach to emission reductions, has cut its energy intensity(the amount of energy used to produce a Euro of output) by 20% over the 1992-2004 period compared to only 11.5% in the EU with its mandatory approach (see Figure 2). The strong U.S. economic growth, which averaged over 3% per year from 1192 to 2005 compared to about 1% in the EU, is responsible for the US's more rapid reduction in energy intensity.

Figure 2: *Comparison of EU and US Energy Intensity Reduction, 1992-2004*



Source: EIA, International Energy Annual 2004. (Percentage changes are calculated using Total Primary Energy Consumption per Dollar of Gross Domestic Product.)

Technology development and deployment offers the most efficient and effective way to reduce GHG emissions and a strong economy tends to pull through capital investment faster. There are only two ways to reduce CO2 emissions from fossil fuel use - use less fossil fuel or develop technologies to use energy more efficiently, to capture emissions or to substitute for fossil energy. There is an abundance of economic literature demonstrating the relationship between energy use and economic growth, as well as the negative impacts of curtailing energy use. Long-term, new technologies offer the most promise for affecting GHG emission rates and atmospheric concentration levels.

Strategies to increase energy security and enhance environmental protection

Increased energy security in the developed countries including the EU will depend on factors such as increased energy efficiency, technology developments in both fossil fuels (carbon capture and storage, for example) and renewable fuels (wind and solar in particular) and possibly increased reliance on nuclear power for electricity generation. However, in order to reduce the potential threat of global climate change, it will be necessary to increase energy efficiency and reduce the growth of greenhouse gas emissions in the developing world since that is where the strong growth in emissions is coming from.

New research by Drs. David Montgomery and Sugandha Tuladhar of CRA International makes the case that agreements such as the Asia Pacific Partnership on Clean Development and Climate, an agreement signed in 2005 by India, China, South Korea, Japan, Australia and the United States, offers an approach to climate change policy that can reconcile the objectives of economic growth and environmental improvement for developing countries (see www.iccfglobal.org for full paper). Together, the Partners have 45 percent of the world's population and emit 50 percent of manmade CO_2 emissions. The projections of very strong growth in greenhouse gases in developing countries over the next 20 years means that there is enormous potential for reducing emissions through market-based mechanisms for technology transfer.

Promoting a favorable investment climate in developing countries

Drs. Montgomery and Tuladhar note that there are several critical factors for ensuring the success of an international agreement which relies strongly on private sector investment for success. Their research shows that institutional reform is a critical issue for the Partnership, because the lack of a market oriented investment climate is a principal obstacle to reducing greenhouse gas emissions in China, India and other Asian economies. China and India have both started the process of creating market-based economic systems, with clear benefits in the form of increased rates of economic growth. But the reform process has been slow and halting, leaving in place substantial institutional barriers to technological change, productivity growth, and improvements in emissions. The World Bank and other institutions have carried out extensive investigations about the role of specific institutions in creating a positive investment climate. These include minimizing corruption and regulatory burdens, establishing an effective rule of law, recognition of intellectual property rights, reducing the role of government in the economy, removing energy price distortions, providing an adequate infrastructure and an educated and motivated labor force.

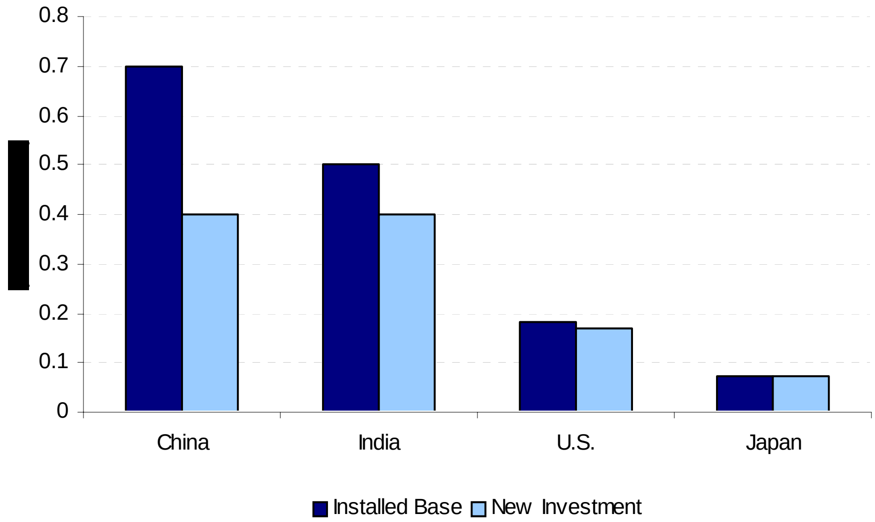
Quantifying the importance of technology transfer for emission reductions

As described above, technology is critically important because emissions per dollar of income are far larger in developing countries than in the United States or other industrial countries. This is both a challenge and an opportunity. It is a challenge because it is the high emissions intensity – and relatively slow or non-existent improvement in emissions intensity – that is behind the high rate of growth in developing country emissions.

Opportunities exist because the technology of energy use in developing countries embodies far higher emissions per dollar of output than does technology used in the United States; this is true of new investment in countries like China and India as well as their installed base (See Figure 3). The technology embodied in the installed base of capital equipment in China produces emissions at about four times the rate of technology in use in the United States. China's emissions intensity is improving rapidly, but even so its new investment embodies technology with twice the emissions intensity of new investment in the United States. India is making almost no improvement in its emissions intensity, with the installed base and new investment having very similar emissions intensity. India's new investment also embodies technology with twice the emissions intensity of new investment in the United States.

(see Figure 3 overleaf)

***Figure 3**: Greenhouse Gas Emissions Associated with Existing and New Investment in 2001 (Million tons of Carbon per $Billion of Gross Domestic Product at Market Exchange Rates)*



Their calculations show that emission reductions can be achieved by closing the technology gap. The potential from bringing the emissions intensity of developing countries up to that currently associated with new investment in the United States is comparable to what could be achieved by the Kyoto Protocol (See Table 1). These are near term opportunities from changing the nature of current investment and accelerating replacement of the existing capital stock. Moreover, if achieved through transfer of economic technologies it is likely that these emission reductions will be accompanied by overall economic benefits for the countries involved.

***Table 1**: Cumulative Greenhouse Gas Emission Reductions Achievable Through Technology Transfer and Increased Investment*

	To 2012 (MMTCE)	**To 2017 (MMTCE)**
Adopt US technology for new investment in China and India	**2600**	**5200**
Adopt US technology with accelerated replacement in China and India	**4200**	**7700**
Adopt continuously improving technology with accelerated replacement in China and India	**5000**	**9800**
EU under Kyoto Protocol (without hot air)	***600***	***1400***
All Annex B countries under Kyoto Protocol (including US and hot air)	***2800***	***7300***

In the first example in Table 1, the CRAI study assumed that in 2005 new investment in China and India immediately moves to the level of technology observed in the United States, and calculate the resulting reduction in cumulative carbon emissions through 2012 and 2017. This is the technology transfer case. In the second case, the CRAI analysis assumes that policies to stimulate foreign direct investment accelerate the replacement of the oldest capital with new equipment, giving even larger savings. In the third case, the assumption is that the new technology continues to improve over time, as it will if policies to stimulate R&D into less emissions-intensive technologies are also put in place. Even the least aggressive of these policies has potential for emissions reductions comparable to those that would be possible if all countries (including the US) achieved exactly the emission reductions required to meet their Kyoto Protocol targets.

The role of international partnerships like the Asia Pacific Partnership in bringing about institutional change

Although it is clear that there is a relationship between institutions, economic growth, and greenhouse gas emissions, there is no general formula that can be applied to identify the specific institutional failures responsible for high emissions per unit of output in a specific country. If there is to be progress on institutional reform, at a minimum the key actors or stakeholders - concerned businesses, other groups with influence on opinion and policy in China and India (including local and regional governments), and national governments - must agree on the nature and scope of the problems and on reforms required to address the problems and identify concrete actions that each government will take to bring about institutional reforms.

Making progress on implementing the AP6 can be accelerated if the governments of Australia, Japan and the United States would fund research on topics such as the investment climate, the level of technology embodied in new investment, the role of FDI and potential energy savings from technology transfer, and the nature and impacts of pricing distortions on energy supply, demand and greenhouse gas emissions in China and India. Government support for research to make clear the direct consequences of proposed reforms for energy efficiency and the benefits of a market based investment climate for the overall process of economic growth would also be helpful.

Conclusions

To be successful, the negotiating process will need to bring forth a sufficient set of offers from each party to bring about meaningful changes in institutions with significant and quantifiable effects technology transfer and on greenhouse gas emissions. These offers would be embodied in an agreement on actions to be taken by all parties, and a framework under which actions would be monitored and additional steps could be agreed. This is the place where the current efforts of the Partnership's taskforces on clean fossil energy, renewable energy and distributed generation, power generation and transmission, steel, aluminum, cement, coal mining and building and appliances to identify technologies and investments that have profit potential and could also reduce emissions would become most useful. These investments would become in a way the reward to China and India for progress on institutional reform. The voluntary nature of private sector actions in the Partnership underscores the need for institutional reform to turn these potentially profitable investments into real projects.

The Marshall Plan is a good example of such a process. After World War II, Europe pledged various actions with the money provided by the US and, when it made good on those pledges, the program was extended and broadened. Exactly the same could be undertaken by the members of the Asia Pacific Partnership. Future actions by Australia, Japan and the United States desired by China and India would be contingent on success in implementing near term reforms agreed in the process.

Economic Growth, Technology Transfer and CO2 Emission Reductions

By

Dr. Margo Thorning

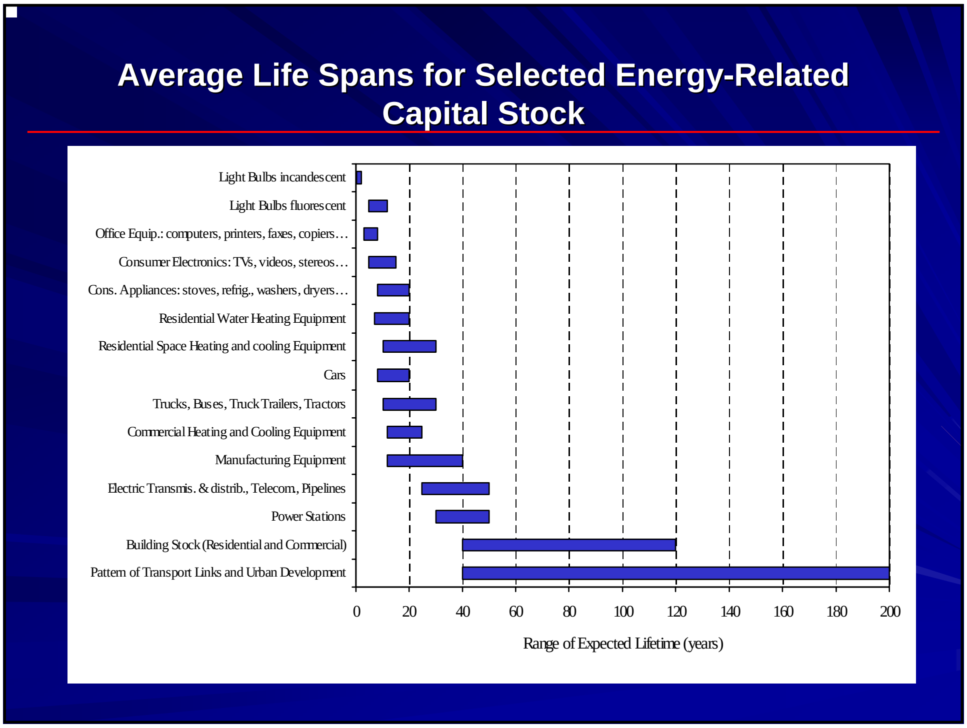
Managing Director
International Council for Capital Formation
April 19, 2007

Brussels Office:
Park Leopold, Rue Wiertz
50/28 B-1050
Brussels, Belgium
Tel: +32.2.401.68.44
Fax: +32.2.401.68.68
Email: mthorning@iccfglobal.org
Web: www.iccfglobal.org

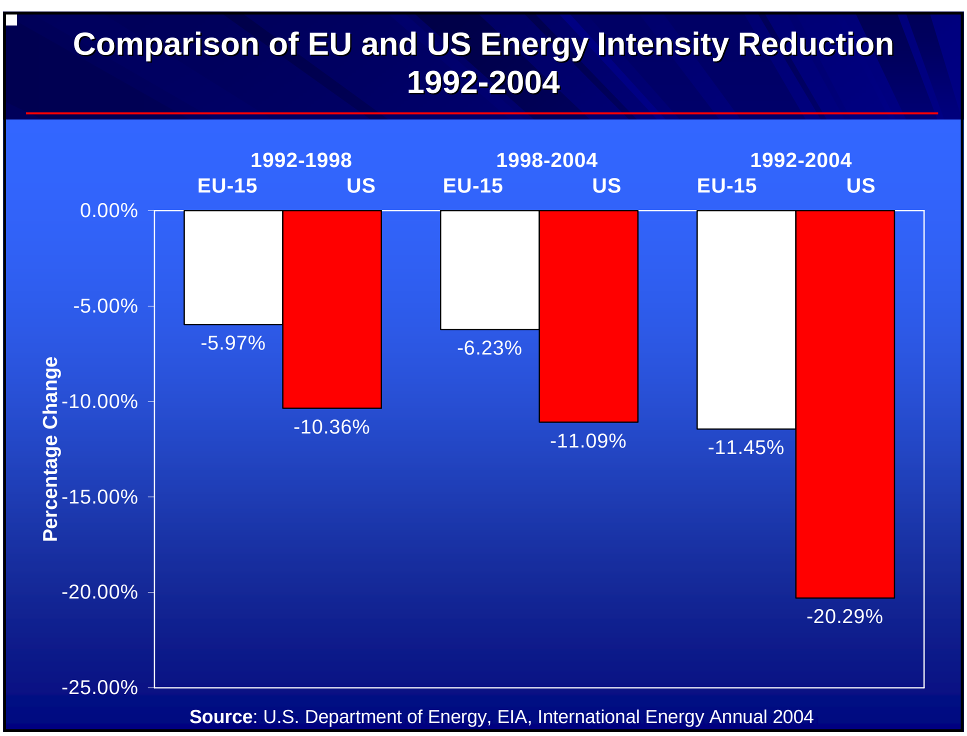
Washington D.C. Office:
1750 K Street, Suite 400
Washington, D.C. 20006
Tel: 202-293-5811
Fax: 202-785-8165

Reality Check on Energy Needs and Climate Change Policy

- **1.6 billion people have no electricity and 2.2 billion cook with biomass, 1.4 million women and children die annually as a result.**
- **Fossil fuels to remain 80% of energy used in 2030**
- **$20 trillion in energy investment needed over next 25 years**
- **Capital stock turns over slowly, limiting speed of new technology adoption**
- **Technology not available for large scale shift to renewables or alternative fuels**
- **Increased government research needed to develop non-fossil fuel alternatives and carbon capture and storage**



Average Life Spans for Selected Energy-Related Capital Stock
Light Bulbs incandescent
Light Bulbs fluorescent
Office Equip.: computers, printers, faxes, copiers…
Consumer Electronics: TVs, videos, stereos…
Cons. Appliances: stoves, refrig., washers, dryers…
Residential Water Heating Equipment
Residential Space Heating and cooling Equipment
Cars
Trucks, Buses, Truck Trailers, Tractors
Commercial Heating and Cooling Equipment
Manufacturing Equipment
Electric Transmis. & distrib., Telecom, Pipelines
Power Stations
Building Stock (Residential and Commercial)
Pattern of Transport Links and Urban Development
0
20
40
60
80
100
120
140
160
180
200
Range of Expected Lifetime (years)



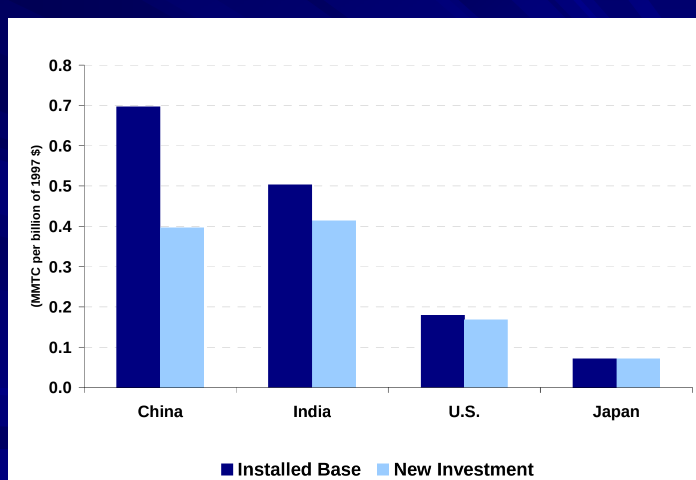
Comparison of EU and US Energy Intensity Reduction 1992-2004
1992-1998
EU-15
US
1998-2004
EU-15
US
1992-2004
EU-15
US
0.00%
-5.00%
-10.00%
-15.00%
-20.00%
-25.00%
Percentage Change
-5.97%
-10.36%
-6.23%
-11.09%
-11.45%
-20.29%
Source: U.S. Department of Energy, EIA, International Energy Annual 2004

Asia-Pacific Partnership on Clean Development and Climate: Goals and Focus

- **Voluntary practical measures** taken by these six countries in the Asia-Pacific region to create new investment opportunities, build local capacity, and remove barriers to the introduction of clean, more efficient technologies.
- Help each country meet **nationally-designed strategies** for improving energy security, reducing pollution, and addressing the long-term challenge of climate change.
- Promote the development and deployment of existing and emerging cleaner, more efficient technologies and practices that will **achieve practical results** in areas such as:

- Energy Efficiency
- Clean Coal
- Natural Gas
- Bioenergy
- Methane Capture/Use
- Civilian Nuclear Power
- Geothermal
- Agriculture/Forestry
- Rural/Village Energy Systems
- Advanced Transportation
- Hydro/Wind/Solar Power
- Building/Home Construction/Operation

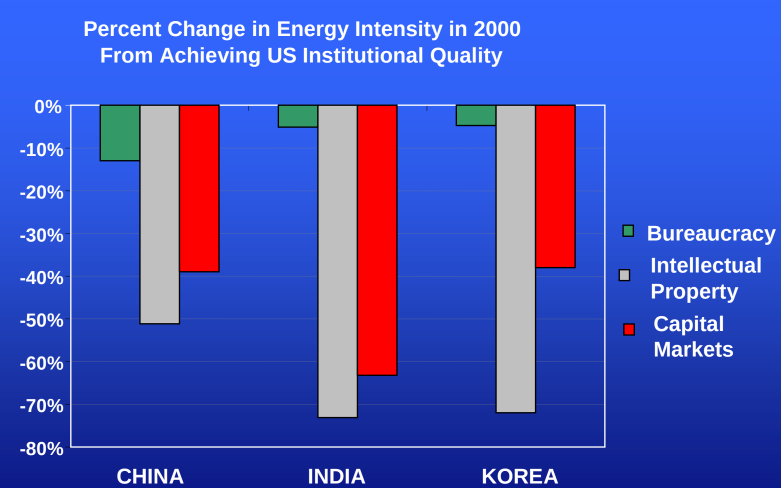
Greenhouse Gas Emissions Associated with Existing and New Investment in 2001 (Million tons C per $Billion GDP at Market Exchange Rates)



The Role of Institutional Change in Promoting Economic Growth in Developing Countries

- Institutional reforms will promote efficient resource use and increased foreign direct investment
- What government policies affect the investment climate ?
  - corruption and regulatory burdens
  - effective legal system and judiciary
  - intellectual property rights
  - role of government in the economy
  - level of infrastructure
  - human capital

Improvements in institutional quality would be sufficient to achieve convergence of energy intensity



Source: CRA regression analysis of institutional quality and energy intensity

India's Role in the Asia Pacific Partnership

India Co-chairs the Steel and Coal Mining Task Forces

Steel Task Force Projects Approved include:

- **Site-visits to each country to collect and exchange information**
- **Develop website on best availability technology**

Coal Mining Task Force Projects Approved include:

- **Underground Coal Gasification workshop in Kolkata (November 2006)**
- **Coal beneficiation project to improve energy efficiency and reduce pollution**
- **Coal mine methane project to increase methane production and utilization**

See www.asiapacificpartnership.org for APP Task Force Reports

Incentivizing Private Sector Investment and Technology Transfer

- stakeholders from business, local and national policymakers must agree on the nature and scope of the problem
- government funding for research on the investment climate, potential energy saving from technology transfer, impact of pricing distortions, can accelerate progress
- meaningful institutional reforms which can be monitored must arise from negotiations
- the Marshall Plan's "pledge and review" approach to inducing institutional reforms provides a model for how the Asia Pacific Partnership can contribute to both economic development and environmental quality

Practical Strategies to Address
Economic Growth and Climate Change Policy

- Use cost / benefit analysis before adopting policies
- Remove barriers to developing world's access to more energy and cleaner technology by promoting economic freedom and market reforms
- Increase R&D for new technologies to reduce energy intensity
- Develop sequestration through both natural and man-made technologies
- Promote nuclear power for electricity
- Promote a truly global solution such as the new Asia Pacific Partnership on Development with its focus on economic growth and technology transfer