Federation of Indian Chambers of Commerce & Industry

Rajasthan State Pollution Control Board

Conference on

CLIMATE CHANGE AND RENEWABLE ENERGY

Exploring the Clean & Green Energy Potential

THEME PAPER

Knowledge Partner

Sustainable Solutions for the Planet

Emergent Ventures India Pvt Ltd

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Theme Paper

Conference on Climate Change & Renewable Energy

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About RSPCB

The Rajasthan State Pollution Control Board is a body corporate constituted under section 4 of the Water (Prevention and Control of Pollution) Act, 1974. It was first constituted on 7th February 1975, with the objectives of prevention, and control of water pollution and maintaining or restoring of wholesomeness of water. Later, it was also entrusted with the responsibilities of prevention, control and abatement of Air Pollution under the provisions of Air (Prevention and Control of Pollution) Act, 1981. Water (Prevention and Control of Pollution) Cess Act, 1977 has been enacted to make the State Board financially independent. Under this act the State Board has been given powers to collect Cess on the basis of water consumed by the industries etc.

Enactment of the Environment (Protection) Act, 1986 has further widened the scope of the activities of the Board. This Act being umbrella legislation, different rules for addressing the problems of various sectors have been enacted under this Act.

About EVI

Emergent Ventures India Pvt. Ltd. (EVI) launched its advisory business in the year 2004 to accelerate action for a sustainable planet by integrating innovative solutions in technology, policy and finance. Since beginning, we have attracted highly qualified professionals, talent as well as equity investments from leading infrastructure Private Equity fund such as IDFC PE (invested in EVI in year 2008) and have launched many initiatives in energy and environment sectors in a highly focused manner.

We provide sustainability, climate change and renewable energy consulting to clients across the globe. We have years of industry experience, robust domain expertise and global work profiles – in location as well as experience. We have significant experience with climate change regulations across the world, through which we actively help shape the international debate on environment & business centric sustainable practices.

As a thought leader in its domain of work, EVI is currently working on over 400 diverse projects across countries such as India, Srilanka, Bangladesh, Pakistan, Singapore, Malaysia, Thailand, Indonesia, Philippines, Mexico, Nigeria, Egypt, Algeria, Nepal, USA, and Europe. Our clients include Governments, UN Organizations, Donor Agencies, NGOs as well as Corporates in Oil & Gas, Utility, Cement, Steel, Pharma, Hospitality, Aviation, Financial, Food & Beverage sectors among others including companies in fortune 500 list.

"EVI exists to catalyze actions for a sustainable planet and create a positive impact by integrating innovative solutions in technology, policy & finance... "

EVI's team comprises of international policy, finance, technology and strategy professionals with strong domain experience in energy & climate policy, sustainable transportation, waste management, resource efficiency & energy management corporate sustainability, carbon markets and renewables (wind & solar). We provide sustainability, climate change and renewable energy consulting to clients across the globe. We have years of industry experience, robust domain expertise and global work profiles – in location as well as experience. We provide sustainability, climate change and renewable energy consulting to clients across the globe.

Executive Summary

The climate issue continues to loom before us- ever increasing in its threat. India stands to loose significantly as it faces threat of uneven monsoon, melting Himalayan glaciers, potential coastal flooding, reduced agricultural productivity and resulting shortages of water and food, degradation of land and unmanageable cities.

India has responded by setting its ambitions higher in terms of renewable energy (165 GW by 2022), distributed energy systems, water conservation, energy conservation (National Mission on Enhance Energy Efficiency), smart grids (smart grid mission with a clear roadmap), eco-friendly 100+ smart cities, new and progressive waste management rules (2015 rules), smart and eco-friendly transportation including electric vehicles (National Electric Mobility Mission Plan) etc. In most of these areas significant work would need to be done by 2030 and a clear momentum needs to be built by 2020.

India's agenda looks like a lot. We have never managed so much change in such a short period of time. However this challenge needs to be met. Policy makers are aware, states have begun to align in with various initiatives, and large programs are being announced. However there is some sense of skepticism. Is it all talk or can we walk the talk?

The total financing requirement to carry out Renewable energy and Climate change interventions ranges into $500 billion. To raise such capital, new investors private investors are required to pitch in the Indian markets. Along with this new and innovative financial models needs to be developed. GOI has started taking positive steps towards this such as Green Bonds, Investment Trusts etc. Recently announced financing of $20 billion from Soft Bank showcases a heightened interest in the Indian markets.

Land acquisitions and allocation remains a priority as well as a major challenge for the GOI in carrying out activities pertaining to Renewable Energy, developing Smart Cities etc.

To walk the talk we need models of implementation excellence. There are some states where resources, policies, and local capabilities can deliver. Perhaps they could be focused on. We also need models of resource access by states, which strictly depend on their adherence to nationally accepted rules and programs and performance which is transparently visible to investors, policy makers and entrepreneurs alike. We need policy frameworks which provide direct market based support to activities which are in line with new priorities and take away support to activities which go against new priorities. This may mean new taxes on fossil fuels, reduced energy subsidies, reduced subsidies to water and waste management activities and new credits (e.g water credits) which support investment in new activities.

Climate Change

Evolution of Climate Change Regime

Tackling climate change presents distinct challenges for international law, which is already complicated to negotiate and difficult to enforce. Climate policies potentially reach all activities that burn fossil fuels and can therefore go to the core of the country's economy. The current international climate change regime comprises of an intermingling network of agreements and mechanisms.

The international political response to climate change initiated with the adoption of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, which sets out a framework for action aimed at stabilizing atmospheric concentrations of greenhouse gases (GHGs) to avoid *"dangerous anthropogenic interference with the climate system".* The Convention, which entered into power on 21 March 1994, now has 196[1] parties. The UNFCCC does not establish binding limits on GHG emissions for any countries. Rather, it lays down framework for further action and cooperation on the issue of climate change.

An apogee in the evolution of the climate regime was when the Kyoto Protocol to the UNFCCC came into force in 16 February 2005[2]. The Protocol outlined emission limits for the Convention's Annex I Parties[3] for the period of 2008-2012 (first commitment period). However, the Kyoto Protocol was not the final word on the issue. Its emission limits covered only a fraction of the world's greenhouse gas (GHG) emissions and those limits expired in 2012.

Since, the nature of the issue is such that it will require a very long term response under conditions of scientific uncertainty. For these reasons, governments are reasonably careful in making commitments under international law to limit GHG emissions. Nevertheless, efforts for combating the harmful effects of climate change have been enduring since the first session of Conference of Party[4] (COP) till date. A brief snapshot of the same is presented in Table 1 below.

Table 1: Brief History of International Negotiations

COP #	Location	Year	Description
COP 1	Berlin, Germany	1995	Aimed at assessing member states' capacity in implementing the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Subsidiary Body for Implementation (SBI). The 'Berlin Mandate' was the result of this meeting with its main task being to draft a protocol or legal instrument to compel Parties to address climate change.
COP 2	Geneva, Switzerland	1996	Focused on stressing the need to accelerate talks on how to strengthen Climate Change Convention
COP 3	Kyoto, Japan	1997	Developed countries agreed to specific targets for cutting their emissions of greenhouse gases. A general framework known as the **Kyoto Protocol** was defined. The protocol was instrumental in efforts aimed at curbing GHG emission. It came up with mechanisms – emission trading, clean development mechanism (CDM), joint implementation
COP 4	Buenos	1998	Aimed at strengthening the provisions of Kyoto Protocol through

[1] https://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php [Accessed on 26th May 2015]
[2] https://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php [Accessed on 26th May 2015]
[3] The Framework Convention divides all the Parties into two main groups: the Annex I countries, which comprise primarily developed countries and the non-Annex I countries, which comprise primarily developing countries based on the principle of "*Common But Differentiated Responsibilities And Respective Capabilities"* reflecting a view that developed countries bear a greater historical responsibility for the accumulation of GHG emissions and have greater capacity to take action.
[4] The Conference of Parties (COP) is the supreme body of the United Nations Framework Convention on Climate Change (UNFCCC). It currently meets once a year to review the Convention's progress and establish the rules of its implementation.

COP #	Location	Year	Description
	Aires, Argentina		the adoption of a 2-year action plan.
COP 5	Bonn, Germany	1999	It set a timeline for completing work on Kyoto Protocol
COP 6	The Hague, Netherlands	2000	The first session of COP 6 took place in the Hague, Netherlands in year 2000. The negotiations took a political turn with the US and EU, carbon credits and non-compliance taking the centre stage. The second session of COP 6 was held in Bonn, Germany and focused on flexible mechanisms, carbon sinks, compliance matters and funding the climate change process.
COP 6	Bonn, Germany	2001	
COP 7	Marrakech, Morocco	2001	Finalized on the Buenos Aires Action Plan and ratification of Kyoto Protocol. The Convention also adopted the Marrakech Accords.
COP 8	New Delhi, India	2002	Adopted the Delhi Ministerial Declaration[5] and New Delhi Work Program
COP 9	Milan, Italy	2003	Adopted **Adaptation fund** to support developing countries in adapting better mechanisms in curbing climate change
COP 10	Buenos Aires, Argentina	2004	Aimed at promoting climate change mitigation and adaptation of cleaner mechanisms as well as post-Kyoto mechanism.
COP 11	Montreal, Canada	2005	Marked first meeting of the parties (MOP-1) to Kyoto Protocol. The conference produced the Montreal Action Plan.
COP 12	Nairobi, Kenya	2006	A five-year plan of work adopted to support climate change adaptation by developing countries.
COP 13	Bali, Indonesia	2007	Post 2012 framework and **Bali Action Plan** were developed.
COP 14	Poznan, Poland	2008	Modality for financing the poor nations in curbing climate change was proposed.
COP 15	Copenhagen, Denmark	2009	Aimed at setting up climate change agreement to succeed Kyoto Protocol. This however, was not realized.
COP 16	Cancun, Mexico	2010	Agreement that called for the 100 billion USD per annum "Green Climate Fund", and a "Climate Technology Centre" and network adopted.
COP 17	Durban, South Africa	2011	Creation of **Green Climate Fund**
COP 18	Doha, Qatar	2012	Aimed at renewing commitments on **Kyoto Protocol with second commitment period** running from 2012 until 2020.
COP 19	Warsaw, Poland	2013	Asked the parties to initiate or intensify domestic preparations for their **intended nationally-determined contributions (INDCs)**, and resolves to accelerate the full implementation of the Bali Action Plan and pre-2020 ambition. Warsaw international mechanism on loss and damage to consider steps to address loss and damage suffered by especially vulnerable countries, and the “Warsaw REDD+ framework,” a series of seven decisions on REDD+ finance, institutional arrangements and methodological issues was adopted.
COP 20	Lima, Peru	2014	Work on a draft text for the Paris agreement underway. Finalization of the process around the submission of INDCs. Approval on an initial two year workplan of the Executive Committee of the Warsaw International Mechanism for Loss and Damage
COP 21	Paris, France	2015	To be conducted this year

[5] http://unfccc.int/cop8/latest/delhidecl_infprop.pdf [Accessed on 26th May 2015]

Clean Development Mechanism

The **Clean Development Mechanism (CDM)**, is defined in Article 12 of the Kyoto Protocol, is a flexible mechanisms with two main goals: 1) to assist countries without emissions targets (i.e., developing countries) in achieving sustainable development, and 2) to help those countries with emission reduction targets under Kyoto (i.e., developed countries) in achieving compliance by allowing them to purchase offsets created by CDM projects.

A number of issues in the CDM process have been identified. Several of these issues were addressed by the new Program of Activities (PoA) that moves to approving 'bundles' of projects instead of accrediting each project individually. But still the scenario remained gloomy with the plunging prices of EUETS CERs (since 2012) and absence of governments' support.

There are 7730 registered CDM projects as per CDM pipeline's[6] data of which only 986 projects are still at validation and 14 have requested registration. For 1988 CDM projects the DOEs have terminated validation, and for 267 the DOEs have given a negative validation. 271 projects were rejected by the EB, and 62 projects were withdrawn. The total issuance is 1551 MCERs. The average issuance success is 89%.

India has been a very active participant in Clean Development Mechanism with 1544 registered projects[7] till date. India's experience from CDM on programme design, MRV system, institutional structuring among other things will help a great deal in implementation of any climate change initiative in the country including NAMA.

Country Level Actions

NAMAs

Nationally Appropriate Mitigation Actions (NAMAs) are increasingly being seen as one of the cornerstones scaling up international mitigation activity (Figure 1). The term was first introduced in the Bali Action Plan of 2007, where all Parties to the United Nations Framework Convention on Climate Change (UNFCCC) agreed to negotiate on - *"Nationally appropriate mitigation actions by developing country Parties in the context of sustainable development, supported and enabled by technology, financing and capacity building, in a measurable, reportable and verifiable manner"*. It is widely agreed that NAMAs will be pivotal for developing comprehensive policies and programs to carry out mitigation action as well as securing climate finance to fund mitigation activities in addition to providing sustainable development benefits.

As per the NAMA database[8], there are 51 NAMAs and 29 feasibility studies in 44 countries till date.

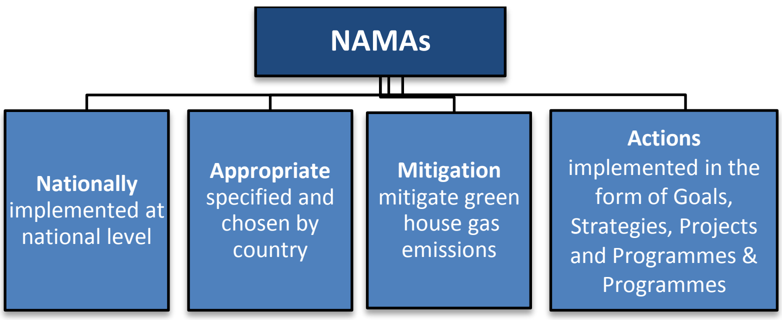


Figure 1: Nationally Appropriate Mitigation Actions (NAMAs)

6 http://www.cdmpipeline.org/ [Accessed on 26th May 2015]
7 http://cdm.unfccc.int/Statistics/Public/CDMinsights/index.html [Accessed on 26th May 2015]
8 http://www.nama-database.org/index.php/Main_Page [Accessed on 26th May 2015]

INDCs

The conference of parties to the UNFCCC at their 19th session (COP-19) at Warsaw in November 2013, decided '***to initiate or intensify domestic preparations for their intended nationally determined contributions (INDC)'*** by reiterating the work done towards achieving the objective of the Convention as set out in its Article 2. In addition, it was also agreed that such contributions have to be communicated well in advance of the 21st session of the COP (i.e., December 2015 in Paris, France) in clear, transparent and understandable manner without prejudice to the legal nature of the contributions (Decision 1/CP.19, paragraph 2(b))[9].

There is no standard definition for INDCs till date. However as per common understanding INDCs (Figure 2) are: ***Clear, transparent and understandable targets (in line with 2^0 target) which the parties intend to take up in the coming years keeping their national circumstances and development priorities into consideration.***

INDCs are, therefore, the basis of post-2020 global emissions reduction commitments that will be included in the future climate agreement.

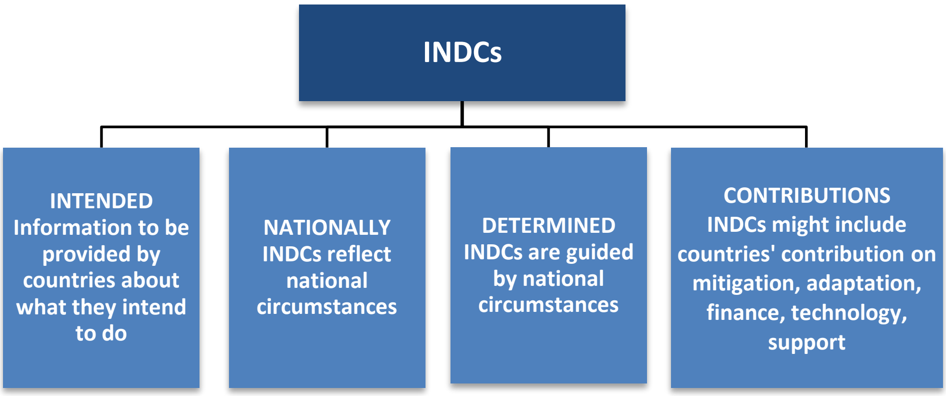


Figure 2: Intended nationally determined contributions (INDCs)

Evolving Financing Mechanism

Since the Rio Conventions were signed in 1992, the international climate finance landscape has grown increasingly more complex. In the 1990s, the World Bank's Global Environmental Facility (GEF) was the chief multilateral agency funding projects and programmes relating to climate change, and the Clean Development Mechanism (CDM) under the Kyoto Protocol was the main source of private climate investment. Over the past decade, however, the international 'architecture' of climate finance has becoming increasingly fragmented. At the international level, new funds such as the Adaptation Fund (AF) and the Climate Investment Funds (CIFs) have been created to direct funding to important international priorities. At the bilateral level, initiatives such as the UK government's International Climate Fund (ICF) and the German government's International Climate Initiative (ICI) have been at the forefront of Annex I country efforts to scale-up climate finance in the fast start period between 2010 and 2012.

Global climate finance architecture is intricate and is channeled through multilateral funds – such as the Global Environment Facility and the Climate Investment Funds – as well as increasingly through bilateral channels (Figure 3). In addition, a growing number of recipient countries have set up national climate change funds that receive funding from multiple developed countries in an effort to coordinate and align donor interests with national priorities.

[9] http://unfccc.int/files/meetings/bonn_oct_2014/in-session/application/pdf/adp2-6_i3_24oct2014t1530.dt.pdf [Accessed on 26th May 2015]

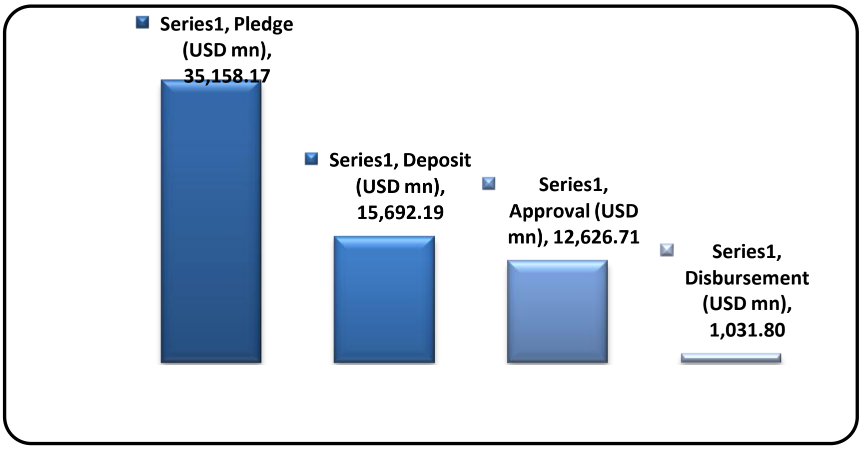


Figure 3: Status of Multilateral Funds and Bilateral Initiatives
(Source[10]: Climate Funds Update, 2014)

An exhaustive list of the funds in the climate domain is provided in Table 2 below.

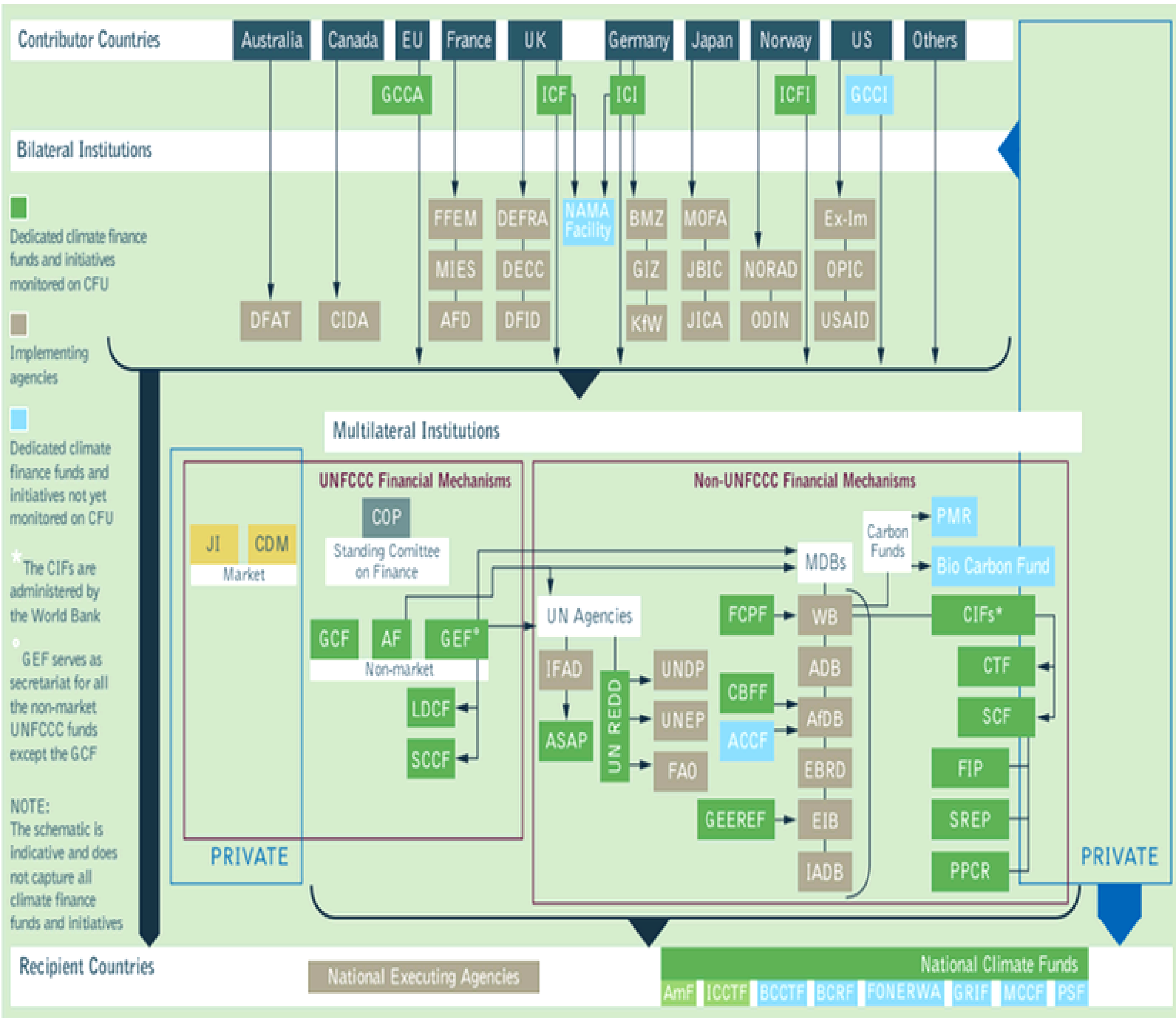


Figure 4: Global architecture of climate finance
(Source[11]: Climate Funds Update, 2014)

[10] http://www.climatefundsupdate.org/ [Accessed on 26th May 2015]
[11] http://www.climatefundsupdate.org/ [Accessed on 26th May 2015]

It has been widely reported that efforts to limit global temperature increases to 2°C will require scaled-up climate finance – particularly in developing countries like India, where there is huge potential for transformational. Estimates suggest that decarbonising the global energy system will require 36-42 trillion USD[12] between 2012 and 2030, or approximately 2 trillion USD per year[13]. At present, global climate finance flows are significantly lower, totaling 359 billion USD[14], of which 15% - or 54 billion USD[15] – are transfers of public climate finance from OECD countries to developing countries.

Evolving Technology Collaboration

In order to meet their climate change mitigation and adaptation objectives, and move towards a sustainable development pathway, developing countries identify and analyze priority technology needs.

Technology transfer to address climate change, including for both mitigation and adaptation solutions, was first addressed in the UNFCCC and was one of the pillars in the 2007 Bali Action Plan. A Technology Mechanism was established in the December 2010 Cancun Agreements. The mechanism has a Technology Executive Committee (TEC), which will do strategic planning, identify barriers and facilitate collaboration. It also has a Climate Technology Centre and Network (CTCN) where the center will facilitate a network of those institutions, networks and initiatives that are already working on climate technology.

The UNFCCC definition of technology transfer is somewhat narrow, as it only reflects technology transfers flowing from Annex II countries to non-Annex I countries. The Intergovernmental Panel on Climate Change (IPCC) uses technology transfer in a much broader sense than UNFCCC. For the IPCC (2002), "technology transfer" (is defined as) "*a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, non-governmental organizations (NGOs) and research/education institutions." (…) "The broad and inclusive term "transfer" encompasses diffusion of technologies and technology cooperation across and within countries. It covers technology transfer processes between developed countries, developing countries and countries with economies in transition, amongst developed countries, amongst developing countries and amongst countries with economies in transition. It comprises the process of learning to understand, utilize and replicate the technology, including the capacity to choose and adapt to local conditions and integrate it with indigenous technologies"*

Technology transfer has three key components: capital goods and equipment, skill and know-how for operating and maintaining equipment, and knowledge and expertise for generating and managing technological change.

Since 1991 various institutions and funding mechanisms (Table 3) have successfully promoted technology transfer to developing countries—including the Global Environment Facility (GEF), the Special Climate Change Fund (SCCF) and the Least Developed Countries Fund (LDCF) of the UNFCCC, the Multilateral Fund (MLF) of the Montreal Protocol on Substances that Deplete the Ozone Layer, the World Bank, regional development banks, international partnerships, national development assistance programs, and nongovernmental organizations. The CDM of the Kyoto Protocol has also played a part.

[12] Kaminker, Ch., Stewart, F. (2012), "The Role of Institutional Investors in Financing Clean Energy", OECD Working Papers on Finance, Insurance and Private Pensions, No.23, OECD Publishing, p4.
[13] Kaminker, Ch., Stewart, F. (2012), "The Role of Institutional Investors in Financing Clean Energy", OECD Working Papers on Finance, Insurance and Private Pensions, No.23, OECD Publishing, p4.
[14] Climate Policy Initiative (2013). The Global Landscape of Climate Finance 2013
[15] Climate Policy Initiative (2013). The Global Landscape of Climate Finance 2013

Table 2: Innovation Functions and the Institutions undertaking them[16]

Functions	Institutions
Priority setting and coordination	UNFCCC – Technology Executive Committee, CEM – CCUS Action Group
Joint RD&D	Bi-lateral efforts - e.g. US/China Clean Energy Research Centers
Information sharing	CEM – Clean Energy Solution Center, IRENA, GCCSI
Capacity building	UNFCCC, IRENA, Bi-lateral efforts
Provision of finance	Bi-lateral efforts, The Green Climate Fund
Supporting hubs and networks	UNFCCC – Climate Technology Centre and Network, IRENA

Funding Intellectual property rights (IPR) protected technology to developing countries remains a contentious topic. For many years industrial countries have viewed IPR as essential for promoting innovation, while developing countries have viewed them as a hindrance to the transfer of critical technologies. In the last 20 years, however, many developing countries have achieved impressive economic progress and have been attracting foreign investment by creating a stable and enabling economic environment at the domestic level. These countries increasingly have access to technologies from anywhere in the globe. In fact, globalization favors developing-country production of many of the most advanced technology products, such as photovoltaic cells.

[16] http://pdf.wri.org/working_papers/innovation_and_technology_transfer.pdf

India's Plans

India is currently the third largest polluting country in the world, emitting 2407 million tCO_2 as of 2015.[17] It is expected to contribute 6% of global GHG emissions by 2020.[18] India's total emissions have been growing steadily since 1990. India has made a commitment to reduce its emissions per unit of GDP 20 to 25% below 2005 levels by 2020[19]. To meet and exceed this goal, India is increasing fuel efficiency standards by 2011; adopting building energy codes by 2012; increasing forest cover to sequester 10% of its annual emissions; and increasing the fraction of electricity derived from wind, solar, and small hydro from the current 8 % to 20 % by 2020. Table 4 below enlists the key commitments made by India in order to combat climate change.

Table 3: Overview of Policy development in climate change domain in India

ACTION AREA	COMMITMENT	PROGRAMS AND POLICIES TO ACHIEVE COMMITMENT
Emissions Reduction	• India has taken the target of reducing its GDP emissions intensity by 20–25% by 2020 compared to 2005 levels (excluding emissions from agriculture) during the negotiations at Copenhagen (2010).	• India's **National Action Plan on Climate Change (NAPCC)**, which is the basis of India's climate policy framework, includes the following eight national missions defined till 2017: — National Solar Mission — National Mission for Enhanced Energy Efficiency — National Mission on Sustainable Habitat — National Water Mission — National Mission for Sustaining the Himalayan Ecosystem — National Mission for Sustainable Agriculture — National Mission on Strategic Knowledge for Climate Change The **Executive Committee on Climate Change** constituted in January, 2013 under the chairmanship of Principal Secretary to Prime Minister to assist the Prime Ministers Council on Climate Change to monitor the implementation of the eight National Missions and other initiatives under the NAPCC. • India's **12th Five Year Plan** for the period 2012–2017 (Government of India, 2013) proposed a re-organization of the NAPCC. The Five Year Plans provide the basic direction for government activities, addressing all sectors and policy areas. • India has formed an **Expert Group on Low Carbon Strategy for Sustainable Growth**. The group's recommendations will be

[17] Global Carbon Atlas, Emissions. Available at: http://www.globalcarbonatlas.org/?q=en/emissions [Accessed on 26th May 2015]
[18] Elzen, M.G. J. den et al. (2012). Analysing the emission gap between pledged emission reductions under the Cancun Agreements and the 2° climate target, The Hague : PBL Netherlands Environmental Assessment Agency. Published April 2012. Available at: http://www.sustainableguernsey.info/blog/wp-content/uploads/2012/05/2012-M04-290412-pbl-2012-analysing-the-emission-gap-between-pledged-emissionreductions-500114021.pdf [Accessed on 26th May 2015]
[19] PMR2012. India's Organizing Framework for Scoping of PMR activities. Published 23 April 2012. Available at: http://www.thepmr.org/system/files/documents/PMR_PA3_India_OrganizingFramework.pdf [Accessed on 26th May 2015]

		adopted in India's Twelfth Five-Year Plan in 2012. • The Ministry of Environment and Forests (MOEF) has a series of measures to strengthen its scientific base and broaden its capabilities around climate change mitigation and adaptation including: — Regular Emissions Inventory; In May 2010, India became the first developing country to publish its **2007 emissions** inventory and promised to release it every other year. — Comprehensive science program with its Indian Network of Climate Change Assessment **(INCCA)**, involving 120 research institutions. — Global Advisory Network Group on Environmental Sciences (GANGES) — National Environmental Sciences Fellows Programme — Expert Committee to Enhance the Scientific Capacity of MoEFCC — Action Plan to Enhance Forestry Science
Clean Energy Deployment	• Install 100 GW of solar energy by 2022 • Install 60 GW of onshore wind power by 2020 • Biofuel legislation sets a target of 20% blending of ethanol and biodiesel in 2017. • Curb emissions by nearly 100 million tons a year and cut annual energy consumption 5 % by 2015 – adding 20 GW of capacity and fuel savings of 23 million tons per year -- through enhanced energy efficiency. • Require mandatory energy-efficient building code for commercial and high-	• The 'National **Solar** Mission', launched in 2010, contains capacity targets for solar energy. — The original targets of the mission were 10 GW by 2017 and 20 GW by 2022 (MNRE, 2010a). Cumulative installed solar power capacity in India reached 3 GW by the end of 2014 (MNRE, 2014a). Therefore, in November 2014, the government announced plans to increase its solar ambition to 100 GW installed capacity by 2022. — India confirmed this scaling-up of the national solar mission during the Conference of the Parties (COP-20) in Lima, December 2014 (UNFCCC, 2014). — By the end of 2014 the Government of India had approved plans for 25 Solar Parks and Ultra Mega Solar Power Projects, with a combined capacity of over 20 GW, to be developed in the coming five years (MNRE, 2014b). • The draft **Wind** policy, released in February 2015 and open for comments until April 2015, proposes a target of 60 GW cumulative installed capacity of onshore wind power by 2020 (MNRE, 2015). — India's current wind energy targets are 27.3 GW by 2017 and 38.5 GW by 2022. Cumulative installed wind power capacity exceeded 22 GW by the end of 2014 (MNRE, 2014a). • The 12th Five Year Plan also proposes a new 'National Wind Energy Mission' similar to the 'National Solar Mission' (Government of India, 2013). However, this wind energy mission has not yet been implemented. • National Policy on **Biofuels** was announced in December 2009 to meet the increasing energy needs of the country and to provide Energy Security. — Biofuel legislation sets a target of 20% blending of ethanol and biodiesel in 2017 — The major goals of the policy are Development and utilization of indigenous non-food feed stocks raised on degraded or waste lands. — The objective is to support R&D, Pilot plant/Demonstration projects leading to commercial development of 2nd Generation biofuels. The ministry supports R & D projects for development of technologies for production of biofuels through Biogas, Pyrolysis and Gasification, besides promoting deployment of technologies for pilot and full-scale projects on biofuels in general.

	rise residential buildings. • Establish efficiency standards and labels for 11 household appliances, such as air-conditioners, lights, and televisions. • Institute green transportation systems in major cities. • Create clean energy financing and incentives. • Implement the Obama-Singh "Green Partnership" on energy security, climate change and food security.	• In February 2015, multiple other draft renewable energy policies were released for comments, including a draft National Mission on **Small Hydro**, a draft National Policy on **Geothermal** Energy and a draft Solar Policy. Achieving the renewable energy targets depends on financial and structural supporting mechanisms. The state-level feed-in schemes and renewable portfolio standards are expected to partly provide this. (IEA, 2014) • Under the National Mission on Enhanced Energy Efficiency, India is establishing measures and policies to curb emissions and cut annual energy consumption. — The Bureau of Energy Efficiency (BEE) established the innovative **Perform, Achieve and Trade (PAT) Mechanism** for Energy Efficiency, which is a trading program for energy intensive industrial facilities and power stations. India's PAT initiative, which resembles an ETS, is currently undergoing its first phase (2012-2015), which is considered a test phase.[20] The scheme covers the country's largest industrial and power generation facilities that, in total, cover more than 50% of fossil fuel use in India. The target is to achieve a 4% to 5% reduction of energy consumption of the participating facilities in 2015 (compared to 2010 levels). 60 % of this is to stem from the power sector and 40% from the industry sector. The effect after 2015 heavily depends on the rules governing the continuation of the scheme, which have yet to be decided. What distinguishes India's PAT from traditional cap-and-trade systems is that cap-and-trade usually entails an absolute cap, whereas PAT specifies energy targets that are intensity-based. India also has a Renewable Energy Certificate (REC) trading system, which is a non-ETS, market-based mechanism to fight climate change. — India has also invested in sustainable buildings: the Green Building Council is projecting 1000 LEED-certified buildings and a $4 billion market by 2012. • India's voluntary Energy Conservation Building Code (ECBC), revised in 2009, is anticipated to become mandatory in 2012. BEE has created an ECBC User Guide to encourage efficient building construction. India has also established a star labeling program for buildings. • BEE has established **voluntary efficiency standards for 11 household appliances** and mandatory standards for refrigerators, air conditioners, tube-lights and transformers. • India will institute mandatory fuel-efficiency standards on all cars and trucks by 2011. India has already converted its bus, taxi, and city vehicle fleets to compressed natural gas in four megacities and is expanding to larger and medium sized cities. A number of major cities, including Delhi and Mumbai, are building new metro rail and bus rapid transit systems. • In 2010 the Indian Government introduced a **coal tax** of 50 rupees (0.8 USD) per metric tonne of coal produced and imported which doubled to 100 rupees per metric tonne in the budget FY 2014-2015. The revenues from the coal tax feed into the National Clean Energy Fund, which provides finance to renewable energy projects. • India and the United States have developed one of the priority initiatives of the **Partnership to Advance Clean Energy (PACE)**, focused on both research and deployment of clean energy technologies. Indian and U.S. labs are working closely together on solar and wind technologies. The Brookhaven National Lab is assisting with creation of India's first zero emissions town in Rajarhat, West Bengal. Furthermore, the United States and India will co-lead the Super-efficient Equipment and Appliances

[20] Climate and Development Knowledge Network, 2013. Creating market support for energy efficiency: India's Perform Achieve and Trade scheme. Published January 2013. Available at: http://r4d.dfid.gov.uk/PDF/Outputs/CDKN/India-PAT_InsideStory.pdf [Accessed on 26th May 2015]

		Deployment (SEAD) Initiative, which will transform the global appliance market by improving incentive and labeling programs, strengthening standards, and funding research and development. Initially, SEAD will focus on strengthening standards for consumer goods such as televisions, lighting and air conditioners.
Deforestation	• Double the rate of restored forest cover, removing 43 million tons CO2e each year, or 6.35% of India's annual greenhouse gas emissions, by 2020.	• Under its Green Mission, India is investing 2.5 billion USD (Rs 11,700 crore) for forest conservation and reforestation projects. India plans to increase investment every year to revitalize 6 million hectares of degraded forestlands. • Setting up of Compensatory Afforestation Fund Management and Planning Authority (CAMPA) • Inclusion of forestry within NAREGA
Adaptation	• Focus on adaptation to climate variability, specifically related to water, agriculture, health and sanitation, forests, coastal-zone infrastructure and protection against extreme weather events.	• India is currently developing its National Mission on Sustainable Agriculture and Water, which focuses on preparing for climate change impacts.

Future of Climate Negotiations

At Paris (COP 21), this year in December 2015, a post-Kyoto global agreement (post 2020) on climate change (including focusing on the adoption of a legally-binding agreement, subsequent pledges by all countries, the Green Climate Fund (GCF) and carbon pricing) would be finalized, in accordance with the Durban Platform for Enhanced Action. This agreement is envisioned to determine the ambition and contours of the global response to climate change in the years ahead.

The outline of the Paris agreement has already begun to take shape (Figure 5) in the preceding COP at Lima wherein all the parties to the UNFCCC decided to submit their INDCs - each Party's contribution towards achieving Article 2[21] of the Convention early in 2015 for an ex-ante review process, clarifying and aggregating pledges to assess their implication for long-term goals. Then, final negotiations are to be completed by the session in Paris in the fall.
Some of the issues which couldn't be progressed in Lima however, might probably be taken up at Paris include the following:

- *Climate Finance and the Green Climate Fund* (the **GCF**) – discourse on setting any deadlines by which the developed countries plan to achieve the target of 100 billion USD worth of contributions to the GCF by 2020.
- *The role of carbon markets* – Talks on carbon market, on Nationally Appropriate Mitigation Actions (NAMAs), the framework for various approaches (FVA) and a new market mechanism (NMM)
- *Clean Development Mechanism* (the CDM) – the review of the CDM's modalities might be mooted upon since there is an existing uncertainty of the role of CDM in a 2015 Agreement and the depressed prices and lack of demand for CERs does not invite any urgency for the CDM reform agenda.
- *Reducing emissions from deforestation and degradation* (REDD+) – negotiations at the Lima COP in relation to REDD+ focused predominantly on safeguards but failed to bear fruit due to concerns expressed by parties who are more likely to be the beneficiaries of such safeguards (e.g. Brazil and other rainforest-rich countries), that such safeguards should only be discussed after certain fundamental elements, such as compliance and enforcement mechanisms, are agreed upon. These might form a part of the upcoming COPs.

Figure 5: Progress from Lima to Paris

India's Stance at Global Negotiations

Despite of much less historical concentration of emissions, India has been conscious of the global challenge of Climate Change. India ratified the Kyoto protocol in 2002; however, as a developing country, it was not required to submit any obligatory reduction commitments. India did submit, in 2009, a voluntary target for reducing the emissions intensity of its GDP by 20-25% relative to 2005 levels by 2020.[22]

In pursuance of the obligations cast on parties to the UNFCCC, India has undertaken to communicate information about the implementation of the Convention, taking into account the common but differentiated responsibilities. The elements of information provided in the communication include a national inventory of

[21] "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system"
[22] PMR2012. India's Organizing Framework for Scoping of PMR activities. Published 23 April 2012. Available at: http://www.thepmr.org/system/files/documents/PMR_PA3_India_OrganizingFramework.pdf [Accessed on 26th May 2015]

anthropogenic emissions by sources and removals by sinks of all GHGs, a general description of steps taken to implement the Convention including an assessment of impacts and vulnerability and any other relevant information. India has recently submitted the Second National Communication (NATCOM) to the UNFCCC in 2012. The first National Communication was submitted in 2004.

Corporate Action on Climate Change in India

1) **INFOSYS**
   Infosys – one of India's largest Information Technology corporations has become the first Indian company to join ***RE100***[23]. As part of its commitment to RE100, Infosys aims to become carbon neutral by 2018. The company is already working to reduce its per capita electricity consumption by 50% from its 2007-2008 levels and source all its electricity from renewable resources by 2018.

During fiscal year 2015, Infosys met 29 % of its electricity needs – about 72.08 million units – for its locations across India through green power. During the same period, Infosys generated over 2911 MWh of electricity through its onsite solar PV installations across India.

2) **TATA group**[24]
   For addressing the climate change issues, TATA group has set up the **Tata Code of Conduct 2008**. The code urges all companies with the group to exercise greater caution in the way they use natural resources and in the manner in which they impact upon pollution levels. Examples of the same enlisted below:

— **Tata Steel** recycles more than 80 per cent of the waste generated and the rest is dispatched into safe landfills.

— At **Tata Chemicals**, water recycling processes and sewage treatment facilities has cut down the dependence on fresh water. It also invests time and resources in saving the whale shark that is an annual visitor to the Mithapur plant.

— **Tata Consultancy Services** (TCS) has committed to building green offices; its buildings will be rated by the Leadership in Energy and Environmental Design (LEED) Green Building Rating System which is the internationally accepted benchmark for green buildings.

— Tata Steel, Tata Motors, Tata Chemicals, Tata Power, Tata Sponge, and Tata Metaliks have registered projects under the CDM in major areas like:

   1. Waste heat recovery power generation
   2. Super critical technology for power generation
   3. Fuel switch
   4. Methane-capture
   5. Energy efficiency improvements
   6. Setting up of renewable energy power generation farms using wind, solar, etc.

3) **ITC**[25]
   ITC commitment to the environment is manifest in its constant endeavour to enlarge its positive carbon footprint. This is achieved not only through enhanced energy conservation, but also through use of renewable energy sources and expanding carbon sequestration through its large scale Social and Farm Forestry Programmes.

— ITC is also constantly expanding its **renewable energy portfolio**. More than 38% of its energy consumption is now met from renewable sources, and this is expected to touch 50% in the next 4-5 years.

[23] **RE100 was launched at Climate Week NYC on September 22, 2014. Seventeen companies have now joined the campaign and made a public commitment to become 100% renewable, including founding members IKEA and Swiss Re. As the campaign spreads in India, it is expected that more Indian companies will switch to renewable power and demonstrate the huge opportunity that exists in India's growing clean economy. A global platform** for major companies committed to 100% renewable power. Available at: http://www.indiacsr.in/en/infosys-becomes-the-1st-indian-company-to-join-re100-renewable-energy-campaign/ [Accessed on 26th May 2015]

[24] http://www.tata.com/article/inside/f5KCaVEfP8s=/TLYVr3YPkMU [Accessed on 26th May 2015]

[25] http://www.itcportal.com/sustainability/cleaner-environment.aspx [Accessed on 26th May 2015]

- Improved utilization of carbon neutral fuels such as **biofuels** in the Paperboards and Specialty Papers Business and the commissioning of 13.8 MW wind power projects in Maharashtra and Tamil Nadu contributed to increased utilization of renewable energy.
- ITC Hotels pioneered the concept of **'Responsible Luxury'** in the hospitality industry (i.e. to deliver the best of luxury in the greenest possible manner) with all its premium luxury hotels (e.g. in Bangalore, Mumbai and Jaipur) being LEED Platinum certified. Further investments in wind energy were also made at the newly built ITC Grand Chola at Chennai.

4) Ambuja Cement [26]

Ambuja Cement and cook stove manufacturer, Envirofit have joined hands to combat indoor air pollution, which claims over 5, 00,000 lives annually. Ambuja Cement has set a target of distributing 10,000 Envirofit cookstoves in 100 days to 60 villages across Rajasthan and Gujarat. A total of 8,000 cook stoves have already been distributed under this venture. Under the ambit of its corporate social responsibility (CSR) partnership, Ambuja Cement targets to achieve a reduction of 1.47 tonnes of CO_2 and 286 gm of black carbon per cookstove annually. This initiative will also directly impact deforestation and reduce usage of 800 kg of wood per family every year.

[26] http://timesofindia.indiatimes.com/city/ahmedabad/Ambuja-Cement-Envirofit-to-provide-green-stoves-in-Gujarat-Rajasthan/articleshow/25899722.cms [Accessed on 26th May 2015]

Renewable Energy Development

India is surging ahead in the field of Clean Energy, the nodal ministry- Ministry of New and Renewable Energy has taken up an ambitious challenge of setting up a capacity of 100 GW of Solar energy in India by 2022. Of this 40 GW expected to be generated from rooftop installations and the remaining 60 GW coming from larger, grid-connected projects, such as solar farms.

The world has now come to believe that Renewable energy is the future. Recently in many forums it has been spoken that government may make it mandatory for all the GENCOs to have certain mix of Renewable (different parentages of Wind and Solar). Looking at the climate change problem and problem of fuel linkages, ever increasing price of fossil fuel; it is a wise decision for such power generation companies to increase their portfolio in Renewable. Out of all these, harnessing wind energy is the most matured technology.

Government has announced an impressive target of having 100 GW installed wind energy capacity by 2022. The government has also pledged continuation of critical incentives for the wind energy sector, such as accelerated depreciation and generation-based incentive. The government is also planning to launch the National Wind Energy Mission which would accelerate the development of wind energy projects and open the offshore wind energy sector as well. Additionally, the government is also looking to make power utilities in various states meet the renewable energy purchase obligation.

These initiatives by the government have already started to reap results. Indian and international project developers have pledged to add over 47 GW of new wind energy capacity by 2022. The Indian government has set a target to install 60 GW worth of wind energy capacity by 2022. This means that around 37 GW capacity would have to be added by March-end 2022.

Solar Energy

The Solar energy received by the earth is more than 15,000 times the world's commercial energy consumption and over 100 times the world's known coal, gas and oil reserves. And this energy is readily available during the day for anyone to tap and that too free and without any constraint. Moreover, the daytime production peak coincides with peak electricity demand making solar ideal supplement to grid. This seeks an immediate attention of policy makers for exploiting this available solar resource in a very efficient and effective manner to overcome the problem of electricity shortage. By changing the solar specific Renewable Purchase Obligation (RPO) target for 2022 from 3% to 10.5% of all power consumption in the country – yet to be ratified under the Electricity Act 2003 – India plans to increase its solar capacity from 20 GW by 2020 to 100 GW by 2022

Solar Rooftops

A rooftop photovoltaic power station, or rooftop PV system, is a photovoltaic system that has its electricity-generating solar panels mounted on the rooftop of a residential or commercial building or structure. The various components of such a system include photovoltaic modules, mounting systems, cables, solar inverters and other electrical accessories. Rooftop mounted systems are small compared to ground-mounted photovoltaic power stations with capacities in the megawatt range.

Installed capacity and potential: Rooftop solar has been relatively lackluster in India with no clear policy thrust so far and only about 350 MW of rooftop solar being installed (<10% of total solar capacity) as depicted in the table below:

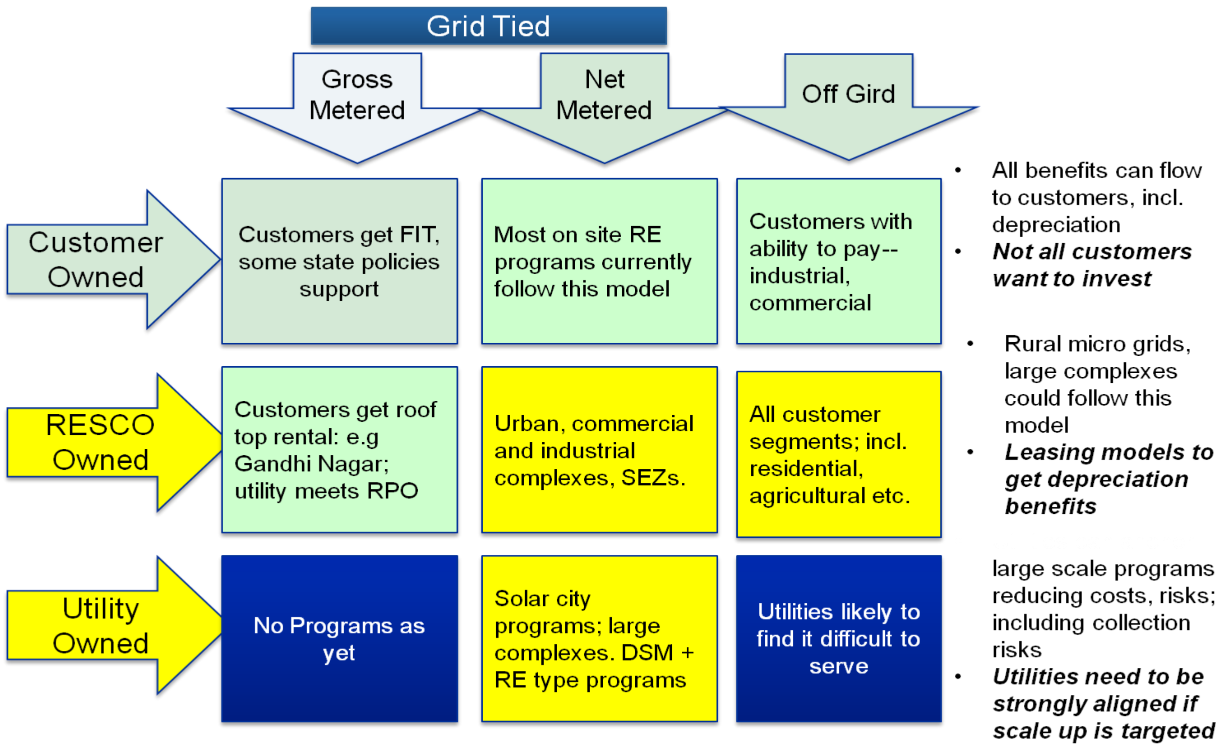
Table 4: Installed Capacity of Solar Rooftop in India

	JK	*PB*	*HR*	*RJ*	*GJ*	*MP*	*MH*	*KA*	*KR*	*TN*	*NE*	*AP*	*Telan.*	*OR*	*CH*	*WB*	*BH*	*JH*	*UP*	*DL*	*UK*
Residential	4	6	7	5	10	5	7	9	2	13	6	6	6	9	6	7	3	1	9	2	3
Industrial	1	7	2	9	7	2	2	6	4	8	2	4	4	2	3	3	1	0	7	4	2
Commercial	5	6	5	7	8	3	11	10	2	15	1	11	11	3	2	3	1	0	8	2	3
Others ~ 8 MW; Total ~ 350 MW																					

Policy framework

Rooftop SPV in India is driven by a mix of national targets and supported by schemes at various legislative levels such as State Solar Policies; Accelerated Depreciation and Capital subsidy. Twenty five states and union territories have put in place net-metering guidelines (draft and approved) for rooftop solar installations.[27] At the central level Ministry of New and Renewable Energy (MNRE) announced the Rooftop PV and Small Solar-Power Generation Programme (RPSSGP) under Phase I of the Solar Mission to encourage grid connected projects. Under RPSSGP, grid connected small solar PV systems (ground and roof mounted systems of capacity not more than 2 MW each) of 90.8 MW capacity were commissioned as on 31st December, 2013[28]. The Solar Energy Corporation of India (SECI) is also promoting grid connected rooftop systems (100—500 kWp) under RESCO model, in which SECI will buy and sell electricity to utilities at INR 5.50/kWh

Figure 6: Potential Business Models for Solar Rooftop in India



[27] http://www.bridgetoindia.com/wp-content/uploads/2015/06/BRIDGE-TO-INDIA_india-solar-handbook_2015_online-1.pdf
[28] MNRE

Scale Up challenges and recommendations

Technical Issues

- LV/MV connection: LV connection can reduce project costs although can present grid stability issues
- Grid Availability: In case of grid unavailability, the plant doesn't generate. Therefore it is essential to ensure grid availability in grid tied systems
- Surplus Power: the power producers are seldom paid for excess generation
- Accelerated depreciation for IPPs: AD is generally unavailable to IPPs which results in the market disruption
- Quality concerns: Due to an enormous no. of industry players, the cost pressure is extremely high which in turn results in provision of sub-quality components
- Standardized rooftop packages: Although difficult due to the variety of institutions, some standard configurations can be developed, especially for residential consumers, individual owned rooftop SPV system with 1kWp–-5kWp standard combinations could be preferred

Regulatory issues

- Project finance: MNRE is working with various DFIs to formalize an interest rate subvention scheme. RE has also been recently announced as a priority sector for lending. Despite this the interest rates available are trailing on the higher end.
- Legal enforcement of contracts: The payback period in case of solar is very long, thus it is important to establish robust legal systems for settlement of contract discrepancies
- Energy storage and compensation for loss of power generation during grid unavailability is not supported by policies
    - Renewable Energy Certificates are not available for off grid projects which needs to be allowed
- REC benefits can be shared between discoms, building owners, RESCOs and other stakeholders in return for sharing of responsibilities and functions such as connectivity, collections, permitting, etc.
- Soft Costs: for rooftop power producers incur soft costs in the form of Customer Contracting; Design and feasibility assessment, Connectivity permissions; Accessing subsidies (incl RECs); Arranging finance; risks of collection; Customer service etc. these costs can be These costs can be reduced with 'clustering', and 'scalable program designs'. At present these costs can be Rs 5-15/W depending on the scale of operation

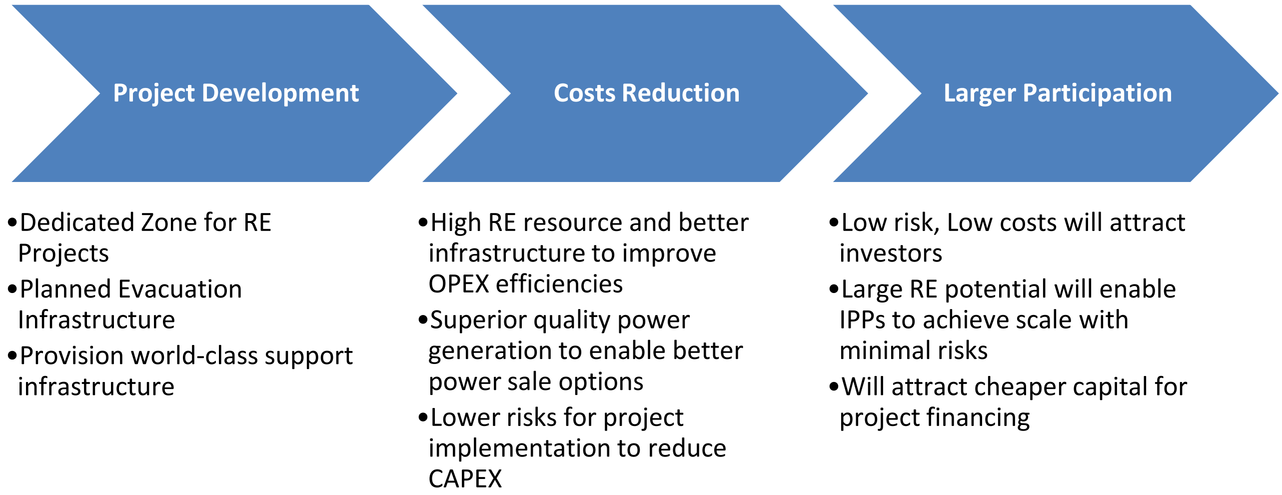
Hybrid RE parks – Renewable Energy Zones

The deployment of Renewable Energy (RE) in India is dominated by Project Developers (who in the past have been the OEMs) undertaking entire project development value chain (which includes grid approval application, resource assessment, land identification, approvals/clearances, PPA, installation & commissioning). Such approach requires large efforts and investments, with significant development risks arising from issues of land, regulatory approvals, larger evacuation constraints and lower availability etc. Further, for smaller, dispersed plant capacities developed by individual developers, costs associated with supporting infrastructure (evacuation, roads, communication, water linkage, etc.) is prohibitively high increasing the cost barrier for RE. As a result, the pace of deployment of RE power plants in the country is relatively slow, in view of the total RE potential in the country – for example, currently India is able to deploy up to 2-3 GW of wind per annum, against the need for 10-15 GW per annum considering the fact that our wind manufacturing capacity exceeds 10 GW.

Hybrid RE parks – Renewable Energy Zone (REZ) is a specific high RE resource zone, which is developed to provision pre-developed activities such as generation license, land, common infrastructure, evacuation, etc to allow faster deployment of RE projects at minimal cost to the society

Some highlights of a REZ are presented in the figure below:

Figure 7: Features of REZ



Challenges for RE Deployment

- **High Development Risk:** Includes soft costs such as conducting investment-grade assessments, land procurement, infrastructure development, obtaining clearances, etc
- **High OPEX/ Scalability Issues:** Small size projects adversely impacts economy of scale effect; further, small scale projects does not allow appropriate infrastructure development at sites
- **High Cost of Capital:** Difficulty in calculating realistic costs and benefits of RE projects due to technology risk, project development variables, resource assessment risk, etc.
- **Limited Transmission Infrastructure:** Decentralized project implementation poses constraint of development of transmission infrastructure

Further, lack of long term planning for transmission infrastructure in high RE resource regions is further slowing the adoption of RE power plants. For example, States such as Tamil Nadu that have high RE penetration (over 40% by capacity, primarily wind) are experiencing transmission congestion and grid instability.

In this respect, a coordinated "RE zones" approach could potentially, lead to a 'cost-effective' RE generation, with lower 'investment risks' for developers. For development of such zones, resource assessment through GIS mapping, in-depth planning of actual infrastructure needs, realistic cost assessments, reliability, and benefits will have to be evaluated, in addition to technical, socio-economic, and environmental implementation criteria for spatial refinement of resource-rich areas. Further, understanding and developing integration criteria for multiple renewable technologies is crucial to gauge trade-offs and added synergies involved in infrastructure planning.

Benefits of Renewable Energy Zone

Investors/ Developers

Reduced costs
- Project costs

O&M costs

Faster time to develop
- 30-32 month of lead time reduction

Reduced risks
- Development risks
- Financing risks
- Operational risks

Efficient Generation

Transmission companies

- Better investment planning
- Reduced Investment/capacity evacuated
- Improved Frequency/voltage regulation
- Reduced losses
- Easier Grid management
- Reduced maintenance costs

State

Attracting Investment:
- Ability to scale up RE capacity quickly
- Long term FDI
- Attractive for manufacturing capacity investment

Effective use of land

Local Community
- Effective control of ESG compliance
- 'Value' to local community
- Local service revenues

Ability to upgrade RE capacities in future

Lenders

- Reduced risks
- Scalable lending potential
- Enhanced cover through risk insurance
- Possible state guarantees to provide further protection

Renewable Energy Zones vs. Solar Parks

With announcement of 25 solar parks by the MNRE of 500MW plus capacity each, EVI had undertaken a cost benefit analysis of REZ in comparison to Solar Parks.

For the same, for a total area assumed of 56.25 sq km of contiguous land, the following were the key financial and generation benefits of development of REZ:

Table 5: Key Financial and Generation benefits of REZ

Renewable Energy Zones		
Wind Installed Capacity	875	MW
Solar Installed Capacity	1900	MW
Shadow Region Based Installation of solar	600	
Total Installed Capacity	**3375**	**MW**
Total Units Generated from REZ Model	52,42,221	MWh
Total Units Generated from Solar in shadow region	10,08,615	MWh
Total Generation from REZ	**62,50,836**	**MWh**
Peak Generation	**2600**	**MWh**
Solar Parks		
Installed Capacity within Same Area	2749	MW
Total Generation	46,66,406	MWh
Benefits		
Increased Generation from same land area	34%	
Increased Installed Capacity	23%	

Renewable Energy Zones		
Increased Transmission Requirement for similar Installed Capacity	30%	

Based on the above analysis, it is evident that REZ has a clear defined benefit against solar parks. Such benefits is now recognized by many industry experts based on our case presentation and World Bank and MNRE also recognizes the concept, thereby including integrated Renewable Energy Parks in its latest draft release on solar parks.

Wind Energy

India has significant wind potential. On Shore Wind Potential has recently been estimated to be 2000 GW+ and off shore potential at 1000 GW+. Attractiveness of wind is enhanced because it generates more power during peak load period of evenings, levelized cost of wind energy is close to grid or better in most wind rich states, it doesn't cover the land mass completely allowing agriculture or plantation type activities around it etc.

Wind resource measurement in India is being carried out extensively. Under National Wind Resource Assessment programme, Ministry through National Institute of Wind Energy, Chennai (erstwhile Centre for Wind Energy Technology (C-WET)) and State Nodal Agencies had installed and monitored 794 dedicated Wind Monitoring Stations (WMS) of height ranging from 20 m to 120 m (20m, 25m, 50m, 80m, 100m & 120m) throughout the country as on 31.12.2014. Initially the wind monitoring was carried out only in known windy areas. Now it is extended to new/ uncovered areas which are not explored in earlier projects to complete Indian Wind resource mapping. Further hundreds of private winds monitoring stations are also operational in the country.

Government has announced an impressive target of having 100 GW installed wind energy capacity by 2022. The government has also pledged continuation of critical incentives for the wind energy sector, such as accelerated depreciation and generation-based incentive. The government is also launching the National Wind Energy Mission which would accelerate the development of wind energy projects and open the offshore wind energy sector as well. Additionally, the government is also looking to make power utilities in various states meet the renewable energy purchase obligation and new generating companies also to have renewable generation obligation which will have wind as one of the primary focus.

These initiatives by the government have already started to reap results. Indian and international project developers have pledged to add over 47 GW of new wind energy capacity by 2022. The Indian government has set a target to install 60 GW worth of wind energy capacity by 2022. This means that around 37 GW capacity would have to be added by March-end 2022

Large scale wind Generation

India has seen large scale wind generation across the different state of India. A total capacity of 23,444 MW[29] has been established up to 31 Mar 2015, mainly in Tamil Nadu, Gujarat, Maharashtra, Andhra Pradesh, Karnataka and Rajasthan. Wind electric generators of unit sizes between 225 kW and 2.1 MW have been deployed across the country. India now ranks 5th in the world after China, USA, Germany and Spain in grid connected wind power installations. A cumulative total of over 179 billions units of electricity have been fed to the State Electricity Grids up to March, 2014.

The average growth of wind power installation has been good, except in FY 2014-15, and growth of wind power is expected to increase at speedy rate due to government policies.

[29] http://mnre.gov.in/mission-and-vision-2/achievements/

Tamil Nadu has the largest installed wind capacity of 7,394 MW followed by Maharashtra with 4369.8 MW. Gujarat ranks third in the country with an installed base of 3,581.3 MW till 31st March 2014. The installed capacity, in comparison to the gross potential for each state, is presented in below Table 6:

Table 6: State wise Estimated Potential and Installed Capacity of Wind Power

Sr No.	States	Estimated Potential (MW)[30]		Installed Wind Power Capacity (MW) as on 31st Mar 2015
		@50m	@80m	
1	Tamil Nadu	5374	14152	7450.68
2	Maharashtra	5439	5961	4469.5
3	Gujarat	10609	35071	3649.5
4	Karnataka	8591	13593	2633.3
5	Rajasthan	5005	5050	3310.1
6	Madhya Pradesh	920	2931	876.4
7	Andhra Pradesh	5394	14497	1001.3
8	Others	7008	10696	53.22
	Total	49130	102788	23444

India Wind Power Capacity Addition – Year wise[31]

Table 7: Yearly Capacity Addition

Year	Installed Capacity (MW)
Upto 31.03.2002	1666.8
2002-03	242
2003-04	615.2
2004-05	1111.7
2005-06	1716.2
2006-07	1742.1
2007-08	1663.3
2008-09	1484.9
2009-10	1564.6
2010-11	2349.2
2011-12	3196.7
2012-13	1700.4
2013-14	2079.4
2014-15	2311.0
Total	**23444**

A good number of Wind Electric Generator (WEG) manufacturers are active in India offering WEGs in the range of 800 kW to 2,500 kW. Hitherto Suzlon, Enercon, and Vestas were the major suppliers of WEG's in India. The advent of new players like GE, Gamesa, Regen Powertech, Kenersys, INOX as well as large manufacturing capacity established in China like Sinovel , Minyang, Goldwind etc, have also plans to enter Indian market market and are expected to make the WEG industry more competitive and consumer oriented.

[30] http://niwe.res.in/department_wra_est.php
[31] Source: Wind Power India

Scaling up wind energy in India

Wind energy, with feed-in tariff determined by state regulatory commissions, Generation Based Incentive (GBI), Depreciation benefit, Tax holidays, carbon credits and other policy supports, has become a commercially viable option for electricity generation avoiding atmospheric pollution and global warming. In the last two decades, the technology for Wind Turbine Generators (WTGs) has improved significantly and large machines (500 kW to 2,500 kW and above) are being deployed extensively all over the world to generate power sustainably and cost effectively.

Among others, the key benefits of wind energy are:

Environment, Health & Safety Related:

1. Wind is Environment friendly, there will be no air emissions during power generation;
2. No water requirement during power generation, least water requirement during construction;
3. No adverse social impact, such as mass rehabilitation etc.;
4. Safety — least risks of catastrophic events as in the case of large hydro or thermal plants;

Energy Security:

1. No dependence on fuel linkages/ import of fossil fuels from outside the country;
2. Economic security — no dependence on cost fluctuations in prices of fuel leading to domestic inflationary pressures, no foreign exchange outflow,

Least Time/ Cost-over run:

1. Low gestation period — less than six to twelve months from concept to commissioning, besides interest on capital costs, there is very little expense on O&M, and the fuel (wind) is free and without any royalty (as in case of some conventional power projects);

Financial Benefits:

1. Long term Feed-in PPAs are available
2. Accelerated depreciation/ Generation based incentive (GBI) benefits
3. Wind power projects qualify for CDM/ REC benefits
4. After introduction of modular forecasting and scheduling technologies, now it is possible to schedule the wind power generation

Others

1. It can be developed in modular form with possibilities for extension at a later date;

Following are the policy supports which are helpful for scaling up the wind power project in India

Policy Support for Wind Energy: The Government interventions remain the backbone of RE market development across the globe. A review of policies and regulatory frameworks indicates that commercialization of RETs remains dependent on government support, be it in the form of fiscal support or other support like favourable access to the grid. The use of these instruments at the state and the central levels has allowed large scale deployment of RE and development of new business models across the country. The key policy instruments for promotion of RE include tax incentives, FiTs, subsidies, RECs, and GBI.

1. **Income Tax Exemptions**: All companies in India are required to pay taxes on their profits (Current corporate tax rate is 32.45[32] per cent). As per Income Tax Law, the corporate tax rate is 32.45 percent (Income tax rate 30 percent + Surcharge 5 percent + Education Cess 3 percent) for income below INR 100 million (USD 1.6 million) and 33.99 percent for incomes above INR 100 million (USD 1.6 million)[33]. The Government of India, under Section 80-IA of Income Tax Law Act, 1961 (IT Law), exempts all infrastructure assets (this includes RE generators) from income tax for a block of any 10 consecutive years out of the first fifteen

[32] Income tax rate 30 + Surcharge 5 + Education Cess 3. As per Income tax law. Available at http://law.incometaxindia.gov.in/DIT/File_opener.aspx?page=FINA&schT=FIN&csId=30d194ca-afe8-4ed5-afc6-f7c6d83451eb&&pId=9c845744-9bd9-4c83-aa3a-f3cb1dcd62f7&sch=&title=Taxmann20-20Direct20Tax20Laws

[33] http://law.incometaxindia.gov.in/DIT/File_opener.aspx?page=FINA&schT=FIN&csId=30d194ca-afe8-4ed5-afc6-f7c6d83451eb&&pId=9c845744-9bd9-4c83-aa3a-f3cb1dcd62f7&sch=&title=Taxmann20-20Direct20Tax20Laws

years of operation, however Minimum Alternative Tax needs to be paid and can be credited from future tax payouts.

2. **Accelerated Depreciation:** In order to promote RE, the accelerated depreciation on wind electric generator is permissible upto 80% for income tax calculations subject to a minimum utilization for 6 months in the year in which deduction is claimed. The accelerated depreciation benefit has been a very effective tool for mobilizing funds for wind turbine technologies. The accelerated depreciation benefit was available for wind energy projects and was the key driver for capacity addition in the country's wind sector. However, the benefit was withdrawn in April 2012. This withdrawal negatively impacted the growth of wind capacity. For instance, during the FY 2012-13, only 1,700 MW of wind power capacity was added as compared to 3,164 MW[34] in the previous financial year. In 2014, the Government has again decided to bring AD for wind assets which is likely to proliferate the investment opportunities. There is certain limitation associated with AD, because wind projects are capital intensive, with low taxable profits in the initial years, unable to absorb the high depreciation. Hence, the benefit of accelerated depreciation can only be utilized when the company owning the wind asset generates enough profits from other businesses. Independent Power Producers (IPP), which is the key drivers of investments in RE, suffers as a result because they invest via SPVs in each project.

3. **Feed-in Tariffs:** It is one of the most successful policy instruments for promoting wind energy. State governments across the country have been providing long term support to wind industry through FiTs, also known as preferential tariffs. Under the FiT framework, wind power is procured by Distribution Companies (DISCOMs) at the FiT specified by SERCs. FiTs, applicable over a period of 10 to 25 years, ensure predictable financial returns over the life of the project. The SERCs determine FiTs for wind energy generation plants using a cost plus approach based on following factors:

    - Achievable capacity utilization factors based on the availability of resource;
    - Operating costs (O&M expenses, capital replacement);
    - Capital expenditure (project cost);
    - Share of debt and the cost of debt; and
    - Expected return on equity.

4. **Renewable Energy Certificates (RECs):** Its market based instrument to promote renewable energy and facilitate renewable purchase obligations (RPO). REC mechanism is aimed at addressing the mismatch between availability of RE resources in state and the requirement of the obligated entities to meet the renewable purchase obligation (RPO), and is available to generators if they don't benefit from prefrerntial tariffs for generation or transmission and wheeling.

5. **Generation based incentives**: In December 2009, MNRE introduced the GBI scheme41 for wind energy projects to facilitate the entry of large IPPs. This scheme was available only to those developers who did not avail themselves of accelerated depreciation benefits and sold power to the state distribution companies.

Under the GBI scheme, IREDA provided an incentive of INR 0.50 per kWh (US cent 0.8 per kWh) of wind power fed into the grid, with a total project lifecycle cap of INR 6.25 million per MW[35] (USD 0.1 million per MW) and an annual cap of INR 1.55 million per MW (USD 24,700 per MW). While the target was to develop 4,000 MW through GBI, the scheme was discontinued in March, 2012, even though only 2,247 MW of wind capacity had been installed under the scheme. However, it was re-introduced in August 2013 and will be applicable for the

[34]http://mnre.gov.in/file-manager/UserFiles/wp_installed.htm
[35] Revised to INR 10 million/MW in the policy announced recently

entire period of the 12th Five Year Plan42. The cap on GBI was increased for a project to INR 10 million per MW (USD 0.16 million per MW) with an annual cap of INR 2.5 million per MW (USD 40,000 per MW).

Scale Up Challenges

1. Cost of setting up of large wind farm is still significantly very high posing a serious challenge. Capital cost per megawatt is high due to increased cost on account of transportation of components to site, higher raw material and labour cost, increase in statutory fees payable to the state nodal agencies, and electricity board for permission.
2. ROW issue has been observed one the biggest issue which is posing threat to development of large scale wind power and delay in project implementation has been a common issue across the India.
3. Grid augmentation is one of the major hurdle for development of large scale wind power, e.g. in TamilNadu there is serious issue of grid availability for wind projects during the peak wind season. When large wind power plants are located away from the load centres, laying dedicated transmission lines to evacuate the unreliable secondary wind power is additional cost liability
4. The biggest challenge today is acquiring land for the wind farms due to local issues, lack of clarity and transparency, evacuation bottlenecks, and an inconsistent policy environment. We are developing our own land bank along with evacuation infrastructure to cater to the next three to four years business plan.
5. High O&M cost of wind project

Policy challenges

1. Lack of policy implementation such as REC guidelines has been launched long way back though there is no serious commitment from DISCOM to purchase the REC and there is no penalties imposed on defaulted DISCOM and subsequently there is huge revenue loss for project developers who has opted for sale of power under REC mechanism.
2. It has been observed that states are delaying signing of PPA which affects the commissioning of wind farm.
3. Payment security: It has been observed that in many states across India payment towards supply of electricity to Gird has not been credited to developers on time and there is almost delay of 5-8 months in revenue realisation which affects the developers revenue stream.
4. Tariff in few states such as Tamil Nadu, Karnataka, and Gujarat are still far below as compared to other states such as Madhya Pradesh and Rajasthan.

Apart from above following are the Policy and Regulatory Issues at National Level

- Regulatory non-uniformity across states.
- Absence of long term feed-in-policy.
- RPO non-enforcement.
- Weak financial health of distribution licensees.
- Delay in GBI payments
- Non-implementation of open access in states
- Very high transaction for inter-state wind power sale.
- No policy on hybrid (solar and wind) and offshore power projects.
- Power evacuation

Renewable Energy and Water Challenge

Drinking Water Challenge

Drinking water supply and sanitation in India continue to be inadequate, despite longstanding efforts by the various levels of government and communities at improving coverage. Although the level of investment in water and sanitation, albeit low by international standards, has increased during the 2000s, more than 100 million people lack access to safe water and 802 million have no sanitation services. A number of innovative approaches to improve water supply and sanitation have been tested in India, in particular in the early 2000s. These include demand-driven approaches in rural water supply since 1999, community-led total sanitation, a public-private partnerships to improve the continuity of urban water supply in Karnataka, and the use of micro-credit to women in order to improve access to water. According to Indian norms, access to improved water supply exists if at least 40 litres/capita/day of safe drinking water are provided within a distance of 1.6 km or 100 meter of elevation difference, to be relaxed as per field conditions.

Reasons for water contamination

Some of the crucial issues affecting quality of water supply in rural India are unregulated groundwater extraction and water pollution due to poor waste management laws. Water is rendered unfit for consumption due to various reasons:

- Surface water supplies are often contaminated with feacal matter due to the widespread practice of open defecation. The presence of microbiological contaminants such as bacteria, viruses and parasites impact water potability.
- Drinking water may also contain chemical contaminants that are by-products of industrial and agricultural activities. 80% of sewage in India is untreated and flows directly into the nation's rivers, polluting one of the main sources of drinking water.
- Groundwater in many heavily populated areas of India contains arsenic and fluoride contamination. Specifically, districts in seventeen states suffer from fluoride contamination and traces of arsenic contamination have been found in seven states (in the Ganga-Brahmaputra plain) in India. Ill effects of consuming fluoride-contaminated water include skeletal fluorosis, a crippling disease that leads to joint pains, bone fractures, nerve destruction and stunted growth. Consumption of arsenic contaminated water over the long-term results in arsenicosis, a cancer-causing disease that debilitates the hands, feet, and mouth.

Purification System and their challenges

There are a number of water treatment technologies to choose from and yet so few of them have been put to work sustainably and at scale in India. In an earlier post, I talked about the huge demand-supply gap for safe drinking water in India. Treat water centrally or at point of use when ones purifying drinking water, there are two main choices:

- Treating water centrally - These systems are set up by the government, have high initial costs, and require a high degree of maintenance and upkeep. Unfortunately, contamination is rampant during distribution due to poorly maintained pipes and most people in cities still use home filter systems.
- Treating water at the point of use (e.g. home, office, restaurant) – these systems are expensive and require regular maintenance and membrane/filter changes making them unattractive for use in villages.

Seeking to bridge this gap in rural areas, **community water systems are designed for villages.** These systems are set up at a central location from which villagers purchase purified water in jerry cans to be carried home themselves or to be delivered by the water company. Aquasafi, Spring Health, Waterlife and Water Health International are examples of companies that have made significant progress in setting up such community water systems across villages in India. **Most rural water systems are driven by big hearts rather than**

sustainable models. A number of operators are trying to solve India's drinking water problem — government bodies, non-profit organizations, CSR (corporate social responsibility) arms of large corporates and for-profit companies. For most of these entities, a rural water project provides a warm feeling and an improved image. Rural water systems set up by large organizations rarely work because they are driven by big hearts rather than sustainable models. Water is given for free or at very low prices, insufficient to cover costs of installing and, more importantly, operating the systems. Due to inadequate ongoing funding and commitments, rural India is littered with non-operational water systems funded by well-intended organizations. **Free or subsidized water systems most often fail to deliver long-term, affordable, quality drinking water to Indian villages**.

Business models

Companies delivering water to rural India have been experimenting with various business models tailored according to the needs of the local market. Most water companies adopt one or more of the below models.

- **Outright Sale:** Here the water company sells the water system to the government, NGO or CSR. Often the village panchayat (local government) owns and operates the plant either directly or through a jointly constituted committee. Revenue generated through the sale of purified water (typically at INR 2-5 for a 20 litre jerry can) is used to fund operations. Often these systems are maintained poorly as the revenue does not cover the necessary operating costs.
- **Sale and Maintenance:** This model is similar to the previous one in which the system is sold outright, usually to the government. However, in this case, the water company continues to service and maintain the system for a fee. Generally, these continue to operate well although the price is higher (e.g. INR 4-7 for 20 litres) because the professional water company is being paid to properly maintain these units.
- **Franchise:** Here the water company identifies a local entrepreneur who contributes part of the initial system cost. The entrepreneur operates the system and shares part of the profit with the water company. In this model too water is sold at a higher rate (INR 6-10 for 20 litres) to recover the initial capex cost (most of which is borne by the water company).

Innovative approaches to delivering clean drinking water

While most companies have adopted one or more of the above business models, there are a few companies that have broken the mould and have developed innovative approaches to deliver clean water in India. Here's a look at some of them:

- **Microfinance and Water:** Lack of access to safe water and sanitation to the financial resources to secure these necessities is a cyclical problem faced by the rural poor. Water Credit, an innovative program launched by Water.org addresses this issue by providing small loans to households for the purchase of water filtration systems. The supposedly 'unbankable' low-income population has yielded a 99% recovery rate for WaterCredit (since 2003). Hindustan Unilever too has a similar model where it tied up with Spandana Microfinance to promote sales of its flagship product Pureit. Bundled with a small loan, sales of Pureit increased dramatically- 1% penetration in areas with no loan access to 40% penetration when backed by a microfinance scheme. In another such initiative, Milaap, a Unitus Seed Fund portfolio company, tied up with Guardian, a microfinance institution and Yunus Social Business Fund, to provide micro loans people in Tamil Nadu for building water connections and toilets in their homes.
- **Water Wheel:** Wello's simple yet ambitious goal is to deliver clean water to a thirsty world and its Water Wheel is aimed at doing exactly this. An answer to the problem of women and girls wasting precious time and energy time fetching water, Water Wheel enables collectors to roll 50 liters of water instead of carrying it on their heads. It is made of high-quality, durable plastic and sold at approximately Rs. 1,500 ($25) per wheel, designed to last for more than five years. Wello is also exploring the possibility of purifying water while the wheel is being rolled.
- **LifeStraw:** Designed to bring clean water to the poorest of the poor, Vestergaard's LifeStraw is a simple straw that can filter around 1,000 liters of water, enough to hydrate a person for a year. It is a portable point-of-use filter that removes microbiological contaminants in water without the use of electricity or batteries. The family version of the straw includes a tabletop storage tank and can purify 30,000 liters of water, enough to serve a typical family for three to five years.

- **Water ATMs:** Swajal & Sarvajal's solar-powered water ATMs dispenses clean drinking water at the swipe of a prepaid smart card. These companies extensively use cloud computing and mobile technology to monitor operations, control quality and minimize costs. Use of a prepaid system for both the entrepreneur and the customer solves the problems of revenue collection and under-reporting. This is a very unique and successful model where an entrepreneur from the village sells the card and earns revenue. The village water committee takes the onus of Operations and Maintenance of the system. The bonus of using technology: men are now eager to collect water and show off their smart cards!

Although companies are trying creative approaches, water for the masses is a difficult business to crack. Most venture capital funds and impact investors have stayed away from the sector in India due to complexities involved in building a successful water business. While there have been a few investments in the space (Spring Health, Water Health, Waterlife and Greywater have raised institutional funds), it still remains to be seen whether these companies can build profitable businesses by catering to India's low-income populations.

To conclude, providing safe drinking water to all in rural India is a challenging task. Given the diversity of the country and its people, solutions have to be diverse. One has to look at an approach that seeks the participation of users through interventions engaging the communities with various government schemes and policies. Citizens should be made aware of the demand for clean drinking water as a right. Such an integrated approach would incorporate collaborative efforts of various sectors involving the government, civil society and needless to say the people. Solar Energy is a source of renewable energy which is very conveniently tapped to produce drinking water with RO systems. These two technologies "Swajal" and "Sarvajal" actually provide a solution on drinking water to both rural and urban communities. Solar energy is also used to distil brackish or saline water potable. Especially in Rural India Solar energy can run whole water purification System of considerable volume to cater to the drinking water requirement. Going ahead GOI, Civil Organizations, NGOs should focus on renewable energy technologies to produce or make water potable.

Irrigation Water Challenge

Agriculture and related activities provides employment to more than 50% of the country's workforce, though the contribution to GDP is only 15%. The importance of agriculture can be established from the fact that it is the primary source for livelihood sustenance of more than seventy percent of India's population.

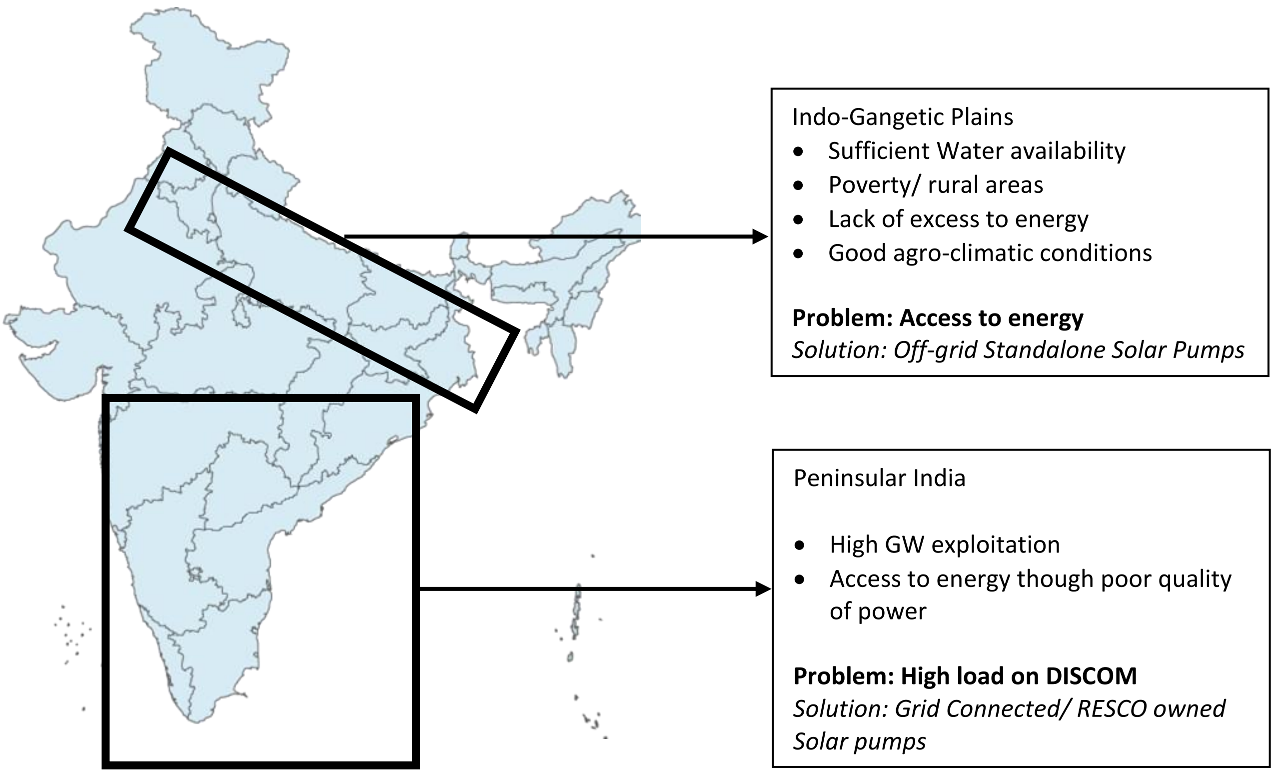
Agricultural improvement is the key to India's overall growth and economic enhancement, there is an immediate requirement for addressing the key productivity challenges in agriculture. Enhancing agriculture productivity requires strengthening the inputs and market linkages such use of improved quality of seeds, use of fertilisers and pesticides, adopting better cropping practices, crop diversification, etc. However the biggest and the most critical input for enhancing productivity will remain access to water for irrigation.

Irrigation in the country is dominated by groundwater, the exploitation of which is private investment led. The country today has around 19 million grid connected pump-sets and 7 million diesel pump-sets. India uses more than 4 billion litres of diesel and around 85 million tons of coal per annum to support water pumping for irrigation.

The challenges to efficient irrigation in India vary from in different geographies. These can be divided in two broader challenges:

- Access to Energy for Irrigation
- Excessive groundwater (GW) extraction- resulting in increased loads on DISCOMS and lack of quality power

Figure 8: Irrigation Scenario in India- IGB and Peninsular India



The Access to Energy Challenge in Agriculture and Irrigation

Due to a lack of power supply to the farmers, most farmers irrigate their crops using diesel pump sets. However with increasing price of diesel, there has been a substantial increase in the cost of delivered energy and irrigation, which has further reduced the returns these farmers receive from the market. Depending on the crop, the irrigation costs vary between Rs 5000 to 30000/acre, if diesel pumps are used, almost 20%-30% of crop value

Excessive load on power utilities (DISCOMS) catering to Irrigation

Irrigation constitutes 20%-40% of total electricity consumption in Indian states. The states pass on subsidies to compensate DISCOMS resulting in a demand-supply stress. Erratic grid supply and high cost of diesel pumping continue to remain the main problem areas for the farmers. Poor irrigation as a result of these issues results in significant yield losses. ***Under such conditions, solar based-irrigation service delivery offers an appropriate solution***. The use of solar energy for water pumping for irrigation purposes constitutes an environment-friendly and low-maintenance possibility for pumping irrigation water.

Serving irrigation loads puts significant stress on DISCOMS. Since power is cheap; farmers tend to use 'cheap' pumps even if they are inefficient. Irrigation loads are not regular, and tend to bunch up. Moreover, the DISCOMS are mandated to provide low cost of power for agriculture, this does not build an incentive for efficient water use.

Increasing Dis-com subsidy	Water stress	Increasing food demand	Farmer stress
• Irrigation accounts for 19% of electricity supplied by the grid. In many states such as Rajasthan, Karnataka, it touches 40% level. • There is a large unmet demand	• Northern states such as Rajasthan, Punjab, Haryana- are stressed (127%-170% overdraw) • Decreasing water table, increasing energy needs • Agriculture accounts for 80% of water needs; 60% of irrigation needs met from groundwater, and this share is increasing.	• Government has announced a target of 400 mn T of food grain production by 2020 (260 mn T in 2013-14) • The mix will also need to change from primarily grains to grain-oilseed-horticulture-fruits-vegetables, which are irrigation intensive • This will require expansion in irrigation capacity.	• Most states suffer from 'denial of service'; Long delays in grant of new connections; Poor quality power; Unpredictable power availability • This leads to use of DG sets (~8-10 mn pumps being used in India), which is unaffordable for most commodity crops

Solution

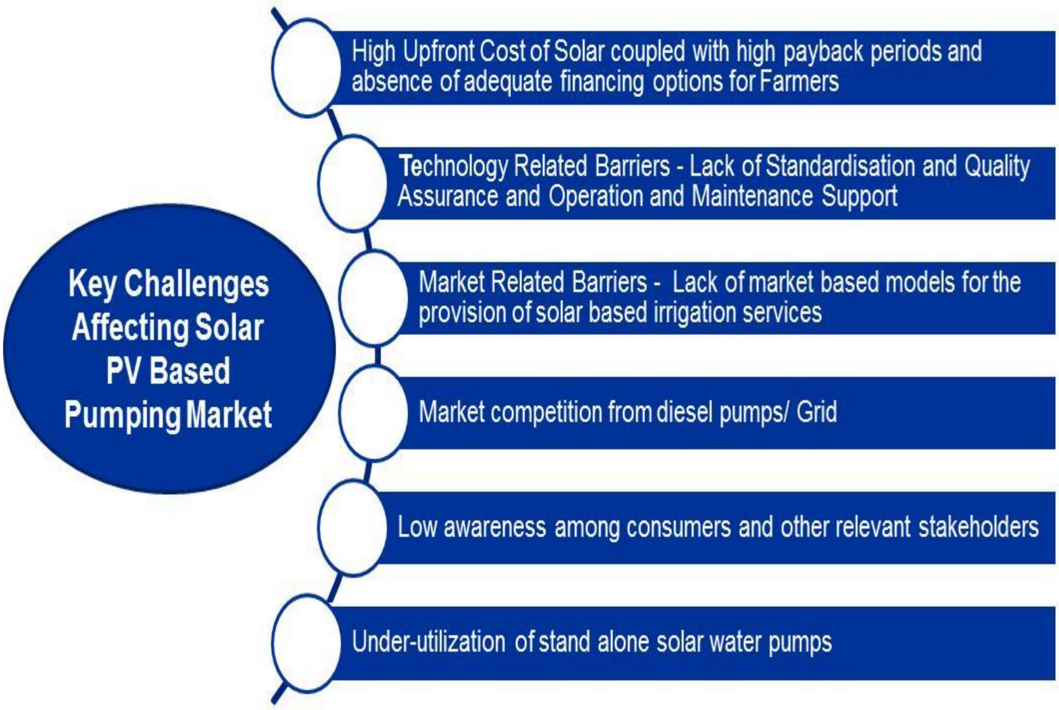
The solution to these challenges can be achieved using a threefold program, as stipulated in the Figure below:

Efficient Pumps	Solarize	Private Sector participation
• Replace existing pumps with efficient pumps (realize 30%+ efficiency gains) • 'Assure' water flow rates to be similar to existing pumps- trial runs, pre and post installation.	• Reduce energy required for irrigation to zero • Irrigation pumps work ~50-200 days in a year. For remaining days, energy generated can be exported to the grid • Irrigation pumps can act as anchor loads for rural micro grid operation.	• Private sector participation to • Replace pumps • Set up generating capacity • Maintain pumps, feeders, generation etc. • Manage demand – to make the loads even. • Other operational roles like metering, collections etc. • With correct revenue model, private sector can scale, reduce costs, bring in efficiencies.

Challenges for provision of Solar-based Irrigation Services

Although solar PV-based pumping offers a number of advantages, a few challenges have been constraining the development of a solar PV-based pumping market (highlighted in the figure below).

Figure 9: Challenges for provision of Solar-based Irrigation Services



Business model options for Solar Irrigation

In order to address the above challenges, appropriate business models need to be adopted, such as

1. Grid Connected Models- Areas with sufficient power infrastructure; GW table is low
    a. Micro Grid RESCO- Net metering
    b. Micro Grid RESCO- Gross Metering
    c. Individual solar pumps- Entrepreneurship development (Farmer will invest)
    d. Individual Solar Pumps- A RESCO will invest
2. Off-grid systems- Areas with favourable ago-climatic zones; good GW level
    a. Establishing irrigation Grid- managed by RESCO
    b. Individual Irrigation schemes, invested by RESCOs
    c. Individual Irrigation schemes, invested by Farmers

These models are elaborated as below:

Options for grid connected pumps

Model-1.1: Micro Grid (RESCO- Net metering)

The beneficiaries will form a Renewable Energy Services Company (RESCO) which would carry out the following activities:

- Replacing old pumps with new efficient pumps.
- Setting up a generating station feeding the pumps; manages the distribution network/feeder etc. Capital subsidy (pump-replacement, generating station)
- DISCOM pays for Net power exported to grid, after use of irrigation loads, at a FIT ('net metering')
- Payment by the Farmers/DISCOM for supplying power at existing rates.
- Payment for upkeep of feeders (DISCOM)

Model-1.2: Micro Grid: RESCO- Gross Metering

Similar to Model-1.1 except that RESCO gets compensated for 'gross power generated' irrespective of what gets consumed by the irrigation loads.

Model-1.3 Individual solar pumps: Farmer Invested

In this model the Farmers will pay for the entire pump and receive capital subsidies. RESCO will be assigned the role of system management and/or maintenance contract for each pump/ operation of escrow account to service farmer loans etc. Compensation to farmers will be provided for net power exported at a defined FIT rate (net metering concept).

Model-1.4: Individual Solar Pumps: RESCO Invested

It is similar to Model-1.3, except the RESCO will invest in each solar pump system for a farmer, replacing old pumps. RESCO shares with the farmer value linked to Net Power Exports (X); RESCO is in turn paid by the DISCOM for each unit of power exported to the Grid from the pumps managed by it.

Options for Off Grid Pumps

Model-2.1: irrigation Grid, managed by RESCO

The RESCO will replace old pumps with efficient pumps and sets up a generating station feeding the pumps. The pumps will be connected with distribution lines. The distribution lines can also serve other segments to use excess generation at pumps (domestic, community, commercial, industrial). The RESCO will pay (to the farmer) for water supplied/ electricity supplied.

Model-2.2: Individual Pumps, invested by RESCOs

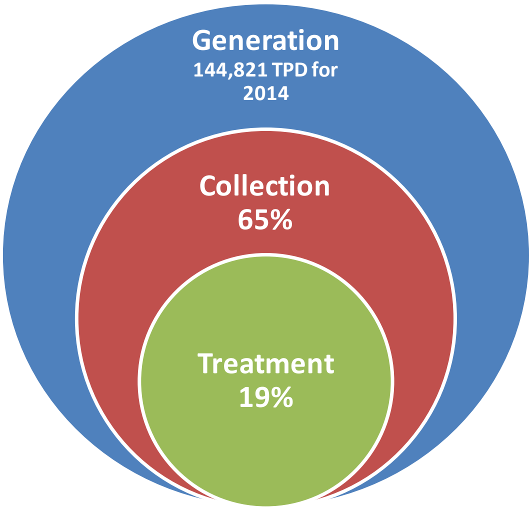
The RESCO will set up individual solar pumps for each farmer (or a group that shares irrigation RESCO finances it through capital subsidy and its own capital, RESCO operationally controls and maintains the pumps. Farmer pays for water supplied and/or electricity supplied plus the lease rental.

Model-2.3: Individual pumps- Farmer Invested

It is similar to Model-2.2 except the farmer invests each solar pump system; the farmer can finance the pump through subsidies and low cost loans (NABARD schemes for farm implements). In high subsidy areas like Rajasthan, RESCOs are able to provide some soft financing for farmers too.

Waste Challenge

India is the second largest country in the world by population after China. Population reached 1,210 million people counted at the last census in 2011, and 1,286 million has been estimated by the end of 2015 (Ministry of Home Affairs, 2011).



Due to rapid economic growth, India's urban population has been increasing from 286 million in 2001 to 377 million in 2011 (Ministry of Home Affairs, 2011) and it is expected to reach 590 million by 2030 (McKinsey, 2010). The amount of MSW generated by Indian urban population has also increased from 81.6 thousand TPD in 2001 to 144.8 thousand TPD in 2014 (CPCB, 2014). According to Central Pollution Control Board (CPCB, 2014), 92.8 thousand Ton per day (TPD) of MSW was collected in urban areas (around 65% of all waste generated in urban areas), and only 27.1 thousand TPD (around 19% of all waste generated) was processed or treated by using mitigation options like composting or vermi composting or waste-to-energy plants. The remaining quantity of collected waste is dumped into solid waste disposal sites (SWDS) without any treatment.

Management of such a huge amount of MSW in the country has emerged as a severe problem not only because of the environmental, hygienic and aesthetic concerns but also because of the sheer quantities generated every day that need to be collected, transported, treated and disposed.

The Government of India (GoI) has invested significantly in Solid Waste Management (SWM) projects under the 12th and 13th Finance Commission in form of grants and funds under the Jawaharlal Nehru National Urban Renewable Mission (JNNURM) and the Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT) (MoUD and CPHEEO, 2014). According to the 12th Finance Commission 2005-10 report, GoI has provided USD 410 million (INR 25 billion) as grant to states for Urban Local Bodies (ULBs) specifically for SWM through public-private partnerships (PPPs) (Finance Commission India, 2004).

As on August 8, 2014, 46 MSW projects entailing an investment of USD 350 million (INR 21.1 billion) had been sanctioned under the Urban Infrastructure and Governance component of the JNNURM. The additional central assistance (ACA) commitment towards these projects stood at USD 187 million (INR 11.23 billion). Under the UIDSSMT component, 67 MSW projects worth USD 85 million (INR 5.11 billion) have been sanctioned as on March 31, 2014. The ACA commitment towards these projects stood at USD 70 million (INR 4.21 billion). Further, at least eight projects costing in excess of USD 316 million (INR 19 billion) are under implementation on a PPP basis, at the state level (India Infrastructure Research, 2014).

Despite this significant investment, the present scenario of waste management is not very encouraging in India and requires immediate attention. Proper SWM will not only reduce the pressure on ecosystem and human health but it will also minimize the contribution to climate change.

As per a study conducted by EVI, the waste disposal at SWDS of urban centers in India has resulted in emissions of 18.6 million tons of CO_2 eq in 2014 and is expected to reach 41.09 million tons by 2030, an increase of more than 100% in the next 15 years.

Source(s) of MSW

As per draft Solid Waste Management Rules (2015), MSW includes the commercial and residential waste produced in municipal or notified areas in either solid or semi-solid form without industrial hazardous waste, e-waste and including treated bio-medical waste. However in practice, MSW usually contains food wastes, paper, wood, textiles, plastics, metals, glass, street sweepings and general wastes from parks. Sometimes other types of wastes like construction and demolition (C&D) waste, hazardous waste (e.g., batteries) and e-waste (from electronic goods) are also mixed with MSW.

State	Quantity Generated (TPD)	% Generated
Maharashtra	26,820	19%
Uttar Pradesh	19180	13%
Tamil Nadu	14532	10%
Andhra Pradesh	11500	8%
Karnataka	9500	7%
Gujarat	9227	6%
West Bengal	8674	6%
Delhi	7500	5%
Madhya Pradesh	5079	4%
Rajasthan	5037	3%

Table 8: Source(s) of MSW

As per CPCB (2014), Maharashtra, Uttar Pradesh, Tamil Nadu and Andhra Pradesh together generate over 50% of the total MSW generation in the country. These are the states with high levels of urbanization.

As per study conducted by EVI, there are 53 cities above 1 million inhabitants and they have generated more than 40% of the total waste generated in India in 2011. Cities with more than 1 million inhabitants are expected to be 68 by 2030 and they are expected to generate more than 50% of the total waste generated in India.

Waste generation rate and its composition

As per EVI estimate, waste generation rates vary across urban cities from 349 grams per capita per day to 485 grams per capita per day.

Waste composition also widely varies across India and the same has been provided below (Annepu, 2012).

Region/City	Compostable (%)	Recyclables (%)	Inerts (%)	Moisture (%)
Metros	50.89	16.28	32.82	46
Other cities	51.91	19.23	28.86	49
East India	50.41	21.44	28.15	46
North India	52.38	16.78	30.85	49
South India	53.41	17.02	29.57	51
West India	50.41	21.44	28.15	46
Overall Urban India	**51.3**	**17.48**	**31.21**	**47**

Table 9: Waste generation rate and its composition

Collection and transport of waste

In many Indian cities door-to-door waste collection exists in which waste is collected from households. However the collection efficiency varies from less than 50% in smaller cities to 90% in bigger cities (Annepu, 2012).

Waste collected from households and other sources is carried to a collection point. These collection points show poor sanitary conditions and pose health hazards to the workers and waste pickers. At these collection points part of the wet waste is eaten by stray animals and recyclable parts are collected by waste pickers. In some cities, non-governmental organizations (NGOs) are involved in the collection of recyclables through the service of waste pickers.

These collection points are also referred to as transfer stations as waste from these collection points is transferred to trucks. These trucks are owned and maintained by municipal corporations or private contractors. These trucks collect waste from collection centers generally in the afternoon and carry the waste to dump sites or waste treatment facilities for processing of waste before disposal.

There is no organized segregation of waste at source due to a lack of awareness and willingness among households. Only few isolated pilot projects on separate waste collection from a limited number of households exist. In some cases (e.g., in Bangalore), it has been found that recyclable wastes are separated from wet wastes during collection by corporation staff.

Figure 10: Transfer centres

Recycling

In India, it is general practice by households to segregate high worth recyclable materials (like newspaper, plastic bottles, glass, metals etc.) and sell it to Kabariwalas (itinerant waste buyers) on direct payment. Recyclables of less value (torn paper, plastic pieces, glass pieces, metal pieces etc.) are mixed with MSW. The recyclable component in MSW varies from 15% to 26% in waste collected from households.


Figure 11: Recycling of plastic bottles

Recycling in India is largely carried out by the informal sector. The informal sector consists of waste pickers, itinerant waste buyers, dealers and recycling units. Waste pickers constitute the largest population in the informal sector. The recyclables collected by waste pickers are sold to small, medium and larger dealers. The dealers sell it directly or through large scale dealers to recycling units.

As per an estimate, the informal sector recycles 15%-20% of the recyclable components of MSW collected in India. It has to be mentioned that this number excludes the amount of waste recycled from MSW prior to collection, which is commonly not accounted for and can amount to four times the quantity recycled from officially collected waste. This implies an estimated overall recycling share of 56% of recyclable waste generated (Annepu, 2012).

Treatment of waste

There are 645 compost/vermicompost plants and 71 waste-to-energy plants (Refuse Derived Fuel (RDF)/pellet - 18, Biogas plants - 41 and power plants - 12) set up by ULBs for treatment of waste (CPCB, 2014). However, most of the treatment facilities have encountered severe problems during operation or operate at throughputs far below their capacity. This has led to less treatment of waste resulting in respectively higher waste disposal to SWDS sites.

TREATMENT TECHNOLOGIES

Compost/ Vermi-compost plants – 645

Waste-to-Energy plants – 71

a. RDF/pellet - 18
b. Biogas plants – 41
c. Power Plants – 12

Disposal of waste


Figure 12: Disposal of waste

As per CPCB (2014), more than 80% of waste generated (117.2 thousand TPD) is dumped to SWDS sites without any treatment. India had only 69 sanitary landfill sites constructed and operational in 2013-14 (CPCB, 2014); hence most of the MSW waste is dumped on open land or at unsanitary landfills (open dump sites).

Open dumping of waste or unsanitary landfill sites lack of monitoring of the site. Stray animals and birds feed on the waste. Leachate or methane collection systems are absent and the waste is exposed to natural elements such as heavy rain or strong winds. Even the sanitary landfills are not properly managed which results in landfill fire, leachate problems, methane emissions etc.

The following table shows operating and planned landfill sites across India (CPCB, 2014)

Table 10: operating and planned landfill sites across India

Reported during 2013-14	Number
Landfill sites constructed	69
Initiative taken for construction of new landfill sites	164
Landfill sites identified	774

ULBs from smaller cities have not yet identified landfill sites in accordance with MSW Rules (2000). In larger cities like Delhi, existing landfill sites have been exhausted and the respective local bodies do not have resources to acquire new land. Such lack of landfill sites decreases MSW collection and treatment efficiency.

The current SWM services are inefficient, incur heavy expenditure and are so low as to be a potential threat to the public health and environmental quality. Improper solid waste management deteriorates public health, causes environmental pollution, accelerates natural resources degradation, causes climate change and greatly impacts the quality of life of citizens.

Policies for SWM management

Government of India recognizes that the existing state of MSW management systems in the country is also raising serious public health concerns and sanitation issues that need to be addressed in the public interest. GOI has formulated various policies for MSW management.

Table 11: Policies for SWM Management

Year	Policy
1994-95	Strategy paper by NEERI
2000	MSW Management and Handling Rules, 2000
2000	MSW Manual - CPHEEO
2005	JNNURM – I -46 MSW projects of Rs 2100 Cr sanctioned till March 31, 2014 -67 MSW projects of Rs 511 Cr sanctioned till March 31, 2014
2005-10	12^{th} Finance Commission – Rs 2500 Cr for 423 Class-I cities
2006	Strategy & Action Plan for the use of Compost in cities 2006
2007-12	11^{th} Five Year Plan–Working Group recommended an investment of Rs 2210 Cr for MSWM
2008	National Urban Sanitation Policy
2008	Service Level Benchmarking in MSWM, 2008
2010	National Mission on Sustainable Habitat
2010-15	13^{th} Finance Commission established standards for delivery of essential services
2011	Renewal of 500 urban habitations as per the plans stated by MoUD
2011	Plastic Waste (Management & Handling) Rules, 2011
2013	Draft Municipal Solid Waste (Management & handling) Rules, 2013
2014	Development of 100 smart cities
2015	Draft Solid Waste Management Rules, 2015

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