COALITION for INNOVATION, EMPLOYMENT and DEVELOPMENT

A Policy Approach for Supporting Clean Energy Technology in India

Prepared for the Coalition for Innovation, Employment and Development

USINDIA BusinessCouncil

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Chapter I

The Challenge Facing India

Establishing an inviting marketplace for the best clean tech innovators, inventors and entrepreneurs from around the world

The spread of clean energy technology has assumed great importance in the context of global warming and the emission of greenhouse gases. Although India's carbon emissions of approximately one-ton-per-capita are only one fourth the world average, the overall emissions from India are likely to increase dramatically in the coming years due to a growing population and an expanding economy. According to the 2007 World Energy Outlook report, India accounted for 4% of the world's overall carbon emissions in 2005. However, this share is expected to double to 8% by 2030, even as per capita emissions remain well below those of OECD countries and even most developing countries.

India's economic growth will move millions of its citizens out of poverty, but it will also mean dramatically increased energy consumption for transportation, manufacturing, heating and other applications. If this increasing consumption of energy takes place in an inefficient manner, it will mean even greater pollution and health problems in India's already congested cities and make India a major contributor to global climate change. India must retool its aging infrastructure to both accommodate rapid growth and also meet aggressive energy efficiency goals set forth in its own National Action Plan on Climate Change.

A study conducted in 2006 by India's Planning Commission estimated that in order to maintain a sustained economic growth rate of around 9% per year for the next 25 years, India's primary energy supply must go up by 3 to 4 times and electricity generation by about 5 times over the same period. As India's electricity generation is now primarily dependent on coal, its coal production would have to increase a staggering 5 times - from nearly 400 million tons per year to 2 billion tons per year.

The International Energy Agency has estimated that India may be required to invest $1.25 trillion to meet its energy requirements over the next 20 years. This total is higher than India's current Gross Domestic Product. Thus, India will face considerable challenges to fund its increasing energy needs.

As India and the rest of the world come to grips with estimates such as this, it is clear that the status quo is indeed unsustainable.

Presently, India is largely dependent on fossil fuels – mainly coal (over 55%) and oil and natural gas (over 35%) – for meeting its energy requirements. Import dependence is high in relation to petroleum products, between 70% - 80% of India's requirements have to be met by imports.

India is the world's third largest coal producer and has proven reserves that can last for at least 45 years assuming a

5% annual growth in energy production. However, most of the coal currently being extracted is of poor quality, with an ash content ranging from 30% to 45%. Imports now comprise 10% of total demand, accounting for 50% of the demand for coking coal required for steel making and 5% of the non-coking coal required for power generation. Imports are expected to rise sharply in the near future due to little or no development of underground coalmines and increasing constraints on the availability of land for mining.

Recent natural gas finds may be used to mitigate the effect of coal shortages for power sector requirements in the short term; however, with increasing energy requirements India is bound to remain heavily dependent on imported oil and natural gas for a long time to come.

As we will discuss in more detail throughout this report, the Indian Government has made significant commitments to clean technologies and energy efficiency, and we can see examples of these commitments beginning to take hold. Unfortunately, clean and alternative energy sources account for only a small portion of India's overall energy capacity. Their utilization will have to increase dramatically to have an impact over the long term.

The mix of clean technologies is promising, however, as we have seen hydroelectric projects harness the power of India's rivers and wind power usage increase as companies like Suzlon have found a global marketplace.

To meet its full potential India will need to develop, promote and deploy a wide range of clean technologies while simultaneously addressing significant demands for improvement of its infrastructure. This will require establishing an inviting marketplace for the best innovators, inventors and entrepreneurs from around the world.

India's progression along this path will take place in a competitive global environment. Other major emerging economies (namely China) have prioritized the development of vibrant clean technology industries within their long-term growth strategies. India is well-placed to be an important global player in this industry and the decisions it makes now and its level of support for innovation, investment and commercialization will set the tone.

The positions India takes and the policies it adopts also matter profoundly to the global debate on climate change. India is a leading voice among developing countries and is emerging as a dynamic leader across a range of innovative industries. As we approach significant milestones such as the U.N. Framework Convention on Climate Change in Copenhagen, India should be a strong and clear voice on behalf of innovation.

This report is dedicated to exploring the clean technologies that will truly make a difference for India and to demonstrating that India must establish policies that promote and respect the intellectual property that will be the foundation of clean tech innovations made in India and around the world.

Chapter II

Innovation is Essential … The Technologies that Will Matter for India

Solar

The landscape for solar innovation is wide open in India

India has about 300 days of sunshine in a year, but has achieved very little in terms of tapping this potential. The main limitations have been the low efficiency and high costs of current photovoltaic (PV) solar technologies. Most of the PV applications in India are stand-alone systems that do not connect to the energy grid. The Indian government is only now beginning to make a concerted effort to develop large-scale grid connection projects primarily because of cost and technological issues.

Despite the lack of a comprehensive government strategy, the manufacturing capacity of solar PV cells and modules has been surprisingly strong. Currently, India has over 180 megawatts (MW) of solar cell manufacturing capacity and over 200 MW of solar module capacity. Investment in the Indian solar industry is expected to grow by more than $10 billion over the next ten years. Given the lack of domestic demand for solar PV systems, however, about 70% of existing and new production capacity will tap export markets, primarily in Europe.

> India will "develop solar energy as a source of abundant energy to power our economy and to transform the lives of our people."
>
> *-Prime Minister Manmohan Singh*

That tide may be turning though, as a series of private sector announcements indicate a significant increase in solar cell manufacturing in India. In addition, Prime Minister Manmohan Singh made solar power the centerpiece of his *Climate Change Action Plan* in June 2008, saying India will "develop solar energy as a source of abundant energy to power our economy and to transform the lives of our people."

This high-level commitment has come with policies designed to incentivize production and deployment in India, including:

- Allowing 100 percent foreign direct investment in the solar industry
- Zero or very low customs and excise duties on most solar products
- Tax benefits for deployment in disadvantaged areas
- Investment incentives
- Support for research and development

It is significant to note that a number of Indian firms dominate the country's solar market. These companies are either in the public sector or in joint ventures with large global players. The major public sector solar manufacturers are Bharat Heavy Electricals Limited, Central Electronics Limited, and Rajasthan Electronics and Instruments Limited. A number of significant private sector players operate mostly through joint ventures and international

collaborations such as Moser Baer PV Technologies, Tata BP Solar India, Signet Solar and Astonfield Renewable Resources.

These global collaborations seem to be expanding and showing tangible results. In March, 2009 U.S. solar equipment producer eSolar announced a 10 year partnership with Indian technology firm ACME Group to build up to 1,000 MW of solar thermal power plants in India. This is eSolar's first international licensing agreement and will result in significant financial and technological collaboration between the two firms.

India is clearly not lacking for domestic innovation, investment and commitment to solar power. The know-how and capacity to meet Prime Minister Singh's commitment is in the hands of Indian firms that are now collaborating effectively with international partners. So while access to and development of technology and intellectual property are enabling innovation, issues such as an inadequate grid and limited battery capacity for generated power are hampering implementation. Indeed, the landscape for solar innovation is wide open in India; since 2001 only 9 patents for solar energy technologies have been granted in the country.[1]

As India grapples with these difficult challenges, innovative Indian companies like Auro Power Systems will be leading the way. Based in Bangalore, Auro Power Systems has developed a battery-based uniform power system for use in homes and offices. Their uninterruptable power supply (UPS) systems are being used to maintain power at cell towers, and their innovative battery technologies are replacing traditional gas-powered generators to reduce both air and noise pollution. This green technology innovator is now developing renewable energy products that will enable their UPS systems to run almost completely off the grid by using solar, wind and even hybrids of the two to power their systems. Auro Power has facilities throughout India, and their products are helping to augment the power grid and keep India's computers and mobile communications up and running.[2]

While India experiments with solar lights, solar water pumps, and domestic solar cookers for use particularly in rural areas, a major development has been the use of concentrating solar power for mass cooking in pilgrimage centers like Tiruputi, Shirdi, Mt. Abu, Auroville, and even for students in Satyabhama University in the South. These solar kitchens prepare thousands of meals per day and each of the facilities is equal to a megawatt-sized power station in terms of steam generation capacity. These developments mean significant savings in use of cooking gas and are based upon innovations made by Indian firms such as Gadhia Solar Energy Systems, the largest manufacturer of solar steam cooking

> Domestic firms such as Bharat Heavy Electricals Limited, Central Electronics Limited, Rajasthan Electronics and Instruments Limited, Moser Baer PV Technologies, Tata BP Solar India, Signet Solar and Astonfield Renewable Resources dominate the solar market in India.

[1] Indian Patent Office Bibliographic Search Report on Solar Energy

[2] http://www.auroups.com/p7.html.

systems in the world in collaboration with HTGmbh.

In addition to benefits in terms of reduced energy usage, simple breakthroughs like these translate into real jobs in India. The U.N. estimates that replacing traditional cook stoves with recently developed advanced biomass and solar cooking technologies in 9 million households could create 150,000 jobs.[3]

These are tremendous examples of Indian innovation at work. Developments such as these are primarily based upon smart economic policies that incentivize experimentation, production and deployment. They also demonstrate that additional players are entering the field to improve existing technologies and meet growing global demand. It is estimated that as many as 600 companies are involved in the solar panel market globally, with as many as 60 new companies joining each year since 2000.[4]

Biofuels

A jatropha project led by Indian Railways could lead to 44,000 jobs for Indian farmers

As technologies develop that allow us to make more efficient use of oil, we also need to look at ways to develop alternatives. Biofuels can be developed from a range of plants and biological matter; the possibilities are almost limitless. Biofuels or agrofuels can be produced from food crops with particularly high sugar content such as corn, sugar cane, and sugar beets; or with high oil content like soybean, palm, and algae. Although food crops provide an instant supply for producing biofuels, using other non-food crops and biomass to produce fuel may be the more preferable route in India. These second generation biofuels use non-food crops and waste materials, keeping the food supply intact.

Inedible oils like jatropha, karanj, and mahua are therefore attracting more attention as there is a possibility of cultivating them on wastelands. Estimates on the yields that can be expected from jatropha or karanj cultivation vary from a low of 1 ton of biodiesel per acre to 2.5 tons per acre (0.4 tons to 1 ton per hectare). However, significant work needs to be done on cultivation practices and the economics of processing and cultivation before large-scale commercialization becomes possible.

One major emerging player in the development of jatropha plantations for production of biodiesel is Indian Railways. With 5,000 diesel locomotives consuming over 580 million gallons (2 billion litres) of high-speed diesel annually, they anticipate saving between 29 to 116 million gallons (110 to 440 million litres) depending on the proportion of biodiesel used. The Railways intend to use land they already own along existing tracks, and have identified about 356,000 acres (44,000 hectares) out of a possible 1.5 million acres (190,000 hectares) for use. Initial biodiesel production is being undertaken in partnership with Indian Oil Corporation on 4,000 acres (500

[3] Green Jobs: Towards Sustainable Work in a Low-Carbon World, U.N. Environment Programme, 2007
[4] www.eetindia.co.in/ART_8800555294_1800008_NT_2621f49d.HTM

hectares) of land, with four esterification plants planned at a cost of $15.5 million. The Railways have started testing performance of their locomotives with various biodiesel admixtures.[5] India's National Biodiesel Program estimates that each new hectare of jatropha production results in one full-time job.[6] So, Indian Railways' project alone could lead to 44,000 jobs for Indian farmers.

General Motors India has established a pilot project with Central Salt & Marine Chemicals Research Institute to develop biodiesel from jatropha to test in its vehicles. Daimler and the Indian industrial group Mahindra & Mahindra are also working on a similar project. Mahindra & Mahindra have already demonstrated exceptional capacity for technological development by developing the first SUV in Asia to run entirely on biodiesel.[7] These types of win-win collaborations present a tremendous opportunity to develop and transfer cutting-edge technology that will have a significant impact in India and in markets across the globe.

To meet its energy goals, India will look not just to the collaboration of large and established firms such as these, but also to the innovative spark of entrepreneurial start-ups like Husk Power Systems. Husk Power Systems was launched in 2007 by two Indian engineers, Manoj Sinha and Gyanesh Pandey along with a fellow student Charles Ransler studying at the Darden School of Business in Virginia. Husk is active in the state of Bihar, where it owns and operates a number of rice husk based, mini power plants that offer pay-as-you-go service to small villages in the area. The firm has received seed money from Shell Foundation for their bio mass gasification technology venture and won the University of Virginia competition for the best business plan in 2008, the University of Texas competition for social innovation, and the Draper Fisher Jurvetson and CISCO sponsored Global Best Business Plan competition in 2009. For projects both big and small, effective national economic policy is by far the most important ingredient to the growth and success of India's biofuel ambitions.

To this end, India has made a promising start. Its national biofuel policy, announced in 2008, aims to bring up the proportion of biodiesel and ethanol in four wheelers to 20% by 2017. Extraction of biofuels from inedible plants grown in wastelands is encouraged, while irrigated land cannot be used for this purpose. A minimum support price to encourage farmers to grow inedible oils would be put in place and would also serve as a minimum purchase price for bioethanol and biodiesel by oil companies based on cost of production and import prices for ethanol or prevailing diesel prices in the case of biodiesel.[8] India's Finance Minister Pranab Mukherjee has announced a plan for a tax reduction on biodiesel.[9]

India has a strong base to build these efforts upon, and the potential for job

[5] PPT Indian Railway Organization for Alternate Fuels.
[6] Worldwatch Institute, Biofuels for Transport: Global Potential and Implications for Sustainable Energy and Agriculture, 2007.
[7] http://www.indiaprwire.com/pressrelease/auto/200702071841.htm

[8] Government of India Press Note relating to Cabinet decision of September 2008.
[9] Budget announcements by India's Finance Ministry on 6th July 2009.

creation has been demonstrated. For example, in India's capital New Delhi, the introduction of 6,100 buses running on compressed natural gas by the end 2009 is expected to lead to the creation of 18,000 new jobs. [10] *Going forward, the U.N. estimates that India* could create some 900,000 jobs by 2025 within its broad and growing biofuels industry.

Intellectual property is the lynchpin of these initiatives that will stimulate innovation and foster partnerships that will benefit automobile companies, energy firms as well as agriculture business consulting groups who will all contribute to building viable biofuel vehicles and developing the technologies and agricultural practices that will support their widespread adoption.

Nuclear

Perhaps no other sector will be as impacted by India's approach to intellectual property protection and effective technology transfer as will the nuclear sector

Nuclear energy will play an important role in fulfilling India's energy needs, and as a result of the landmark U.S.-India Civil Nuclear Agreement stands to be a cornerstone of the relationship between the two nations for years to come. The Agreement has led to a sea change in thinking on the role of nuclear energy in contributing to fulfilling India's energy needs.

India presently has 17 nuclear power plants with a total generation capacity of 4,120 MW. These have been operating at much less than optimal capacities, however, because of the lack of fuel supplies and glitches caused by sanctions that prevented the purchase of many dual use technology items. Therefore, it's not surprising that the World Energy Outlook 2007 estimated India's generating capacity from nuclear energy would reach only 17,000 MW by 2030.

The Indian Government has a more optimistic assessment of the growth of its nuclear energy generating capacity, however, putting it between 48,000 and 63,000 MW by 2032. As a result of the Agreement, which has removed barriers to the supply of fuel and imported reactor technology, these estimates may be more accurate and may actually be exceeded.

India lacks the uranium needed to obtain a generating capacity of more that 10,000 MW based purely on indigenously available supplies; on the other hand, it has one third of the world's resources of thorium, an alternative to uranium which allows power plants to operate more cleanly with less harmful waste. India's installed base of conventional uranium based power plants will fill many of its existing needs, but global collaborations and the development of new technologies will clearly lead the way.

Fast breeder reactors, which utilize the spent fuel coming from conventional reactors to extract plutonium by reprocessing and use it along with the remaining depleted uranium to produce electricity and breed or generate more plutonium, are a key technology. Based upon indigenous technology India expects its first fast breeder reactor, with 500 MW capacity, to be operational by the end of 2012. The growth of fast

[10] Green Jobs: Towards Sustainable Work in a Low-Carbon World, U.N. Environment Programme, 2007

breeder reactors in India is not limited by access to intellectual property or technological know-how and will accelerate in coming years as technological collaborations with international nuclear power companies flourish. The key variable will be India's access to imported fuel.

Beyond this development, India is also working to develop the technology to leverage its vast supply of thorium in the fast breeder reactors to convert this non-radioactive material into radioactive Uranium 233. Once this is done successfully, India's potential for generating nuclear power would be theoretically large enough to take care of all its energy needs. It will be limited only by the number of sites available for setting up such power plants.

These advancements represent real game-changers for India. Through them, the country hopes to achieve a generating capacity of 7,500 MW by 2012 and to increase this to 20,000 MW by 2020. This vast potential has led to collaborations with four of the leading nuclear energy companies in the world – AREVA, RusAtom, Westinghouse and General Electric – to build up 24 nuclear power plants with capacities exceeding 1,000 MW each. Sites for power plants to be set up with the help of U.S. companies have been identified in the southern state of Andhra Pradesh and the western state of Gujarat. AREVA has proposed Jaitpur as the site of its projects and RusAtom looks to build plants in Kudankulam.

India's emergence as a nuclear energy leader has implications for Indian and foreign business entities. The present institutional arrangement, whereby the state-owned Nuclear Power Corporation of India has a monopoly over nuclear power generation, will be difficult to sustain in the face of the rapid growth projected. This process will likely have to open up to other state-owned entities and eventually private sector groups.

Perhaps no other sector will be as impacted by India's approach to intellectual property protection and effective technology transfer as will the nuclear sector.

The development and construction of new reactors will certainly affect India's major engineering conglomerates, such as Larsen & Toubro, Jindal Steel, Tatas, and Mahindras, in major ways. In order to ensure that India's nuclear plants are capable of producing electricity at competitive prices, it will be necessary to maximize production and fabrication of as many components as possible within India. The scale of this work, the advanced technology, and safety and confidentiality issues involved will challenge India's private sector firms as never before. They will have to acquire competencies which match the best available anywhere.

Many of them will have to develop their own technology solutions to reduce costs and implementation time – technology solutions which might be worth patenting for marketing internationally at the appropriate time. Nuclear Power Corporation of India Limited (NPCIL) itself could become a pioneer in fast breeder reactor based power plants and later thorium based plants.

As India firms grow and international nuclear firms seek partnerships within India, it may become necessary to revisit

the current limitations on patenting relating to nuclear technologies. Domestic and international firms will certainly want to protect the intellectual property they develop at great cost and effort.

Wind

Indian firm Suzlon's U.S. manufacturing facility based in Minnesota employs 150 workers to produce rotor blades

Estimates of India's Wind power potential vary between 45,000 MW and 65,000 MW. At the end of 2007, India had the fourth largest installed wind capacity in the world after Germany, the U.S., and Spain.[11]

Today, India has the capacity to produce over 10,500 MW through wind power, which accounts for 3 percent of all energy production in India. The Indian Government has supported the expansion of wind power by allowing companies that install wind turbines to depreciate 80% of the costs in the first year. This has driven investment based primarily as a tax strategy and to a lesser extent to supply India's energy consumption. The government has recently linked the depreciation policies to incentives for generation and supply to the grid as well, which should lead to large capacities being set up by independent companies.

These policies have helped to open the market and driven highly effective collaborations among leading wind power innovators in India. For example, in 2005, GE helped develop a 12-megawatt wind farm in the village of Radhapuram in Tamil Nadu. This project was designed to provide power for Surana Industries, an Indian producer of thermo mechanically treated bar steel and stainless steel products and components.[12] This is a truly "green" project, with GE providing expertise, technology and local jobs to help a large factory use wind power to drive its operations. Projects like this are being replicated throughout India and will continue to flourish based upon sound government policies that welcome collaborations and incentivize innovation.

Any description of India's wind energy development program would be incomplete without a description of the pioneering role played by Suzlon, which is India's largest wind-energy provider. In terms of market share, the company is the largest wind turbine manufacturer in Asia. Now combined with REpower, it is the third-largest wind energy solutions provider globally.

Suzlon has substantial manufacturing facilities in India, the U.S., China, and Belgium. In addition, Suzlon sources 80% of its supplies from Indian firms. Over the past three years, it has expanded considerably, making two large overseas acquisitions (Hansen and REpower) and significantly increasing its own manufacturing capacity. It expects the majority of its revenues to come from international markets (primarily the U.S. and China).

Suzlon's manufacturing facilities in the U.S. are based in Minnesota, where its 150 employees produce rotor blades. It

[11] Janet L. Sawin, "Wind Power Still Soaring," in Worldwatch Institute, *Vital Signs 2007-2008*

[12] http://www.ge.com/in/news/news_india_12.html

has been involved in more than 50 projects in the U.S. and enjoys a strong position in the market with repeat orders from many existing customers. Major orders in recent years have included customers like Horizon Wind (400 MW) based in Texas, PPM energy (400 MW) based in Portland, Oregon and Edison Mission Group (630 MW) based in Irvine California. The U.S. accounts for over 50% of Suzlon's global sales.[13]

Indian company Suzlon is the largest wind energy company in Asia and the third largest in the world.

Suzlon provides total solutions in wind power generation, involving site development, design, manufacturing, installation, operation, and maintenance services. Its products include integrated service for the wind turbines and wind parks. Suzlon has developed some of the largest wind parks in Asia, including the world's largest wind park of its kind with over 200 MW capacity. Already in 2009, Suzlon has won international orders equivalent to 388 MW.

The company is also focused on research and development, undertaken primarily through its wholly owned subsidiaries. Its R&D initiatives include upgrading and increasing the cost-efficiency of its existing wind turbine generator (WTG) models and designing, developing, and stabilizing new models. Suzlon is also moving ahead in areas such as aerodynamic performance enhancements, development of turbine variants for local markets, increasing reliability, and automated operations.

Suzlon has developed world-class technology and this India-based company will clearly rely on its intellectual property to fuel even greater growth in the future. It has initiated cases to protect its intellectual property and improvements, and has filed for patents for some of its innovations and closely guarded core developments that are proprietary in nature. Suzlon filed applications for six patents in 2007 and that doubled to twelve in 2008.

Hydrogen

Indian Oil Corporation has recently proposed opening the first hydrogen fuel dispensing facility in Delhi

Hydrogen fuel cell technology is an early stage technology that is being developed for powering vehicles and buses. For its part, the U.S. government has invested around $1.2 billion in hydrogen research and development to help bring these vehicles to market. The attraction of this technology is that it requires no additional fuel or electricity and all that is emitted is pure water. Companies like GM, Honda and BMW are also investing in developing hydrogen fuel cell vehicles and Iceland is putting in place hydrogen fueling stations and has begun testing the technology to power ships, buses and cars.[14]

Realizing the importance of hydrogen as a carbon free fuel of the future, the Government of India set up a National Hydrogen Energy Board in October 2003, with the Minister for New & Renewable Energy Sources as the Chair and

[13] www.suzlon.com; Annual Reports 2007 -2008, 2008 -09.

[14] http://features.csmonitor.com/environment/2009/02/12/iceland-strides-toward-a-hydrogen-economy/

representation from industry, academia, and exports in the field. The Board oversees the preparation of a National Hydrogen Energy Road Map, monitors of the development of hydrogen energy and the fuel cell program, and recommends fiscal and other measures for fostering public-private partnerships in this area.

A committee headed by Ratan Tata, a leading Indian industrialist, was tasked with the preparation of the National Hydrogen Energy Road Map.[15] The Road Map, finalized in 2006, contains the following elements:

- production of low cost carbon free hydrogen;
- developing viable technologies for storage, distribution and transport;
- setting up public-private partnerships to demonstrate key applications for hydrogen as a fuel, particularly in decentralized power generation and as a fuel for automobiles;
- promoting the Green Initiative for Future Transport (GIFT), which would develop and demonstrate hydrogen powered internal combustion engines and fuel cells suitable for all types of automobiles;
- promoting the Green Initiative for Power Development (GIP), which would develop turbines and fuel cell based generating systems ranging from small-sized generators to megawatt-sized generators for decentralized power supply; and
- setting a target of 1,000 MW of hydrogen-based power and a million vehicles fueled by hydrogen energy by 2020.

Work on hydrogen technologies has been initiated in some of the Indian Institutes of Technology and in the Atomic Energy establishment. However, it is still at an early stage.

Meanwhile, Indian Oil Corporation has recently proposed opening the first hydrogen fuel dispensing facility in Delhi. This will be used to fuel vehicles presently running on CNG with a mixture of 20% hydrogen obtained by electrolysis. The Ministry of Petroleum has also created a $20 million fund to be spent on hydrogen-related research by Indian public sector energy companies.[16]

Thermal

India's plans for bringing new large thermal power projects online will be at the center of its efforts to address the rapid growth of domestic carbon emissions

Thermal power holds special significance for India; it constitutes 63% of the total generating capacity in India and accounts for 81% of the total power produced.

The total installed capacity for thermal power is 92,000 MW, 83% of which is coal-based and 16% of which is gas-based, with the remainder based on diesel. India's energy strategy envisions increasing the capacity of thermal plants, including gas based by nearly 80%. A large part of this new capacity is to be based on supercritical technology in an attempt to reach world standards in terms of fuel conversion efficiency.

[15] Incidentally Tata Nano, the world's cheapest car at a price slightly over $2,000, has been produced and is being marketed by Tata motors.

[16] www.petrotech2009.org and Business Standard dated 23rd December 2008.

Supercritical power plants operate at temperatures and pressures above the critical point of water, i.e. above the temperature and pressure at which the liquid and gas phases of water coexist in equilibrium, at which point there is no difference between water gas and liquid water. Supercritical power plants require less coal per megawatt-hour, leading to lower emissions (including carbon dioxide and mercury), higher efficiency and lower fuel costs per megawatt.[17]

India is relying on adoption and adaptation of supercritical technologies to achieve a quantum jump in the efficiency of its power plants from a level of 30% to 40% to match the current standard prevailing in developed countries.[18] In the supercritical thermal technology area there are a number of joint ventures between Indian and foreign firms to manufacture the boilers, generators and other equipment in India to cater for the very high pressures and temperatures required.

These partnerships include Alstom and Bharat Forge, ABB and Tatas, Mitsubishi Heavy Industries, Larsen & Toubro, Ansaldo Caldio & GB Engineering, and Toshiba and JSW. The traditional public sector supplier, Bharat Heavy Electricals is also collaborating with Alstom and Siemens. In addition, Indian firms, including public sector generating companies, have purchased plants and equipment from foreign firms to meet their current requirements. Aquatech, a U.S. firm, has won the bid for the desalinization plant required for Tata's enormous thermal power project being built in Mundra.

Several major private sector industrial groups have entered the thermal power generation business including Tata, Reliance, GVK, GMR, Lanco, Torrent, Sterlite and Adani. These companies also have investments in other infrastructure sectors.

India's plans for bringing new large thermal power projects online will be at the center of its efforts to address the rapid growth of domestic carbon emissions. The 2007 World Energy Outlook report observed that India's

Several major private sector industrial groups have entered the thermal power generation business including Tata, Reliance, GVK, GMR, Lanco, Torrent, Sterlite and Adani

power sector is one of the most CO_2-intensive in the world, accounting for 60% of India's CO_2 emissions. This is due to the very poor efficiency of India's current generation of power plants. Addressing this is a high priority for the Indian government and an area where the country certainly needs to deploy more efficient and technologically advanced power plants. Should India be able to bring the efficiency of its power plants in line with those in Europe, and ultimately the U.S., it would be able to limit the projected doubling of per capita carbon emissions over the next 20 years.

[17] http://www.greenfacts.org/glossary/pqrs/supercritical-ultra-supercritical-technology.htm.

[18] No published source – based on discussions with Power Ministry officials.

Hydroelectric

Hydroelectric projects in India are beginning to see technological advancements equal to those being made in other areas such as solar and wind

The promise of hydro is profound. It is clean, renewable, and more flexible than other clean technologies.

India has an installed capacity of 36,000 MW of hydropower and has potential for another 150,000 MW, mainly in the Himalayan states of northern India, moving west to east from Jammu & Kashmir through Himachal Pradesh, Uttaranchal, Sikkim and the northeastern states. Sites for an additional pumped storage capacity of 94,000 MW have been identified, and an additional potential of nearly 10,000 MW is available for mini and micro hydro projects. Although this is clearly a technology that can contribute significantly to India's energy mix, it is currently hampered by resettlement and environmental issues.

Hydropower projects are highly capital-intensive and difficult to implement. It is not simply a matter of gaining the IP or know-how to build a hydro plant. A litany of challenges ranging from difficult working conditions and short working seasons to technical design issues based on geology and environmental issues make developing hydropower as difficult as it is promising.

India has proposed to bring another 50,000 MW of hydropower production online by 2025, with a major proportion being in the form of "run of the river" projects, which avoid many of the human and ecological problems associated with some projects.

India's National Hydro Power Corporation is the largest public sector entity to be involved in hydroelectric generation in a specialized manner. There are a number of other entities – The Sutlej Valley Hydro Power Corporation, Tehri Hydel Power Corporation and North Eastern Electric Power Corporation Limited (*NEEPCO*) which are also partnering with the Central and state Governments concerned across India.

Major private sector players such as Tata Power Company, Jai Prakash HP Ltd, and JPPVL are building and operating projects of the size of 100 MW or lower in Himachal Pradesh and Uttarakhand, and even smaller sizes in Maharashtra. These companies are also getting involved in larger projects in Himachal, Sikkim, Uttarakhand and Madhya Pradesh.

Hydro electric projects in India are beginning to see technological advancements equal to those being made in other areas such as solar and wind. Sophisticated projects are beginning to come online as partnerships with foreign firms such as Alstom, VA Tech, Voith Hydro and Doosan expand and present great potential for hydro power in India. For example, Voith Hydro has established a plant near the industrial city of Vadodara to produce for small hydro plants in India. This approach provides a natural transfer of technology and know-how, allows components for hydro projects to be competitively priced and creates jobs throughout India. A true win-win.

Chapter III

Intellectual Property will be the Catalyst for Clean Tech Innovation and Deployment in India

A Growing Body of Work Demonstrates that IP Supports the Diffusion of Clean Technologies

One common denominator across all the clean technologies we have discussed is that they are pushing technological barriers. India has set some ambitious goals including the Ministry of Power's "Power for all" by 2012 goal and goals of Prime Minister Mr. Manmohan Singh's C*limate Change Action Plan* discussed earlier in this report. Technological advancement will be key to meeting these goals, and will literally require a "moon-shot" for an entire generation of scientists, engineers, inventors and entrepreneurs. They will seek and find solutions and they will also fail at times. But they will always establish valuable intellectual property as the result of a massive commitment of capital and resources. It is abundantly clear that this intellectual property is a defining catalyst in terms of the development and diffusion of clean technology in India.

This reality is being demonstrated by a range of studies dedicated to understanding the role of IP in the deployment of clean technologies.

Report from the International Energy Agency

In 2001, the International Energy Agency (IEA) contributed significantly to the dialogue with its report "Technology Without Borders: Case Studies in Successful Technology Transfer." This study cited "strengthening intellectual property rights" as one of the key actions that governments can take to improved the environment for the transfer of climate-friendly technologies.[19]

The IEA report contained several case studies, including a seminal program in the early 1990s led by the World Bank and the Global Environmental Facility (GEF) to improve the domestic markets for wind, hydroelectric and solar technologies. By helping set positive government policies, build the capacity of Indian innovators and producers, and strengthen public awareness of clean technologies, this program helped establish a set of tax incentives, favorable clean-electricity generation policies and acceptance of the technologies by commercial investors to created the right environment for private investment in renewables. This began to lay the groundwork for India becoming a major player in the global renewable energy industry.

Report from the U.S. International Trade Commission

The U.S. International Trade Commission (ITC) completed a study in 2008 that reviewed the impact of patents in the field of industrial biotechnology. This can mean enzymes that breakdown

[19]http://www.iea.org/textbase/nppdf/free/2000/ctifull2001.pdf

biomass to produce biofuels or more environmentally friendly bio-based plastics. In very plain terms the ITC declared that, "patents are facilitating, not stifling innovation."

The ITC found that between 1975 and 2006, the U.S. Patent and Trademark Office issued 20,428 patents for industrial biotech. ITC's analysis of this dense collection of patents revealed a number of trends. First, there is a notable growth in the number of patents held by U.S. universities (fueled by the Bayh-Dole Act of 1980). Second, patents in this field are not concentrated in the hands of a few owners and new patentees are steadily entering the market. Finally, more than 70% of the companies interviewed by the ITC for this study said that "patent barriers" are one of the least significant issues they face.

A May 2009 needs assessment conducted by the UNFCCC asked 70 developing nations to cite their views on barriers to clean technology transfer … The measures identified were:

- national involvement to attract foreign investments
- increased participation of the private sector in technology transfer
- removal of subsidies and price distortions
- improvement of collaborative research and development of environmentally sound technologies
- increased public awareness.

The words "intellectual property" did not even appear in this 58-page report.

What does this mean for innovation? First of all, the report highlights the importance of collaboration within the broader innovation process. Another way to describe collaboration is "technology transfer," and IP rights are the fuel for technology transfer in an innovative process that is now entirely global. According to the ITC, "Patents and other types of intellectual property, facilitate increasingly frequent collaborations by providing the foundation for the transfer of technology and knowledge between firm, university, and government actors." In other words: IP = collaboration = innovation.

This is the appropriate way to frame the debate around technology transfer when discussing the development of clean technologies in India. Technology transfer is appropriately understood as a means to an end, not an end in and of itself. As the ITC points out, the transfer of technologies and know-how requires a systemic approach involving sophisticated collaborations that rely upon the basic rules of a strong IP regime.

Those who advocate for broad-based compulsory licenses or a limit on clean technology patents fail to understand that the transfer of technology is a process requiring rules and structure. You may be able to move IP from point A to point B through a compulsory license, but you haven't transferred the technology in a meaningful way.

Report from the European Commission's Directorate General for Trade

A report commissioned by the European Commission's Directorate General for

Trade (DG Trade) entitled "Are IPR a Barrier to the Transfer of Climate Change Technology?" analyzed over 215,000 patents filed globally from 1998-2005 for seven "emissions reducing" technologies. These include solar, wind, and fuel cell technologies that accounted for over 80% of all clean energy patent applications over the period reviewed. The trends they discovered reinforce and compliment the work of the ITC.

First, the EU's report finds that, contrary to fears of monopoly ownership of certain green technologies, "no single nationality actually dominates the market for a particular technology."

> **"It seems unlikely that IP protection is a significant barrier to adoption of energy efficiency in developing countries."**
> **-** *Jennifer Haverkamp, Managing Director for International Policy & Negotiations, Environmental Defense Fund*

This leads to the most important question: what does this mean for the transfer of clean energy technologies among developed, emerging and developing economies? The EU's report stated that "for several of the seven most advanced technologies for which we have patent information, emerging countries account for a significant share of the patents which are protected in developing countries, making it less likely that patents and IPR constitute a major barrier for *transfer* (their emphasis) of carbon abatement technology from developed to emerging economies." This is not merely a statistical observation, but is clearly the reality in India. We have noted several examples across a variety of technologies that show the pathway for the effective transfer and, more importantly, the deployment of important clean technologies already exists in India and is producing demonstrable results.

We should also note that an interesting dynamic exists in terms of access to technologies by less developed countries that certainly share India's need for clean and effective sources of energy. According to the EU's report, "least developed countries can meet ambitious (carbon) abatement targets by applying mostly technology which is not protected by IPR … Hence, for the least developed countries, IPR protection does not appear to be a barrier for transferring the technology necessary for meeting the abatement targets which are currently being discussed."

UNFCC Survey of Developing Countries

Further, data from diverse sources also calls into question the notion that IPR represents a barrier to clean technology deployment. A May 2009 needs assessment conducted by the UNFCCC asked 70 developing nations to cite their views on barriers to clean technology transfer. The results are significant, "the main barriers to technology transfer identified were economic and market barriers. The measures identified by Parties to address these barriers were, inter alia: national involvement to attract foreign investments; increased participation of the private sector in technology transfer; removal of subsidies and price distortions; improvement of collaborative research and development of environmentally sound technologies

(ESTs); and increased public awareness." The words "intellectual property" did not even appear in this 58 page report.

Despite these facts, some, including Indian government officials, have claimed that IP protections are a barrier to the diffusion of clean energy technologies and encouraged global government bodies like the United Nations to intervene. It should be clear that changing global rules regarding the protection of IP (for example, by expanding compulsory licensing) would not just be a solution in search of a problem, it would have a devastating impact on the innovative process that will address and solve our biggest challenges. Again, the EU's report makes the case clearly and at length: "IPR protection is not the main barrier preventing the transfer of environmental technologies to developing countries. A large number of relevant technologies are not patented in low-income developing countries, and in emerging market economies a significant number is patented by local companies." It then goes on to say that "there is a serious risk that a broad use of compulsory licensing (or other measures weakening IP rights) would constitute a disincentive for companies engaged in that sector, which might reduce their investment in such technologies. This would clearly be detrimental in the long term…. IPR as such is not what makes technology too expensive for the least developed countries and emerging economies to access."

Comments from the Environmental Defense Fund

At a July 29, 2009 hearing held by the U.S. House of Representatives Select Committee on Energy Independence and Global Warming, Jennifer Haverkamp, Managing Director for International Policy & Negotiations, Environmental Defense Fund made several very insightful and effective observations. She began by stating that in UN negotiations so far, "intellectual property discussions display strong rhetoric but limited analytical basis." She went on to note that, "It seems unlikely that IP protection is a significant barrier to adoption of energy efficiency in developing countries," and that should concerns over IP protection arise, "other fora (WIPO, the WTO TRIPs Agreement), with their flexibility provisions and the requisite expertise and mandates, appear better positioned than the UN Framework Convention on Climate Change to address the issue."[20]

[20] http://www.edf.org/documents/10291_Haverkamp_IPR_&_Tech_Transfer_Testimony_072909.pdf

The Flow of Investment Capital and Creation of Millions of Indian Jobs

This innovation and technological deployment will lead to real job growth in India as well. **The deployment of the technologies discussed in this report could lead to the creation of nearly 10 million new jobs in India over the next 25 years.**[21]

In addition, respect for intellectual property and innovation will welcome investment capital that also stimulates job growth. Over the past year, India has attracted nearly $350 million in venture capital to support clean tech companies. A study led by the Indian group Assocham and the global consulting firm Deloitte estimates that an additional $3.5b in venture funding could flow to Indian clean tech projects in the coming years. This will translate into real jobs.[22] The group Environmental Entrepreneurs and the Natural Resources Defense Council found that for every $100 million in venture capital invested, approximately 2,700 jobs are created. Thus, the current level of clean tech venture funding leads to the creation of nearly 10,000 jobs in India every year, and could ultimately add nearly 100,000 jobs in the near term.

Indian job creation estimates for specific clean technologies:

- **44,000** jatropha biofuel projects *(Indian Railways)*
- **150,000** for transitioning to advanced cooking technologies *(U.N)*
- **100,000** jobs based on projected venture funding
- **213,000** jobs in wind energy by 2030 *(Global Wind Energy Council and the Indian Wind Turbine Manufacturers Association (IWTMA)*

The U.S., India, and other major economies will have some tough decisions to make in terms of addressing global climate change and developing next-generation energy sources. Whether or not to support innovation and protect the IP which will get us there is simply not one of them. Both hard data and empirical evidence now clearly demonstrate that the protection of intellectual property is essential to the development, commercialization, and transfer of a range of promising clean energy technologies. It will also lead to significant job growth in India.

[21] See Appendix I for comments on methodology

[22] http://www.thehindubusinessline.com/2009/06/24/stories/2009062450460300.htm

Chapter IV

The Gap Between Reality in India and Rhetoric at the U.N.

Private Sector Collaborations Belie Bureaucratic Proclamations

In contrast to the stance the Indian government has taken in the UN climate change negotiations, India's power industry (presently dominated by state enterprises) has been taking practical actions to enter into licensing arrangements with international partners to introduce more efficient technologies for power generation and develop more energy efficient practices. For example, the biggest supplier of equipment to India's energy sector, the government owned Bharat Heavy Electricals has teamed up with Alstom and Siemens to build equipment for 'super critical' and 'ultra super critical' power plants. Private sector collaboration is also extensive, with a range of firms including Bharat Forge, GE, Alstom, Tatas, ABB, Larsen & Toubro, Mitsubishi Heavy Industries, GB Engineering, Ansaldio Caldio, JSW and Toshiba establishing a variety of partnerships.

This has happened routinely and without fanfare, and the agreements have been negotiated in like manner as other commercial contracts. No issues of compulsory licensing or exorbitant royalties or license fees have been raised in public forums in respect of such agreements. In fact, Suzlon, India's leading wind energy company, has gone one step further - actually purchasing the foreign companies which owned the technology it needed access to, along with the manufacturing facilities to drive its worldwide operations.

This effective pattern of collaboration is working not only in the energy sector, but also in other sectors of economic activity where India has sought to acquire necessary technology. The prestigious Delhi Metro Rail Project (DMRC is joint owned by the Government of India and the Government of the National Capital Territory) has worked with a number of global suppliers to acquire sophisticated tunnel boring machines and coaches. Some of the most well-known water treatment desalinization projects owned and run mainly by public bodies in India utilize services and technology provided by foreign technology providers such as GE, Degremont and Aquatech. All these projects either directly or indirectly serve to reduce carbon emissions in India.

> The National Knowledge Commission, a key initiative of Prime Minister Manmohan Singh, has reinforced the view of Indian industry with its observation that, "IPRs have emerged as an indispensible strategic tool in today's knowledge economies and societies, particularly in the context of economic globalization.

There is a strong consensus within Indian industry for adoption of proven clean technologies in every sphere of economic activity, provided they make long term economic sense. This is

particularly true of investment in new plant and equipment.

The National Knowledge Commission, a key initiative of Prime Minister Manmohan Singh, has reinforced the view of Indian industry with its observation that, "IPRs have emerged as an indispensible strategic tool in today's knowledge economies and societies, particularly in the context of economic globalization. An entity's ability to compete in the global market depends to a large extent on its capacity to generate new ideas through innovation in science and technology, where such ideas are transformed into wealth generating products. IPR by conferring exclusive monopoly rights to its owner for a limited duration has emerged as a significant factor in creating incentives for innovation and generation of economic value. An effective IPR system is also a constituent of a reliable legal environment, which in turn becomes an important factor for decisions on foreign investment and technology transfer."

India's power industry (presently dominated by state enterprises) has been taking practical actions to enter into licensing arrangements with international partners to introduce more efficient technologies for power generation and develop more energy efficient practices.

These are not just idle observations, but demonstrate Prime Minister Singh's keen recognition of the factors driving his economy and what will underpin India's growth and competitiveness for generations to come. His views should also serve as a guidepost for India's engagement in fora such as the UNFCCC, WIPO and the WTO as they consider the role IP plays in the development and deployment of significant new technologies.

These views also represent the forward looking position of people who are confident about India's ability to hold its own, in the emerging global economy, where progress will be driven primarily by knowledge and the ability to execute.

There are those however who worry that a strong international IP regime might somehow hold back India's progress and development. There may be lingering fears of an earlier era – of India not having significant innovative capacity or the ability to pay for patented knowledge.

There is also a certain lack of realization that the main barriers to adoption of new technologies may have much more to do with the level of absorptive capacity, social and economic conditions than with intellectual property rights. The reality is that the lack of patent protection will inevitably diminish the incentives available to innovators without leading to useful exploitation of new technologies by developing countries.

It is far more effective to apply the views expressed by the National Knowledge Commission to create conditions in India that further promote domestic R&D on climate change related technologies, instead of arguing for dilution of patent rights.

Unfortunately, some of the views expressed on behalf of India that seem to

contradict the ideology of the National Knowledge Commission. A recent summary of India's stance and perceptions on current climate change negotiations stated that the Government of India does not believe that the transfer of technology can be left to the market mechanism alone and has called not only for such technologies to be treated as 'public goods' but also for compulsory licensing of such technologies as a matter of routine. This seems to be in contradiction to the very concept of compulsory licensing in the Indian Patents Act and their intent within the TRIPS Agreement.[23] Advocacy of compulsory licensing as a rule, rather than as an exception, is shortsighted and would be harmful to India's interests in the long run. By its very nature, compulsory licensing is an instrument meant to handle emergencies over the short term; a climate change mitigation program lasting half a century cannot fit into this category.

Compulsory Licenses Slow Technological Development and Diffusion

Rushing to implement a broad compulsory licensing regime for energy technologies would be harmful to India's own rapid industrialization and technological development efforts in the long run, as it would create doubts among innovative companies around the world about the business viability of sharing such technologies with Indian firms.

This outcome is not just idle speculation. According to a U.N. report, "In the case of China … wind power companies have been eager to invest there, but have not deployed the latest designs—for fear that domestic companies will reverse-engineer and copy them."[24] India should be cautious not to make this same mistake.

> India's forward looking steps have helped to establish a vibrant IT industry and made India a global technology leader. This pattern could easily repeat itself in the clean technology space if India supports IP rights and lowers barriers to entry for innovative energy technologies.

As recognized by diverse entities ranging from Indian energy firms, the EU, the Environmental Defense Fund and the U.S. Congress, treating clean energy technologies as "public goods" is an untenable position and would remove the incentive for many still nascent and promising technologies. Besides that, the whole argument about whether technology should be as a "public good" fails to recognize facts regarding actual IP ownership, and more troubling, it distracts us from the most immediate challenges.

As the study conducted by the EU points out, in developing countries most clean technologies are not even patented and in emerging economies (like India) most

[23] THE ROAD TO COPENHAGEN: India's Position on Climate Change Issues - ttp://pmindia.nic.in/Climate%20Change_16.03.09.pdf and Government of India Submission to UNFCCC on Technology Transfer Mechanism - http://unfccc.int/files/kyoto_protocol/application/pdf/indiatechtransfer171008.pdf

[24] Green Jobs: Towards Sustainable Work in a Low-Carbon World, U.N. Environment Programme, 2007

carbon abatement technologies are actually patented by other emerging economies, not only by developed countries.

Forward Looking Economic Policies and Reducing Trade Barriers Have Proven Effective

In fact, it would be more useful and practical for India to follow the strategy it used for the development of its information technology sector, specifically dropping to almost zero all tariff and non tariff barriers, respecting intellectual property and welcoming investment.[25] A 2008 OECD study addressing the role of technology transfer for developing countries cited India's success in this regard, "Initially, leading multinational firms such as Hewlett Packard, Texas Instruments, and Motorola set up subsidiaries in India for purposes of outsourcing tasks from developed countries. Over time, those tasks became more complex from serving as call centers to writing software modules. Moreover, indigenous firms have emerged as global players, such as Infosys Technologies, IC.Net, Mastek, and Tata Consultancy Services."[26] India's forward looking steps in this area have helped to establish a vibrant IT industry and made India a global technology leader. This pattern could easily repeat itself in the clean technology space if India supports IP rights and lowers barriers to entry for innovative energy technologies.

The most immediate step to take to reduce costs associated with the global deployment of leading clean energy technologies has nothing to do with IP. The need of the hour is to eliminate all tariff and non tariff barriers on clean technologies so that an environment conducive to their early deployment is created.

Unfortunately, the rationale for pushing policies like compulsory licenses or patent exclusions for clean technologies have little to do with getting them deployed and allowing them to make an impact for citizens and for our environment. Endorsement of such policies is all the more surprising for a country like India, which has never used compulsory licensing. Perhaps these are just negotiating strategies. If so, they are extremely short sighted – the confusion caused by them might make the suppliers of technology hesitate to share it on account of the uncertainty caused by such stances or it will at least impel them to raise license fees to compensate for risk and uncertainty.

[25] India is a signatory to the WTO Information Technology Agreement

[26] http://lysander.sourceoecd.org/vl=521671/cl=11/nw=1/rpsv/cgi-in/wppdf?file=5kzr6fh57jln.pdf

Chapter V

Policy Recommendations that will Address Real Barriers and Support Clean Tech Innovation and Deployment in India

Making Intellectual Property Part of the Solution

As countries engage in negotiations to combat the effects of global climate change, it is clear that any effective solution will require the commitment of all nations, developed and developing.

This will certainly require a dual commitment from the developed world to not only help these developing and emerging economies to get access but to also work with them on implementing and using these clean energy technologies.

Weaning the world from fossil fuels will take time, perhaps decades. But in the meanwhile, clean and renewable energy sources will provide a significant piece of the puzzle. The United States and India have already taken the first step with their civilian nuclear energy agreement. India now has full access to clean reliable nuclear energy. With agreements in place with France, Russia, and the United States, the Indian government will soon have a major piece of their overall energy solution.

It should be clear that making intellectual property the problem is short-sighted and will jeopardize the unique potential that the U.S. and India have to work collaboratively towards real and meaningful solutions.

The goal now is to give India and other nations the opportunity to find the other pieces to their energy puzzle. Countless companies and nations have invested billions in creating ways to take advantage of renewable energy. Much of this technology is in private hands, the product of invention and significant R&D expense. Now the question is - how do we get this technology into full use in India?

It should be clear that imperiling the protection of intellectual property is short-sighted and will jeopardize the unique potential that the U.S. and India have to work collaboratively towards real and meaningful solutions.

Pushing aside IP protections and simply "taking" the technology the government thinks it needs doesn't solve the problem of how to implement and utilize the technology. For example, in the United States, wind technology is widely available, but a huge unsolved problem is building the energy infrastructure necessary to actually store and transmit the energy generated by wind farms in rural areas to the cities and towns where it can be used. India will face these same problems, even if there's a photocopy of the patent and a blueprint of the technology. In the end, issuing a compulsory license for a technology the government finds attractive is a superficial approach that sidesteps the really tough and important issues such as

regulatory costs, infrastructure improvements, and capital investments.

Apart from proprietary technologies, India is free to use clean energy inventions that are no longer under patent protection. If those technologies have been previously patented elsewhere in the world, a copy of the patent is a download away. Once again, however, there is still a world of difference between knowing something and actually being able to put it to use.

The goal is for India to be capable of actually manufacturing and employing these technologies. All the compulsory licenses in the world won't build an energy efficient factory or provide the necessary technical expertise to allow India to make use of clean energy technology. The Indian government and its own industry leaders will need to partner with the best and brightest companies from around the world to ultimately realize the promise of clean and reliable energy, not threaten to simply take the technology they want.

Building the infrastructure, maintaining alternative energy facilities, and achieving consumer demand for "green" products will require India to work with the private sector. As we have seen with civilian nuclear energy, there is much to be gained when a choice is made to engage and work with the global community.

Here is the policy approach that will help to ensure, going forward, a solid commitment towards a solution.

Protection, Technology Diffusion and a Competitive Marketplace

The IP-based solution takes into account tenets of India's National Knowledge Commission and experiences that have proven effective in the past like the growth of the IT industry in India. This approach is based upon the promotion and protection of IP, focusing on technology diffusion and creating a competitive marketplace. Getting clean energy technology into India will require that the government work with private sector innovators. Providing a commercially viable licensing regime for green technologies will certainly go a long way toward encouraging other companies to bring their green innovations to India. Effective IP enforcement will not only improve the business climate but also encourage innovators to bring their latest technologies into the Indian market. Ensuring legal certainty and protecting the rights of innovators will encourage international joint ventures and collaboration.

The Role of Effective Patent Protection

Before we even get to the licensing stage, we first need to discuss patent protection. Though India's recent updates to their national patent law brought it closer in line with its international obligations, there are several outstanding issues. These include protection for regulatory test data, incremental innovations, and patent pendency. In the clean energy space, patent pendency, or the time it takes to actually receive a patent, is the most pressing issue. In the United States, an inventor has the option to file a petition to make their patent application

"special" if it will somehow improve the availability of energy or have a positive impact on the environment. Since these types of "green" inventions benefit the public good, the U.S. patent office does not charge additional fees and filing the petition effectively bumps the application to the head of the line. Implementing a similar policy in India will be important and helpful in getting the latest green technology into the country and in use.

India also does not allow patents in the field of atomic energy. While India does this within the parameters of the WTO's Trade Related Aspects of Intellectual Property (TRIPS) regime, it may nonetheless be advisable for India to revisit this policy in light of the developments in this area which are bound to occur as a result of U.S.-India Civil Nuclear Agreement. Ultimately, the U.S.-India Nuclear Agreement will depend upon collaboration (and technology transfer) between the Nuclear Power Corporation of India and foreign firms like Areva, General Electric, Rusatom, and Westinghouse to quicken the pace of the nuclear power generation capacity. There could be similar collaborations between private firms in India and foreign players. It may therefore be useful for India to review its policy on patents in the nuclear field. For instance, while the U.S. does not allow patents for nuclear weapon related technologies, other nuclear technologies can be patented on a case by case basis, with the permission of the Department of Energy. A similar flexibility on the Indian side could mean faster progression in collaboration and transfer of technologies.

A Win-Win Environment for Technology Diffusion

For many companies their strategy is to license the technology they own. For others, their strategy is to design, build and sell an end-product. Lessening the restrictions on foreign companies entering into joint ventures in India will improve the likelihood of the formation of partnerships which enable technology transfer and R&D collaboration. Especially important will be encouraging foreign companies to engage in joint ventures with Indian universities and academic research centers. There is even opportunity here for private sector and government cooperation as well.

A significant area for collaboration between India and other innovator nations is the current effort to implement a technology transfer regime in India. India is expected to soon pass the Public Funded R&D Bill that would put in place a legal framework to support widespread commercialization, innovation and economic growth based upon publicly funded R&D projects. The impact will be significant. According to the Federation of Indian Chambers of Commerce and Industry (FICCI) the bill, "will lead to the development of a rich local base of IP to arm Indian companies as they compete in the world marketplace and cross-

> There is a tremendous opportunity for India to assume a leadership role in the U.N. Framework Convention on Climate Change discussions on the topic of supporting and promoting clean technology innovation

license IP with other enterprises around the world."[27]

The importance of this bill was noted at the time of its introduction in 2007:

"A phenomenal transformation in the attitude and approach to R&D in industry has taken place. From a 'back seat' position a mere ten years ago, R&D in Indian industry is now in the 'front seat' of corporate strategy. In several sectors, business driven research has given way to research driven business."[28]

Creating a Competitive Marketplace for Clean Technologies

For innovative companies looking to provide solutions in the Indian marketplace, ensuring a competitive and open environment is paramount. The first step in ensuring market access for green technologies would be to reduce or eliminate tariffs. If local Indian companies are not producing the technology that India needs, and if the Indian government feels that the costs for foreign goods are too high, then the government needs to eliminate exorbitant tariffs to bring down the cost. A country cannot seriously make the argument that a product is too expensive while it charges high import tariffs that effectively price it out of the market and then argue that the foreign producer is to blame and needs to reduce the price that they charge. It is a specious argument and one that will prevent India's citizens from ultimately benefitting from existing alternative and renewable energy technologies.

Once these green technologies enter the market, companies will then need to setup manufacturing facilities, distribution points, and develop a sales and maintenance networks throughout the country. This will not only create countless new jobs but also provide tax revenues to the government and create new manufacturing capacity and infrastructure in India.

Tax incentives will also play a strong role for companies and consumers. At the Central and State government level, India can provide companies with incentives to build renewable energy facilities. The Indian government may also consider providing tax credits to consumers, who retro-fit buildings with green technologies or install solar paneling to roofs. These incentives can help encourage consumers to adopt green technologies and help multiply the benefits of using these technologies.

This is a win-win for both the Indian government and its people. By working together with industry the Indian government will be able to achieve many of its climate and economic goals.

Ultimately, to maximize the potential for clean technology growth in India and to accomplish their goals we may need to look beyond the elements discussed in this report.

There is a tremendous opportunity for India to assume a leadership role in the U.N. Framework Convention on Climate Change discussions on the topic of supporting and promoting clean technology innovation. This position should be guided by facts that demonstrate that IP is not a barrier to clean tech diffusion, and that it in fact

[27] http://www.indiarnd.com/papers/PFRD.pdf
[28] http://www.indiarnd.com/html/titles.htm#k

promotes the deployment of important technologies. India should also see the significant potential that a robust, cutting-edge clean tech industry will have in creating millions of good jobs in India in the coming years.

Conclusion

India is blessed with abundant natural resources and it is perfectly situated to utilize alternative energy sources, such as solar, wind and geothermal … It is an energy innovator as well.

Clean energy has already captured the public's imagination. As the months and years go by, we will see even greater growth and use of clean, renewable sources of energy in all facets of our daily lives. As countries, like India, move their people out of poverty, the need for clean reliable energy becomes less of a luxury and to put it quite simply -- a necessity. The planet cannot sustain continued exponential growth in the use of fossil fuels, and so renewable energy and clean technologies will fill a greater part of the gap. As this report has detailed, India's energy needs are great, but luckily so are the options for filling them.

India is not only blessed with abundant natural resources, it is perfectly situated to utilize alternative energy sources, such as solar, wind and geothermal. It is an energy innovator as well. India is a leader in wind power use and innovation, with Indian wind technology being exported throughout the world. Having abundant year-round sunshine, solar energy is even being used in villages and temples for cooking and electricity. And as India's domestic nuclear industry continues to develop, with additional plants starting to come online, domestic energy production will continue to grow.

As this report has discussed, India will need to implement an effective strategy to not only ensure that it fully utilizes the clean energy technologies that it already possesses, but that ensures continuing access to technologies it will eventually need. By protecting the rights of innovators, and creating an investment climate that encourages the use of new and varied types of green technologies, India will find the solution it so desperately seeks in solving its energy concerns.

But to realize the dream of clean energy independence will require massive investments into infrastructure, education, and research & development. Though the technology exists, it will be up to the Indian government and industry to work to build-up India's infrastructure, in not only its cities but also in villages and rural areas. These infrastructure investments are a giant piece of the puzzle.

As part of the ongoing international climate talks, India has been pushing for cheaper access to technology. But the real issue will come down to building the infrastructure needed to actually use it. The wide variety of clean energy technologies available means that the question of access is really one of choice. Ultimately, any support that developed countries provide, as the price for successful climate negotiations, will need to go toward lowering barriers to market entry and construction, rather than weakening intellectual property protections.

Though there are clear takeaways for government action, industry must also realize that this new field will reward

those who make the early deals --- it is a buyer's market. Once the infrastructure is built, countries will have little incentive to switch from one set of clean tech to another as the benefit of doing so would likely be minimal as compared to the cost. Right now, there are many players on the field, each one looking for their chance to hit it big. Countries are in the driver's seat, and if one technology does not provide the best cost to value ratio, there are others to choose from.

Intellectual property protection should not be seen as a barrier to access; it is the reason access even exists. The free market, itself, will play a large role in ensuring fair access to green technologies. Innovators are not looking to develop technology merely to have it sit on a shelf --- they are looking to market it, license it, and recoup their costs so that they can continue to innovate. Quite simply, if an innovator chooses not to play, it gains nothing, and will be left to watch as others most certainly will reap the rewards.

Clean technology advancements in India will help meet the ambitious goals articulated by its leaders and it will also have a significant human impact. The potential for clean technology innovations, partnerships and deployments to create up to 10 million good-paying jobs in India will put it on par with the original "green revolution" in India. This will be realized by welcoming and respecting innovation, continuing to address important structural needs and opening the vast Indian market.

As this report has detailed, there is no single technology that will be the panacea for the world's current and future energy needs. It will take many different pieces, put together, to drive us toward the solution. The first piece will be infrastructure, the second will be alternative sources of energy, and the third will include clean technologies to counteract the effects of CO2 emissions and environmental pollution that has accumulated from the start of the industrial revolution. Though we know where we want to go, the path is not yet clear and the road is still being built. But with a clear purpose and direction our journey has already begun.

The potential for clean technology innovations, partnerships and deployments to create up to **10 million good-paying jobs** in India will put it on par with the original "green revolution" in India. This will be realized by welcoming and respecting innovation, continuing to address important structural needs and opening the vast Indian market.

APPENDIX I

Estimation of additional jobs likely to be created by Indian Clean Technology Initiatives by 2025

A. The norms adopted by the Indian Central Electricity Authority (CEA) for calculation of manpower requirements are :

- Hydro (Construction + Maintenance) 11.9 persons per MW
- Thermal(Construction + Maintenance) 9.1 persons per MW
- Nuclear ((Construction + Maintenance) 9.9 persons per MW
- Distribution 1 per 1000 consumers – in our calculations we have assumed 200 million households as against a population exceeding 1 billion

B. For new and renewable energy the figures were obtained from the World Institute of Sustainable Energy (WISE) report and represent the maximum potential development for each energy category within their scenario for India.

C. The CEA norms have been then been used to calculate additional employment over 25 years for hydro, thermal (whether coal or gas or oil), and nuclear based on the projections given from the WISE renewable scenario for India. Only half the number for coal based-plants have been taken as "green". The estimates have been increased by 9.6/7 because the Government has increased the Committee's estimates by this factor

D. The following table represents generating capacities after 25 years in forced renewable scenario is extracted from page 46 of the report on integrated energy policy as mentioned in column 2. Column 3 is based on calculations as described in the assumptions above

Source	**Capacity**	**Calculation of man power requirement (projected – current capacity) in MW x Employment factor**
Coal	**269997 MW**	**(269997 -77000)x9.1 = 175627/2 =878136**
Natural Gas	**69815 MW**	**(69815 -15000) x9.1 = 498817**
Coal Bed Methane	**27778 MW**	**(27778 -0)x 9.1 =252780**
In Situ Coal Gas	**22222 MW**	**(22222 -0)x9.1 =202220**
Nuclear	**63060 MW**	**(63060 – 4120)x9.9=583506**
Hydro	**150153 MW**	**(150153 – 36000)x11.9 =1358421**
IGCC Pet Coke	**3137**	**(3137-0)x9.1=28547**
SUBTOTAL for		**3802427x9.6/7=5214757**

main stream energy upped by a factor of 9.6/7		
Add margin for distribution at 1 person for 1000 households for 200 million households		**200000**
Estimate for Renewables from World Institute of Sustainable Energy		**2800000**
Estimate for forestry and Social forestry		**36000000000/3x5/40000=1500000**
TOTAL		**9,714,757**