Institut du développement durable et des relations internationales – Adresse postale : 27, rue Saint-Guillaume – 75337 Paris Cedex 07 – France – Tél. 01 45 49 76 60 – iddri@iddri.org – www.iddri.org

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Opportunities for an India-European Union Partnership on Energy and Climate Security

Carine Barbier (IDDRI), with the collaboration of Ritu Mathur (TERI)

This document aims to provide input for the 12th meeting of the EU-India civil society round table, taking place in Paris on 15 and 16 July 2008, on climate change issues.

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In putting this document online, IDDRI's aim is to disseminate works that it believes to be of interest to inform the debate. For any questions, please contact the author: carine.barbier@iddri.org.

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Introduction

Future decades will be characterised by the increasing shortage of hydrocarbon resources to supply growing world demand, and by increasing emissions of greenhouse gases, far exceeding the threshold of catastrophic climate change. The various resulting threats to economic growth, social welfare and world stability will be highly prejudicial to global sustainability.

The IPCC Fourth Assessment Report finds that it will be extremely difficult to contain the increase of global temperatures within the limit of two degrees Celsius. Such a target would require a reduction of global GHG emissions before 2015 and a further reduction of between 50% and 85% of the 2000 emissions level by 2050.

The projected impacts of climate change entail an alarming range of risks, vulnerabilities and choices confronting policy-makers and citizens. The challenge facing the international community is twofold. Industrial countries will find, long before the turn of the century, that major changes in behaviour are unavoidable; "business as usual" will not be an option. These changes may be forced by events, or may be implemented more smoothly if these risks are assessed and acted upon in a timely manner. Emerging countries, in particular those with very large populations, such as China or India, will find that large-scale replication of the behaviours and life-styles of the industrialised countries will be practically impossible. Though they have an indisputable right to development, irreversible aspects of their mode of growth must be avoided. In this context, while developed countries can play a role in catalysing the process of technological leapfrogging in the developing countries through appropriate technology transfer mechanisms and financial support, the developed world can also draw lessons from the inherently frugal lifestyles and consumption patterns of the developing countries and from the innovating solutions adopted towards low-energy development paths.

Multilateral and bilateral cooperation is crucial in order to achieve the UNFCCC target. The European Union and India have, for decades, been cooperating in various fields. A partnership on climate change issues, at both intergovernmental and civil society levels, would be an extremely positive step for both regions. This should not be limited to technology transfer from Europe to India, as is the case within the framework of the Clean Development Mechanism (CDM). Today, quite a few innovations in the environmental field are developed within the emerging countries themselves. This partnership should be primarily conceived as a reciprocal exchange of competencies and the co-development of new technologies. The climate emergency demands the construction of a new development model; this must be the focus of the EU-India partnership's contribution.

Energy and Climate Security: a common concern of the EU and India

A "business as usual" scenario is not an option

The economic development and urbanisation of the Western countries took place during the 20th century, in a world of abundant, cheap energy. The European Union's energy consumption therefore increased spectacularly from the 1950s, while its urban infrastructure was shaped by the booming motor industry. The fact that energy consumption per capita in Europe is only half that in North America is due principally to limited energy resources having imposed some restraint on Europe, and to its relatively dense population having necessitated high density patterns of urbanisation, which limited transport needs. The two oil crises of 1973 and 1979 led Europe to concentrate, from then, on assuring its energy security and conducting energy efficiency policies.

In spite of the oil crises, world primary energy consumption has never stopped growing. It has doubled since the beginning of the 1970s. The industrialised countries are responsible for a third of this growth, but the greater part of the increase in demand for energy has, since then, come from developing countries. Nonetheless, taking population growth into account, per capita energy consumption has only doubled in developing countries, while it has increased fourfold between 1900 and 1997 in the OECD countries. Energy consumption in the latter is currently six times higher than it is in the developing countries.

While the differences in per capita energy and material consumption may be partly on account of the variation in development levels itself, an analysis undertaken by TERI indicates that India's per capita consumption of some of the key energy intensive materials such as steel and cement even in 2031 would be lower than the current levels in the developed countries (Figure 1), but they seems to follow the same trend. India's steel consumption is estimated to increase from 49 kg/capita in 2005 to 272 kg/capita by 2031 as compared to a level of 371 kg/capita in USA and 975 kg/capita in Korea in 2005. Similarly, while cement consumption is expected to increase to 847 kg/capita by 2031 in India which is in between Japan's and Korea's current levels. It is necessary to point out that energy intensive material consumptions are particularly high during the phase of industrialization and urbanization of the countries.

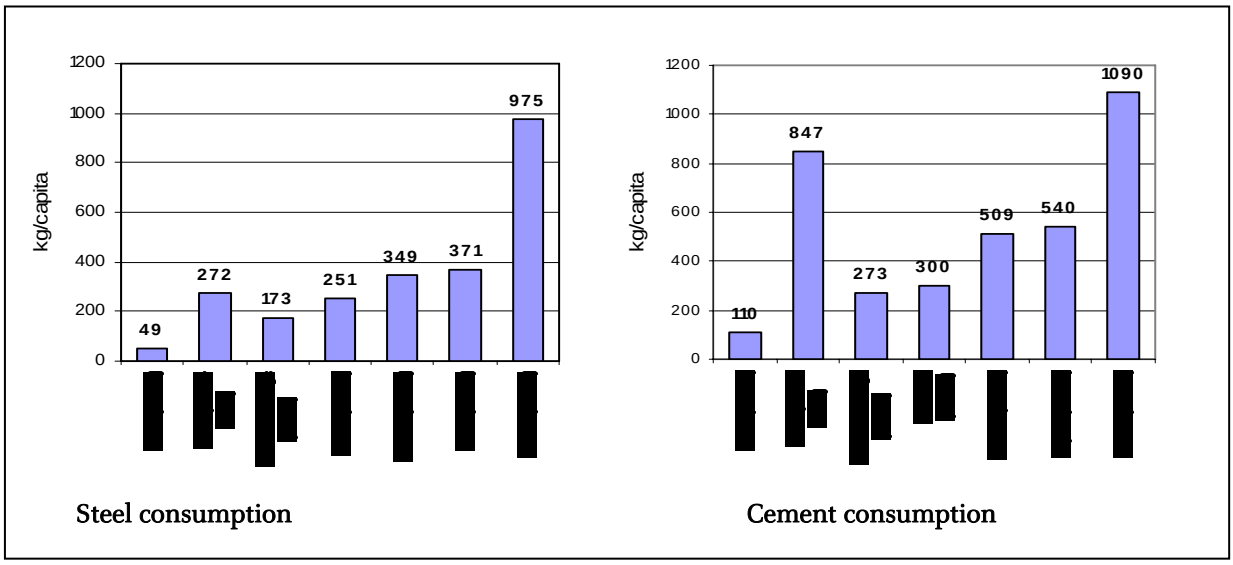


Figure 1: Comparison of per capita material consumption across countries

A comparison of mobility estimates indicates that while India's demand for motorized passenger transportation is likely to grow to 10,000 km/capita/year by 2031, the demand in the industrialized world was already in the range of 17,000 km/capita/year and that in the USA at 24,000 km/capita/year in the year 1997 (Figure 2).

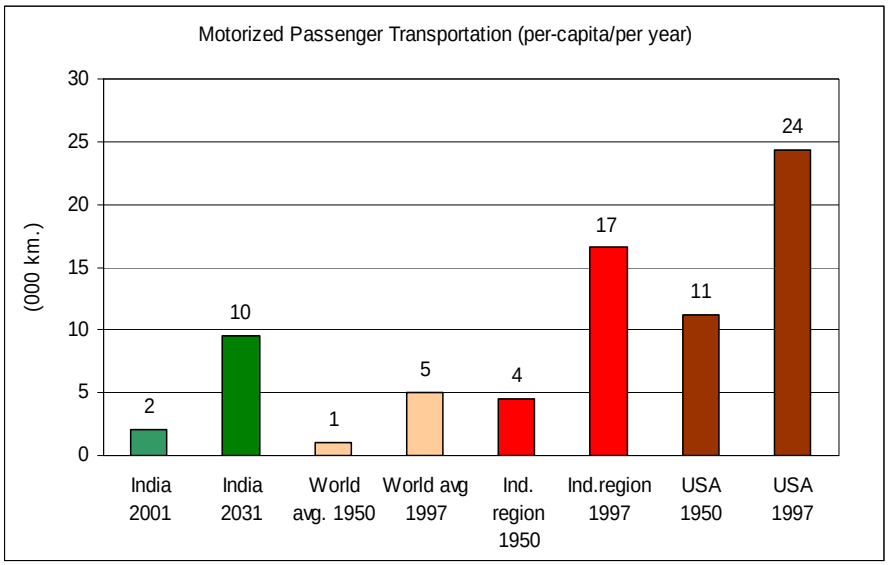


Figure 2 Comparison of demand for motorized transport across countries

Further, as reflected in Figure 3, while the Government's plans for economic growth and providing electricity to all is expected to lead to a large increase in India's per capita electricity consumption (from 457 kWh/capita in 2004 to 2251 kWh/capita by 2031), this would still be rather modest when compared with existing consumption patterns in countries such as UK (6206 kWh/capita in 2004) and USA (13,338 kWh/capita in 2004).

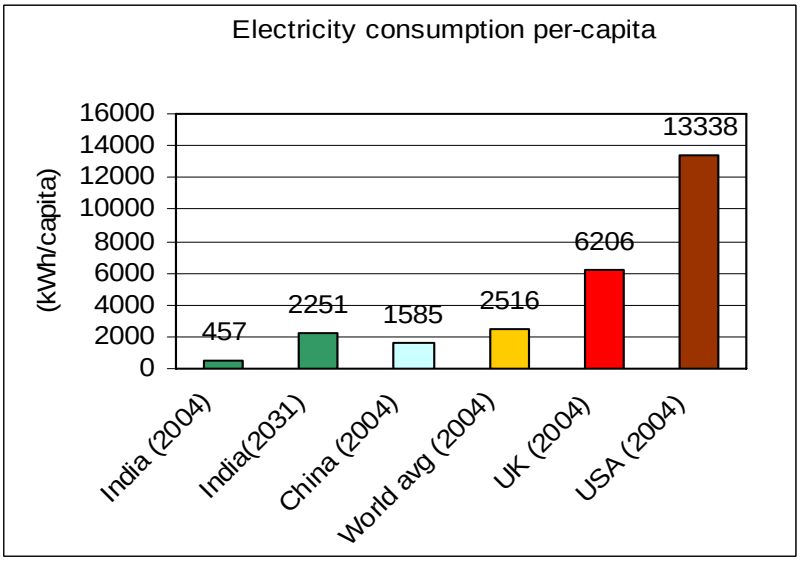


Figure 3: Comparison of per capita electricity consumption across countries

While the per-capita energy consumption is expected to be still lower in 2031 than the current level of industrialized countries, the consumption patterns may follow the same trend if energy conservation policies are not enforced. Increase in the total energy requirements is imminent given the country's need for development and plans for rapid economic growth.

At the global level as well, with current trends, nothing indicates that the growth in energy demand will dip in the coming years. According to the IEA Reference Scenario, world primary energy demand will increase by 55% between 2005 and 2030 and fossil fuels will meet 84% of that increase. This will involve an increase of 73% in coal production. Oil production will swell from 36 million to 61 million barrels per day. Such a "business as usual" scenario is not tenable, either from an environmental, or from a social and economic point of view. CO_2 emissions will increase from 27 Gt in 2005, to 42 Gt in

2030, which is well above what our climate system can support. The exploitation of non-conventional oil resources, or of coal liquefaction technologies, both have particularly damaging consequences for the environment. Moreover, fossil fuel resources are inherently exhaustible, numerous studies predict the peaking of oil production in the near future, reinforcing the hypothesis of a long term rise in the price of oil. The IEA report also states that the increase in oil production capacity assumed in the Reference Scenario is very unreliable; any delay could lead to an abrupt increase in the price of oil by 2015, thus weakening world economic growth.

In the face of such challenges, an international consensus is emerging for strong, collective action to be undertaken to assure energy and climate security, which the world economy needs. This will be revealed by the progress achieved within the context of preparation for the Conference of the Parties (COP 9 – UNFCCC), which will take place in Copenhagen and which should define a new international climate change regime.

The contrasting energy situations of Europe and India

In the European Union, primary energy consumption has been increasing at half the average world speed for the last 30 years. According to the IEA Reference Scenario, this consumption will continue to grow, but at a slower rate, until 2030.

In case of India, while the per capita energy consumption is still a fraction of that in several countries of the developed world (10 times lower than the per capita consumption in Europe), its commercial energy use has increased considerably in absolute terms, growing at about 6% during the past two decades and making India the fifth largest country in terms of primary energy consumption. India is currently one of the fastest growing economies of the world, and implications of its levels and patterns of energy use and associated emissions have generated interest globally in the context of discussions related with efficient use of energy and lowering future carbon footprints.

Figure 4 shows that the gap between the levels of energy consumption in Europe and India has widened over the last 30 years. Per capita consumption in Europe increased by 0.6 toe between 1975 and 2005, while that of India increased by only 0.2 toe. The IEA Reference Scenario predicts a more rapid growth in per capita energy consumption in India by 2030, meaning it will move somewhat closer to the European Union level.

Figure 4: Primary energy consumption per capita

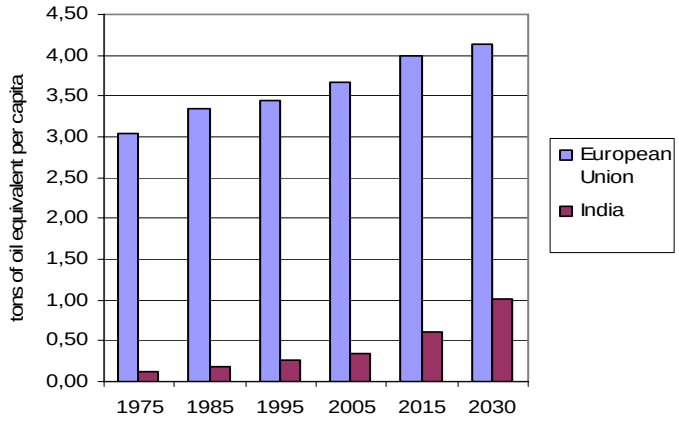
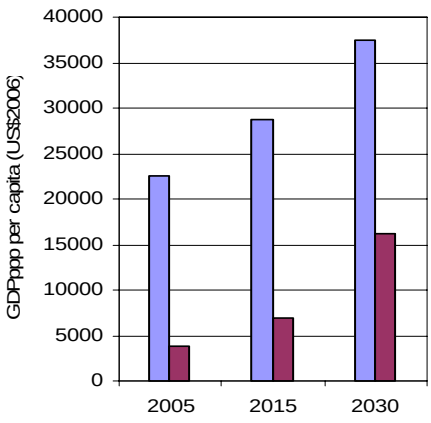


Figure 5: Gross Domestic Product per capita (ppp)



For reference, the growth in GDP per capita used in the IEA scenario is shown in Figure 5. Note that a gap of about $20,000 between the two levels of GDP is maintained during the 2005-2030 period, showing a limited degree of catch-up of the standard of living in India in relation to that of the European Union. While overall improvement in the human development index is important, it needs to be accomplished in ways that minimize the carbon footprint.

The developmental challenge that India faces at present is especially formidable on several counts. First, about 72% of its population still resides in rural areas that often lack access to basic infrastructural

requirements such as clean drinking water or adequate health and education facilities. Moreover, around 44% of the population does not have access to electricity[1]. Several of these households continue to depend on inefficient traditional energy forms such as firewood, crop residue and dung, due to either the lack of access to or their inability to afford modern fuels to meet their requirements. It is estimated that 27.5% of the population was below the poverty line in 2004-05.

Recognizing the fact that rapid economic growth is an essential prerequisite to reducing poverty, the Approach Paper to the Eleventh Plan emphasizes the need to achieve economic growth of over 8% over the next couple of Plan periods. Moreover, the Planning Commission has established the monitorable targets for poverty alleviation for the Tenth Five-Year Plan and beyond (annex).

Accomplishing these monitorable targets would require significant specific physical investments in creation of new infrastructure, and provision of services. For example, construction of additional buildings and access roads for health and family welfare centres in both rural and urban areas that would require significant energy inputs by the way of the indirect energy embodied in the materials used in their construction. Besides, electricity would be required in these health centres for lighting, space-conditioning, refrigeration etc., besides fuel for ambulances used for referral transport.

It is estimated that CO_2 emissions from the iron & steel, cement & aluminum production sectors (key materials for infrastructure development) are likely to increase by around 15 times of 2001 levels by 2031 in order to meet some of the country's developmental goals.

In the context of its developmental objectives and plans for rapid economic growth, the country would require significant levels of energy and physical investments for the creation of adequate infrastructure and provision of services to its already large population base. Various estimates indicate that India would need to increase its primary energy supply by at least 3 to 4 times and its electricity generation capacity by 5 to 6 times of the 2003/04 levels, by the year 2031. The Integrated Energy Policy report brought out by the Planning Commission estimates that under an 8% GDP growth scenario, India's total energy requirements would be in the range of 1536 Mtoe to 1887 Mtoe by 2031 under alternative scenarios of fuel and technological diffusion[2]. TERI's analysis indicates that under a 8% GDP growth scenario with current plans and policies of the Government, commercial energy needs would increase to 2108 Mtoe by 2031/32 and CO_2 emissions would grow by around 7 times during this period[3]. Moreover, it is estimated that coal and oil would continue to account for most of the energy requirements even by the year 2031.

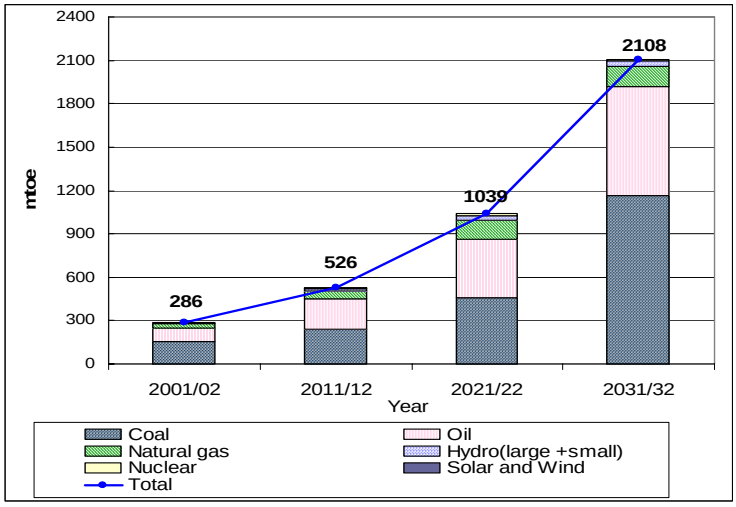


Figure 6: Commercial Energy Supply in India (BAU Scenario)[4]

[1] Census of India, 2001.

[2] Planning Commission, 2002. Tenth Five-Year Plan (2002–07). Planning Commission, Government of India.

[3] TERI, 2006a, National Energy Map for India - Technology Vision 2030.

[4] Source: TERI estimates, 2006.

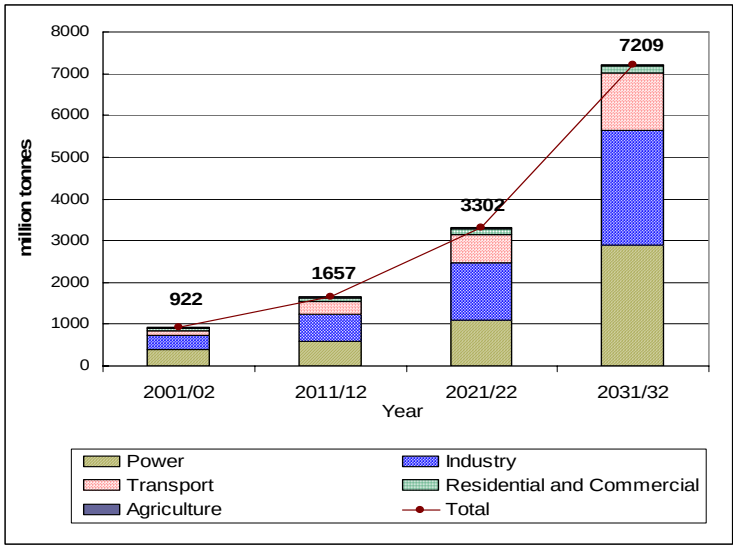


Figure 7: CO_2 Emissions from Energy Use (BAU Scenario)[4]

Such "business-as-usual" scenarios are not sustainable for environmental reasons but also for economic reasons and energy dependency, as we will see it thereafter.

The European Union and India are both struggling to achieve energy security

The EU imports more than 50% of its energy requirements. It has set itself the target of raising its energy efficiency by 20% and reducing its emissions of GHG by 20% by 2020. Moreover, 20% of its energy supply should be provided by renewable energy. With the launch of the "Energy and climate change package", the European Union is clearly signalling its intention to take the global leadership on climate change mitigation. [5]

Table 1 Main energy and climate change policies of the European Union

Cross-cutting issues
- Directive on GHG emissions trading within the EU (2003)
- Linking project-based mechanisms to GHG emissions trading (2004)
- Decision for monitoring Community GHG emissions and for implementing the Kyoto Protocol (2004)
- The Energy and Climate Change Package (2007)

Energy
- Directive on the promotion of renewable energy sources (2001)
- Directive on taxation of energy products (2003)
- Directive on energy performance of buildings (2003)
- Directive on the promotion of co-generation (CHP) (2004)

Transport
- Promotion of the use of bio-fuels for transport

Agriculture (Biofuels, Cross compliance), Landfill Directive

[5] Stravos Dimas, EU Environment Commissioner, http://www.eurunion.org/news/speeches/2007/070510sd.htm

Accomplishing the targets of the *Energy and Climate Change Package* will not, however, be easy. If the European Union has managed to limit the growth of its energy consumption since 1990, it owes this in large part to the deindustrialisation of the former East Germany and to the economic recession experienced by some of the new EU members, events that it is to be hoped will not be repeated. The final energy consumption of the Europe of 15, on the other hand, increased by 18% between 1990 and 2004. The upward trends in the building and transport sectors persist; achieving a significant dip in these two key sectors will demand particularly proactive steps.

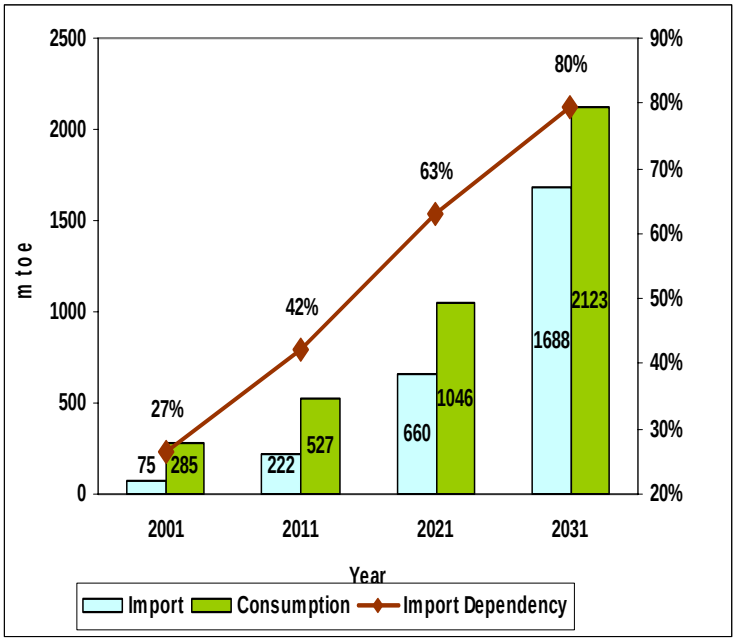


Figure 8: India's energy import dependency[6]

In 2004/05, India imported around 120.9 Mtoe of coal, oil and gas (an import dependency of around 27%). Although India has depended on oil imports for several decades, imports of coal and gas have started only during the last decade. By 2031, India's import dependency is likely to increase to around 80% under a business-as-usual scenario as reflected in Figure 8[7]. Several studies have reinforced the fact that fossil fuels are expected to continue playing an extremely significant role even under scenarios of rapid and enhanced penetration of renewable and nuclear energy technologies.

This is clearly an unsustainable trend with implications not only in terms of large monetary outflows but also in terms of the infrastructural requirements for port development, handling and transportation of this energy. Future levels and patterns of energy use in India therefore raise concern not only in the global context, but also with regard to national concerns of energy security, infrastructural adequacy and pressures on the local environment.

This situation also puts it in competition with China to find new oil supply sources. Conscious of the difficulties of coping with the country's growth in energy demand, a Ministry of Energy was created in 1992, renamed in 2006 the Ministry of New and Renewable Energy (MNRE). In parallel with its efforts to enhance the energy efficiency of its heavy industry and power stations, India began to turn to renewable energies in the 1970s. R & D and demonstration programmes have been established, diffused by a network of non-governmental institutions and organisations, which ensure deployment of these technologies. Financial incentives have also made a broad contribution to this development. Indian wind farm capacity is now ranked fifth in the world, with 8-9 GW installed. Know-how has been developed with regard to biomass gasifiers and photovoltaic systems to meet the electricity needs of rural areas. India, therefore, has some of the world's major manufacturers of photovoltaic solar panels.

[6] TERI estimates, 2006.

[7] TERI, 2006a, National Energy Map for India - Technology Vision 2030.

Nonetheless, the share of renewable energy in India's energy balance is making only limited progress such is the growth in total energy demand. India, like the European Union, needs to focus upon low-energy development paths as this is the only possible way to ensure their energy and climate security.

The European Union and all the industrialised countries, which must play major roles in the struggle against climate change, possess the technological, institutional and financial capabilities to dramatically reduce their greenhouse gas emissions. The political will to act is crucial. The EU commitments to reduce GHG emissions by as much as 20% or 30% of the 2000 level by 2020 show the way.

The current phase of development of emerging countries – urbanisation, industrialisation – represents a major opportunity to divert their development towards low-carbon paths. India's current decisions regarding infrastructures needs and patterns of consumption will have a decisive impact both upon global efforts to stabilise greenhouse gas emissions, and upon the feasible rate of reduction to achieve sustainable levels.

The impact of climate change is much more severe in India than in Europe

The impact of climate change is already being felt in both Europe and India, and increasingly conscious public opinion is putting pressure on governments to act. Nonetheless, the EU has a much higher adaptive capacity than India, thanks to its level of development and the resilience of its economy to extreme climatic events.

In India, 700 million people in rural areas are directly dependent upon sectors vulnerable to climate change (agriculture, forests and fisheries) and upon natural resources (water, biodiversity, mangroves, coastal zones, grasslands). With an economy closely tied to its natural resource base and climate-sensitive sectors, India faces a major threat because of the projected changes in climate. Climate change may alter the distribution and quality of India's natural resources such as freshwater and arable land and coastal and marine resources.

Changes in key climate variables, namely, temperature, precipitation, and humidity, may have significant long-term implications for the quality and quantity of water. Changes are likely in the long-term lean-season water flows of large snow- and glacier-fed river systems of the Brahmaputra, the Ganga, and the Indus. A decline in the total run-off for all river basins, except Narmada and Tapti, is projected in India's NATCOM I (NATCOM, 2004). A decline in run-off by more than two-thirds is also projected for the Sabarmati and Luni basins.

Concentration of droughts is projected in the states of Gujarat and Rajasthan, which are already drought-prone, and in Orissa, which is currently flood-prone.

Wheat production for the country as a whole may decline after 2020 and rice production may be adversely impacted in the eastern states. Boundary changes in the growth of crops are also expected. Studies by the *Indian Agricultural Research Institute (*IARI) indicate the possibility of a loss of 4–5 million tons in annual wheat production with every 1 °C rise in temperature[8] (even after considering the carbon fertilization effect. Small changes in temperature and rainfall have significant effects on the quality of fruits, vegetables, tea, coffee, aromatic and medicinal plants, and basmati rice. Pathogens and insect populations are strongly dependent upon temperature and humidity, and changes in these parameters may also change their population dynamics. Other impacts may include lower yields from dairy cattle and decline in fish breeding, migration, and harvests. Rise in sea surface temperatures may lead to a decline in coral reefs.

In terms of implications on health, changes in climate may alter the distribution of important vector species (for example, malarial mosquitoes) and may increase the spread of such diseases to new areas.

In India, about 40 million hectares of land is flood-prone, including most of the river basins in the north and the north-eastern belt, affecting about 30 million people on an average each year (NCDM and NDMD, 1999).

A mean sea level rise (SLR) of 15–38 cm is projected along India's coast by the mid 21st century and of 46–59 cm by 2100. India's NATCOM I assessed the vulnerability of coastal districts based on physical exposure to SLR, social exposure based on population affected, and economic impacts. Additionally, a

8 1 ·C increase in temperature in India may roughly coincide with the 2020–30 period.

projected increase in the intensity of tropical cyclones by 15% poses a threat to the heavily populated coastal zones in the country[9].

A study assessing the impacts of projected climate change on forest ecosystems in India, indicates that in 2085, between 68% and 77% of the forested grids in India are likely to experience shift in forest types depending upon projected climate change scenarios[10]. Biodiversity is also likely to be impacted under the projected climate scenarios due to the changes or shifts in forest or vegetation types, forest dieback during the transient phase, and different species responding differently to climate change.

Addressing climate change: priorities for collaboration

As we have stressed, the "business as usual" scenarios are not a desirable option. The aims of energy security and climate change mitigation cannot be achieved unless the European Union makes a very significant reduction in its energy consumption and unless India adopts a low-energy development path, while meeting its development needs.

Critical windows of opportunity for climate protection must be identified in patterns of development. The sectors and industries whose GHG emissions cannot be neglected over the next decades must also be pinpointed. Priorities for action must then be selected, taking into consideration the high inertia of both infrastructure and of patterns of production and consumption. This approach makes it possible to rapidly focus in from a macro-perspective to the sectoral detail that is necessary to identify key decision-makers, institutional organisations and other levers of change, so that international cooperation policy may be directed towards them.

A preliminary analysis to explore the scope for further reducing India's energy use indicates that there exists significant potential to reduce energy consumption and thereby CO2 emissions as well. Figure 9 provides an indication of the theoretical potential at the sectoral level to reduce emissions till the year 2031.

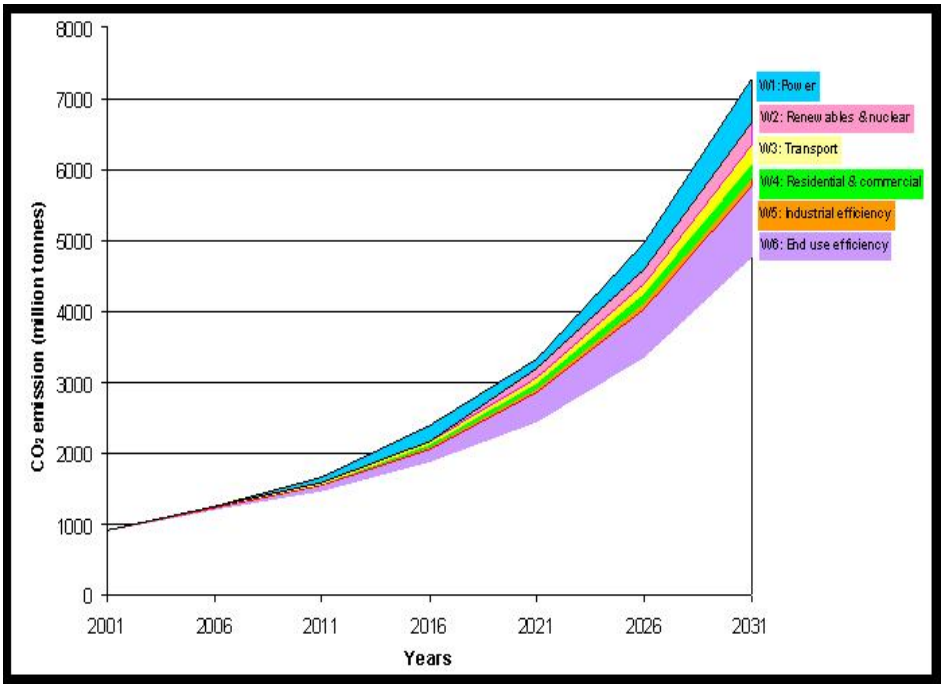


Figure 9: Sectoral CO_2 emission reduction potential [11]

[9] NATCOM. 2004. India's Initial National Communication to the United Nations Framework Convention on Climate Change. Ministry of Environment and Forests.

[10] Ravindranath N.H. , Joshi N.V., Sukumar R and Saxena A. Curr. Sci. 2006. 90. 354-361.

[11] Source: TERI estimates, 2006.

Some quick estimates indicate that approximately 550 million tonnes of CO_2 emissions could theoretically be reduced during 2012-2017 from 3 of the most energy intensive sectors namely steel, cement and power generation in India by adopting low carbon fuels and technologies in these sectors. However, the additional investment requirements for achieving this emission reduction is estimated at around 25 Billion US$ (at 2001 prices) during 2012-2017 and these are of the same order of magnitude as the Governments' fiscal support for meeting social and environmental development targets for the country.

Avoiding energy lock-in and carbon-intensive investments

Cooperation on energy and climate issues should aim to avoid choices that entail either threats to energy security, or irreversible emission trends, while recognising the overriding need of economic and social development. In the EU and in India, emissions trends in some sectors require urgent action in order to avoid carbon lock-in. This is particularly true of those sectors characterised by considerable inertia, such as transport infrastructure, the residential sector, or power generation.

Urban infrastructure

Figure 10 shows the growth in final energy consumption, by sector in India and in the European Union, as predicted by the IEA Reference Scenario. Note that in the "residential, tertiary and agricultural" sector, the housing sector is broadly predominant in India, as in the European Union. The industrial sector should remain the prime energy-consuming sector in India in 2030, but transport and building (residential-tertiary) also progress very rapidly. In the European Union, the strongest increase in energy consumption clearly concerns building and transport. Efforts to control energy consumption must, indisputably, focus on those two sectors.

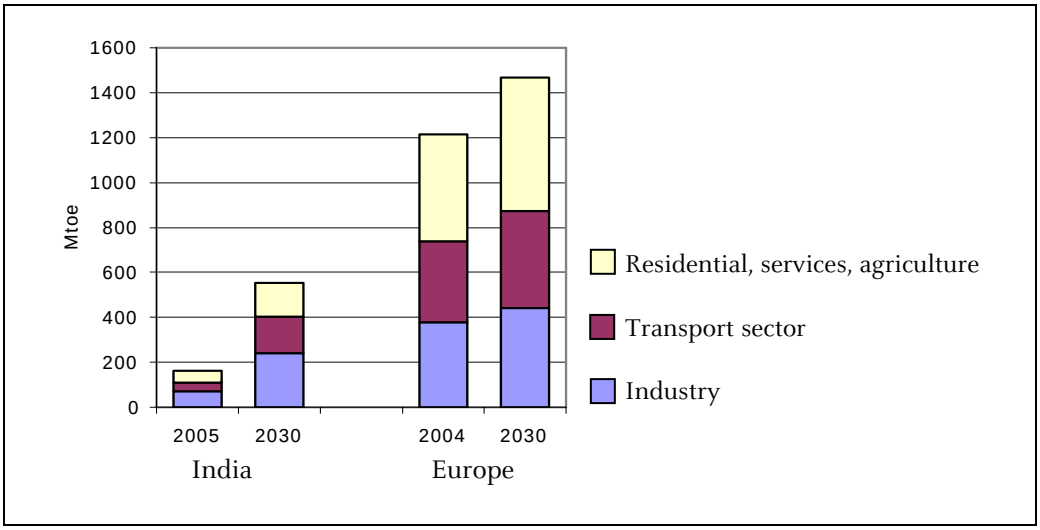


Figure 10: Final energy consumption (excluding biomass, IEA Reference Scenario[12])

In Europe, in spite of the establishment of thermal regulations in construction following the oil crises of the 1970s, the per capita energy consumption in the residential sector has continued to increase in all countries, with the exception of Germany. This is fundamentally due to the insufficient improvement in performance of buildings with regard to the growth of developed surface areas. One of the major reasons for the rise in energy consumption in the transport sector is the urban sprawl of European cities. Since the 1950s, European cities have spread on average by 78%, while their populations have increased by only 33%. This phenomenon, enabled by the mass ownership of cars, causes ever-increasing transport needs.

[12] *World Energy Outlook 2006* for the EU, *World Energy Outlook 2007* for India, IEA.

The problems of urbanism are, nonetheless, different in Europe and in India. In Europe, urbanisation is essentially complete; the cities have been built. Efforts must generally be concentrated first on the thermal rehabilitation of existing buildings, and then on urban planning to limit urban sprawl and on reallocating highways to sustainable transportation means, at the expense of the car.

In India, efforts must be concentrated on the quality of infrastructure under construction. The Indian population is 1.1 billion people and is likely to overtake that of China by 2035. Its urbanisation rate is still low (29%), but is increasing rapidly. The urban population should increase by 590 million people by 2030[13]. Rapid urbanization is likely to be associated with complex challenges. Accommodating that population constitutes a huge challenge in terms of providing access to housing and to basic services (water, electricity, transport, etc.). Moreover, as is shown by the increase in cars in India, a major rise in household energy consumption must be anticipated during the coming years, accompanying the increase in incomes, whether in housing or transport. Thus, the environmental quality of the infrastructure built will determine the level of energy consumption and of CO_2 emissions of the country for decades to come. The strong inertia of urban infrastructure means choices must be made that protect the energy security of the country and are environmentally friendly.

A partnership between India and the European Union can be formed on the development of clean technologies and their diffusion (as we shall see later) and, above all, on experience sharing in the establishment of policies aimed at regional planning; integrated urban planning; the implementation of energy performance standards for buildings and amenities, soft practices and of support programmes aimed at local authorities and stakeholders in the building and transport sectors.

The electricity sector

In the European Union, electricity currently represents 18% of the total final energy consumption. This share is constantly increasing. A major increase in electricity consumption is expected by 2030 (34%), which is not consistent with the energy efficiency targets that the EU has set itself. Installed capacity could thus grow from 750 GW in 2005 to nearly 1,200 GW in 2030, with a major increase in the share of natural gas and renewable energy in the energy mix. Thus, the CO2 emissions of the electricity sector will certainly grow less quickly than will the production of electricity, but this will be insufficient to provide the necessary dip.

In India, electricity consumption represents 12% of final energy consumption, a share which could double by 2030. The anticipated growth of installed capacity is greater than 5% pa, growing from nearly 150 GW in 2005 to 520 GW in 2030[14]. This growth originates in industrial and tertiary development, the increase in individual consumption consequent upon improved household purchasing power and, to a lesser degree, the spread of access to electricity. According to the IEA Reference Scenario, the share of coal will remain at 70% of electricity production and the sector's CO_2 emissions will increase threefold by 2030, reaching 1.9 Gt CO_2.

In the European Union, though coal accounts for only 30% of electricity production, it represents 70% of the electricity sector's CO_2 emissions. Just as in India, this energy source weighs heavily in the electricity sector's CO_2 emissions. The quantity of coal resources still available explains why this energy source will probably remain indispensable for a long time to come. Two complementary options must also be considered; first, a very ambitious electricity efficiency policy and, second, improving energy efficiency in coal-fired power stations and developing carbon capture and storage systems for new power stations.

Indeed, the potential renewable energy resources that could be mobilised for electricity production are considerable, but they will provide only a minor share of this production if the demand for electricity continues to grow at its present speed. Moreover, carbon capture and storage is also just a partial solution: significant development is not expected before 2020; the possibilities of large-scale storage are still relatively poorly understood. Finally, this solution may confront public opinion unfavourable to its deployment, particularly in Europe. The sites for carbon storage that are most easily accessible and considered as safe are depleted oil and gas fields; their storage capacity is estimated as

[13] TERI.

[14] *World Energy Outlook 2007*, reference scenario, IEA.

between 5 and 10 $GtCO_2$ for India, which only represents 5 to 10 years of the country's current total emissions[15].

Curbing electricity consumption, in particular in industry and in the residential-tertiary sector, is therefore essential in the European Union. In particular, this depends on developing cogeneration, improving industrial processes, reinforcing standards and encouraging the use of efficient equipment in the home and the tertiary sector etc. The European Union has already taken various steps in this direction, but their impact is still insufficient. The involvement of the member countries in the adoption and implementation of directives must also be increased. India must follow the same path to slow down the growth of this sector. Such a policy will make it possible to limit investment in new productive capacity for India and to restrain renewal requirements of European installations, many of which will reach the end of their life during the next 20 years.

Technology co-development and diffusion

The rapid development and adoption of new technologies are critical to meeting the challenges of energy security and climate change. The European Union and India are interested in, and may collaborate on, new technology research and development, in order to increase the energy efficiency of heavy industry and the power sector, and to develop energy efficient equipment for all sectors. Two courses of action are required: first, the development of new environmentally friendly technologies and second, the dissemination of the best technologies already available. This target entails rapidly establishing incentives for innovation to develop new products and to encourage access to efficient technologies at reasonable prices, in order to avoid investment in energy-intensive technologies. Technology co-development and diffusion may be related either to mitigation purposes or to adaptation purposes.

Incentives for innovation

Two types of instruments are available to public authorities to encourage innovation:

- The technology push: R&D investments enabling the transformation of a scientific discovery into marketable products.
- The market pull: incentives to put efficient products on the market using price mechanisms (tax incentives, subsidies, carbon tax, public procurement etc.) or regulations.

The European Union R&D budget has grown significantly in recent years. The Seventh Framework Programme (2007-2013) includes an R&D budget of €53 billion, compared to €17 billion in the previous programme. Specific programmes relating to energy and the environment (including climate change) have respective budgets of €2.3 billion and €1.9 billion. The research budget devoted to renewable energy is divided evenly between the public and the private sector and amounted to €690 million in 2002. These budgets are complemented by the particular budget of each member country. It should, however, be noted that R&D in Europe remains very fragmented at the institutional level (public and private research centres, universities, specialist agencies etc.); better coordination of research and development efforts would be desirable[16].

In case of India as well, research and development in the energy sector is becoming even more crucial with the increasing pressure of making available adequate and affordable energy in an environmentally friendly and sustainable manner. The total expenditure on R&D in 2004-05 for the energy sector was Rs.920 million for nuclear power and Rs.700 million for Ministry of Power, Coal and Non-Conventional Energy Sources. It represents 0.2% of the turnover of all energy firms, i.e. only one-tenth of the rate at which industry in developed countries spends on R&D. In 2006, a report for the Planning Commission mentioned that Indian State should spend much more on R&D in this sector and suggested to create a "National Energy Fund" with a grant of Rs 10 billion for the first year (excluding

[15] *World Energy Outlook 2007*, IEA.

[16] European Commission, Towards a European Strategic Energy Technology Plan, Communication to the Council, The European Parliament and the EESC, 2006.

atomic energy)[17]. The report also stressed the need for 'Directed' Basic Research to be promoted in the Energy Sector.

An amount of US$ 1238 million is projected as the requirement for addressing the energy R&D needs (excluding nuclear energy), over and above the plan budgets (for the eleventh five year plan period) of the Ministries and Departments dealing with R&D in the energy sector i.e. the Ministry of New & Renewable Energy, the Ministry of Power, the Ministry of Petroleum & Natural Gas, the Ministry of Coal and the Department of Atomic Energy.

Table 2: Some of the main priority areas for energy sector R&D in India during Eleventh five year plan period

- Development and Production of New Materials
- R&D in Bio-Fuels
- Rural Energy R&D to Promote the Available Energy Technologies
- Combustion Research Initiative
- Energy R&D in the Indian Railways
- Hydrogen as a Source of Clean Energy
- Advanced Coal Technologies
- Ultra Super Critical Technologies
- R&D in the Power Sector
- Renewable Energy R&D
- Energy Storage Systems
- Futuristic Energy Sources
- Energy Efficiency
- Technologically Important Crystals -Facility to Manufacture Polysilicon for Production of Single Crystals of Silicon
- Light Emitting Diodes (LEDs) – A Viable Alternative to Fluorescent Lighting
- Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs) – Viable Alternate Propulsion Systems

The European Union and India have every interest in developing energy efficient technologies and in seizing opportunities to become leaders in specific markets in which they enjoy relative advantages. Such a strategy should be the subject of public policy for innovation support in these sectors. These policies are even more useful in a developing country, such as India, where private sector stakeholders do not always have the capability to undertake high risk or may be unable to undertake the higher upfront investments on their own. In this regard, developed countries can play a key role in demonstrating the success of the technologies or by supporting their adoption.

Different modes of cooperation between the EU and India are thus conceivable:

- Cooperation on research and development by organising and financing shared research centres for particular technological targets;
- Financing a joint fund for innovation support, making it possible to obtain joint patents that can be employed by Indian or European stakeholders;
- Developing pilot demonstration projects for clean technologies.

Encouraging technology transfers between the two regions

Foreign companies are often, through their imports of means of production and intermediate products, the preferred vectors of technology transfers in the host country. In such circumstances, the diffusion of these new technologies to domestic stakeholders remains weak, the core of the technologies often remaining in the control of the foreign stakeholders. Two courses of action are possible in order to facilitate transfers of property rights and to develop the markets for available clean technologies:

[17] Integrated Energy Policy, Report of the Expert Committee, Government of India, Planning Commision, August 2006

- Support for the development of joint ventures, together with cross-cutting training programmes, agreements on joint patents, exemptions from duty etc.
- Public authority management of technology transfers, guaranteeing, in particular, the clear definition of the rights transferred and the monitoring of their application.

Another course of action is the use of compulsory licences, given the urgency of establishing energy and climate security policies. This is a method used by governments to accelerate the diffusion of new technologies. It is recognised by Article 31 of the WTO agreement on property rights (Trade-Related Aspects of Intellectual Property Rights) and permits the use of a patent by the government, or by third parties authorised by the government, without the owner's authorisation. Two major conditions must be respected: the person or the company requesting a licence must first have tried, unsuccessfully, to obtain a voluntary licence from the patent holder according to reasonable commercial procedures; and adequate compensation must be paid to the holder of the right. One example of this is the US Clean Air Act, which awarded compulsory licences for patented technologies in order to facilitate compliance with mandatory standards.

Incentives for the diffusion of efficient technologies

R&D investments must be complemented by other policies aimed at creating or developing markets, in order to ensure large-scale diffusion of efficient technologies. Research into advanced technologies, or technological breakthroughs often hide the fact that numerous efficient technologies are available but not at all widespread. Major energy saving resources thus often remain unexploited.

An innovative institutional framework with suitable incentives would encourage the adoption of these technologies, whether energy efficient technologies, or those using renewable energy. This framework can be made up of a number of accompanying measures: assistance to particular stakeholders in the sector (for example for the provision of efficient materials or equipment), public procurement aimed at enlarging the market for these products, training programmes for particular trades, information and publicity campaigns, urban traffic regulations, etc. For example, the Swedish "Golden Carrot" programme, launched in the 1990s, involved agreeing public procurement contracts for 32 low-energy consumption products, in exchange for compliance with certain specifications. In the same vein, in 1993 the US EPA and 24 electricity distribution companies in the USA launched a competition for a super-efficient refrigerator; $30 million were offered to the manufacturer producing a low-cost, low-energy consumption refrigerator.

In contrast, regulations or incentives encouraging the diffusion of energy-inefficient technologies must be reviewed or abandoned (e.g. certain subsidies for fossil fuels; support for manufacturing sectors without any reciprocal commitment regarding the nature of the products put on the market, or the industrial processes utilised; over-strict regulations requiring the use of costly patented technologies etc.). The policies and regulations adopted by the governments must thus avoid erecting obstacles to the development and diffusion of efficient technologies.

The institutional framework to be established in order to encourage innovation and the diffusion of efficient technologies must be able to act simultaneously on technical standards, the implementation of suitable regulations and the definition and use of intellectual property rights. Cooperation between India and the EU on the strategies for adoption to this effect would be very helpful.

Addressing adaptation to climate change

Public policies and R&D budgets in India address social and economic development. In this context, adaptation issues are a main concern. Several of India's social-sector schemes emphasize livelihood security and welfare of the weaker sections. At present, while none of the schemes is explicitly referred to as an Adaptation schemes, many contain elements (objectives and targets) that clearly relate to risks from climate variability.

Based on the budgetary allocations (RE) for adaptation-related programmes in India during the Ninth and Tenth Plan periods, various schemes and programmes under implementation have been selected and their outlays grouped under the following categories related with adaptation: (a) crop improvement and research, (b) poverty alleviation and livelihood preservation, (c) drought-proofing and flood control,

(d) risk financing, (e) forest conservation, (f) health, (g) forest conservation, and (h) rural education and infrastructure.

The analysis indicates that India's expenditure on adaptation activities has increased from Rs 164 billion (1.62% of GDP) in 1997/98 to Rs 747 billion (2.63% of GDP) during 2006/07. This is mainly due to increased outlays on several newly designed schemes, including the Rural Employment Guarantee Programme launched in 2006.

So far the efforts towards adaptation in India are restricted towards R & D and are supported under the National Communications process through the GEF. There is a need for country wide integrated assessments on impacts along with the identification of measures that would help reduce the associated losses. Cost benefit assessments of various options are to be carried out followed by a clearly laid out action plan for implementation of suggested interventions.

These analyses reinforce the fact that countries like India are not only faced with complex development challenges that they must take on as a national priority, but also that they would find it difficult to divert financial resources away from the development goals to other objectives.

The EU-India Partnership must be able to rely upon civil society

With growing economic interdependence and the shared risks of catastrophic climate change, it is in the interests of major economies to increase the scale and depth of cooperation in facing the challenges of energy and climate change. Agreement on a post-Kyoto international regime at COP 15 in 2009 would constitute a strong signal to address climate change. Moreover, achievement of this goal would require major involvement of all stakeholders at both domestic and international collaboration levels: national governments, local authorities, private companies, NGOs, trades unions, consumers and citizens.

A consolidated partnership on energy and climate change issues

The 8th EU-India Summit took place in November 2007 in Delhi, confirming the strengthening of relations between the two regions. The importance of cooperation on the energy security and climate change issues was reaffirmed, as is shown in the following extracts of the India-EU Joint Statement signed at the end of that summit on 30 November 2007:

"Both India and the EU attach high priority to tackling climate change and promoting energy security as a key to stable and sustainable development. Energy is an important area of ongoing and future policy dialogue and practical cooperation between India and the EU. The two sides noted the valuable contribution of the India-EU Energy Panel, which had its third meeting in June 2007 in Brussels. They agreed to expand the scope of the working group on Coal with alternate meetings adopting different emphasis on mining oriented and conversion technologies, including enhanced generation efficiency, carbon capture and control respectively. It was also decided to have Indian participation in the international Biofuels forum. The two sides agreed to work towards a new flagship project on R&D in solar energy. In addition, leaders agreed to enhance cooperation on energy efficiency on an international level. They also recognised the importance of improving efficiency, in particular through the adoption of collaborative approaches in energy-intensive sectors."

"The EU and India agreed to work together bilaterally to accelerate their countries' transitions towards a low carbon economy, e.g. in the context of the EU-India Joint Initiative on Clean Development and Climate Change. They agreed the importance to sustainable development of synergies between energy security, sustainable energy supply, improved air quality, innovation and action to tackle climate change. They agreed on the importance of private sector engagement and investment in tackling climate change."

"The two sides reiterated their commitment to the United Nations Framework Convention on Climate Change and the Kyoto Protocol. They are committed to moving forward in the UN forum and called on all parties to actively and constructively participate in the UN Climate Change Conference (UNFCCC) in Bali in December 2007. They also agreed that an integrated approach to climate change and energy is crucial, and particularly stressed the need to exploit the synergies between the promotion of energy security, improved air quality and reduction of greenhouse gas emissions to ensure consistency between meeting the ultimate objectives of the UNFCCC and energy policy and economic

growth and development goals. They emphasised the importance of a post-2012 agreement for GHG reduction commitments by developed countries in facilitating significant cost reductions of clean technologies and their transfer, deployment and dissemination, as well strengthening the global carbon market and intensifying cooperation on the adaptation to the increasing adverse impacts of climate change."[18]

This resolve displayed by India and the EU to work together should translate into greater acknowledgement of energy and climate change issues, whether across the range of economic, scientific and technical cooperation programmes, or within the framework of the political dialogue established between the two regions. To that effect, the EU announced the creation of a *European Business and Technology Centre* (EBTC) in New Delhi, with a grant of €7 million, to foster links between the business and scientific communities from both sides, one of the issues will be climate change. An India-EU Initiative on Clean Development and Climate Change was also launched in 2005 with, as its main areas of concern:

- Voluntary, practical measures to be taken forward at successive India-EU Summits;
- Focussing on clean technology cooperation;
- Encouraging and promoting sustainable patterns of consumption and production;
- Cooperation on the CDM;
- Cooperation on adaptation to climate change and integration of adaptation concerns into sustainable development strategies.

These various initiatives call for three comments:

1) These initiatives are new and need to take practical form through measures that will ensure them a real impact, especially in the field of the energy efficiency, which has, to date, been inadequately addressed.
2) Consistent with the priorities that we have identified in the second part of this document, it would be desirable to extend this cooperation to include sustainable urban development issues, a field that is often neglected because it is more complex to deal with. Integrated urban planning and the development of low-energy transport systems and buildings are the key elements of sustainable urban development, in Europe as in India. As we have previously noted, in order to limit greenhouse gas emissions in the long term and at the same time to combat urban pollution, mobilisation of the stakeholders concerned and the establishment of public policies in this field will be decisive.
3) The Clean Development Mechanism (CDM) has, up until now, shown itself unsuited to the establishment of sectoral energy saving policies. Out of the 1,500 CDM projects that the United Nations Framework Convention on Climate Change (UNFCCC) has registered, the majority concern energy production; very few deal with energy demand. Nonetheless, the definition of a programmatic CDM at the Conference of the Parties in Montreal in 2005 must encourage the establishment of energy efficiency programmes in energy-use sectors. The building and transport sectors must be able to fit into this. A partnership between the EU and India could commit itself to developing large-scale programmes in these sectors and to devising methodologies suited to the CDM criteria, thus encouraging positive change in the rules of that mechanism.

Developing better mutual understanding of climate change issues

The IPCC's efforts to compile and disseminate a broad body of knowledge about climate change are unprecedented and represent a key element of intergovernmental cooperation on climate change. Mutual understanding of the stakes and priorities for action regarding climate change is essential both at the international level and at the domestic level. First, citizens must be made aware of the impacts of climate change, what a future low-carbon society would look like and what their lives might be like in 2050. Such a global perspective might be necessary if they are to be actively involved in this change.

The challenge of climate change will not be met without the support of civil society. In a world of high energy prices, synergies must be found between climate change issues and each country's main concerns, e.g. development, employment and poverty eradication. If the population perceives energy

[18] EU India Summit, Joint Statement, New Delhi, 30 November 2007 – http://ec.europa.eu/external_relations/india/sum11_07/index.htm

efficiency and climate change mitigation policies as menacing their jobs and their standard of living, there will be no popular support for addressing this problem and the adoption of policies that are equal to the challenge will be doomed to failure. It is therefore essential to mobilise the population and civil society stakeholders around the challenge of climate change.

There are numerous win-win policies, capable of simultaneously offering social and environmental benefits. A study by the European Trade Union Confederation shows how policies against climate change can benefit employment by the creation of new branches of industry, building rehabilitation programmes, the development of energy services, public transport and renewable energy etc. Beyond the question of employment, a profound transformation of our consumption patterns is as much an economic as a social challenge, especially because most households, including European ones, lack the means to pay high energy prices. The situation is much more tense in India, where there are large subsidies to encourage access to energy. Any price rise is a potential source of social conflict; the oil price rise cannot be fully passed on to consumers. Therefore, the deficits of energy suppliers and the State are constantly worsening. By reducing energy bills, energy efficiency policies are essential in order to ensure social cohesion.

Of course, there are some contradictions between social and environmental concerns. Lifestyles have to change and industrial sectors will need to be restructured. Consequently, the involvement of members of civil society through democratic processes is all the more important.

National and local level initiatives can be taken to increase awareness of these challenges among the population and all those involved. One example is the National Conference on Climate Change organised by South Africa in October 2005, which brought together thousands of participants over several days (in particular, representatives of local authorities and NGOs from all over the country), with the political support of several government ministries. That conference received a lot of media coverage, demonstrating the Government's commitment on this subject. A European fund could facilitate such initiatives in India as well as in Europe.

Partnership at all levels between the two regions

The first EU-India Summit in 2000 recognised the importance of a dialogue between civil societies and led to the launch of the India-EU Round Table in 2001, involving, in particular, political parties, trades unions, universities, professional associations and NGOs. Partnerships must be developed at all levels.

Universities and research centres

There is a need for research partnerships on energy and climate change between European and Indian universities, based on the definition of joint research projects and the exchange of students and researchers. Centres of excellence on climate change impacts and adaptation could be co-financed. Joint and multidisciplinary research platforms would foster understanding of the issue of sustainable development in its various dimensions: technical, economic, sociological and political. This involves better coordination on the themes of energy and climate change between European research centres themselves.

Local authorities

There is a considerable amount of collaboration between European cities on the question of sustainable development. One specific example is the *Energie-Cites* association, a network of European local authorities for a local sustainable energy policy. It brings together over 150 members from 24 European countries, representing more than 500 cities. This is a very active platform for exchange between local authorities and a source of valuable information for developing methods and projects in the interests of sustainable development. This network is working, for example, on Local Climate Plans (LCP). These are voluntary action frameworks for a particular area, enabling the mobilisation of all the authority's local partners and stakeholders, as well as bringing together and giving visibility to all of the policies aimed at reducing greenhouse gas emissions. A Local Climate Plan should make it possible to identify sources of greenhouse gas emissions, to set reduction targets, to define sectoral policies, to

organise the implementation of the action plan with all the local stakeholders and, finally, to evaluate the results.

Following the example of *Energie-cites'* practices, bridge building must be encouraged between European and Indian cities, making experience sharing possible and reinforcing collaboration between local stakeholders.

NGOs and trades union federations

There is a very well developed network of NGOs at local and national levels, in India as in the European Union, which are active in the environmental and development fields. They are essential to raising public awareness and often have considerable experience of implementing projects at the local level.

The role of the NGOs and trades unions is also that of spokespersons for local communities, citizens and workers. Because the involvement of all stakeholders is necessary to confront the challenge of climate change, the participation of NGOs and trades unions in this field must be encouraged; recommendations to public authorities must be formulated to identify synergies between the social and environmental concerns of the population. Here again, joint deliberation between European and Indian sister organisations, and experience sharing on the practices adopted, can be very useful levers to encourage support for sustainable development issues.

On the initiative of civil society organisations, campaigns are growing around the world to raise awareness of the climate emergency among the public and decision-makers. The Global Climate Campaign today involves organisations from nearly a hundred of the world's countries. Joint initiatives are undertaken, especially at each Conference of the Parties of the UNFCCC.

Finally, it should be noted that the European Trade Union Confederation has carried out important work drafting documents on the themes of energy and climate change. All these initiatives show how this concern is more and more broadly shared across all levels of society, constituting an essential factor in changing our lifestyles towards greater equity and respect for the environment.

Summary of the recommendations

1. The EU-India Partnership on energy and climate security should be conceived as a reciprocal exchange of competencies and the co-development of new technologies, considering that innovations in the environmental field are developed within the emerging countries themselves.

2. "Business as usual" scenarios are not an option, both for the European Union and India. The climate emergency demands the construction of a new development model, this must be the focus of the EU-India partnership's contribution.

3. The aims of energy security and climate change mitigation cannot be achieved unless the European Union makes a very significant reduction in its energy consumption and unless India adopts a low-energy development path, while meeting its development needs. In the EU and in India, emissions trends in some sectors require urgent action in order to avoid carbon lock-in. This is particularly true of those sectors characterised by considerable inertia, such as transport infrastructure, the residential sector, or power generation.

4. In Europe, urbanisation is essentially complete. Efforts must be concentrated first on the thermal rehabilitation of existing buildings, and then on urban planning to limit urban sprawl and on reallocating highways to sustainable transportation means, at the expense of the car. In India, efforts must be concentrated on the quality of infrastructure under construction which determine the level of energy consumption and of CO_2 emissions of the country for decades to come. A partnership between India and the European Union can be formed on the development of clean technologies and their diffusion and, above all, on experience sharing in the establishment of policies aimed at regional planning; integrated urban planning; the implementation of energy performance standards for buildings and amenities, soft practices and of support programmes aimed at local authorities and stakeholders in the building and transport sectors.

5. In the power sector, the potential renewable energy resources are considerable. Carbon capture and storage is also a relevant option to mitigate CO_2 emissions. But they will remain partial solutions if the demand for electricity continues to grow at its present speed. Curbing electricity consumption, in particular in industry and in the residential-tertiary sector, is therefore essential.

6. The European Union and India may collaborate on new technology research and development, in order to increase the energy efficiency of heavy industry and the power sector, and to develop energy efficient equipment for all sectors:

- The development of new environmentally friendly technologies : Cooperation on research and development by organising and financing shared research centres for particular technological targets; Financing a joint fund for innovation support, making it possible to obtain joint patents that can be employed by Indian or European stakeholders; Developing pilot demonstration projects for clean technologies.
- To facilitate transfers of property rights and to develop the markets for available clean technologies: Support for the development of joint ventures, together with cross-cutting training programmes, agreements on joint patents, exemptions from duty etc.; Public authority management of technology transfers, guaranteeing, in particular, the clear definition of the rights transferred and the monitoring of their application ; Use of compulsory licences
- The dissemination of the best technologies already available : an innovative institutional framework with suitable incentives is required (assistance to particular stakeholders, public procurement, training programmes for particular trades, information and publicity campaigns, urban traffic regulations, etc.)
- The policies and regulations adopted by the governments must avoid erecting obstacles to the development and diffusion of efficient technologies.

7. An India-EU Initiative on Clean Development and Climate Change must take practical form through measures that will ensure them a real impact, especially in the field of the energy efficiency. Sustainable urban development issues should be included in these measures.

8. In the framework of CDM, a partnership between the EU and India could commit itself to developing large-scale programmes in building and transport sectors and to devising methodologies suited to the CDM criteria, thus encouraging positive change in the rules of that mechanism.

9. The challenge of climate change will not be met without the support of civil society. In a world of high energy prices, synergies must be found between climate change issues and each country's main concerns, e.g. development, employment and poverty eradication. Win-win policies, capable of simultaneously offering social and environmental benefits, must be identified.

10. The involvement of members of civil society through democratic processes is crucial. National and local level initiatives can be taken to increase awareness of climate change challenges among the population and all those involved. A European fund could facilitate such initiatives in India as well as in Europe.

11. Bridge building must be encouraged between European and Indian universities, local authorities, NGOs and trades union federations, making experience sharing possible and reinforcing collaboration between local stakeholders. The role of the NGOs and trades unions is also that of spokespersons for local communities, citizens and workers. They can contribute to formulate recommendations to public authorities to identify synergies between the social and environmental concerns of the population.

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Annex

Monitorable targets for Tenth Five-Year Plan and beyond

- Reduction of poverty ratio by 5% by 2007 and by 15% by 2012.
- Providing gainful and high-quality employment at least to addition to the labour force over the Tenth Five-year Plan period.
- All children in school by 2003; all children to complete five years of schooling by 2007.
- Reduction in gender gaps in literacy and wage rates by at least 50% by 2007.
- Reduction in the decadal rate of population growth between 2001 and 2011 to 16.2%.
- Increase in literacy rates to 75% within the Plan period.
- Reduction of IMR (infant mortality rate) to 45 per 1000 live births by 2007 and to 28 by 2012.
- Reduction of MMR (maternal mortality ratio) to 2 per 1000 live births by 2007 and to 1 by 2012.
- Increase in forest and tree cover to 25% by 2007 and 33% by 2012
- All villages to have sustained access to potable drinking water within the Plan period

Source: Planning Commission, Tenth Five-Year Plan (2002–07), (New Delhi: Planning Commission, Government of India, 2002b)