Asian Energy Institute

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Contents

Editor Deepti Mahajan

The AEI (Asian Energy Institute) is a network of 17 energy institutes from Asian countries. These include Bangladesh, China, India, Indonesia, Iran, Japan, Jordan, Korea, Kuwait, Malaysia, the Philippines, Pakistan, Sri Lanka, and Thailand. Besides, there are 14 associate members, both within and outside Asia. The AEI was formally established in August 1989. Its aims and objectives are to promote greater information exchange; facilitate sharing and dissemination of knowledge; undertake research and training activities that are of common interest to its members; and analyse global energy developments and their implications. TERI hosts the secretariat of the AEI at present. The secretariat publishes a biannual newsletter that informs the readers about the diverse research activities undertaken by the member institutes. Currently, the AEI is hosting the regional secretariat for REEEP (Renewable Energy and Energy Efficiency Partnership) in South Asia.

Editorial

*R K Pachauri**

The Asian Energy Institute (AEI) was established in 1989 and has been in existence for 20 years now. Perhaps this was a development ahead of its time because there are all forms of networking arrangements including various institutions that are being initiated today. In 1989 any such network was clearly an isolated development. The manner in which the AEI came into existence has probably been forgotten by most people. The concept emerged in the Asian Relations Commemorative Conference held in 1987 exactly forty years after Mahatma Gandhi organized the first Asian Relations Conference. This forum too was clearly ahead of its time because Mahatma Gandhi saw the awakening of Asia as an outcome that was inevitable after the Second World War and the emergence of several nations, including India, from colonial rule. As against the domination of global affairs by the countries of the West, he visualized Asia developing its own identity both in cultural and economic terms, and making its presence felt on the world stage during the second half of the 20th century, and of course, to a much greater extent in the 21st as well.

Recent economic trends and events have clearly elevated the Asian region to a level that is not only providing this continent with greater attention, but in fact a certain level of awe, because of the rise particularly of China and perhaps to a lesser extent of India. The oft repeated cliché that the 21st century will be Asia's century is no longer to be ignored and could become the dominant reality of global developments in the coming decades.

At the same time, energy and environment issues are coming to be the defining sectors of economic growth and development not only in the 21st century but would be so further beyond. The challenge of climate change and issues of security of energy supply require the world to move in a distinctly new direction as far as energy supply and consumption is concerned. Asia, with the highest rate of growth of any region in the world and with the bulk of its infrastructure yet to be built, will necessarily have to be in the vanguard of the new paradigm of economic growth and development that the entire world will have to adopt and pursue. Naturally, whatever changes are to take place in the energy sector on this continent would have to ensure that the very basic needs of the poor, who still number several hundreds of million people, are met fully and are in no way ignored or compromised. It would require innovation of the highest order to ensure that growth and energy consumption take place in a manner that is sustainable and in keeping with the goal of complete removal of poverty – a goal that every country on the continent has to focus on far more seriously than has been the case in the past.

This set of complexities poses challenges that must be met by the intellectual resources available in the region. It would be essential to optimize the use of these resources through exchange of ideas and experiences, and the spread of innovation, to meet the challenges of the future within a timeframe that is reasonable and justifiable. The AEI holds the potential for playing such a role and becoming the leader of innovation in policy and planning, for the benefit of almost half the population of this planet that resides in Asia. As we complete 20 years of existence of the AEI, perhaps the time has come to seek a commitment of established financial support that would provide the AEI with its inherent relevance supported by adequate resources, so that it can really make a difference in articulating a new approach involving energy-environment-development. It may, therefore, be necessary to think afresh and come up with a new lease of life for this entity, which clearly holds greater promise for the future than was obvious at any time in the past. I personally feel that a meeting of all the heads of institutions that are members of the AEI is now overdue, so that we can establish and pursue new directions with a sense of urgency and renewed mission for this organization. In other words, after 20 years of existence, the AEI should emerge as a network which experiences rebirth for its adult life, a life which heralds a new and sustainable path of development for Asia. And for the world, which will some day follow Asia's lead.

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Mitigation actions in China: under the framework of measurable, reportable, and verifiable policies

*Fei Teng, Yu Wang, Alun Gu**

Introduction

The BAP (Bali Action Plan), adopted by the Conference of Parties to the UNFCCC (United Nations Framework Convention on Climate Change) in 2007, calls for MRV (measurable, reportable, and verifiable) policies and measures to mitigate GHG (greenhouse gas) emissions in developing countries. These NAMAs (nationally appropriate mitigation actions) are to be supported by the UNFCCC parties through finance, technology, and capacity building. The BAP provisions offer an opportunity to consider the types of policies and measures that best suit individual countries' circumstances in light of their development challenges and institutional strengths.

In considering how such a tailored approach to individual country actions would work under a global agreement, it is worth looking for current examples of developing country programmes that can be measured, reported, and verified ('MRVed' in the current vernacular) and examine how countries themselves currently undertake mitigation policies and measures. China provides a rich set of examples of such policies due to its active efforts to cut its growth in energy use, and its dependence on fossil fuels. Many of these policies have been in effect for several years and, thus, provide empirical evidence for how such programmes can work on the ground.

The BAP provisions acknowledge the fact that developing countries are already making efforts to reduce emissions and are moving towards a low-carbon pathway. China is a good example. It has an ambitious set of policies and measures, which are discussed in detail in the next section. The BAP also creates a new space for developing countries to receive support for such actions. It stipulates that these countries will be provided with technology, finance, and capacity-building support for NAMAs. The BAP, therefore, broadens participation in GHG mitigation from previous agreements while maintaining important distinctions between the developed and the developing countries. A policy framework that maintains this distinction and recognizes actions, in both sets of countries, will be an essential part of achieving a global climate agreement.

The phrase MRV was critical to the agreement of the BAP, and the way in which the concept of MRV is reflected in the post-2012 agreement will have significant implications for the effectiveness of the agreement for stakeholders in both the developing and developed countries. This paper will highlight how MRV is currently applied domestically in China in order to inform the discussions around a post-2012 climate agreement. It does not, however, make any specific proposals for negotiators; it only seeks to inform international discussion on how MRV might be applied in practice and, therefore, what provisions might be required in a UNFCCC climate agreement.

Although the BAP does not precisely define NAMAs, the term suggests that such actions will derive from a country-driven approach. Submissions from parties to the UNFCCC suggest that these NAMAs should integrate two goals—changing a country's economic development path to be more sustainable and contributing to GHG mitigation. Other submissions suggest that NAMAs should respect the development right of the developing countries and should be guided by their existing development plans or strategies. The NAMAs can achieve the goal of GHG mitigation through policies and measures that have either a direct or an indirect impact on emission reduction. International support can presumably enhance the effect of NAMAs, if configured correctly.

Major findings from country review in China

The review of the existing practices in China confirms the following conclusions. First, most current actions are self-funded mitigation actions within the context of sustainable development. These mitigation actions differ significantly as a result of varying circumstances and policy tools. For example, mitigation actions in the buildings sector are mainly based on energy code and regulations while mitigation actions in renewable energy mainly focus on development goals and preferable tax policies. There is no one fit-all solution for NAMAs. NAMAs should reflect the specific development priority of each country. The flexibility of NAMAs is important for developing countries to gain mitigation benefits as much as possible.

Second, not all mitigation actions will result in direct or quantifiable emission reduction. For example, it is difficult to quantify mitigation benefit from an energy efficiency research and development programme. Some

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mitigation actions have limited emission reduction potential in near-term but have an overarching impact on the long-term emission path, for example, urban planning and mass transit programmes in large cities. Mitigation actions should not only focus on those actions with quantifiable and immediate mitigation benefits but should also focus on those with slow but increasing mitigation benefits. The latter is often out of sight of the current carbon market.

Third, a domestic statistics, monitoring, and evaluation system has been established. Such a system shares the idea of requirement of MRV, and has been used to measure and assess the progress in energy intensity reduction and energy saving in key enterprises. The evaluation system not only focuses on quantifiable outcomes but also focuses on other qualitative elements such as institutional arrangement, training, and capacity building.

The Chinese government has a very comprehensive national mitigation strategy. The mitigation actions focus on development and are diverse in terms of type and scope. The initial review of these NAMAs undertaken by the Chinese government, combined with other research on the role of NAMAs in a post-2012 international climate agreement, provides valuable insights into the design of MRV systems.

Nationally appropriate mitigation actions

NAMAs are a set of policy tools ranging from quantified targets to institutional reform, and research and development plans. Some NAMAs exist but are not fully implemented because of financial and technological constraints. For example, the low-carbon city planning for some Chinese cities still exists only on paper due to lack of financial and technological resources. Progress on such mitigation actions could be enhanced with support from developed countries.

In theory, under a post-2012 climate agreement, NAMAs could be either defined through an agreed list or could emerge from broad national mitigation strategies or low-carbon programmes. The latter approach seems to encourage the development of a diversity of policies and measures, as evidenced by the range of NAMAs found in this paper. Given that the identification of NAMAs is likely to be a country-driven process, some important questions remain—is it reasonable to ask developing countries to choose which of their policies and measures could be submitted as NAMAs in order to garner external support? Will the countries simply submit all of their NAMAs, among which donors would decide which they chose to support? Does this mean that MRV of actions would also be nationally determined? Will there be any specific financial and technical support for the MRV process? All of these questions remain to be answered through international negotiations.

Measurement

Measurement is central to MRV and metrics are the starting point of measurement. A wide range of mitigation policies have been adopted by the Chinese government in the energy, agriculture, urban-planning, transport, and industry sectors. These policies are generally country-driven to fulfil the development goals and needs of China and also to mitigate GHG emissions. Due to the diversity of development goals in different sectors, the mitigation policies and measures are also diverse in terms of GHG impacts. The policies and measures which are eligible for sustainable development should have direct or indirect GHG benefits. Those GHG benefits may be quantifiable in terms of different metrics—GHG reduction, energy saving, acres of reforestation, research and development funding, and so on.

In most cases the metrics are output-related, that is, it is the outcome of a mitigation action that is measured. The outcome of the mitigation action may be measured in GHG emissions, energy saving or other physical metrics which can be translated into reductions in GHG emissions. Energy-related metrics or other physical metrics can be used as proxies when the emission reduction cannot be measured directly. These metrics can be translated to emission reduction metrics (that is, tCO^2e) if proper methodologies are available.

It should be noted that the metrics for the outcomes of mitigation actions could be either the deviation of emissions from a recognized baseline or total emissions. However, the metrics are not always defined in terms of the outcome of mitigation actions. Where outcomes are hard to measure accurately, metrics may instead be defined as the mitigation actions themselves or key inputs required to implement them. For example, a tax on fossil fuels may contribute to reducing GHG emissions but the exact amount of emission reduction is hard to separate from the price effect and increased energy efficiency. In that case, the level of fossil fuel tax may be a more appropriate metric.

Therefore, as has been shown in the review, China currently employs a diverse set of metrics. There are advantages and disadvantages to this. The advantage of using a diverse set of metrics and standards is that these programmes can be developed, adapted, and integrated into the nation's overall development programme. By using measures directly related to energy or transportation, for example, it is easier to relate these efforts to both GHG mitigation, and to overall economic development goals. It also allows countries to measure progress and outcomes using targets and quotas, for example, and these might better suit their institutional strengths. At the same time, it enables countries to avoid a situation where an underdeveloped carbon accounting system leaves them without an appropriate tool to report their efforts on carbon mitigation to the international community. Use of proxy GHG metrics or qualitative metrics is, therefore, an important first step. GHG measurement requires complex accounting systems and most developing countries, including China, do not have these systems fully developed. However, there is a wide range of international experience to build on including systems such as the Greenhouse Gas Protocol, developed under the auspices of the World Business Council for Sustainable Development and the World Resources Institute. China has pilot programmes to improve GHG accounting in some industries but these are not comprehensive.

Many of China's metrics are direct measurements. But there is the additional issue of progress over a period of time or policies or measures or NAMAs that a well-designed MRV system can also address, and which we try to address by looking at qualitative as well as immediately quantifiable measures.

The disadvantages of diverse metrics include the bureaucratic effort required to collate and synthesize data at the national level and the complexity of creating a system at the international level that suits all participating countries. These disadvantages will become more acute when it comes to linking NAMAs to international support from developed country donors. This will require some forward thinking. These are, however, issues that might be dealt with in time and through the building of trust among countries under a post-2012 climate agreement.

Reporting and verification

There are already domestic reporting processes for various mitigation policies and measures in China across different levels and sectors. Most of the mitigation actions reviewed in this paper are unilateral actions supported through domestic resources without international provisions in terms of financial and technological support. A few have small levels of international support. Some reporting and verification processes are decentralized and not integrated at the national level, while others have been aggregated at different levels. For example, reporting and verification of energy-intensity targets is implemented from the enterprise level all the way to the national level.

Developing countries could further improve reporting and verification processes by integrating them at the national level to coordinate mitigation actions in different sectors. For most qualitative measures, for which there is no formal domestic procedure for reporting and verification, a national or international registry could be developed to recognize and assess these measures at the national or international level. This could provide a starting point for design of reporting and verification procedures.

An international architecture for MRV

The BAP provisions, as outlined at the beginning of this paper, offer an opportunity to consider the types of policies and measures that best suit individual countries' circumstances and help to seek support for them. Many of the NAMAs described above, are the kinds of actions that the international community might want to consider supporting. However, the right MRV structures will need to be created in order to ensure that these national programmes lead to significant mitigation outcomes.

Some important issues, regarding what these structures might be, remain open. In terms of measurement, some questions include—should a system be established that is based on outcomes or on performance-related metrics? And how can the international system support national measurement processes for GHG emissions?

On the reporting side these questions include—should unilateral mitigation actions be reported to the international community? If yes, how should this be carried out? How should the outcome of enhanced mitigation actions that are supported by international finance and technology be reported? And how might the support itself be reported?

With regard to verification, the international community will need to consider how international verification processes might complement national systems and how incentives can be configured to encourage verification across all sectors in all countries?

In terms of institutional structures, some questions include—how should the linkage between these actions and capacity building support be established? Will a registry-type approach, which is being considered under the UNFCCC and describes a system for 'registering' NAMAs in a central reporting system, be enough and how will this be linked to support structures?

As can be seen from the list of questions above, much discussion needs to take place in order to ensure that the right incentives and conditions are created for developing country mitigation and support for NAMAs. Much can be learnt from existing national, provincial, and local-level processes and these examples lend themselves well to further research on how to improve and expand upon NAMAs in China.

Conclusion

Major developing countries, such as China, have adopted serious mitigation efforts to control their GHG emissions and contribute to global efforts to deal with climate change. Some of these mitigation policies and measures have been reported and verified through domestic processes. These mitigation efforts should be recognized by the international community, entered into the UNFCCC registry, and supported by a process of MRV under the post-2012 climate agreement. This could enhance the range and scale of actions through the provision of financial, technological, and capacity-building support from developed parties. Agreement on the definitions of terms, such as NAMAs and MRV, will be an important part of the consensus-building process.

Some significant conclusions can be put forth. First, an MRV framework should cover mitigation actions, not just the emissions reductions resulting from these actions. Not all individual mitigation actions will result in direct and measurable emissions reduction. Uniform guidelines for NAMAs may be helpful for the developing countries to frame their mitigation actions but it is not necessary for them to strictly follow these guidelines.

Second, most NAMAs are undertaken within the context of sustainable development policies and measures, and their level and scope may differ significantly as a result of varying national circumstances and development paths. Any guideline for NAMAs should allow different types of goals, commitments, instruments, and policy tools for the developing countries. In particular, NAMAs should reflect the specific development priorities of each country.

Finally, the reporting and verification process for mitigation actions could be bolstered to give a more comprehensive picture of what actions have been taken and what outcomes have resulted. Such structures could provide better information to decision makers in the developing countries and could also avoid possible double counting of mitigation actions.

Success depends on the ability of the international community to create the right environment for mitigation to take place. The BAP provides the starting point. The challenge now is to translate this into concrete outcomes.

Fostering economic development while addressing climate change: role of smart energy in India

*Nitu Goel**

Introduction

Given the strong correlation between human development, economic activities, and growth in energy and infrastructure, it is evident that energy requirements in India will increase rapidly. This article, while discussing the dual challenge of development and climate change, explores the role of smart energy – renewables and energy efficiency – in addressing this challenge.

India's development goals

India is the seventh largest country in the world and Asia's second largest nation with an area of 3.29 million km^2. Over the years, India has made substantial progress in social welfare with an HDI (Human Development Index) of 0.619 in 2008 (UNDP 2007). However, the 128th position of India in the HDI list reiterates the fact that the country needs to move upward significantly in human development. Poverty reduction and providing basic amenities to its citizens is one of the biggest challenges facing India today, and accelerated economic development is the solution. Literature reveals that no country has substantially reduced poverty without massively increasing its use of energy (ADB 2007). Therefore, energy being a key component in ensuring this, places India amongst the large energy-consuming economy in the world.

Realizing the fact that the future social and economic development of the nation is premised on achieving a high rate of equitable economic growth, the Government of India in its Eleventh Five-year Plan (2007/8–2011/12) has set several monitorable targets to ensure economic development, and to bring about an improvement in the living conditions of its citizens. Box 1 shows these monitorable socio-economic targets of the Eleventh Five-year Plan.

However, realization of these development goals will require additional infrastructure, thereby, having implications on energy demand and consequently on emissions.

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Box 1 Monitorable socio-economic targets of the Eleventh Plan

Income and poverty

Accelerate GDP (gross domestic product) growth rate from 8% to 10% and then maintain at 10% in the Twelfth Plan in order to double the per capita income by 2016/17.

Increase agricultural GDP growth rate to 4% per year to ensure a broader spread of benefits.

Create 70 million new work opportunities

Reduce educated unemployment to below 5%

Raise real wage rate of unskilled workers by 20%

Reduce the head count ratio of consumption poverty by 10 percentage points

Education

Reduce drop out rates of children from elementary school from 52.2% in 2003/04 to 20% by 2011/12

Develop minimum standards of educational attainment in elementary school, and by regular testing, monitor effectiveness of education to ensure quality

Increase literacy rate of children of age seven years or more to 85%

Lower gender gap in literacy to 10 percentage points

Increase the percentage of each cohort going to higher education from the present 10% to 15% by the end of the Eleventh Plan

Health

Reduce IMR (infant mortality rate) to 28 and MMR (maternal mortality ratio) to 1 per 1000 live births

Reduce total fertility rate to 2.1

Provide clean drinking water to all by 2009 and ensure that there are no slip-backs by the end of the Eleventh Plan

Reduce malnutrition among children of age group 0–3 years to half its present level

Reduce anaemia among women and girls by 50% by the end of the Eleventh Plan

Women and children

Raise the sex ratio for age group 0–6 years to 935 by 2011/12 and to 950 by 2016/17

Ensure that at least 33% of direct and indirect beneficiaries of all government schemes are women and girl children

Ensure that all children enjoy a safe childhood, without any compulsion to work

Infrastructure

Ensure electricity connection to all village and BPL (below poverty line) households by 2009 and round-the-clock power by the end of the Plan

Ensure all-weather road connection to all habitation with a population of 1000 and above (500 in hilly and tribal areas) by 2009 and ensure coverage of all significant habitation by 2015

Connect every village by telephone by November 2007 and provide broadband connectivity to all villages by 2012

Provide homestead sites to all by 2012 and step up the pace of house construction for rural poor to cover all the poor by 2016/17

Environment

Increase forest and tree cover by 5 percentage points

Attain WHO (World Health Organization) standards of air quality in all major cities by 2011/12

Treat all urban wastewater by 2011/12 to clean rivers

Increase energy efficiency by 20 percentage points by 2016/17

Trends in energy and greenhouse gas emissions in India

As India is treading the high economic growth and development pathway, its energy needs are expected to rise in significant proportions in the future. A noticeable feature of the energy sector in India is the dominance of coal in the total primary energy supply contributing more than half of its TPES. The industry sector is the highest energy consumer followed by the transport and residential sectors (Table 1) (TERI 2008a).

The energy sector in India has been responsible for a major share in emissions accounting for nearly 61% of the total emissions; agriculture stands to be the second with about 28% of the emissions (Table 2).

Table 1 Sector-wise final commercial energy consumption (in MTOE) in India[1]

Sector	1980/81	1990/91	1996/97	2000/01	2005/06	2006/07
Agriculture	1.6	4.9	8.3	15.2	15.1	16.8
Industry	36.9	62.9	84.0	77.4	96.2	102.9
Transport	17.4	28.0	40.0	33.5	36.5	40.3
Residential and commercial	5.6	12.6	16.1	24.1	32.6	35.0
Other energy uses	1.9	3.9	7.0	13.4	18.7	16.5
Non-energy uses	5.3	12.6	15.8	28.0	17.5	18.4
Total	68.7	124.9	171.1	191.6	216.5	229.9

Source Various editions of the TERI Energy Data Directory and Yearbook

Energy as an imperative for development

Energy is key to the growth and development of a country, and it is critically important for developing economies. Energy will also be required to meet the targets set up by these countries under the MDGs (Millennium Development Goals), adopted at the UN Millennium Summit held in Johannesburg in September 2000, for improving the condition of the world's poorest by 2015.

India's development agenda focuses on the need for rapid economic growth as an essential precondition to poverty eradication. Meeting this agenda would require a large-scale increase in infrastructure and availability of adequate and appropriate energy resources. An analysis done by TERI in 2006 studied the energy implications of achieving the MDGs laid by the Government of India. This analysis calculated the energy requirements

[1] Non-energy uses essentially mean use of energy sources for non-energy purposes such as feed stock in fertilizer and petrochemicals industries.

Table 2 GHG emissions/sequestration (MT [million tonnes]) by source

GHG sources and sink categories	CO_2 *emissions*	CH_4 *emissions*	N_2O *emissions*	CO_2 *removals*	CO_2 *equivalent emissions*
All energy	679.47	2.90	0.01		743.82
Industrial processes	99.88	0.00	0.01		102.71
Agriculture		14.18	0.15		344.49
Land use, land-use change, and forestry	37.68	0.01		−23.53	14.29
Waste		1.00	0.01		23.23
Total	817.02	18.08	0.18	−23.53	1228.54

Source MoEF (2004)

for achieving each target. For example, to increase forest cover to 33% by 2012 the inputs required will be fertilizers, fencing, pumping, sampling, and so on, which in turn require energy.

This energy use further has climate change implications, which are explained by the second part of the graph in Figure 1. It can be seen that maximum amount of energy is required to address poverty and unemployment concerns. Therefore, energy is a very important input for achieving socio-economic development and, in India, coal and oil are expected to contribute a large part of this energy need. Accordingly, India faces a formidable challenge in meeting its energy needs in a sustainable manner.

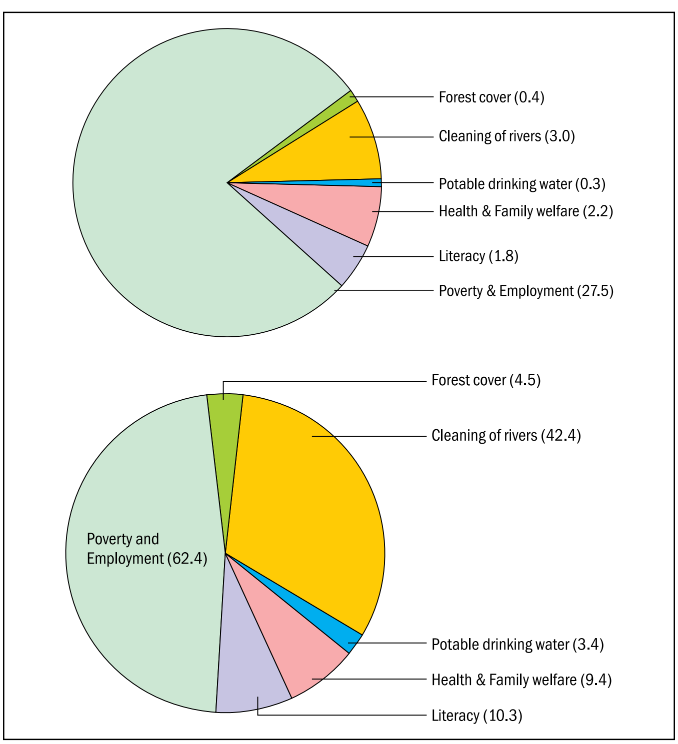

Figure 1 Energy requirements and subsequent emissions in meeting the MDGs
Source TERI (2006)

Future energy and emission scenarios for India

With the growth of the economy, the country's energy requirements are increasingly being seen as an important element in the future global climate change scenario. However, the UNFCCC (United Nations Framework Convention on Climate Change) recognizes 'development as the overarching priority of the developing countries', and states that measures to contain emissions should not be undertaken at the cost of development. Integration of climate change concerns into current development policies and programmes is imperative. The actual amount of energy required, and its consequential GHG (greenhouse gas) emissions, will be a function of the energy pathway that India chooses to follow.

Four theoretical scenarios were developed by TERI to enable an analysis of possible future implications of energy growth for investment needs and GHG emissions (TERI 2008a). A brief description of each scenario is presented in Table 3 below. All four scenarios assume an average annual economic growth rate of about 8% up to the Fifteenth Five-year Plan ending in 2031/32, constant population growth, and affluence with the same economic and social structures.

Table 3 Four alternative energy development and GHG emissions scenarios

Scenario names	*Storyline*
Evolution	Life continues pretty much as we know it, with autonomous efficiency improvements taking place where feasible; renewable energy being used at the same pace; and defined policy priorities being implemented with no real sense of urgency
Revolution	A determined effort is provided here for efficiency improvements both on the supply side and demand side; an accelerated push for renewable energy, nuclear energy, and new technologies such as CTL (coal-to-liquid) and GTL (gas-to-liquid). Energy security concerns are paramount in this scenario
Resolution	This scenario honours the prime minister of India's commitment that India's per capita carbon emissions would never exceed those of the developed world, and it is optimistically assumed here that the developed world would be able to bring down its emissions to a level of 2 tonnes/capita
Ambition	This scenario considers that India sets aside its legitimate arguments on 'common but differentiated responsibilities' and equitable per capita right and takes on even more stringent emission reduction targets (reaching 1.2 tonnes per capita in 2031) towards influencing global response to the challenge of climate change.

Source TERI (2008)

As can be seen from Figure 2 (total commercial energy requirements across the alternative scenarios), policy and technology interventions yield results with a time lag, and significant effects, in terms of reduced overall demand, are seen only from the Thirteenth Five-year Plan period (2016/17–2021/22). By 2031/32, the difference in energy consumption in the evolution scenario and the reference scenario will be of the order of 806 MTOE, which is about 2.8 times the energy consumption in 2001/02. There is a reduction in overall energy consumption and the fuel mix shifts (as depicted in Figure 3) away from coal towards natural gas and renewables.

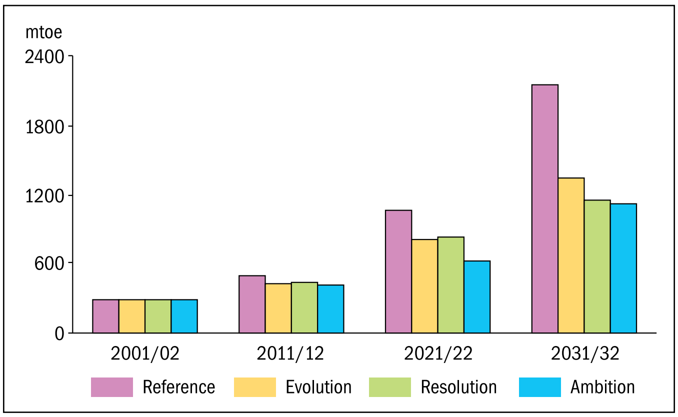

Figure 2 Comparison of commercial energy requirements across scenarios (MTOE)
Source TERI (2008b)

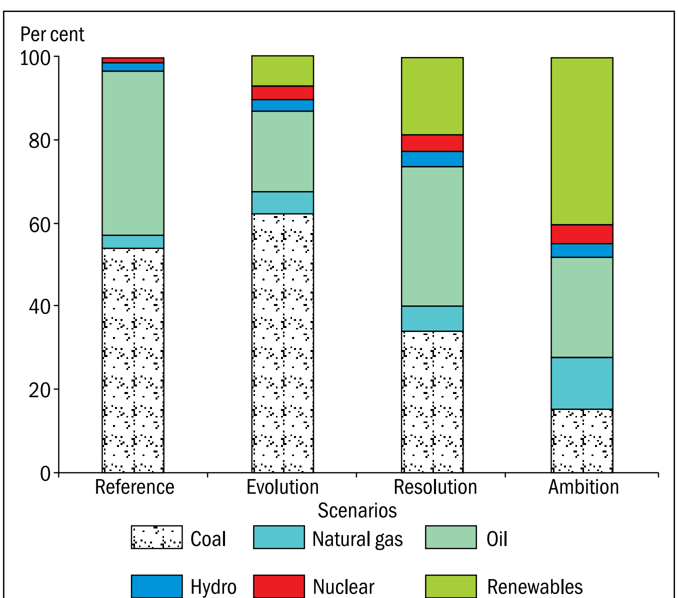

Figure 3 Percentage distribution of primary commercial energy in 2031/32 across various scenarios
Source TERI (2008b)

What role can clean energy play?

It is clear that the Indian economy has a formidable challenge ahead in ensuring energy adequacy and implementing its developmental plans in an environmentally sustainable manner. Ensuring development, while mitigating climate change, requires smart energy choices, and renewables and energy-efficiency options offer solutions in achieving the same.

Renewable energy

RETs (renewable energy technologies) have an important role to play in meeting the challenge of development, while conserving natural resources, and hold great promise for remote areas in terms of providing decentralized power. India still has a large untapped potential of renewable energy sources such as solar, wind, and biomass (see Box 2). It can be seen that, on an average, the achievement exceeded the plan target in the Tenth Plan, with wind power sector performing the best and having the highest potential for the Eleventh Plan period, followed by small hydro and biopower. Waste to energy is one of the sectors which has not achieved its targets and offers considerable potential for the future.

Wind power is one of the most viable renewable technologies for power generation for India. To increase the penetration of technology, the Government of India has fiscal incentives in place in the form of accelerated depreciation and tax holidays.

Solar power has emerged as a strong focus for the Indian government. The Government of India, in June 2008, launched the NAPCC (National Action Plan on Climate Change) consisting of eight national missions with an aim to achieve accelerated development while addressing climate change. One of the missions on

Box 2 Renewable energy targets for the Tenth and Eleventh Five-year plans and achievements during the Tenth Plan period

Renewable power programme	*Tenth Five-year Plan target* (MW)	*Tenth Five-year Plan up to 31 January 2007* (MW)	*Eleventh Five-year Plan target* (MW)
Wind power	1500	6315	10 500
Small hydro (up to 25 MW)	600	1905	1400
Biopower and bagasse-based cogeneration	700	1146.3	1700
Biomass gasification	50	75.85	500
Waste to energy	80	51.98	400
Solar photovoltaic power	145	2.92	50
Total	3075	9497.05	15 000

Source Ministry of New and Renewable Energy (MNRE) solar energy, that is, the National Solar Mission, aims to promote the development and use of solar energy for power generation and other uses, with the ultimate objective of making solar competitive with fossil fuel-based energy options. Its objectives include the establishment of a solar research centre, increased international collaboration on technology development, strengthening of domestic manufacturing capacity, and increased government funding and international support. Importantly, it also contains a target to install 20 000 MW of solar generation capacity by 2020, 100 000 MW by 2030, and 200 000 MW by 2050. SPV (solar photovoltaic) systems are being promoted in India primarily for rural and remote applications. The decentralized systems are solar power plants with mini-grids, solar home-lighting systems, solar lanterns, and solar street lights. The target for the Eleventh Five-year Plan period, that is till 2012, is to add about 50 MW of SPV systems (including both off-grid and grid-connected SPV systems).

Cogeneration is another important sector and has benefited the sugar industry to a large extent in the past. India is the second largest producer of sugar in the world, producing 19.5 MT (million tonne) of sugar annually. The estimated potential in sugar industry alone is about 5000 MW. In various core industries like breweries, caustic soda plants, textile mills, distilleries, fertilizer plants, paper and pulp industry, solvent extraction units, rice mills, and petrochemical plants, estimates put the potential for cogeneration at about 15 000 MW (TERI 2007).

India's Integrated Energy Policy prioritizes the exploitation of the country's full large-scale hydro potential. The government estimates an additional need of 100 000 MW of generating capacity by 2012, expanding grid-based generation to about 225 000 MW. Given that India added about 23 000 MW during the last Five-year Plan of 2002–2007, this will be a quantum jump. The Government of India has decided to acquire an increasing portion of this additional power from the country's vast untapped hydropower resources, only 23% of which has been harnessed so far.

Waste is an important but untapped sector to a large extent in India. The estimated potential of energy recovery from MSW (municipal solid waste) is expected to grow along with the growth of the economy and may reach 0.3 MT per day (5200 MW of installed capacity) by 2017.

India, being a tropical country, has enormous potential for energy generation through biomass. Biomass energy is normally produced from firewood, agricultural residue, such as bagasse; crop stalks; animal dung, and wastes generated from agro-based industries. Biomass gasifiers for power generation offer great potential for decentralized applications in rural areas. Moreover, dual fuel electric power generators (biomass gasifier coupled with diesel) offer a good opportunity for saving fuel and hold potential for decentralized power generation in industries that are generating and using their own captive power, based on diesel, on account of poor reliability of the grid. Small-scale industries can benefit to a large extent by thermal application of gasifiers.

Energy efficiency

The National Mission on Enhanced Energy Efficiency is the key focus for future government action on energy efficiency. The government recently approved the detailed implementation plan for this mission, which is due for release. The mission will help save 5% of yearly energy consumption and nearly 100 MT of carbon dioxide per year. It is based on the 'perform, achieve, and trade' method, which would allocate energy-efficiency improvement targets to the country's most energy-intensive industrial units with the provision of allowing them to retain any energy-efficiency improvements in excess of their target in the form of ESCerts (energy savings certificates).

The mission is not the first effort by the government to improve energy efficiency. The Energy Conservation Act (2001) empowers the government to, inter alia, prescribe and ensure compliance with standards and norms for energy consumers, and prescribe energy conservation building codes and energy audits. There are a range of existing programmes under the BEE (Bureau of Energy Efficiency) in key sectors of energy demand.

A standards and labelling programme, for manufacturers of electrical appliances, was launched in May 2006. Though the programme is voluntary in its current initial stage, the intention is for it to eventually become mandatory.

The ECBC (Energy Conservation Building Code), launched in May 2007, sets energy-efficiency standards for commercial buildings, prescribing minimum standards for external wall, roof, glass structures, lighting, heating, ventilation, and air-conditioning, in each of the five climatic zones in the country. An R&D (research and development) programme will support ECBC by developing energy-efficient windows, low cost insulation material, and so on, and will simulate models to predict energy consumption. The goal is to reduce energy consumption in commercial buildings by 25%–40%.

Another pioneer effort of the BEE is the 'The Bachat Lamp Yojana' which aims to provide energy saving CFLs (compact fluorescent lamps) to domestic households at the price of standard bulbs. The aim is to replace 400 million light points, and recover the price difference through revenue from the CDM (Clean Development Mechanism).

Way forward

In India, significant developments have taken place in the areas of renewable energy, energy efficiency, power sector reforms, energy and infrastructure development, clean coal technologies, cleaner and lesser carbon intensive fuel for transport (including biofuels and environmental quality improvement), and so on. However, there is still large untapped potential in these sectors. The wind sector has a vast untapped energy potential of about 65 000 MW, which is likely to increase to 100 000 MW after complete mapping of the wind energy profile. Currently, India's offshore wind energy potential is completely untapped. India also needs to accelerate the tapping of its hydropower potential as currently hydropower installed capacity is only 36 GW (TERI 2008b).

In the field of solar energy, India needs to rapidly demonstrate solar thermal based power generation applications, with storage both at the centralized and decentralized levels. Joint R&D will be required to facilitate this process.

With regard to energy efficiency, despite the efforts made by the Government of India, there has been limited penetration of technologies due to the high upfront investment requirements and lack of awareness about technologies. Large-scale programmes, supported by multilateral organizations and market mechanism such as programmatic CDM, would further accelerate deployment of energy- efficient technologies. For large-scale development and dissemination of clean technologies, huge investments will be required. The role of the international community gains importance in delivering the same. It is vital that the incremental cost of these investments is supported by the developed countries as the opportunity cost for the developing countries is huge, that is, foregoing social development. Therefore, the international climate change negotiations and especially the Copenhagen meeting at the end of this year should aim to achieve an outcome that ensures financial and technological support to the developing countries in promoting the use of renewable energy and fostering energy efficiency. Measures to promote energy efficiency and renewable energy, while designed to promote development, will also have an important co-benefit in terms of moderating emissions.

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Managing energy import dependence: lessons from Japan

*Mitali Das Gupta**

Introduction

Japan is the world's fourth largest primary energy consumer and the third largest oil consumer with almost 5.05 million barrels consumed per day (after USA and China). Japan is also well known for its deficiency of energy resources. Apart from some small oil deposits in Niigata Prefecture on the Japan Sea coast, and some low-quality coal in Hokkaido, Japan is almost singularly bereft of hydrocarbons. As a result, the country is a large-scale importer of oil and presently its entire oil and gas supply is met through imports. However, even with this level of vulnerability, Japan is still an economic superpower. Securing stable energy supplies from abroad, and achieving the desired mix of fuels and technology at home, have preoccupied Japanese policy-makers since the 1970s. But new realities are pushing energy security to the top of the political agenda in a way that has not been seen in the past. In this context it is probably important to study the Japanese policy in managing energy import dependence in a way where elements of a more assertive government are shaping up the energy market. The paper also makes a comparative assessment with India in terms of the energy policies of the two countries in securing energy imports.

Japan's energy demand situation and projections

Oil is the most consumed energy resource in Japan (about 50%). For many years, petroleum demand in Japan has increased in line with the country's high economic growth rate. However, in the transportation sector, gasoline demand started to decrease since early 2000 due to the limited growth of passenger vehicle population and decrease in fuel consumption due to the introduction of tighter fuel economy standards for new vehicles. The industrial sector also showed a decline in its oil consumption owing to large-scale energy-efficiency measures and shift to alternative fuels. As a result oil consumption declined by 0.36% on an average between 1990 and 2007 (BP Statistics 2008). Coal meets approximately 18% of Japan's total energy needs (METI 2006). Japan has 355 million tonnes (MT) of coal reserves and primarily imports coal from abroad. The domestic coal production was to the tune of 1.4 MT in 2007 and Kushiro is the only operating coal mine (BP Statistics 2008). Natural gas and nuclear power are increasingly gaining importance in Japan's energy basket. According to Oil and Gas Journal (OGJ), Japan had 738 billion cubic feet (BCF) of proven natural gas reserves, as of January 2008, of which it produced 132 BCF of natural gas in 2007. At the time of the first oil crisis, natural gas supplied only 2% of the nation's energy, but its use has increased to almost 15% today. Japan is the third largest consumer of nuclear power in the world after the US and France, and currently has 55 operating nuclear reactors with a total installed generating capacity of around 50 gigawatt (GW) (EIA 2008). Hydroelectric power and renewable energy account for a relatively small percentage of total energy consumption in the country (around 3%–4%).

According to forecasts made by the IEEJ (The Institute of Energy Economics), Japan (2007), final energy demand will show a gradual declining trend by 2050 due to various energy conservation efforts by the end-use sectors (Figure 2). By energy source, it is

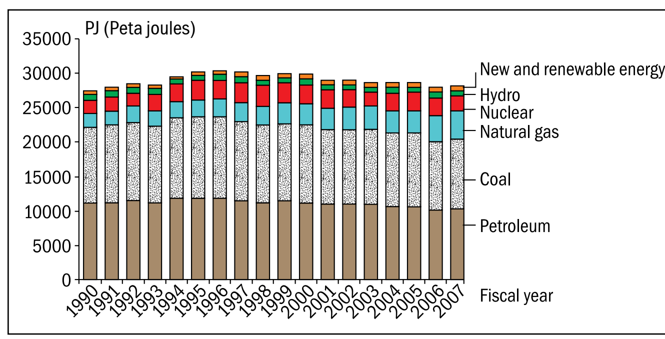

Figure 1 Changes in Japan's primary energy supply (1990–2007)
Source Agency for Natural Resources and Energy, Japan (2007)

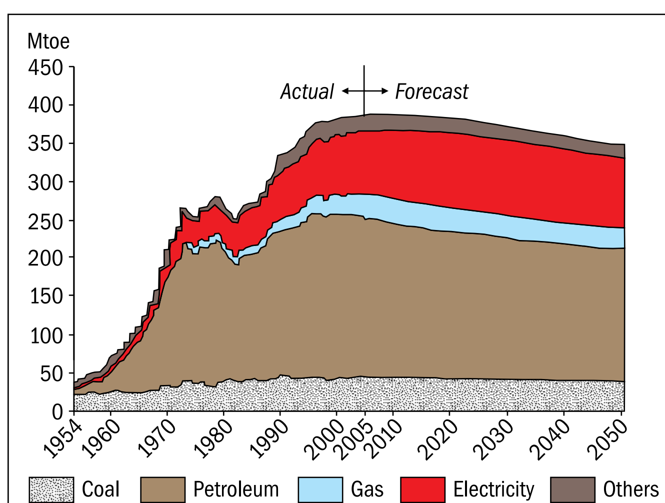

Figure 2 Japan's final energy demand by source
Source Komiyama and Marnay (2008)

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projected that Japan's total crude oil demand is expected to remain flat or even decline slightly to 5.5 million barrels per day (MBPD), the level that it was during the 1990s. It is particularly expected that the automobile sector will achieve significant energy savings and improve fuel efficiency of conventional vehicles, and there will be more penetration of hybrid vehicles. It is expected that demand for coal will also flatten out gradually due to improved generation efficiency of coal-fired power generation and decreasing coke demand for producing steel products. Also, improved efficiency of LNG-fired power generation will level off natural gas consumption. Electricity demand is projected to grow continuously by 2050. With improved efficiency of household equipments, there will be a shift in energy demand to electricity. It is expected that electricity will acquire a share of nearly 30% by 2050 from 22% in 2005. In the future, nuclear power generation will be a major source of electric supply, and the share of alternative energy sources is also expected to grow steadily.

Japan's reducing energy demand in the future has raised concerns about its role in the Asian energy balance. Since 1993, when China became a net oil importer, Japanese analysts recognized that their giant neighbour would consume more energy as it grew. However, few anticipated how rapidly China would grow or how dramatically it would reshape the face of the Asian energy market. At present, China and India are the major energy consumers in the Asian market and Indonesia has shifted from a net oil exporter to a net oil importer. In the wake of this surging demand, Japan's share of regional oil demand could fall to just 14% of total Asian demand by 2020, as compared to about 20% in 2007. A similar situation may arise in the case of gas too. IEA projections indicate that Japan's share of gas will fall by approximately 19% of the global market by 2020. These trends have raised concerns that if Japan's share in the global energy market shrinks, its purchasing power will weaken and it will face more serious competition for securing resources.

Japan's energy import dependence

Energy imports in Japan – comprising of petroleum and petroleum products, LPG, LNG, and coal together – make up for roughly 30% of the total import value of Japan. Of this, crude petroleum and LNG constitute the maximum import share as shown in Table 1. Imports of crude petroleum generally form 14%–15% of the total import value. However, in March 2008, the rise in the share of petroleum imports to 21% is attributed to high oil prices during the period.

For Japan, coal imports originate primarily in Australia, China, Indonesia, Canada, and Russia. The biggest share of coal comes from Australia (59%), 16% originates in China, 11% from Indonesia, and the remaining 14% is diversified sufficiently from other countries (Nosko 2005). Japan imports coal primarily because Japanese coal contains high levels of sulphur and is much costlier than imported coal. Coal is traded solely by the contracting private companies and since state subsidies for domestic coal ceased in 2001, the state's only policy towards coal is towards promotion of clean coal technology and meeting Kyoto goals, through investing in clean coal research and also maintaining a balanced primary energy mix.

Due to gap between domestic consumption and production, Japan remains the second largest net importer of oil after the US, having imported around 250 MT in 2007 (BP Statistics 2008). The country is primarily dependent on the Middle East for its oil imports as roughly 85% of Japanese crude oil imports originate in the region. Japan is currently looking towards Russia, Central Asia, and Africa in order to geographically diversify its oil imports and enhance domestic energy security. In an effort to mitigate the country's lack of domestic oil resources, Japanese oil companies have sought participation in exploration and production projects overseas. Although Japan is not a major oil producing country, it has a robust oil sector, comprising of various state-run, private, and foreign companies. The

Table 1 Energy imports of Japan during the last three years (value in yen)

	March 2007		March 2008		February 2009	
	Value	% share	Value	% share	Value	% share
Mineral fuels	153 098 6020	25.9	223 335 5197	33.9	104 835 7030	30.4
Petroleum	917 134 042	15.5	139 522 8391	21.2	485 489 424	14.1
Petroleum products	134 786 878	2.3	199 454 853	3.0	615 716 07	1.8
Petroleum spirits	116 754 702	2.0	154 173 283	2.3	330 519 58	1.0
LNG	223 617 356	3.8	374 850 661	5.7	266 648 432	7.7
LPG	102 050 475	1.7	111 333 755	1.7	386 545 31	1.1
Coal	150 025 502	2.5	145 299 469	2.2	195 640 209	5.7

Note % share denotes the share in total imports

Source Trade Statistics of Japan, Ministry of Finance. Available online at <http://www.customs.go.jp/toukei/info/index_e.htm>

government's 2006 energy strategy plan contains the goal of increasing 'Hinomaru oil', that is, oil developed and imported through domestic producers from current 15% to 40% by 2030 (IEA 2008).

Lacking international pipeline connections, Japan is the largest importer of liquefied natural gas (LNG) in the world and currently accounts for about 40% of global LNG imports. The country has 24 operating LNG import terminals. Recent plans to increase import capacity include Inpex's proposed $900 million, 1.5 MT per year (73 BCF/y) LNG terminal at Naoetsu port, which is to be operationalized in 2014. Japan's sources of gas imports are more diversified than its sources of oil imports as the country is dependent on the Middle East for roughly about 26% of its LNG imports. The other important sources are Indonesia, Malaysia, and Australia. In addition to long-term contracts, Japan also receives a significant number of spot cargoes. A price disparity between spot- and long-term cargoes has emerged and spot prices were nearly twice as high as prices of contracted volumes in 2008. Despite the higher price, there has been a surge of spot LNG imports in 2007/08. According to some analysts, this is due to the devastating earthquake in July 2007 due to which the Kashiwazaki-Kariwa nuclear power plant was shut down and, thus, there was an immediate need to increase LNG import volumes (IEA 2008). Figure 3 shows the sources of Japanese oil and gas imports in 2007.

Energy policy of Japan: towards reducing import dependence

Japan's New National Energy Strategy, unveiled by METI (Ministry of Economy, Trade and Industry) in May 2006, provides an insight into the change in thinking that is taking place in the country. The new plan represents an attempt by the government to build a coherent vision to guide its role in energy markets, reinforcing the shift away from open market towards greater government intervention. The plan has set some numerical targets that the Japanese government should undertake in the next 15–20 years to increase its energy security status and reduce dependence on imported sources (Table 2).

Table 2 Numerical targets set by Japan's National Energy Strategy

Energy security measure	*2030 target*
Energy conservation	Increase economy-wide by at least 30%
Overall oil dependence	Reduce to 40% of total primary energy supply
Crude oil imports	Increase ratio to 40% of total crude oil imports by Japanese companies through overseas exploration
Nuclear power	Increase production to 30%–40% of total electricity supply

Source Evans (2006)

Energy conservation policies

Lack of domestic natural resources has placed a premium on highly energy-efficient practices in Japan. The two oil crises of the 1970s had a great impact on Japan's subsequent energy policies resulting in the enactment of the law concerning the rational use of energy (Energy Conservation Law) in 1979, and this provided a legal basis for energy conservation activities. While energy consumption in the industrial sector has generally remained steady since the first oil crisis, that in the residential, commercial, and transport sectors has increased significantly. However, the energy intensity per

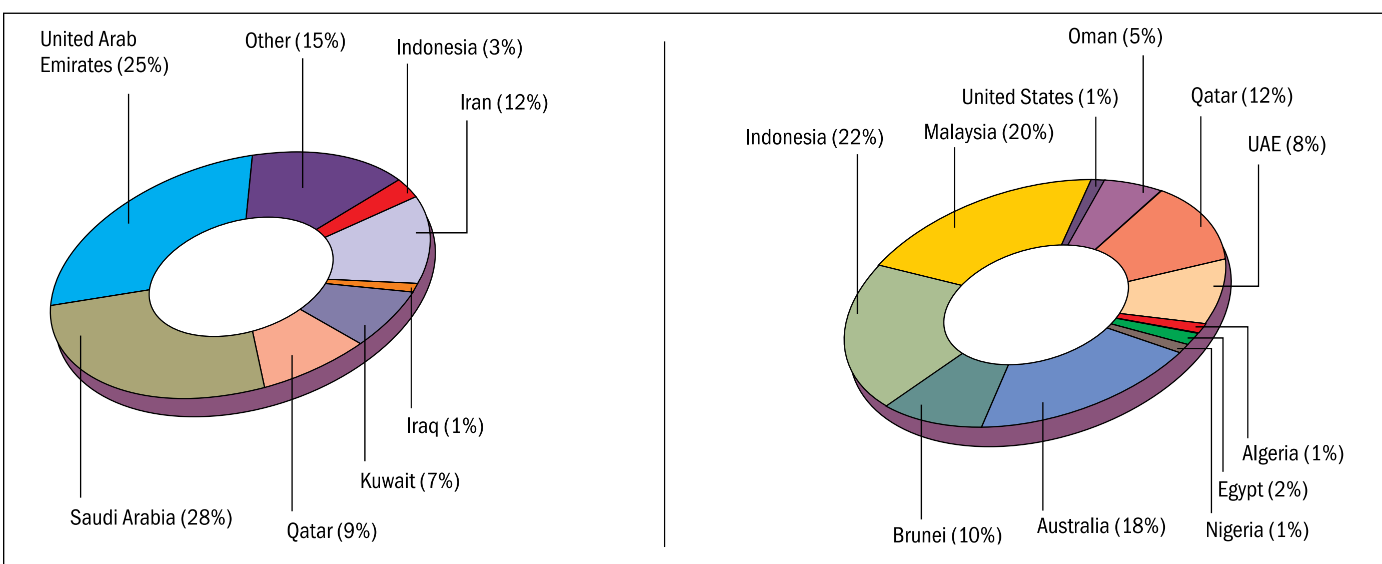

Figure 3 Japan's oil and gas imports by sources in 2007
Sources BP (2008) and EIA (2008)

GDP has improved by 37% over the past 30 years (Miki 2006), owing to the strong implementation of the energy conservation law. Within the industrial sector, companies are required to prepare medium- and long-term plans and implement energy management on their own initiative. The Top Runner Programme was developed in 1999, in addition to the existing Energy Conservation Law. It applies to machineries and equipments in the residential, commercial, and transportation sectors. The concept is to set the fuel efficiency standards higher than the performance of the best product among the products that are commercially available in the same product category. The energy-saving labeling system has been introduced to inform consumers about energy efficiency of home appliances and promote energy-efficient products. Within the residential sector, submission of notification of energy-saving measures to the competent authorities for residences of a certain size (a total floor area of 2000 m^2 or more), as in the case of non-residential buildings, is mandatory. There is also a nation-wide campaign in Japan to reduce indoor air conditioning by wearing clothes which make people feel cool in summer and warm in winter. The campaign called 'Cool Biz' (during summers) and 'Warm Biz' (during winters) helps office workers adapt to set room temperatures. A similar initiative called 'Uchi Eco' has been launched, encouraging individuals to save energy at home by focusing on appropriate clothing, food, and housing. The Japanese government estimates that if demand-side measures in the end-use sectors can be put in place then an aggregate of 56 million kl energy will be saved in 2010, almost equivalent to the annual energy consumption in all households in Japan (The Energy Conservation Centre 2008). To promote energy conservation in equipments, investment in industry and commerce, easy loan programmes and tax reduction schemes have been established by the Energy Conservation Assistance Law.

Exploration and production

At present, Japanese firms are responsible for developing and importing approximately 15% of the country's crude oil needs. The new energy strategy calls for their contribution to be expanded to 40% of Japan's total oil consumption by 2030 by investing in overseas supply. Japanese companies have actively sought participation in natural gas exploration and production projects abroad. Japan's overseas oil projects are primarily located in the Middle East and Southeast Asia. Table 3 shows some of the major investments in overseas projects that Japan has made in recent years.

Until recently, Japan's oil sector was dominated by the Japan National Oil Corporation (JNOC), which was formed by the Japanese government in 1967 and was leading oil exploration and production domestically and overseas. In November 2001, then-Prime Minister Koizumi, announced the planned breakup of JNOC. Many of JNOC's activities were spun off into the Japan Oil, Gas, and Metals National Corporation (JOGMEC) in 2004. JOGMEC is a state-run enterprise that helps Japanese companies involved in exploration and production overseas. Two of the largest companies, formed through this process, are Inpex—now Japan's largest oil company, and the Japan Petroleum Exploration Co. Ltd. (Japex). These two companies have spent \$434 000 and \$319 5000, respectively, in 2006 for upstream research and development (R&D) (Koike et al 2008).

Promotion of nuclear energy

Despite a series of problems and accidents, nuclear energy remains at the core of Japan's energy policy, in an effort to achieve the country's obligation under the Kyoto Protocol. Japan currently has 55 operating nuclear reactors with a total installed generating capacity of around 50 GW, making it the third-largest nuclear power generator in the world behind the US and France (EIA 2008). By 2005, nuclear power accounted for 30% of all electricity generation in Japan, compared to around 17%–18% for the rest of the world. This is an astounding difference and is indicative of the emphasis on reducing dependence on fossil fuels. Preliminary data shows that Japan produced 268 billion kWh of nuclear-generated electricity in 2007. Proponents of nuclear power point to its low operating costs and the historically stable costs for uranium fuel, especially when compared to oil or natural gas. The New National Energy Strategy calls for raising the percentage of nuclear power in total national electric supply from the present 30% to close to 40% or more by 2030. In October 2005, the Atomic Energy Commission of Japan adopted a long-term nuclear plan maintaining the nation's nuclear fuel cycle programme, which reprocesses all the spent nuclear fuel to extract plutonium for future use as nuclear fuel (Masaki 2006). Also METI affiliated Agency for Natural Resources and Energy unveiled a plan in December 2005 to build a new and technologically advanced fast breeder reactor (FBR) by 2030 to replace Monju.[1] The new FBR would be used as model reactor for about a decade and then commercialized to replace light water reactors by 2050.

Technology innovation

Japan's experience with solar photovoltaic (PV) power provides a good example of technology innovation. Rapid

[1] The prototype Monju FBR in Tsuruga, Japan, has remained shut down since a sodium leak and subsequent fire in December 1995.

Table 3 Japan's overseas investment in oil and gas

Kuwait/ Saudi Arabi	Japanese-owned Arabian Oil Company (AOC)	Contract to purchase 100 000 bbl/d from Khafji field until 2023	Neutral Zone, Khafji and Hout fields	AOC served as operator of Khafji and Hout oil fields in the Natural Zone between Kuwait and Saudi Arabia (also known as the Divided Zone) but lost its concessions in the Saudi portion in 2000 and in the Kuwait portion in 2003. AOC remained active in the area under a service contract that began in 2003, but Kuwait declined to renew this contract when it expired in early 2008. Only the purchase contract remains. Japan is still the largest importer of Saudi crude oil in Asia.
Iran	Inpex	10%	Azadegan	In 2004, Inpex was awarded a $2 billion contract to develop the Azadegan oil field, which is estimated to hold 26 billion barrels of oil reserves. Inpex was originally the operator and held a 75% stake, but in 2006, the state-owned National Iranian Oil Company (NIOC) slashed Inpex's share to 10% and assumed responsibility for operation of the field. Inpex stated that it is not attempting to raise its stake in the project, citing excessive investment costs. The field is expected to produce 150 000–260 000 bbl/d.
Caspian Sea	Inpex	10%	Azeri-Chirag, Guneshli (ACG) Project	In 2003, Inpex acquired a 10% stake in the ACG Project in Azeri territory of the Caspian Sea. ACG oil fields currently produce around 735 000 bbl/d of oil and are expected to reach 1 million bbl/d in 2009. Estimates of recoverable reserves have been revised upward from 5.4 billion barrels to 9 billion barrels. Inpex is currently involved in the development of the deep-water Guneshli field, which was expected to start production in 2008.
Kazakhstan	Inpex	8%	North Caspian Sea Block, Kashagan	Inpex obtained this interest in the offshore oil field in 1998. Production is currently underway and is expected to reach 1.2 million bbl/d.
Russia	Sakhalin Oil and Gas Development Company (SODECO), a consortium of public and private Japanese oil companies	30%	Sakhalin-I	Sakhalin-I contains an estimated 2.3 billion barrels of oil and current production has reached 250 000 bbl/d. The Sakhalin projects are increasingly important to Japan as the country tries to geographically diversify its sources of oil imports.
Russia	Mitsui and Mitsubishi	22.5% (combined)	Sakhalin-II	Sakhalin-II has estimated reserves of 1 billion barrels of oil.
South America	Frade Japao Petroleo Limitada (FJPL)	18.3%	Frade block, Northern Campos Basin	As a joint venture between Inpex and the Sojitz Corporation, FJPL's working interest in this block, off the coast of Brazil, is the first time a Japanese enterprise has participated in oil production in Brazil. Commercial production was expected to begin in 2009.

Source EIA Country Analysis Brief –Japan. Details available at <http://www.eia.doe.gov/emeu/cabs/Japan/Full.html>

technology innovation has made Japan the world's leading producer of PV cells. The installed PV AQ power in Japan has quadrupled, growing from 330 MW in 2000 to 1422 MW in 2005 (Evans 2006). Japan's success in solar technology has been made possible through a combination of favorable economics and supportive government policies. The Japanese government has allocated more than $250 million per year to support solar power. Of course high electricity prices have also played a role. Japanese companies like Sharp, Kyocera, Sanyo Electric, and Mitsubishi Electric are now dominating global cell and module production. With increasing economies of scale, greater competition, and incremental technological improvements, prices for PV installation in Japan have been decreasing and Japanese firms have been able to bring solar closer to the cost of domestic residential grid-based power. The ability to make solar energy more affordable has helped diffusion of this alternative technology to external markets as well and helped the economy to reduce its import dependence to some extent.

Comparative assessment of India and Japan

There are some fundamental differences between India and Japan in terms of their energy consumption parameters as depicted in Table 4. Though Japan's self sufficiency is far below that of India's, the per capita energy consumption of India is just about 9% of that of Japan. There is a huge imbalance between Japans' production and consumption levels of hydrocarbons, unlike India, resulting in greater reliance of Japan on energy imports.

There is a basic difference in the objectives of the two countries as far as formulation of energy policy is concerned. As opposed to Japan, where the priority is to focus on energy conservation efforts, technology innovation and greater reliance on nuclear energy in order to increase self sufficiency, in India, the primary objective of the energy policy is energy access, that is to provide safe, convenient, and affordable energy services to all people. To achieve this, it calls for certain measures to realize a cost-effective energy system—1) promotion of market competition, 2) pricing and allocation of resources through market mechanisms, 3) improvement of energy efficiency across the energy chain, 4) policy for promoting alternative energy usage, 5) expansion of energy sources and supply, and 6) enhancement of energy related research and development operations. The Indian government has been implementing various policies to enhance its energy security by alternative energy development, energy saving policies, developing domestic resources as well as enhancing political relations with oil producing countries. The Ministry of Petroleum and Natural Gas has teamed up with the Ministry of External affairs to set up the Standing Advisory Committee on Oil Diplomacy for Energy Security for improving energy security through promotion of investment in overseas upstream oil and gas operations. Unlike Japan, which is now easing regulations and restrictions for foreign sector investment in the upstream sector since the early nineties, India has steadily implemented deregulation and liberalization of the oil sector by promoting participation from both foreign and domestic sector companies. As far as the downstream sector is concerned, Japan is placed better than India. Japan had 4.7 million bbl/d of oil refining capacity at 31 facilities, as of January 2008, and has the second-largest refining capacity in the Asia-Pacific region after China. The refining sector in Japan has been characterized by overcapacity in recent years, as domestic petroleum products' consumption has stagnated. As compared to Japan, India had 2.26 million bbl/d of crude oil refining capacity at 18 facilities as of January 2008 (EIA 2009) and has the eighth largest refinery capacity in the world.

Table 4 Comparison between India and Japan

	Japan	India
Total energy demand	World's no. 4	World's no. 5
Growth of energy consumption (average annual growth between 1990–2007)	0.98	4.51
Per capita demand (million Btu per person)	178.7	15.9
Self sufficiency	6.9%	82.3%
Oil's share in total energy demand	50%	23%
Oil import dependence	98%	72%
Dependence on Middle East	85%	64%
Respective rankings in the world for 2007		
Crude oil		
Consumption	5	3
Production	23	47
Natural gas		
Consumption	18	6
Production	23	46
Coal		
Consumption	3	6
Production	3	66

Sources Data compiled from EIA (2009); BP (2008) and METI (2006)

Japan has realized the world's best energy-efficiency standards and has top-level energy intensity in the industrial sector among other developed countries. Between 1973 and 2003, the overall energy intensity per GDP has improved by about 40% in the country. Japan has incurred the second largest governmental R&D expenditure for technology advancement after the US. Even though the Indian government has considered various energy demand reduction measures since the 1990s and effectuated an Energy Conservation Law in 2001, improvement of energy efficiency has been limited in the various end-use sectors. An important institutional challenge for the implementation of energy-saving measures in India is perhaps to reform energy prices and also to raise awareness on energy conservation.

The Indian government has been looking at fuel diversification like Japan. India is well endowed with hydropower. The installed capacity of hydroelectricity is 34 GW, while the potential is 150 GW. India is ranked fourth in the world in wind energy—the current installed capacity of which is about 6 GW. India produces 1900 million litres of ethanol and is the fourth largest producer of ethanol in the world (after Brazil, USA, and China). Oil seeds of Jatropha curcas constitute the feedstock for biodiesel. The country also has a vast potential for solar energy. With about 300 clear sunny days in a year, India receives enough solar energy to generate thousand times more than the likely electricity demand in India in 2015. But unlike Japan, there has been a very slow progress of these alternative technologies in India primarily owing to the lack of suitable technology development and deployment and also little public support. Hence, it is believed that despite the possibilities for fuel diversification, fossil fuels will continue to dominate sources of energy.

Nuclear energy in India constitutes just about 1% of the total energy consumption, as compared to 13% in Japan. Nuclear power has been favored as an alternative source of energy, not only because it enhances energy security, but also because it allows electric utilities to meet stated environmental objectives. However, it is difficult to comment on the future of nuclear energy in India largely due to political reasons. But there have been some positive developments. India's signing the International Thermonuclear Experimental Reactor (ITER) Accord on 21 November 2006 – along with seven major countries for a global project, envisaging the construction of an experimental nuclear fusion reactor – is much more significant than the Indo-US nuclear deal, since it would take care of India's energy security requirements. Concurrent with this, India has plans and projects for making its own indigenous thorium-based fast breeder reactors. India has also sought Japan's support for gaining access to high-tech know-how and equipments for the peaceful use of atomic energy.

India has resources but technology advancement is very slow. Japan's case is the opposite. Herein lies the importance of an energy collaboration between the two countries. It is important for both countries to develop specific cooperation projects in the energy sector, including cooperation in clean energy, energy technologies, new and renewable energy sources, and in energy conservation and efficiency programmes. To this end, The Japan-India Energy Forum, which was successfully convened for the first time in December 2006 through the efforts of the New Energy and Industrial Technology Development Organization (NEDO), Japan, and TERI deserves mention. Apart from this, a few other advancements that have taken place on Japan-India energy cooperation are summarized in table 5.

In conclusion it can be said that given its wealth and size, Japan will continue to be one of the world's most important energy markets for years to come. However, Japan's energy security challenges will grow in the future as its relative size in Asia's energy balances declines. The new energy strategy not only seeks to reduce Japan's external dependencies, but also favors more active government intervention in shaping internal and external markets. Japan's new long-term strategy holds potential benefits for countries like India. Japan's role as an incubator for innovative energy technologies, and its well-maintained position in advancement of energy-efficiency measures provide areas for countries like India to tap in.

Table 5 Recent progress in Japan-India energy cooperation

Energy conservation	The Petroleum Conservation Research Association (PCRA) of India and the Energy Conservation Centre of Japan signed an MoU
	NEDO provided technical training courses concerning energy conservation for Indian cement engineers.
	NEDO started a demonstration project for coke dry quenching (CDQ) facilities.
Joint exploration	Oil and Natural Gas Corporation (ONGC) of India and JOGMEC of Japan signed an MoU.
Power sector	The Energy Conservation Centre dispatched experts on a long-term basis to the Bureau of Energy Efficiency (BEE) of India's Ministry of Power
Coal	The Government of Japan conducted training concerning clean coal technology

Source METI (2006)

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