INDIA

Population: 1,150,196,000 (2008)
Source: Demographic Yearbook 2008,
Table 5 Estimates of mid-year population: 1999-2008
http://unstats.un.org/unsd/demographic/products/dyb/dyb2008.htm

Carbon emissions per country: 2007: 1 612 362
Source: (CDIAC) Carbon dioxide emissions (CO_2), thousand metric tons of CO_2
http://unstats.un.org/unsd/mdg/SeriesDetail.aspx?srid=749&crid=

Carbon emissions per capita: 2007, India: 1,3844
Source: (CDIAC) Carbon dioxide emissions (CO_2), metric tons of CO_2 per capita
http://unstats.un.org/unsd/mdg/SeriesDetail.aspx?srid=751&crid=

Population below $1 (PPP) per day, percentage: 2005: 41,6 %
Source: http://unstats.un.org/unsd/mdg/Data.aspx

GDP per capita: India $ 3,400 (2010 est.)
Source: https://www.cia.gov/library/publications/the-world-factbook/rankorder/2004rank.html

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INDIA

This section on India constitutes to a large extent an extract and analysis of the WWF-commissioned national review titled "Indian innovation system – development and diffusion of low-carbon technologies", produced by Centre for Emerging Market Solutions, Indian School of Business, April 2010. More elaborate description and analysis of India's national climate innovation system can be found in the full report at www.climatesolver.org.

As India and other emerging economies develop, energy requirements, per capita consumption and emissions are all expected to increase dramatically. This has raised serious concerns about increased carbon emissions and the effects on global warming. Climate change already takes its toll on many parts of the Indian population. Climate-induced natural hazards such as droughts, floods, and cyclones as well as disrupted rain seasons that destroy vital livelihoods are some of the very tangible effects of climate change in India today.

Despite a global downturn, the Indian economy registered a GDP growth rate of about 6.5% in 2008-2009. The country's greenhouse gas emissions have risen concurrently. Estimates show that while India in per capita terms emits much below the global average, the country is in absolute terms the third largest GHG emitting country in the world. Looking forward, India needs a sustained growth rate of 8-9% over the next twenty years to keep up with population growth and lift a quarter of its population out of poverty. This implies that India will need to increase its primary energy supply by a factor of three to four and to increase electricity generation by a factor of five to six, based on 2003-2004 levels. Energy demand is increasing at a rate of 2.5% annually while over 600 million Indians still have no access to electricity and very limited access to any form of renewable energy. The challenge is to ensure continued economic growth while applying sustainable solutions to environment protection, climate mitigation, and climate adaptation.

India is moving ahead aggressively on low-carbon technologies. The government objective on solar energy calls for 20 GWh of installed solar power generation capacity by 2020. Some progress has already been made in other areas of renewable energy. With 16.2 GWh of installed capacity from mostly wind, but also significant amounts of biomass and mini-hydro power, India ranks 5th worldwide as a producer of renewable energy. In terms of investment, India is ranked 10th among G20 members and constitutes 2% of total G20 investment in renewable energy.[109]

Meeting India's dual challenges of development and sustainability requires an alternative development paradigm. The reconceptualization of development and prosperity needs to be revisited on the basis of ensuring access to basic needs of food, water and energy security in a carbon constrained world through innovations and solutions which are small-scale in nature and addresses the problem of the masses.

109 PEW Charitable Trusts (2010).

The Climate Innovation System in India

The role of the government

India was the first country to have a dedicated Ministry for New and Renewable Energy (MNRE). The Ministry has recently announced India's ambitious Solar Mission mentioned in the section above, and an Energy Efficiency Mission is in the final stages of review.

At the national level, policies are co-ordinated through MNRE in co-operation with several other concerned ministries and departments. At the state level, policies are implemented by dedicated nodal agencies.

The strategy of "low carbon climate resilient development" pathway is well enshrined in India's National Action Plan for Climate Change (NAPCC), which provides a comprehensive framework for addressing challenges of climate change and its impacts, while following a path of ecologically sustainable development. The strategies in the Indian context would require addressing two imperatives – (i) the first is to protect the poor and the vulnerable through inclusive, sustainable development that is sensitive to climate change issues; and (ii) the second is the need to achieve growth objectives through a qualitative change in direction enhancing ecological sustainability and mitigating greenhouse gas emissions. This would require integrating development strategies with adaptation and mitigation strategies.

The government works through a variety of regulatory incentives to promote investments in targeted market areas. Such incentive mechanisms generally follow one of two approaches: a) financial incentives for generating renewable energy (or increasing energy efficiency) and b) requiring state electricity boards to purchase a certain amount of renewable energy. Individual states often have separate additional incentive schemes or vary in their implementation of schemes. Among the financial incentives for energy generation and efficiency improvement are higher tariffs for renewable energy, access to preferential loans through renewable energy development boards, and some grants for collaborative R&D projects with research institutes. Incentives were initially often based on a plant's installed capacity, but have recently taken positive steps towards more strongly emphasizing generated capacity.

In addition to MNRE, the Bureau of Energy Efficiency (BEE) has been particularly pro-active. One of the BEE's most successful programs, the energy star rating, which informs consumers about the energy usage of appliances they buy, was initially implemented on a voluntary basis. Once the BEE could demonstrate consumer demand for a rating scheme (and consumers' willingness to buy higher-rated appliances), it became easier to introduce a mandatory scheme. The approach and the rating scheme were successful enough to warrant an expansion into agricultural and manufacturing equipment, as well as office buildings. BEE appears to rely less on outright subsidies and other financial incentives than it does on other demand-side mechanisms.

Many ministries employ policy guidance and incentive schemes that target low-carbon technologies directly or indirectly. But the process is still on-going, and policy development and implementation vary widely across states. This may create some beneficial competition between states, but it also creates an environment of policy uncertainty as well as barriers for a national rollout of successful technologies by both firms and public institutions.

Knowledge institutions

By the end of the 1980s, India was perceived as having a strong scientific and technological infrastructure among developing countries. However, these knowledge institutions had very limited contact with industry, and were more focused on teaching than on research. Their research contribution has consequently been fairly small. For a long time, graduates found few applications for their skills in industry and emigrated in large numbers. This trend is now reversing, and many emigrants are returning to India, bringing with them new sources of relationships, knowledge, and financing.

There are several technical degree courses that focus on environmental sciences and even renewable energy. Still, so far there are hardly any opportunities to gain degrees in management in these fields. As an example, TERI University offers both technical and management degrees for clean technology and sustainable enterprise. However, the MBA program is geared more towards developing sustainability awareness among corporate managers than towards developing green entrepreneurs (a situation that India, unfortunately, has in common with the rest of the world).

The government of India runs a large network of research institutions, but political and regional development goals have historically often been more important than research productivity in choosing the location of a laboratory. This has led to a fragmentation of already stretched resources, including budgets, equipment, and researchers. The Council of Scientific and Industrial Research (CSIR) has launched an incentives-based program to encourage increased applicability of research, and offers centralized administrative support for patenting and licensing. Despite early successes, the gap between researchers and interested entrepreneurs remains very large. CSIR has also launched the New Millennium Indian Technology Leadership Initiative to work on cutting edge technologies with the expressed goal of collaborating with industry on high-risk projects that might otherwise remain unfunded. To date, among many projects a few energy projects are being pursued, such as fuel cell development and local adaptation of windmill technology.

Entrepreneurs and the private sector

Low-carbon entrepreneurship is still nascent in India, but it is accelerating thanks to increased awareness of both government and investor interest. The low number of companies currently present in the market means there are large-scale opportunities, even for non-technologists. Many current start-ups are focused on adapting existing technologies to Indian markets and/or developing business models suitable for Indian markets. Developing reliable supply and distribution chains is as much or more of a concern as getting the technology right. Currently, many entrepreneurs build their businesses around a technology that they have developed or acquired. More customer-centric business models are likely to result in greater success for firms as well as broader deployment of low-carbon technologies. This includes a focus on “last-mile” issues of reaching customers, collecting payments, and servicing equipment.

There is a growing view that India provides a domestic market for large scale deployment of clean technologies and at the same time has the potential to become a key player globally in providing clean energy solutions that the world needs, especially to the population at the bottom of pyramid.

Entrepreneurs interviewed for the WWF study fell into two camps as far as their perspectives on government and policy-development processes were concerned. One group tried to minimize government contact as much as possible, even to the point of insisting that business models must avoid government subsidies, specialized tariffs,

Production of jaggery (raw sugar) in Uttar Pradesh, India. The waste material, bagasse, can be used as a source of biomass energy.

or other financial incentives. This group found that the bureaucracy was too difficult to deal with, and that policy-making was too unstable to provide reliable long-term financial predictability. The second group has developed extensive and deep contacts with the government. Some included consulting and research for policy makers in their activities; others relied on relationships for specific negotiations or to give feedback on policies. The closest contacts resulted from the efforts of entrepreneurs to help create a business ecosystem for their particular low-carbon sector.

Sources of financing for the firms in this study were as varied as the entrepreneurs themselves. They ranged from boot-strapping based on existing business, to "friends and family", to business family investors, to venture capitalists. Entrepreneurs in general found it easy to generate interest in low-carbon businesses thanks to the awareness of climate issues. However, they found that converting that interest into capital proved very difficult. Small startups in particular found it very hard to raise capital, and discovered that government funding sources are hard to get and often not worth the effort. They also usually require firms to show revenues or collateral, neither of which most startups have.

Investors pointed out that many entrepreneurs also resist certain forms of funding. Indian entrepreneurs appear to value full control of their companies far more than the American entrepreneurs that venture capitalists are used to. Often, first-time entrepreneurs have skewed expectations regarding the valuation of their company, or they underestimate the responsibilities that come with accepting equity financing from an investor.

Experiences from the expanding ICT sector may benefit climate innovations in India

Intermediaries and incubators

The Department of Science and Technology's National Science and Technology Entrepreneurship Development Board (NSTEDB) runs a network of 61 technology business incubators. These are all housed in research and education institutions and NSTEDB provides start-up help and funding for the incubators. However, the distance of most Indian academic institutions from applied research and markets is a distinct weakness of these incubators. While none of these incubators is currently focused on low-carbon technologies, around fifteen to thirty clean technology companies are being incubated across the NSTEDB incubator network.

The Technology Development Board and the Department of Science and Technology provide some grants that are available for entrepreneurs wishing to commercialize a technology. However, the conditions for these grants are quite stringent, and the amounts are relatively small. Another intermediary institution, New Ventures India (NVI), was set up with the goal to identify scalable green businesses and to link them with resources, including capital. NVI has a portfolio of 41 companies (2010) in various development stages. They maintain a network of interested investors, provide access to domain knowledge and are setting up a mentoring network. A final example is the Gujarat Cleaner Production Center, which was instituted as an awareness and training center to improve environmental standards in a wide range of manufacturing industries. Part of the center is involved in a World Bank capacity-building project to establish a climate innovation center.

Challenges and Recommended strategies

Strengthening systems for knowledge development and information-sharing

Universities in India have strengths in engineering & technical training. But with less than 5% of India's R&D spending, universities are clearly more focused on teaching than research. Another caveat for accelerated research is the tendency that even graduates with specialized high-quality training tend to avoid the risks of joining a start-up or a new sector with high perceived risk and prefer therefore to work in the IT sector.

Government research laboratories have significantly higher research budgets than the universities, but still far less than any industrialized economy, which is a particular drawback in a capital-intensive sector. Research in the government labs, like in the universities, remains strongly fragmented and thus difficult to access or accelerate. As a result, research budgets are also diluted. The prevailing culture of pursuing knowledge for knowledge's sake while ignoring application and commercialization of research is slowly changing, but there is still much room for improvement. Agricultural sciences have traditionally had a stronger focus on application and have built networks of farmers to work with. This could potentially be an advantage in terms of, for example, the development of biofuel technologies and the corresponding supply chains.

In a science-driven industry, such as low-carbon technology, there is a tendency to focus on tertiary education. However, basic vocational skills will be equally, if not more, important for the success of low-carbon companies in India. Some of the biggest challenges in the sector revolve around equipment maintenance that can be completed by a technician with rudimentary training.

Building capacities and increasing resources

Early-stage investment is clearly a choke point in India's low-carbon innovation system. The real and perceived technology risks only exacerbate the problem. There is a need to develop creative financing mechanisms and incentives for investors in order to bridge this gap and enable enterprises and entrepreneurs access to start-up investments. One example of such initiatives is the fund that MNRE and CIIE are establishing, which subsidizes returns for private investors. In general, it would be useful to raise seed funds with both government and private investment - there are also a range of other potential mechanisms that could manage and allocate grants to low-carbon technology investments.

In some instances the risks of early-stage investment are so high that private investors will never carry them, e.g., commercialization and prototyping of new technologies. In these cases, the government could step in to reduce or eliminate this risk, or act as a long-term investor itself. The size of such investments should be carefully considered; the current Technology Development Board grants are too small to have the desired impact. A smaller number of large grants would be more effective. Ideally, some dedicated seed funds and preferential bank lending schemes would focus exclusively on low-carbon technologies.

Furthermore, adding to the challenges of India's climate innovation system, activities in specialized low-carbon technologies are few and fragmented. This combination reduces the likelihood of student-run start-ups emerging out of university labs. The lack of specialized training, combined with the young age of the low-carbon sector in India means that few senior technologists are positioned to create start-ups; and few recent (specialized) graduates are interested.

Indian firms traditionally spend very little on formal R&D. This includes many of the entrepreneurs in this study who run fairly low-tech businesses and focus on adaptation of technology and on developing adequate business models. This may also be related to the lack of networks in the sector that would bring together strong teams (business + technology, experience + young entrepreneurs) to run more sophisticated start-ups.

Establishing an enabling institutional framework

India's low-carbon innovation system suffers from many of the same problems as India's innovation system in general. However, problems are often exacerbated by the fact that this is a science-driven industry with high (perceived) technology risks due to a strongly policy-driven industry as well as the long-time horizons and the comparatively low prestige of the low-carbon sector.

Renewable energy standards and other legislation must be properly implemented and enforced if markets are to work. Involvement of very many ministries and agencies in development of policies and regulations, sometimes with conflicting interests, drastically reduces the efficiency and sustainability of the national climate innovation system. These circumstances are confirmed by entrepreneurs and other key stakeholder groups, which stress that MNRE is implementing many different relevant policies, but without a unifying vision. The current dramatic variations in state policies will eventually become a burden to the deployment of low-carbon technologies. A progression to more uniform policies is recommended. The single most important policy issue affecting entrepreneurs remains paperwork reduction. True single-window clearance would improve access to and the effectiveness of many existing schemes. Ideally, a single window would cover both state and federal paperwork.

The weak co-ordination between the state and national government (especially since nodal agencies are often understaffed and underfunded) coupled with the enormous range of different state policies, is a huge challenge in India today. This leads to high regulatory uncertainty, and presents an obstacle to firms who might otherwise scale their operations faster and across all states.

Taking into consideration that the government's development of policies in the area of low-carbon energy technologies is fairly recent, it should also be stressed that the focus areas of low-carbon policies within MNRE are not necessarily targeting the most important issues. For example, grid upgrading, forests, energy efficiency and fossil fuel subsidies all lie outside the purview of MNRE.

Analysis of the enabling environment for low-carbon entrepreneurs shows that despite the multitude of different schemes and incentives, many entrepreneurs feel that qualifying for government benefits is impossible or not worth the effort. General scepticism also leads many to doubt the permanence of the schemes, and they will therefore avoid including them in their business plans. The effectiveness and consistency of the schemes is also in doubt. National uncertainties are exacerbated by global uncertainties about carbon markets. Despite much proclaimed interest, financing for low-carbon technologies is hampered by perceptions of both investors and investees. Venture capitalists and angel investors remain focused on the IT industry and on low-risk, mid to late-stage financing. Entrepreneurs often misunderstand the terms and consequences of a typical equity investment.

Establishing a national platform for coordination and information exchange

At government level, policies and interests in the low-carbon sector often conflict with one another or simply do not work well together. It would be useful to establish

Climate innovations can reduce India's dependency on fossil fuels and bring a low carbon resilient development.

a strong body or agency that maintains an overview over all low-carbon issues and is located in a power center, such that it has the competence to steer related policies. Such a center-state national platform would also provide strengthened and more systematic co-ordination and streamlining.

In the private sector there is a need of improved policy research and a formal industry consultancy mechanism that could ensure that policy development considers market and financial implications more strongly and more realistically. In the field of R&D, there is a need to provide better access to existing knowledge, research and technologies by all climate innovation stakeholders. It is proposed that an open-source online platform be established, which may include or complement a panel of experts in the low-carbon sector. The platform may be developed in line with the UNFCCC efforts to create Climate Technology Network Centres (CTCN) which will link different existing and new centers of technology development, deployment, and diffusion in various countries of the world.