LEVELING THE PLAYING FIELD BETWEEN CONVENTIONAL AND NEW ENERGY SOURCES

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I. THE GLOBAL CONTEXT: THE DRIVERS OF OUR IMBALANCES

"You can't fish with a tennis racket"
N. Eyzaguirre; former Chilean Minister of Finance

We are living on the hinges of a paradigmatic change. For thousands of years, living standards displayed no truly long-term trends, or any significant variation from country to country. Then, in the 1700s, came the first sudden swing with the Industrial Revolution, which propelled a remarkable and sustained rise in the living standards, first in Britain, then in a few places, mainly in Europe, nations of European descent, and Japan.

More than four-fifths of humanity remained, however, mired in the agricultural past –- making the world a profoundly unequal place.

In the 1950s, first in some Asian economies, and more recently other emerging economies, including the two most populous countries – China and India – began to grow at rates ranging between 7 and 10 percent, thereby generating a renewed and major convergence with vast consequences on how economic activities could and should be conducted.

The energy/environment discussion is symptomatic of this major change underway. At the risk of oversimplifying (but only slightly) matters, development – particularly in the early stages – is an energy-intensive process, since it consists of replacing human and animal toil for machines.

Most of them are hydrocarbons powered, where considerable sunk investments make them the most affordable and easy to use alternatives. And since such technologies are high gas emitting, a major change has to take place to enable us to assure continued growth and convergence of living standards around the world, while reducing their environmental implications. The question is how this can be done.

In response to this situation, a multitude of international institutions, conventions, principles, standards and pacts have been set up, but with little tangible impact "on the ground". The obvious difficulties may well be a reflection of inter-governmental organizations ability to respond above-mentioned paradigm shift – from the fall of centrally planned economies; the increased mobility of goods, services, funds and people across borders; to the consequent diminishing relevance of the nation-state and Governments, the declining importance of countries unable to adapt their institutions and economies to the more flexible conditions around the world, and the

associated shift of the center of gravity from the Mediterranean and the Atlantic towards the Pacific rim, and from traditional public institutions (on which most of current mechanisms tend to be anchored) to new actors in the civil society and private sectors.

It is difficult not to escape the impression that such arrangements to have been built essentially on obsolete institutions, too inflexible to deal with a more dynamic, agile and creative world. Among such arrangements are the United Nations Framework Conventions on Climatic (have that has established emission reduction targets for the 2008-12 under the Kyoto Protocol, the various Conference of the Parties (COP) of the United Nations Convention on Climate Change (UNFCCC) or the subsequent framework development for multilateral and regional institutions and initiatives.

Various reviews, such as the World Bank's "Changes in CO2 emissions from Energy Use", point to the mixed, if not meager results. It thus appears that some rethinking of is necessary to engage more effectively the forces unleashed by the above-mentioned changes. The tendency to produce goals and programs operationally disconnected from economic development, as if environmental concerns could be addressed through top-down directives or engineering fixes tended to produce a "ban it or produce a better mousetrap" mindset. This approach to the issue has been the outcome of excessively ideologically driven approach to the issue, too insensitive to the economic dimensions of energy and the environment.

While environmentalists do not measure the costs of their demands, and much less their implications on energy supply and economic development, in the emerging markets more than anywhere else, prices (including transaction costs) take it all. Prices in the end dictate social behavior. Unpopular directives can be imposed – but the burden in the end is passed on to the taxpayer. This can reduce competitiveness, and shift demand elsewhere, create vested interests that tend to perpetuate subsides, and reduce ultimately flexibility to adapt to emerging trends. Quite often, this results in generating institutionally-intensive solutions for institutionally-weak countries, which are too complex to implement. In this context, two broad, more spontaneous developments are worth noting.

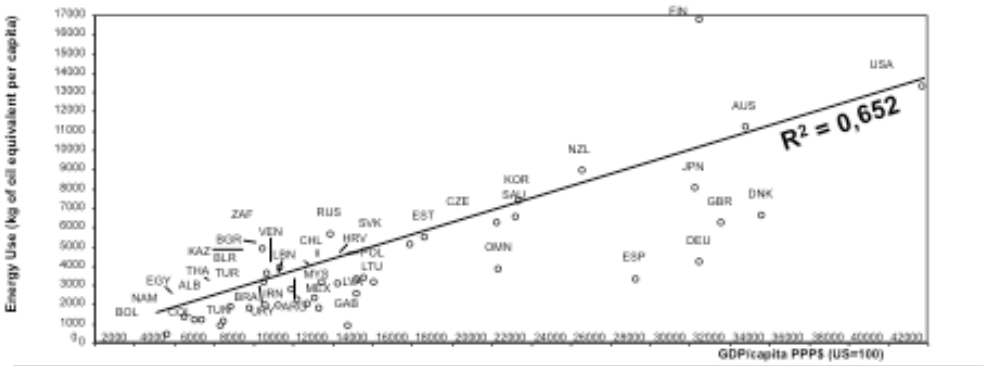
First, since the adoption of UNFCCC, international efforts have been made to control the green house gas (GHG) levels. While some progress has been made, it has become increasingly clear that a global regime that has the potential to reduce the GHG emissions in a sufficient scale is difficult (or impossible) to achieve. While efforts are still being made to reach an international treaty on climate change mitigation, companies and countries have started to look at alternative technological options to prepare for the

situation, suggesting that bottom-up approaches have operational potential.

Second, energy is basic to development, and thus needs to be approached more holistically and with greater awareness of incentive structures that motivate people and institutions to act in the manner they do. Modern energy services can transform peoples' lives for the better. They can improve peoples' productivity. They have the potential to free millions from the daily grind of water and fuel wood collection, and through the provision of artificial lighting can extend the working day, providing the invaluable ability to invest more time in education, health, and the community. They open a window to the world through radio, television, and the telephone. In the aggregate, they are a powerful engine of economic and social opportunity: no country has managed to develop much beyond a subsistence economy without ensuring at least minimum access to energy services for a broad section of its population – and not surprisingly, greater energy use fueled higher income generation and, conversely, lower energy consumption have constrained economic development.

Energy intensity and economic development

Energy use and GDP per capita for selected countries



- Strong positive correlation between GDP/capita PPP and Energy use/capita: the higher the GDP/capita PPP, the higher the Energy use/capita
- However, there are a few examples of countries with high GDP/capita PPP that are relatively efficient compared with countries at similar levels (GBR, Denmark, Spain, Japan), suggesting potential gains from energy efficiency measures

3 *Source: World Bank Data*

It is thus not surprising to find that the billions who live in developing countries attach high priority to increased energy services. On average, these people spend nearly 12% of their income on energy – more than five times the average for those living in OECD countries. As a "revealed preference," to use economic jargon, energy services are high on the agenda of the world's poorest people.

In short, developing countries, where the bulk of growth and increased emissions are likely to occur, face a formidable challenge: lifting million of people out of poverty while protecting some of the most important and biologically rich ecosystems. Achieving both objectives will require finding win-win solutions and, where those cannot be found, making judicious trade-offs based on thorough appraisal of what is gained and what is lost.

II. THE CHALLENGE: TRENDS AND WHERE TO FOCUS

> "In God we trust; all the rest will have to bring in their numbers"
> N.Y. Mayor Bloomberg

In the next 25 years, as the world grows from six to eight billion inhabitants (of which seven billion in developing countries) roughly 50 million only will be added to the rich world. In 40 or 50 years hence, this trend may accelerate. We will thus face growing problems and, of course, growing opportunities.

Given limited known resources, particularly primary commodities to underpin such level of growth, with say some 3% growth on average up to 2050, we will at that stage have a $150 trillion global economy – of which $60 trillion in the developing world, up eight times from what it is today.

To fuel this level of economic activity, energy use will inevitably increase, and as economic activity is triggered by proliferation of people, particularly moving into cities and towns, such trends are bound to generate additional pressure on both the environment and energy needs, and consequent implications on climate change and sustainable development. The growth is all in terms of people in the developing world. The issue of climate change has thus a disproportionate effect on those people who are vulnerable and who are in developing countries.

2.1 Demand Growth, Technologies and Vulnerabilities

Accordingly, the issue is how it will be possible to address a shift of this magnitude when doing "more of the same" by all accounts is not feasible. It would be nice to have hydrogen or fusion solutions, or for that matter atomic energy that is safe. But at the moment, developing countries, which are endowed significantly with coal and, to some degree, with oil and gas for the foreseeable future can rely more easily on hydrocarbons to fuel their development. Efforts on renewables from solar to wind to geothermal and tidal would be desirable, but they are as of now a small part of the equation.

The bottom line is that currently such non-traditional sources constitute some 2% of global energy supply. And if they could be taken to 3 or 4%, this may help up to a point -- and even 5 would already appear to be beyond the range that anybody has projected over the next 15 to 20 years. All indications are that the issue for us does not seem that renewables is the immediate answer at any rate, at least at current technological development.

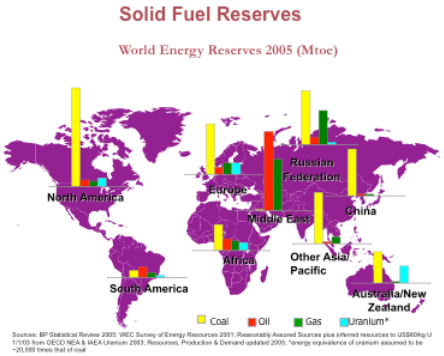
Thus, all the science and technologies development should proceed at as vigorous a pace as is possible to bring about a breakthrough. In the meantime, we need to modify policies, save as much energy usage as possible, and clean up the act so to speak in terms of carbon emissions.

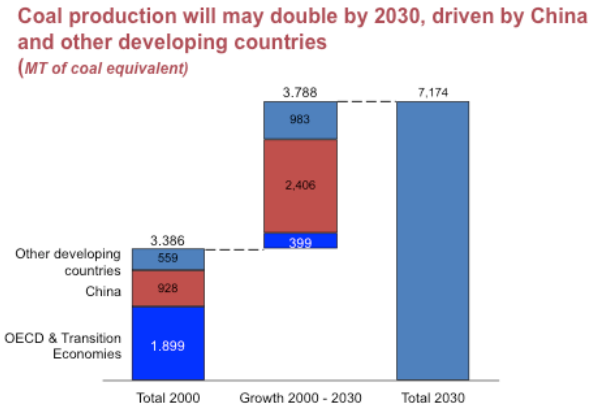
If renewables are going to be significant part of the solution, their costs must be brought down to a point that they can be attractive, because as noted above, the bulk of growth comes from poor, not rich countries. All this requires a better partnership and policy framework with high-income countries, if such research is to be underpinned effectively by proper human and financial resources.

Under the circumstances, fossil fuels – oil, gas and coal, which still supply around 80% of the world's energy – are likely to continue to power the global economy until at least mid-century. Even if published oil reserves do cover only some 40 years of current consumption, there are substantial reserves of gas and coal. But today, more than half of the world's oil is being supplied through international trade, with a high level of geographical mismatch between sources of supply and demand. Coal, the fuel that started the Industrial Revolution, and the fossil fuel least beset by anxieties surrounding 'resource nationalism', looks set for a renewed lease of life as the world's most abundant, affordable and secure fuel source – if only its carbon impacts can be tamed.

Currently, 50% of the US' electricity, 80% of China's and 70% of India's electricity is generated from coal, most of it from their own domestic resources, while China is starting up a coal-fired power station every few days and the US has 150 new coal-fired power plants on the drawing-board. Increasing coal production that will come on stream in response to demand growth will facilitate this trend.

The graphs below depict proven solid fuel reserves around the world and expect response of increased coal production to meet energy needs.





With global consumption continuing expansion, there is growing awareness of natural resources constraints. This topic is gaining added importance as prices of many natural resources post new record highs, particularly the of hydrocarbons. Not only are high commodities prices eating into consumer's budgets and forcing reassessments of how people live, they may also be pointing to possible long-term shortages of important natural resources.

Much of the explanation for high commodity prices is rooted in the resource-hungry emerging market economies. Because of their strong growth rates, these countries, above all China, have consumed commodities at double-digit annual growth rates since 1990, a good part of which have ended up in finished goods or services that are re-exported to developed countries.

Any projection of global energy demand must deal with the various uncertainties that could have a critical impact on the path of demand growth in both the short- and the long-term. Most important among these variables are GDP growth, regulation, and technology breakthroughs.

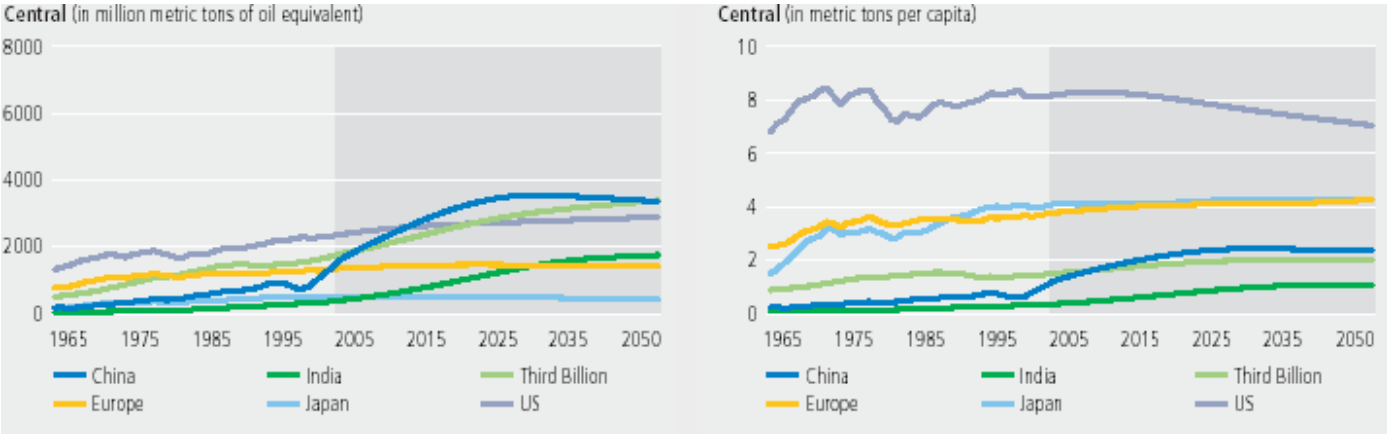
The specter of more expensive energy, along with concerns about its availability and environmental impact, has renewed interest in finding more efficient ways to use it. Yet while there is potential to reduce consumption and minimize costs by using existing technologies and without changing everyday habits. So why haven't these prospects been realized already? Four fundamental barriers stand out. Such efforts typically require large upfront investments to achieve savings that accrue later. In addition, it has low mindshare, and opportunities are fragmented across billions of devices and consumers in millions of locations. Finally, the organizations that would be primarily responsible for implementing energy efficiency find it hard to measure, which makes them less motivated to act.

That said, with primary energy demand projected to increase by more than half over the next 25 years, the world is facing the formidable twin challenges of finding secure and affordable supplies of energy while addressing the environmental impacts of that increased consumption. The geographic dislocation between the sources of energy supply and demand and the heightened geopolitical risk in some of the traditional energy-supplying regions is also encouraging consuming nations to cast their nets wider for alternative supplies and greater energy security. The US, the world's largest consumer of energy, and China and India, the fastest-growing consumers, are characterized by relatively low or declining oil and gas reserves. They all possess substantial reserves of coal... but coal is the most carbon emitting-intensive of the fossil fuels.

Worries about global energy security have intensified. If current economic and political trends continue, this may be just the start of a decades-long period of heightened tensions, and even conflict, over the issue. Far-sighted, collaborative approaches are now needed on the part of both governments and companies.

Given current and foreseen technologies of energy use, and technical knowledge regarding extraction, processing, and distribution, years of underinvestment, industry consensus projections foresee hydrocarbons (particularly crude oil) supply stretched thin through the end of this decade. However, a surge in capital expenditures in recent years will likely allow for expansion in output given the large and untapped resource base. Increased energy efficiency and fuel substitution, through switching to natural gas and biofuels, are central to easing future supply shortages and may be triggered by increased in prices.

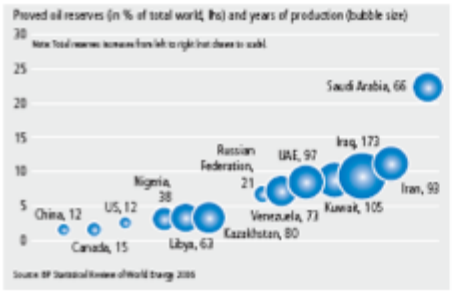
However, demand growth is likely going to continue, driven by expected economic growth of both China and India, as can be seen in the graphs below, which depict the consensus medium level forecasts of the industry:



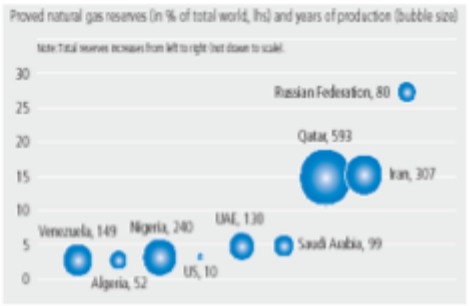
Short of any major discoveries that come into production in the near future, the situation is likely going to continue to be volatile, since in both the case of oil and gas, reserves are concentrated only in a handful of countries, in the main in the Middle East Gulf, and to a much lesser extent in Africa and Latin America.

Current proven and petroleum gas reserves are depicted in the graphs below:

Distribution of the world's proven oil reserves



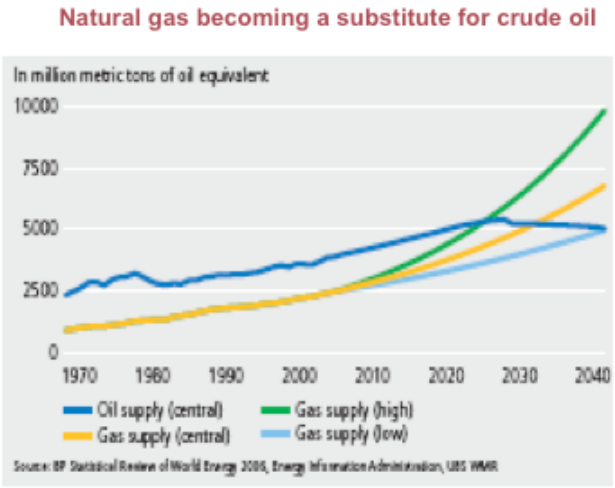
Proven natural gas reserves



Expected slowing in oil supply growth and potential for growth in natural gas supplies may produce a steady transition to the latter and is likely eclipse oil production by the early 2030s, or possibly even sooner.

Supporting this forecast are policy initiatives that promote improved energy supply diversity, reduced dependence on crude oil imports, and increased consumption of lower carbon-emitting sources.

As natural gas is becoming a globally traded commodity and transportation infrastructure is still underdeveloped, there is potential for negotiating favorable agreements that would help producers gain access to world markets, which may help gas becoming a substitute of crude:



2.2 Environmental Implications

Whereas energy prices fluctuate reflecting relative abundance or scarcity of products, and thus provide relatively efficient means of allocating goods and services (i.e. when petroleum prices go up on a sustained basis, so does the investments that eventually increase supply to meet demand requirements), this simple model does not apply for environmental goods and services, because they are generally not bought or sold in markets. As a result, scarcity increases without calling forth the necessary conservation responses.

In short, the prevailing configuration of markets and policies leaves many resources outside the domain of markets, un-owned, un-priced and unaccounted for. More often than not, it subsidizes their excessive use and destruction, despite their growing scarcity and rising social cost. The result is an incentive structure that induces people to maximize their profits not by being efficient and innovative but by appropriating other people's resources and shifting their own costs onto others. As a result, environmental resources, by being "free", are not being used in a sustainable way.

Most scientific studies point that without effective action to limit global warming, temperatures are likely to rise by 9F (5C) by the end of the century, with implications of mass migration to more temperate areas, associated conflicts, and even hunger resulting from drought in low-income countries. Such studies point out, however, that it is possible for the world to keep the temperature rise below 3.6F (2C) - but if world leaders agree

and act to cut global emissions along the lines proposed in the original Kyoto and subsequent COP Conventions. This requires keeping levels of greenhouse gases in the atmosphere below 550 parts per million (ppm) of CO2. However, following scientific evidence that the world is losing its ability to absorb CO2 in the soils and oceans, it seems that more ambitious goals may have to be sought to keep them below 500ppm – or halving the amount of CO2 the world is currently pumping into the atmosphere.

To do this one must reverse the growth of annual CO2 emissions and other greenhouse gases, reducing them from about 47 billion tonnes in 2010 to about 44 billion tonnes in 2020, and decreasing to much less than 20 billion tonnes in 2050. The Kyoto Protocol may have to be extended to take us beyond 2012 (the original commitment period) to meet this level of stabilization target.

Historically, carbon emissions have grown at roughly half the pace of GDP. But to reach the levels deemed safe by the world's scientific community, they must decline by 5 % a year. Achieving this goal without constraining economic growth will require a fundamental shift in attitudes towards energy efficiency; drastic "decarbonization" of energy, heavy-industrial, agriculture, and transportation sectors; and the protection of major rain forests, which act (along with the oceans) as natural carbon sinks.

Work on adaptation is thus as urgent as on mitigation. This is not a case of either/or; both will be needed. Some solutions, such as carbon capture and storage and biofuels, provide both adaptation and mitigation benefits. This, requires, however defraying the incremental costs of tackling climate change to introduce cleaner technologies noted above in the order of 1-2 % of GDP, which makes the entire issue politically charged on account of which countries and segments of the population or sectors need to defray such costs.

As in the coming 15 years some 40% of all power-generation capacity will have to be replaced or built for the first time, there is a significant opportunity for the application of an array of new technologies and policies to achieve an optimal energy mix.

It is to this opening that this paper tries to give some practical responses. What is unlikely, though, is that a single 'silver bullet' can be relied on to deliver a large proportion of the additional clean energy required. In all, the critical question is not to try and pick which technology will prove most important, but how we put in place systems that will ensure that the creativity of the market develops and allocates resources to those technologies that move our energy mix in the right direction at the lowest

cost. We need, too, a regulatory framework to channel public sector basic R&D funding and foster the power of the market. Also, with fossil fuels likely to bear the brunt of generating the world's energy for decades to come, it is essential that they become cleaner.

III. POLICY DESIGN, OPTIONS AND COSTS

> "Eternity is a very long time, particularly towards the end"
> Woody Allen, movie director and actor

> "If we don't change our direction we're likely to end up where we're headed"
> Chinese proverb

The above discussion suggests that in the 21st century, the world faces twin energy-related threats: that of not having adequate and secure supplies of energy at affordable prices and that of environmental harm caused by consuming too much energy in inappropriate ways.

Responding to either of these threats could be relatively straightforward; however, a solution to both simultaneously is one of the great challenges facing this century. With global energy demand increases noted above, calling for a cut in consumption (and consequent development) is not a viable solution to the challenges we face. Inevitably, fossil fuels – and coal in particular – have an important role to play in enhancing energy security and fuelling both economic growth and poverty alleviation globally. Thus, technological innovations and continuing security concerns about oil and supplies are driving developments.

There are accordingly important trade-offs to be considered in policy-making between climate change, energy security and access for vulnerable groups, in addition to a continuing concern to meet energy needs at a reasonable cost. These have led to a wide range of instruments, mainly in developed countries. In general, they illustrate the relatively high cost of renewables compared to traditional sources of energy generation, the respective limits of funding outside of private financing and special skills and approaches they require.

All options involve transactions that must be assessed, not only for energy development, but more broadly in terms of their interaction with agriculture, urbanization and, ultimately, economic development. Often countries have inadvertently introduced duplicate and non-aligned policies at both national and regional levels (European policies to support renewable

energy development, for example) as well as internationally (they have established 14 new funds for climate change/ODA with limited attention to the rules/approaches). The establishment of policies regarding price distortion, subsidies or specific taxes and duties can be difficult to handle and cause unexpected side effects.

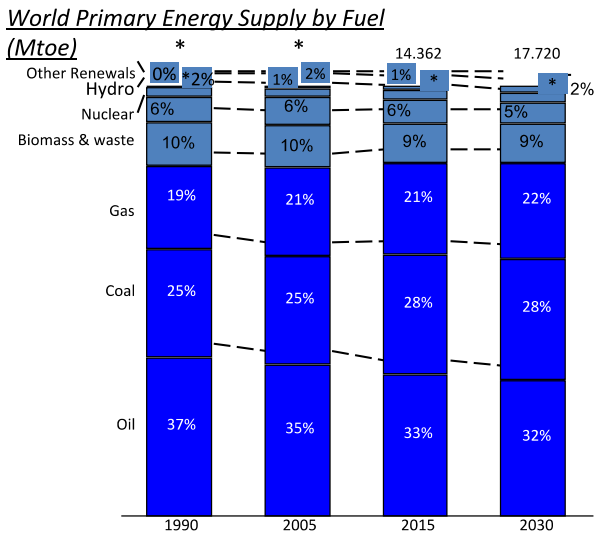
Much of the complexity of energy policy design stems from the above-mentioned multiplicity of objectives. In light of this and international experience, there are a handful of areas to be considered in more detail to identify policies that deserve special attention in specific country situations.

3.1 Provision of Security

Security, including excessive reliance on few sources of supply, has become a major concern leading many major countries to pay greater attention to hazardous energy strategy instead of lower-cost approaches. Fossil fuels will continue to dominate the global energy matrix and, due to its relative abundance, coal is bound to play a critical role.

This is coherent with expected evolution of international markets, as suggested in projections by the IEA.

With high sunk cost advantages of hydrocarbon-based technologies, the core of the future global energy mix will still be conventional sources, including oil (for transport), coal and gas (for power generation)



Source: IEA Technology Perspective, 2006

Overall Trends

- Between 2005 and 2050, the production of coal triples and by 2050, coal becomes the predominant fuel in the mix, accounting for 34% of primary energy use
- Production of natural gas more than doubles and its share increases from 21% in 2003 to 24% in 2050
- Production of oil almost doubles, yet its share of TPES declines from 34% in 2003 to 27% in 2050

Drivers of Coal's strong growth

- High oil prices, which make coal-to-liquids economic, accounting for a dramatic rise in the production of synfuels from coal after 2030 higher gas prices, resulting in more new coal-fired electricity generating plants being built;
- Energy intensive industrial production growth in developing countries, especially China & India (have large coal reserves, yet limited reserves of other energy resources)

While coal projects multiply, other important energy sources are facing several obstacles to increasing investment/production:

- Energy interconnection: A way of reducing the risk of energy supply that is being explored more systematically in developing regions such as the Electrical Interconnection in Central America or the Southern Africa Power Pool, while countries like Turkey are aiming at developing a systematic approach to pipelines and a strategy with a variety of long-term contractual agreements. Such approach could help provide reliable, affordable electricity, by enabling greater economies of scale, renewable energy penetration that otherwise would be onerous, and allow synergistic sharing of complementarities of resources.

- Hydroelectric generation: This, which is the most widespread renewable technology, tends to generate local environmental concerns, posing a challenge for the development of this type of power generation. Cases like Manantali in West Africa, or Itaipú and Yacyretá in Latin America provide power sector integration posibilities across countries. Strategic planning of water resources could be a more deliberate way to explicitly balance power generation and environmental protection, as current Canadian practices illustrate.

- Geothermal generation: This energy source is becoming an increasing option in countries with the right conditions. Through policies that encourage exploration and research, Iceland and the Philippines have become world leaders in geothermal energy, which constitutes about a quarter of their power bases. In other countries like Costa Rica, Kenya, El Salvador, New Zealand, Nicaragua, geothermal energy is more than 10% of its energy. Effective actions to reduce geological risk and encourage the development of such resources include the development of national cadastre of geothermal resources, mechanisms for joint venture investments in initial exploratory grants to enhance the viability of such option;

- Nuclear generation: Despite the relatively low cost and lack of emissions, the issue is not easy particularly for developing countries. Resistance stemming from safety concerns is a major obstacle and international cooperation agreements constitute a potential for some countries - the Nuclear Cooperation Initiative between the U.S. and India is an example of such an approach. However, other challenges such as security in relation to seismic activity, the time required for implementation (potentially more

than ten years for first projects), the disposal of nuclear waste, the scale for efficient operations (especially for plans involving only one plant or a limited number of them) and new technologies currently under development, suggest the need for caution and thorough review before making decisions;

- Other renewable sources: Even though other non-conventional sources are likely to play a limited role in energy balance, there may be niches that are competitive to the current energy price and, given the environmental importance, may offer growth potential. While not yet fully competitive in cost, renewable sources are growing thanks to policies such as feed-in-tariffs (fixed rates) and renewable energy portfolio. Wind power reaches competitive costs in specific areas, as well as solar power in off-grid regions with good radiation, like some areas in Spain and California. Biomass is also an effective option for countries with good forest resources, such as Finland (about 20% of its energy base) and its use together with coal can be cost-effective.

3.2. Environmental balance

On the environmental front, the challenges appear locally and globally. On the former, the increasing public concerns on ecosystems and the social impact have tended to reduce reliance on local environmental clearing processes causing considerable delays to essential energy projects. Measures to reduce the level of conflict could include the strengthening of mechanisms for mediation, transparency and governance processes to facilitate and professionalize (and where possible depolitized) the decision-making.

Globally, the fight against climate change implied a financial commitment to the goals outlined at the Copenhagen and Cancun meetings of $100 billion a year between now and 2020 in public and private sector funding to help developing countries to address their share of the issue. How this volume of global resource mobilization is going to take place has been left undefined.

That said, despite the variety of sources of environmental damage, including sulfur derived from burning coal and nitrogen oxides from vehicles and aircraft, the sources associated with climate change have attracted special attention due to greenhouse gas emissions. For example, all G7 countries except the United States, have ratified the Kyoto Protocol, which provides the framework for such understanding, and are committed to a 6-8% reduction of CO2 emissions, with respect to 1990 levels by 2008-12.

The EU countries have signed the collective reduction reassigned among them as a burden sharing agreement. Apart from Germany and the UK, EU countries that signed the Kyoto Protocol appear to be at significant risk of failing to fulfill commitments to the Protocol. Under the Clear Skies Initiative, the United States proposed an 18% reduction in emissions of GHG related to GDP between 2002 and 2012, which, according to the OECD, leads to increased 18% in emissions.

In response to increased international pressure in adoption of emission restrictions in developing countries, especially among those with higher GDP per capita, some countries have responded through regulations establishing minimum share of renewables in the energy matrix, though it is unlikely that these measures will have significant results.

If such situation continues, some of these countries may consider, in the medium term, measures to absorb the cost of CO2 emissions for power generation as a proportional tax on carbon emissions. Negotiations for the post-Kyoto period may inform policy-makers regarding time-horizons and depth of these policies.

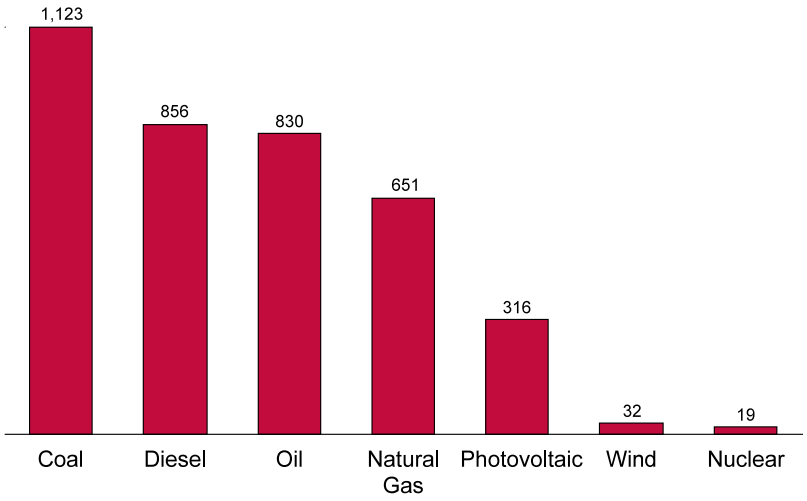
Medium income countries must be prepared to negotiate some international issues, including transitional arrangements for greenhouse gas emissions, as currently there are no obligations for developing countries and much of it will depend on negotiations for monitoring the Kyoto Convention. In the post 2012 period when one might expect that some countries accept voluntary objective obligations, this could mean a modest shift toward carbon reduction.

As there are large differences in emissions by energy sources (per graph below), in the longer term, solutions may need to be anchored in making more viable the lower polluting alternatives.

However, one must read with caution such comparisons, as they have an element of apples-to-apples comparison, since they do not capture fully load factors differentials, such as weather conditions affecting power output of solar energy (and storing conditions are still costly, particularly for evenings or cloudy weather) as well as the time wind solutions can be in operation.

There are large differences in emissions by energy source

CO2 Emissions by energy type (kg carbon equivalent/TEP)



10 Source: "Los Desafíos Políticos y Estratégicos", Catholic University of Chile. J. Cheyre

3.3. Social/Economic Impact

Several developing middle-income countries have achieved rather broad access to electricity in rural areas, covering almost all households. However, real access to low-income families has been challenged by significant increases in the cost of electricity and fuel. Thus, some of these seek to ensure a continuous review of general subsidies for social safety nets and, where necessary, provide progressive rates of energy consumption, to increase accessibility for low-income households and encourage energy saving in higher income households.

From an economic efficiency standpoint, although it is unlikely that energy efficiency provides a definitive solution to increasing energy security, it is always possible to achieve additional gains, as illustrated by countries like Denmark. There are opportunities to explore in areas such as:

- Transport: There is potential to reduce fossil fuel consumption or partially replace it with biofuels. In fact, subsidies and tax incentives have a significant impact on the adoption of biofuels in countries like USA, Australia and Finland. However, and for the moment, the opportunities to profit through structural changes in energy savings are limited and risks include side effects, such as food inflation.

- Industry: Some sectors use large quantities of energy and may have potential for efficiency/cogeneration investments, such as pulp and paper and mining. Where possible, appropriate pricing, including the internalization of the environmental implications could provide incentives for investments to improve efficiency;

- Residential/commercial: The generation of heat for cooking, heating and domestic hot water is an effective element in which several countries are implementing structured policies, such as Germany and Austria. The policies range from mandatory design standards for new construction in Spain and Israel to tax cuts in the USA and Italy to enhance demand for energy efficient appliances.

At a very high level, although there is a strong link between per capita income and energy-related GHG emissions, there is a sevenfold variation between the most and least emissions-intensive countries at a given income level. Reliance on hydropower is part of the story behind these differences, but fuel pricing is another. High subsidizers—those whose diesel prices are less than half the world market rate—emit about twice as much per capita as other countries with similar income levels. And countries with long-standing fuel taxes, such as the United Kingdom, have evolved more energy-efficient transport and land use.

Conversely, energy subsidies are large, burdensome, regressive, and damage the climate. IEA's estimate of a quarter-trillion dollar in subsidies each year outside OECD may understate the current situation. While poor people receive some of these benefits, overall the benefits are skewed to wealthier groups and often dwarf more progressive public expenditure. Fuel subsidies alone are 2 to 7.5 times as large as public spending on health in Bangladesh, Ecuador, the Arab Republic of Egypt, India, Indonesia, Morocco, Pakistan, Turkmenistan, Venezuela, and Yemen. At the same time, subsidies encourage inefficient, carbon-intensive use of energy and build constituencies for this inefficiency.

IV. POLICY IMPLEMENTATION. FROM WORDS TO DEEDS

"Everything is in the execution"
Napoleon Bonaparte

In the context of improving policy direction, countries need to consider mechanisms to ensure coordination between energy and crosscutting approaches that integrate environmental concerns and socio-economic security, while maintaining a neutral policy approach to ensure optimal

investment in the sector. There are no valid generic recommendations on these issues, and each country must find unique solutions for their situation.

However, there are lessons from many countries that have not fully integrated or coordinated cross-sector approaches, especially between energy, environment and industry. The issues typically involves trade-offs that must be assessed broadly in terms of interactions with agriculture and urbanization and, ultimately, economic development.

Finally, policy coherence has become a major challenge in many countries. It is common to find an array of subsidies, grants, tax assistance, etc. applied with little attention to consistency that often produce conflicting signals. In fact, concerns about environmental effects have led to many distorted and conflicting policies, and developing countries should refrain from such practices.

Considering the lessons learned from international practices two orientations can improve energy policies without introducing difficult to overcome distortions: investments in public goods and market vehicles.

4.1. Investments in Public Goods

By implementing policy directions mentioned above, energy authorities could aim at facilitating private investment by mobilizing resources in upstream activities that are unlikely going to be undertaken spontaneously, while avoiding market distortions. On one hand, this can be achieved through targeted investments, which reduce risks or uncertainties that inhibit private investments.

Smart public investment can increase awareness of specific market opportunities, reduce risks inherent in initial explorations and research, and enhance the accuracy of the operational time frame. Such factors can have an effect in attracting or crowding in new investment and, ultimately, in reducing costs for final consumer.

Illustrations of public investments of this type are, mappings or cadastres of renewable energy resources like solar, wind, geothermal and tidal regimes to identify investment priorities. For these sources, the investment cost is reasonably fixed, but load factors vary significantly depending on local conditions, directly influencing the cost of the energy produced. As the economic potential of these projects are as a result rather site specific and can not be easily afforded at individual projects' bases, collection of statistical information to establish resource regimes in different parts of a country could be a cost-effective way to provide basic information for long-

term investment in renewables. Therefore, an initial public investment in such information can unlock basic data to potential investors, which could be recovered based on fees paid by successful investors.

This could be particularly instrumental in geothermal resources, where participants in the process straddle between exploration companies (with solid geological skills) and utilities (with good understanding of energy markets). Successful experiences in mining could be replicated through development of relevant cadastres and the impact can be maximized through expanded service lines (for example, funded research, focused searches, or risk-sharing in exploration work). This could significantly reduce initial and risky upfront investments and enhance value for new investments by facilitating separation of geological from normal business risks associated with power generation.

At the same time, it may be necessary to increase the technical capacity of key regulatory institutions, especially in newer areas like the environment, to facilitate conflict resolution, clarity of investment requirements, and reduce consequent uncertainties for major energy projects.

To this end, special attention need to be focused on: (a) appointments of management through merit-based systems, (b) staff selection based on professional standards, (c) establishment of clear rules and non discretionary processes for project analysis, and (d) mobilization of expertise to assess environmental studies.

In the same way, efforts to streamline processes to reduce the time involved between the authorization and start of construction of energy plants should add significant value and thus induce investment. As the main problems are often not found in processes per se but on actions taken by individual participants that delay investments, mediation and adjudication mechanisms are often useful institutions to address unattended issues of interpretation.

Early warning systems can add flexibility to the energy sector, facilitating detection of issues as they emerge, pricing issues for energy production, carbon markets and strengthening the credibility to reviews/regular feedback aimed at timely action and crisis prevention.

As environmental aspects of energy management have ramifications beyond the energy sector itself, a strategic framework for environmental and climatic changes could help:

1. take effective action on climate, both adaptation and mitigation, which are part of core development efforts - rather than reactive license agreements for individual projects that tend to be controversial, time-consuming and expensive;

2. address consequent increase in resource requirements by broadening existing innovative instruments such as CDM funding beyond current project-by-project approaches that tend to have high transaction costs and limited application to widespread impact, thereby facilitating access to CDM markets to renewable options on a larger scale;

3. establish policy research examining international experiences, knowledge management and capacity building to facilitate policy development and adaptation to the local environment of technologies.

4.2. Market Vehicles

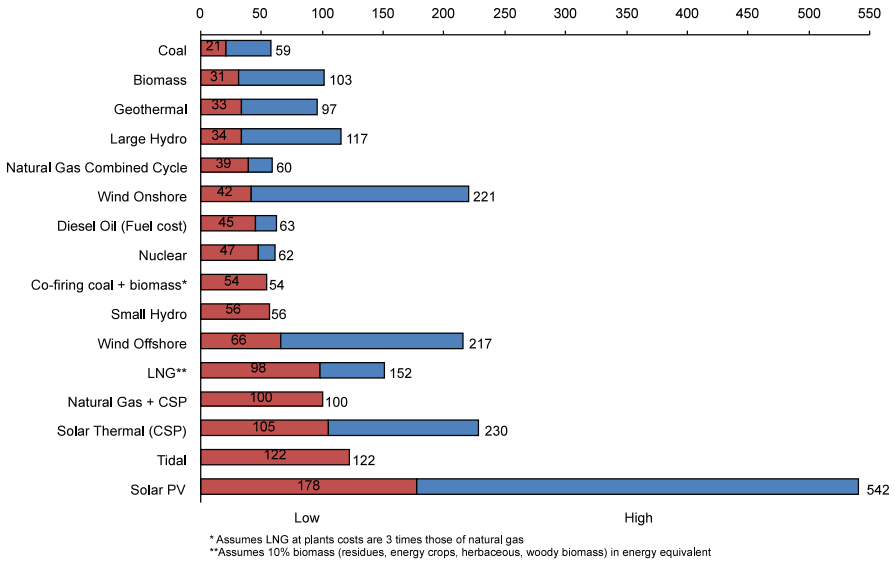
Despite significant variations in terms of environmental impact of different energy sources, market operations do not capture such externalities, thereby tending to favor energy sources of lower out-of-pockets costs that do not properly factor environmental costs and benefits.

In this regards, while some "green technologies" are starting to converge in terms of costs compared to traditional technologies, they could eventually become more attractive when considering CO2 emissions, as seen in the chart below.

The cost differences still require some form of enabling monetization of external factors to produce the necessary incentives and promote such investment in an effective way:

Some "green" technologies are closing the gap in terms of cost…

Cost Comparison, Production Costs (USD/MWh)

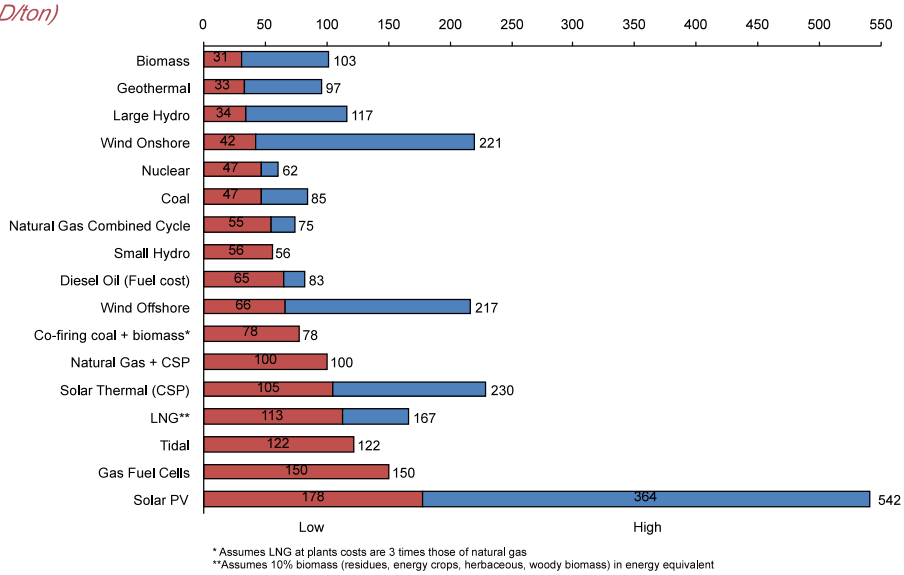


11

Sources: IEA Energy Technology Perspectives, 2006; Ormat Technologies, Inc.

…AND become even more attractive (though still more costly) when considering CO2 emissions

"Green" Cost Comparison, Production Costs (USD/MWh & CO2 Emissions in Tons/MWh at 25 USD/ton)



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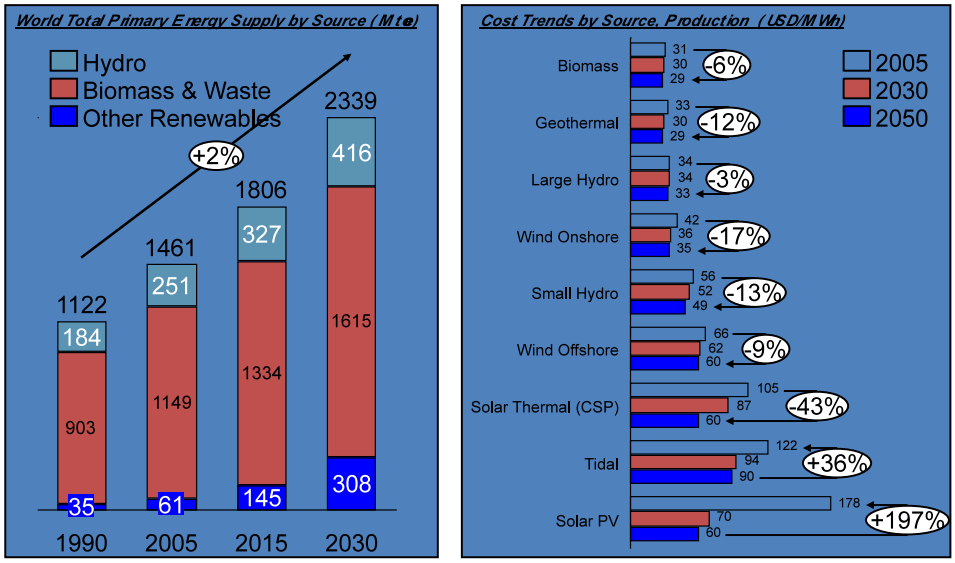
Sources: IEA Energy Technology Perspectives, 2006; Ormat Technologies, Inc.

This coupled with continued cost reduction of non-traditional energy sources as economies of scale and better technologies come on the market, should facilitate the gradual introduction of these sources in the future:

Non-conventional and renewable energy will increase gradually driven by reduced costs



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Source IEA, Energy Technology Perspectives 2006, IEA World Energy Outlook, 2007

While monetization of carbon emission would seem the most obvious route to level the playing field between non-traditional and carbon emitting sources of energy, in practice, after five consecutive years of robust growth, the total value of the global carbon market stalled at $142 billion. Suffering from the lack of post-2012 regulatory clarity, the value of the primary Clean Development Mechanism (CDM) market fell by double-digits for the third year in a row, ending lower than it was in 2005, the first year of the Kyoto Protocol. The Assigned Amount Unit (AAU) market, which grew in 2009 with strong sovereign support, shrank as well in 2010. Finally, the market that had grown most in 2009—allowances under the U.S. Regional Greenhouse Gas Initiative (RGGI)—saw that year's gains erased in 2010.

That said, even in successful and market-driven models, there is room for action to improve market functioning in specific areas of the energy sector. The objective here is to consider policy adjustments that reduce barriers to proper market functioning, as well as mechanisms that internalize externalities and, thus, help convergence between the objectives of project efficiency and general welfare.

A good example of such obstacles is the case of geothermal resources. In countries with high potential, access to resources is often restricted by the framework for concessions, which slows the development of the private sector. The establishment of a framework and regulatory process of open geothermal resource concessions (similar to what has emerged over the

years in the mining sector), would allow increased dynamism in the sector, facilitating and accelerating investment in geothermal power generation.

Similarly, water rights, critical to the development of hydroelectric projects and mining could be subject to market mechanisms more open and transparent fully integrating economic, engineering, environmental and social concerns.

Internalizing environmental costs in market operations can be performed at various levels. Initially, one might consider the development of vehicles that can maximize the opportunities for carbon trading (CDM markets and what may come after 2012). In this area, the biggest obstacle is the high transaction costs and political risks of individual operations, which provide disincentives for investors committing themselves to higher initial outlays that could be compensated by benefitting from lower emissions. The public sector can create tools and institutions to support private participants in the fulfillment of the requirements and serve as an intermediary for political risks.

If such support all this should not be enough to stimulate significant changes, consideration could be given to more direct tools, such as direct pricing or taxation for carbon emissions, benefiting the cleanest sources and punishing the pollutants one. To consider incorporating these mechanisms, special attention must be paid to design them so that they do not introduce bias in existing auction systems. This requires continuous reviews and adjustments to allow tariff structures to reflect evolving economic conditions.

Finally, to improve supply security, it is necessary to consider various options from the establishment of load factor standards in the energy sector to investment vehicles based more on the market, such as special pricing for the capacity or load factor reliability to provide signals to investors in generation and consumers towards alternatives less vulnerable to crises.

V. SUMING UP; THE ISSUE IS COMPLEX – KEEP IT SIMPLE (BUT NOT SIMPLISTIC)

> "Don't throw away the old basket until you know whether the new one holds water"
> Swedish proverb

All considered things considered: (i) increased generating capacity will be almost unavoidable to meet economic and social development needs; (ii) renewable and non-traditional sources of energy will have a growing role,

but a constrained one starting from a rather low basis, and may one day constitute a larger share of the solution as costs are reduced to more competitive levels; (iii) similarly, energy savings will play a role, as long as they concentrate on point sources of efficiency; (iv) irrespective of sources of energy, significant investments will be required in transmission and distribution to bring power to ultimate consumers.

Given such constraints, policymakers must wise up to the higher cost and enabling conditions for environmentally friendly energy development. The multiplicity of stakeholders and challenges of aligning their differing interests, the varying regulatory environments, dearth of financing, complex political frameworks are some of the factors that need to be considered in decision-making to respond more effectively to the manner in which energy-environment issues impact overall development objectives of countries.

At the global level, as Governments continue their deliberations, much remains to be done. Differences among major emitters regarding domestic priorities, approaches and ambition will still need to be resolved before a robust and sustainable international agreement can emerge.

While the international regulatory environment remains uncertain, national and local initiatives are picking up and may offer the potential to collectively overcome the international regulatory gap. The most prominent of these initiatives is California's cap-and-trade scheme, which is expected to begin operating in 2012. Other low-carbon initiatives, including domestic emission reduction targets, clean energy certificate programs, voluntary and pre-compliance domestic offset trading programs, and carbon exchanges, have gained increasing traction in developing economies such as Brazil, China, India, and Mexico. These initiatives signal that, one way or another, solutions that address the climate challenge will emerge.

The issue, however, cannot be addressed by artificial goals, banning expanded energy supply (affecting much needed development requirements in emerging economies) or with expedients, such as subsidizing, say wind mills that generate unreliable power 30% of the time or new technologies with scarce taxpayers' resources that for the time being are expensive. Such actions have their place in specific circumstances, such as off-grid clients in distant markets, particular sites with consistently high solar radiation or good wind regimes, etc. But those circumstances are limited, and thus do not add up for the time being to energy generating solutions that will make a significant dent on needed environmental abatements.

Given the interlocking factors at play, a holistic, integrated and more systemic approach might be more effective in accelerating the substitution of

traditional fuels by modern energy and promoting new energy technologies, including renewables, by removing barriers to their development by:

- **Improving the use of existing technologies** with investment programs that help cut emissions at their source trough substitutions and/or investments of existing, "within reach" cleaner fuels, thereby reducing marginal costs of greenhouse gas abatements, particularly in developing countries, where price sensitivity is bound to be higher. "Early win" cleaner sources could include hydropower, gas and, where feasible integration of power grids for greater economies of scale, rehabilitation of selected degraded facilities for greater energy efficiency, better utilization and disposal of by-products and residuals. Other known replacements for fossil fuels meriting consideration are improved fuel cycles, along with the use of nuclear-generated heat to manufacture transportation fuels from low-grade coal and shale.

- Ensuring that investment decisions take in account the value people put on the environment by **introducing** where possible **market-based instruments that can change environmental behavior** while raising revenues and avoiding energy becoming prohibitively expensive. Poorly functioning markets, incomplete property rights, and misguided policies drive people's behavior in ways that may be rational in the short term, but harmful to the environment and future generations. Natural ecosystems provide valuable services: putting a price on scarce resources leads people to conserve them; moderate reductions in air pollution are likely to pay for themselves in reduced health costs. Indirect effects need particular attention, such as: destructive implications of policy change; poor people being unable to pay for environmental improvements; overinvesting in pollution control. Policy-makers have a choice between two types of instruments – environmental taxes and tradable permits – to supplement more traditional direct intervention and regulations (so called "command and control" measures). The former (i.e. green taxes), the preferred route of European countries, include emission taxes establishing rates emissions, indirect taxes on inputs and products whose use can damage the environment, tax incentives (such as accelerated depreciation, lower tax rates, etc.) for equipment and production methods that save energy or reduce pollution. The latter (i.e. introduction of market based instruments) include tradable permits, cap-and-trade vehicles and CDMs. As conditions to enter such markets have been cumbersome, there is pressure to change the institutional financial architecture to reduce associated transaction costs.

- Encourage innovation to spur and facilitate the adoption of new technologies by helping overcome the inevitable technical risks and high

costs of developing new technologies by ensuring proper **funding and support for "public goods"**. National cadastres need to be developed to establish the resource base of countries (such as prospection of radiation levels for solar technology, or geological work on geothermal potential). Additional funding for basic science and energy research is critically needed to develop a sustainable energy future. Research priorities include photovoltaic, carbon capture and sequestration (CCS), biofuels, hydrogen generation, storage and use. As such upstream R&D expenditures involve significant scientific and cutting edge know-how and technical risks, they may have to be defrayed in developed countries and could help bring down costs non-traditional energy sources to more competitive levels with existing technologies, and thus facilitate in time their application in emerging economies and their consequent contribution to future low emission energy generation.

- Good **policy design includes implementation and enforcement**. More than anywhere else, this requires development of new competencies that are in short supply and a better recognition of institutional weaknesses in many countries, particularly in developing regions, which are unlikely going to be able to manage heavy regulations that require complex oversight and monitoring arrangements. Accordingly, a better balance must be sought and greater reliance on networks and market-driven solutions.

This four-tiered approach creates the scaffolding for people to work from, so that policy makers, the private sector and civil society help in time reduce the current 80% of today's primary energy consumption reliance on non-renewable fossil fuels towards a more clean, clever and competitive form of energy generation and consumption. Solutions aimed at balancing the energy matrix towards alternative sources relying less on polluting hydrocarbons to reduce greenhouse emissions will, however, have to overcome significant sunk costs of combustion-based technologies that put them at great advantage over emerging technologies.

This means facing incremental costs that could recognize and capture important environmental gains to be reflected in pricing signals, which respond more effectively to efficient and effective greenhouse mitigating options. Inevitably, when incremental costs have to be defrayed, the issue can become quite controversial in terms of who pays, and over what timeframe. This requires heavy adaptation to local conditions that differ widely among countries and thus moving the discussion from "best practices" to "good fits".