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ASEM Eco-Innovation Index 2017

Country Report

INDIA

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SUMMARY

India is the largest democratic country in the world. With a population of more than 1.2 billion, it is the second largest populous country and the seventh largest by area. India's economic reforms in the early 1990s did away with the earlier policy of licensing, reducing import tariffs and market interest rates and made public sector enterprises more competitive. Increased economic activities lead to greater economic growth and over the last two decades the real GDP growth rates averaged around 7 percent. There has been marked improvement in India's ranking on various parameters like infrastructure development, technology and innovation, institutional capacities, employable human resources, India's participation in the global value chain networks, etc, at evident from the Global Competitiveness Indices. One of the eventual outcomes of this was the creation of greater economic opportunities leading to substantial decline in poverty rates.

However, with economic growth the challenge at the policy level emerged in creating the right balance between the developmental requirements as well as minimizing the negative externalities linked to natural resource use. In this regard, India introduced the National Environment Policy (NEP), a decade ago, that articulated the spirit of sustainable development. It mentions that a development is sustainable, that respects ecological constraints and the imperatives of social justice. Given the multi sectoral dimension embedded in the definition of the sustainable development, it is evident that addressing the ambitious goal for India will require different institutions working in a coordinated manner. It requires not only cross sectoral, but also multi-level coordination with the active involvement of all stakeholders. The Ministry of Environment, Forest and Climate Change (MoEFCC), took the lead in introducing and amending existing policies on various issues related to the environment. These included protection of the environment, prevention and control of pollution, conservation of flora, fauna, forests and wildlife, afforestation and regeneration of degraded areas, etc. Micro Small and Medium Enterprise sector in India forms the backbone of India's manufacturing sector and strengthening it will go long way in addressing various development and environmental objectives as laid out the NEP. Key programs introduced by the ministry included promotion National Manufacturing Competitiveness Programme, Zero Defect Zero Effect scheme, as well as promoting innovation in MSME clusters.

India's renewable energy program has received significant attention in recent years, where India plans to add 1, 75,000 MW of electricity using various renewable energy technologies. This mission

SUMMARY

is a part of the eight missions that was launched under Government of India's National Action Plan on Climate Change (NAPCC), with an objective towards addressing climate change related adaptation and mitigation while promoting economic development. Apart from the solar mission, the other seven missions include (i) National Mission for Enhanced Energy Efficiency (ii) National Mission on Sustainable Habitats (iii) National Water Mission (iv) National Mission for Sustaining the Himalayan Ecosystem (v) National Mission for a Green India (vi) National Mission for Sustainable Agriculture (vii) National Mission on Strategic Knowledge on Climate Change. Reducing carbon foot print in energy intensive industries and consumer electrical equipments is achieved through the Perform Achieve Trade (PAT) and Product labeling schemes and administered by the BEE.

Bureau of Indian Standards (BIS) support is immense for the economy through provision of safe, reliable and quality goods to consumers; ensuring minimal health hazards to consumers, promotion of import substitution, undertaking testing and certification of various products launched in the market. Government of India through the Swachh Bharat Abhiyan (Clean India Mission) aims to promote cleaning cities, towns and villages, improving waste management and sanitation, as well as raising awareness among citizens. India demonstrated a strong commitment in introducing electric mobility in India where there has been an ambitious plan of making India a primarily electric car driven nation by 2030. The government in this regard launched a scheme for the Faster Adoption and Manufacturing of (hybrid &) Electric Vehicles in India (FAME India) in 2015.

Research and development in eco-innovation is a basic source for addressing sustainable development issues. It helps in the transformation of knowledge into development of processes, products and services that promote economic growth, thereby generating employment. In India, majority of the funding for the basic research is undertaken from the support of the government through the department of Science and Technology. Science, Technology and Innovation Policy, was introduced in 2013 with the aim of enhancing employment generation through R&D in science and technology. A major aspiration of the policy is 'fostering resource-optimized, cost effective innovations, across size and technology domains'. A focus of the policy is on 'providing incentives for commercialization of innovations with focus on green manufacturing '.There are number of business incubator models that have evolved in the India. The department of Science and Technology (DST) provides significant support for initiation of business incubation one through the Science and Technology Entrepreneurship Parks (STEP) that came up in 1990 and more recently through the Technology Business Incubators.

However, for a country like India, where it has a long way to go in successfully meeting the aspirations of millions of people, environmental consequences can be formidable since economic growth will create significant pressure on natural resources like forest, land, water, minerals, and fossil fuels. The ability of the economy to achieve a circular economy will depend a lot on how India is able to integrate life cycle thinking across various policies and programs and use appropriate instruments to tap market signals. Further, it will depend on the ability to reduce the unwarranted quantity of resources required over time to support economic growth that leads to enhancement of social equity and job creation.

1. Eco-Innovation Performance

General Information of the Country

Table 1. India Country Profile

Jurisdiction	Civil courts, Criminal Courts, Executive Courts
Language	Multilingual; National Language Hindi (Devnagari Script)
Population	1.21 billion (Census report, 2011)[1]
Income	GDP per capita (current US$) : US $ 1703 (2016)[2] GDP per capita (current PPP terms): US $ 6572 (2016)[3]
Industry	17 (agriculture & mining); 29 (industry); 54 (service)[4]
Sustainability Index	Social Progress Index: 58.39; Rank: 93[5] Yale Environmental Performance Index: 53.58; Rank: 141[6]
HDI	Human Development Index: 0.624; Rank: 131
Business Environment	Ease of doing business report 2017: 100 (out of 190 countries) Global competitiveness index 2017: 40 (out of 137 countries) Index of economic freedom 2017: 143 (out of 186 countries) Global Innovation Index 2017: 60 (out of 127 countries)

India is the largest democratic country in the world. With a population of more than 1.2 billion, it is the second largest populous country and the seventh largest by area. It is federal country with a parliamentary system of administration. The Constitution of India serves the country's supreme document. Federalism in India is defined as the union of states. Governance in India is "quasi-federal" where the powers are distributed as per the Indian constitution and are divided into three lists, the centre, the state and the concurrent list . This is presented in figure 1.

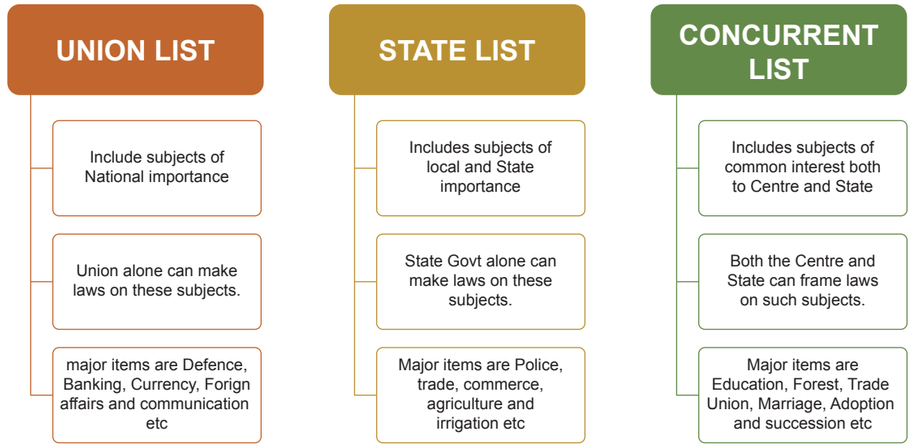

Figure 1. Distribution of powers between central and regional governments
Source: http://vle.du.ac.in/mod/book/print.php?id=13042&chapterid=29844

India is the 6th largest economy by nominal GDP and the 3rd largest by purchasing power parity (PPP). According to World Bank , estimates (2016)[1], India's GDP per capita at current prices is US $1703 and at per capita (PPP terms) is US $ 6572. Post India's independence in 1947, the government's policy was larger governed by import substitution, to promote domestic manufacturing capacity, where the industrialization was under state monitoring. Although it was quite successful during the initial decades post independence, there was stagnation in economic followed by a balance of payment of crisis.

India's success towards achieving economic and human development has been phenomenal. According to the World Bank's report (2016), India's annual nominal GDP growth rate increased from 5.5 percent in 1990, 10.3 percent in 2010, to 7.1 percent in 2016[2]. It is peceived that increased economic activity based on recently declared policies will accelerate India's income growth GDP is projected to grow by 7.6 percent in 2017, before accelerating to 7.8 percent by 2019. India's economic growth will stay strong by a rebound in agriculture along with consumption growth supported by public wages and pensions (World Bank, 2016).[3]

India's economic liberalization and the consequent reforms in the early 1990s did away with the earlier policy of licensing, reduction in the import tariffs and market interest rates and made public sector enterprises more competitive. It also allowed automatic approval of foreign direct investment (FDI) in many economic sectors. This lead to improved economic performance and India achieved an average growth of 6 to 7 percent. In recent times, India eventually emerged as one of the fastest economies of the world.

India has also made remarkable progress in reducing extreme poverty in the past decade. The poverty rate declined from 45.3 percent in 1994 to 21.9 percent in 2012. Since 2005, 137 million people were lifted out of poverty, of which 85 million people moved above the official poverty line between 2010 and 2012 (figure 2).

1 https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=IN

2 World Bank, 2016. World Development Indicators

3 World Bank. 2016. India - Country snapshot. Washington, D.C. : World Bank Group. http://documents.worldbank.org/curated/en/341851476782719063/India-Country-snapshot

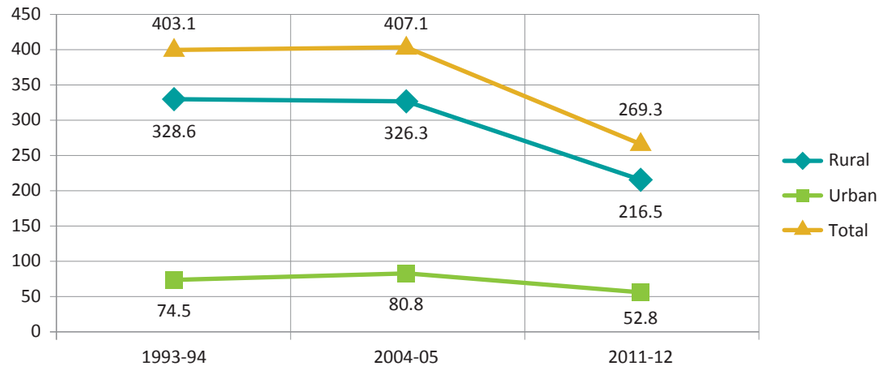

Figure 2. Number of people below the poverty line (million nos) (MoSPI, 2015)
Source: Available at http://mospi.nic.in/sites/default/files/publication_reports/mdg_2july15_1.pdf

The acceleration in rural poverty decline was significant when compared to urban poverty. Despite large gains on the poverty front, India still lags behind the world on many human development parameters. India's child malnutrition rates are high - 38.7 percent of children five and under are malnourished. Over one-fourth (650 million) of 2.4 billion people globally in 2015 who lack access to sanitation live in India. While India has made significant progress in economic growth and absolute poverty, it is still home to 270 million poor people. Significant development challenges remain (World Bank, 2015).

Growing rural migration to urban locations often didn't lead to appropriate economic opportunities for the migrated people and this lead to proliferation of people living in slum and other low cost housing clusters. The cash strapped urban local bodies, which are primarily responsible for providing urban basic services, were unable to cope with the growing urban population pressure often failed in service delivery. Over the last decade, the national government, realizing the challenges, had launched a number of flagship programs that increased additional funding to these institutions for improving urban infrastructure. Major programs are listed below.

- *The Smart Cities Mission*
- *Atal Mission for Rejuvenation and Urban Transformation (AMRUT) Project*
- *Pradhan Mantri Awas Yojana (Urban) or Housing for All by 2022 Mission*
- *Heritage City Development and Augmentation Yojana (HRIDAY)*
- *Jawaharlal Nehru National Urban Renewal Mission*
- *Swachh Bharat Mission (SBM)*

National Production Factors

One of India's greatest assets is the vast pool of human resources. In recent years India has performed well in creating a relatively highly skilled workforce, but when compared to its huge youth population base the share is still very low. The backbone of the India's manufacturing sector is its micro small and medium enterprises, which are largely labour intensive. As a result the capital deployment is comparatively lower. A recent report of the World Economic Forum's titled Global Human Capital Index 2017 ranked India 103rd among 130 countries. Hence investments in technical and professional education as well as in skill development would improve the opportunities for skilled work to the larger young population. The availability of skilled and cheaper labour force would result in additional investments in the manufacturing and service sector thereby creating capital in the economy. However in South Asia, Sri Lanka with a score of 70 is the top performer, followed by Nepal (98), India (103), Bangladesh (111) and Pakistan (125). Except Sri Lanka all the other countries are yet to reach the 60 percent threshold when it comes to development of human capital. Figure 3 presents the comparative assessment based on the overall rank as well as the rank on knowhow obtained by these countries. The figure also includes the rank for China to understand where the countries in the region stand.

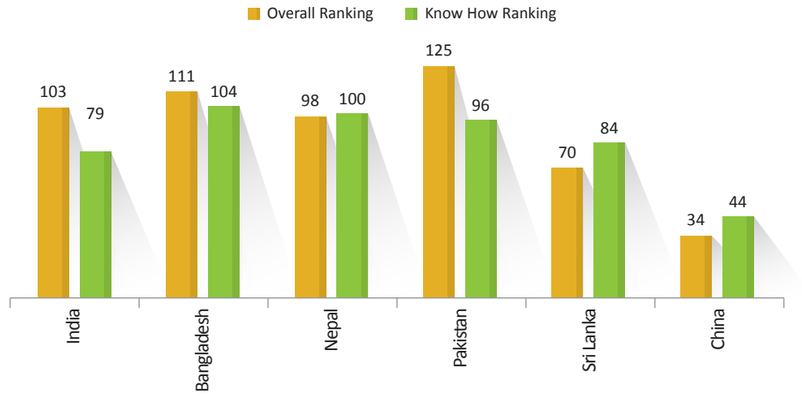

Figure 3. Ranking of countries in South Asia and China based on Global Human Capital Index 2017
Source: http://www3.weforum.org/docs/WEF_Global_Human_Capital_Report_2017.pdf

Institutions

Compared to other areas, under the institution pillar of the Global Competitiveness Index, India was ranked 39th out of 137 countries. Property right and intellectual property protection are very important parameters that determine the strength of existing institutions. India relatively has a low rank (65th) when it came to property right protection, while under intellectual rights protection India has been ranked 52nd.

Other factors like, transparency of government policymaking, business costs of crime and violence, organized crime, efficacy of corporate boards, scored quite low. Business costs of crime and violence has

been very high that made India achieve a rank of 80th while under organized crime India was ranked 89th. When it came to issues related to corporate governance like efficacy of corporate boards, India Business costs of terrorism came out to be very high thus making India stand at 117th out of 137 countries.

Human resources

India is positioned as the medium human development country with 0.624 for 2015 Human Development Index (HDI) ranking 131 out of 188 countries. Between 1990 and 2015, India' HDI had an average annual HDI growth of 1.52 which ranked the third highest in the medium human development country group in which Myanmar achieved the top in the same country category with 1.83 percent (UNDP, 2016) . As seen in the following figure 4 - trends in India's HDI component indices 1990-2015, between 1990 and 2015, India's life expectancy at birth increased by 10.4 years, mean years of schooling increased by 3.3 years and expected years of schooling increased by 4.1 years. India's GNI per capita has increased by about 223.4 percent between 1990 and 2015.

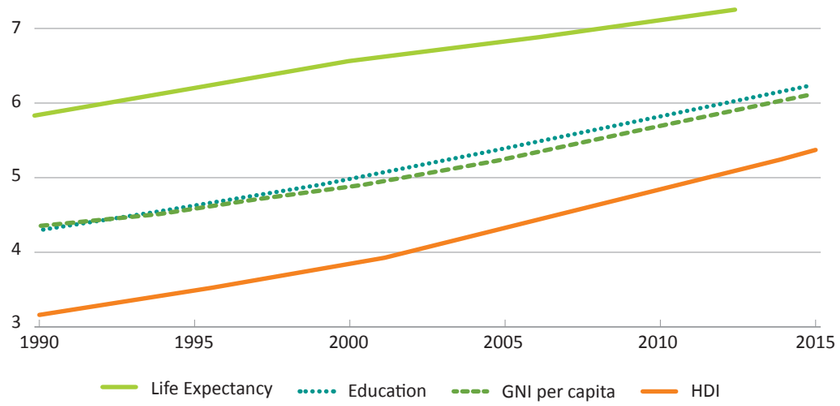

Figure 4. Trends in India's HDI component indices 1990-2015
Source: (2016), Human Development Report 2016: Human Development for Everyone, Briefing note for countries on the 2016 Human Development Report

As per the 15th census conducted in India in 2011, the literacy rate was found to be more than 74 percent although there is significant variation in the literacy rates across different states in India. Key states where the literacy rates are very high include Kerala, Mizoram, Lakshadweep, Goa and Chandigarh that occupy the top five positions, while states like Uttar Pradesh, Jammu & Kashmir, Arunachal Pradesh, Jharkhand, and Bihar, have very poor literacy rates (less than 60 percent) (Census of India, 2011). The top performing states introduced a holistic program to improve quality education. The government's strong commitment is represented through increased government expenditure on infrastructure provisioning, aided-school policy paving way for private entrepreneurs to start up schools and normalizing of remuneration for the school staff including teachers.

When compared to adult literacy rate (approximately 74 percent) the child literacy rate was 9 percent more. Male literacy rate of 80 percent in India is significantly more than the female literacy rate of 65 percent. However, between 1991 and 2011, the female youth achieved higher literacy rate than male. During the same period, the average annual growth in literacy for female was 1.63 percent, while for male was 0.83 percent. India's change in literacy rates over the last two decades is presented from figure 5.

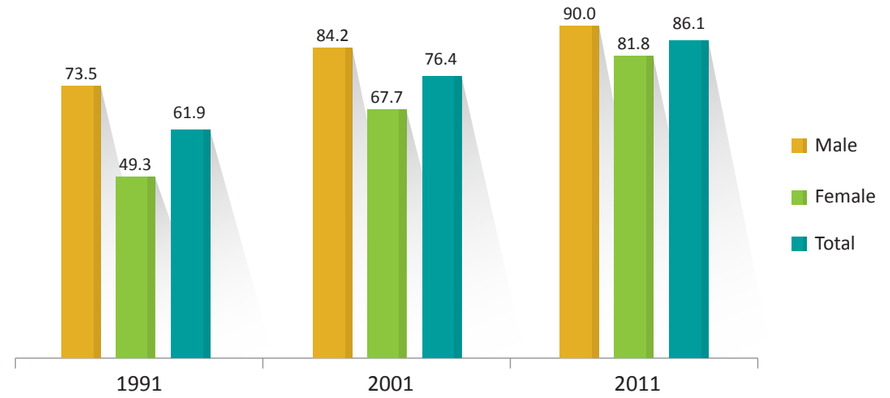

Figure 5. Improvement in Literacy rate in India (in percent)
Source: Available at http://mospi.nic.in/sites/default/files/publication_reports/mdg_2july15_1.pdf

Interestingly, there is significant gap between secondary education and tertiary education rates in India. The secondary education rate is more than 68 percent while tertiary education rate is abysmally low at 23 percent. Areas that need immediate attentions are Internet access in schools, local availability of specialized training services, improved staff training, and increased vocational training institutions.

There has been growing numbers of young Indians pursuing engineering and technology qualifications which was found to double between 2001 and 2011. Growing presence of the multinational corporations in India particularly in Information Technology Enabled Services (ITES) sector, as well as the expansion of businesses by Indian engineering and manufacturing companies resulted in increased demand for technical graduates. Proliferation of technical educational institutions in India could accommodate more students, who are interested in pursuing career in science and technology, from different parts of India

The number of women technical graduates has tripled during the same period. However, among the people those who have achieved graduate degree or above, about 40 percent have been estimated to have a graduate degree in technical education. The share of students pursuing higher education in India is very low. Close 80 percent of the students were found to have enrolled at the undergraduate level, while the share of enrolment for post graduate degree is 12 percent. When it came to quality of scientific research institutions, India ranked 35th out of 137 countries. When it came to availability of engineers and scientist, WEF competiveness report ranked India at 32nd out of 137 countries. However, with higher demand for professional degrees in the job market, there are growing interest among students to pursue management and legal education. Figure 6 presents a comparative assessment based on the overall rank as well as the rank on availability of engineers and scientist obtained by selected countries in South Asia.

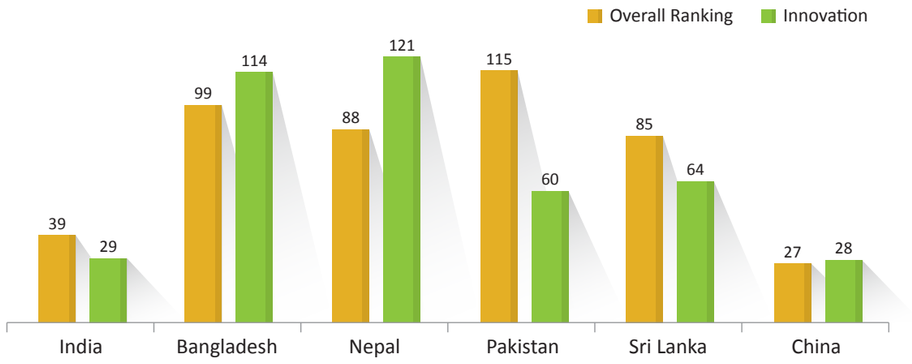

Figure 6. Ranking of countries in South Asia and China based on Global Competitiveness Index 2017
Source: WEF, 2016

Technology and Innovation

Technology development and innovative environment is something which India is lacking significantly. Patent applications /million population is quite low (WEF, 2017), where India was ranked 63 out of 137 countries. Interestingly when it came to capacity for innovation and company spending on R&D the respective ranks for India was 42nd and 23rd.

Innovation is the fundamental source for creation of wealth for an economy and not only benefits commercial activities but also leads to improved quality of life of life. It is the transformation of knowledge into development of products, processes and services that promotes economic growth, thereby generating employment. Majority of the funding for the basic research is undertaken from the support of the government where the government pumps in money to national scientific institutions like the Council of Scientific and Industrial Research (CSIR) organizations, other government research facilities, grants to universities and private-sector researchers, and tax incentives, etc. Over the years India has been able to leverage its huge young dynamic population to create interest in the science and technology education thereby promoting a research ecosystem in the economy. Eventually, it has attracted enough interests from the Indian and multinational companies across the world to tap Indian intellectual capital. Despite this advantage, the expenditure on research and development is quite low and stands at less than one percent of the GDP and the number of R&D professionals per million people is 164 (Govt of India, 2016)[4]. Figure 7 presents the expenditure on research and development in different sectors in India

India is the sixth largest country in the world investing in R&D - four of the top six R&D spending countries are located in Asia - with $71.5 billion in 2016, a 7.5 percent increase over the $66.5 billion estimated to be spent in 2015 (Industrial Research Institute, 2016).[5] India ranked the 3th in R&D productivity by publication but India's total R&D expenditure turned out to be very low by ranking the 40th out of 63 countries according to IMD (2017).[6] In terms of Gross Domestic Expenditure on R&D (GERD) per capita in current PPP $ terms, India has been on the rise since 1996 to 2015. This tendency applies to the total number of R&D personnel with steady growth from 318,443 in 2000 to 528,219 in 2015.[7] These figures could imply that the efficiency of R&D investment relatively high comparing to its size of total R&D expenditure.

4 http://pib.nic.in/newsite/PrintRelease.aspx?relid=160228

5 Industrial Research Institute (2016), 2016 GLOBAL R&D FUNDING FORECAST, https://www.iriweb.org/sites/default/files/2016GlobalR%26DFundingForecast_2.pdf accessed on August 20, 2017.

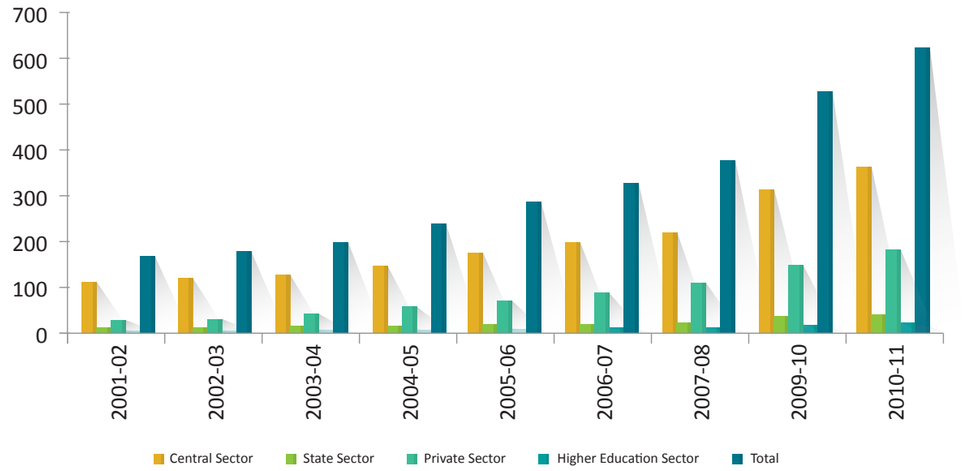

Figure 7. Expenditure on research and development in different sectors in India (INR Billion)
Source: https://data.gov.in/catalog/national-expenditure-research-and-development-sector

The number of patent applications, residents in India has steadily grown from 1,147 in 1990 to 12,579 in 2015[8] comparing to neighboring countries like Bangladeshi and Pakistan with mere changes. The Global Competitiveness Report 2017-2018 notes that India was highly ranked in an innovation pillar ranking the 29 out of 137 countries, the 26th in university-industry collaboration in R&D and the 8h in Government procurement of advanced technology products (WEF, 2017).[9]

India's Engineering R&D (ER&D) Globalization and Services market reached US$ 22.3 billion in 2016 and is set to rise to US$ 38 billion by 2020. India accounted for 40 per cent (US$ 13.4 billion) of the total US$ 34 billion of globalised engineering and R&D in 2016.[10] India has a total of 25 innovation centres in the country and accounts for 27 per cent of Asia's new innovation centres. India-based R&D services companies, which account for around 22 per cent of the global addressed market, grew much faster at 12.67 per cent (India Brand Equity Foundation, 2017). Over the past several years, more multinational technology companies have been setting up R&D projects within India. India is expanding its research presence globally with an increasing number of published technical papers, expanding its output at nearly three times the global average over the past decade. However, India still has a rela-

6 IMD WORLD DIGITAL COMPETITIVENESS RANKING 2017

7 UNESCO http://stats.uis.unesco.org. accessed on2017. 07. 29.

8 https://data.worldbank.org/indicator/IP.PAT.RESD?locations=IN&name_desc=false

9 WEF (2016), Global Competitiveness Index 2016-2017.

10 https://www.ibef.org/download/Innovation-and-Patents-June-2017.pdf

tively small share of the total global output, from 21,269 Web of Science (Thomson Reuters) papers in 2003 to 45,639 in 2012 (Industrial Research Institute, 2016).

Infrastructure

India has been able to improvement public and private infrastructure significantly over the years, yet there are gaps that need immediate attention. India ranked 66th when it came to overall performance of the infrastructure as per the latest world competitiveness report published by WEF, 2017. India might be having a very large road and railway networks yet, there are substantial scope for the improvement in their quality and service delivery. India ranked 28th for railroad infrastructure, while for port and airline infrastructure, it ranked 47th and 61st. In recent years, India have added significant capacity to electricity addition including renewable energy, yet when it came to quality of electricity supply, it was ranked 80th. Availability of latest technologies and firm level adoption of technologies for the automation are very low. One of the reasons for such a finding is the availability of cheap labour. Firm level availability of latest technologies as well as technological absorption has been found to be very low (WEF, 2017)

Market structure

In recent years, the government of India has taken measures to enhance competitiveness of Indian industries by leveraging skill, scale and technology. Yet there exists scope for further improvement in the future. One of the key parameters for competitiveness index is intensity oflocal competition on which India ranks low 98th (WEF, 2017). However, the effect of taxation on to create incentives for investment has increased in recent times. India scored extremely low when it came to procedural challenges in opening new businesses and the time required to start a new business is very high where India ranked 110 out of 137 countries. Prevalence of non tariff barriers is high. Other concerns, as pointed in the world competitiveness report (WEF, 2017)include relatively weak financial services meeting business needs, less affordability of financial services, and difficulty in access to loans. However, the Government of India has taken significant initiatives to strengthen the economic credentials of the country and make it one of the strongest economies in the world. India is fast becoming home to start-ups focused on high growth areas such as mobility, e-commerce and other vertical specific solutions - creating new markets and driving innovation. Owing to higher infrastructure spending, increased fiscal devolution to states, and continued reforms in fiscal and monetary policy, the Indian economic outlook has strengthened. The Government of India is trying to reduce structural and political bottlenecks, attract higher investment and improve economic performance (IBEF, 2017).

Market and Corporate structure

India's market has largely been driven by the services sector, followed by the industrial and agricultural over the last as evident from figure 8.

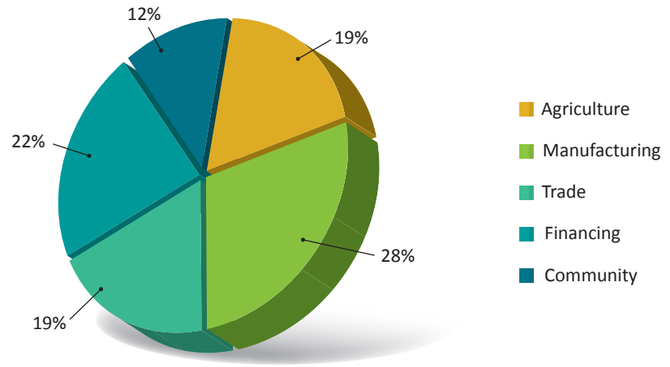

Figure 8. Sectoral income share based on estimates of 2015-16
Source: Economic Survey 2016-2017

Services sector alone contributed to almost 54 percent of GDP followed by manufacturing sector 28 percent and agricultural sector 19 percent. The significant growth in services sector can be traced back to early 1990s at a time when India liberalized its economic policies.

Agriculture

Agriculture sector plays an extremely important role for the Indian economy. Though over the years its share of the GDP has declined, it is still the largest economic sector and plays a major role in the socio-economic development of the country. Close to 60 percent of India's rural households depend on agriculture as their principal means of livelihood. At nearly 180 million hectares, India has the world's second largest agricultural land. India adopted the 'Green Revolution' in the 1960s to that allowed it to overcome low agricultural productivity. This resulted in increased production of food grains, especially in northern states like Punjab, Haryana and Uttar Pradesh. This helped India to achieve self-sufficiency and reduce import dependence. The country is the world's largest producer of tea, turmeric, black pepper, ginger, milk, cashew nuts, and pulses. It is also a leading producer of wheat, rice, groundnut, sugar case and inland fish and tobacco producer. India is also the leading producer of Banana, Mango, Lemon, Guava, Jackfruit and Pomegranate. India is the world's largest silk consumer and the second largest silk producer.

Industry and services

Around 27.6% of the GDP comprises industry which employs 17% of the population (2007 est). Around one-third of industrial labor works in simple household manufacturing processes. With economic reforms, foreign competition, privatization of public sector industries, fast-moving consumer

goods production increased. Indian private sectors which were run by old family firms and needed political connections for survival were challenged with foreign competition and cheaper Chinese imports. These firms revamped management, designed new products, relied on low labor costs and technology to handle these threats.

After agriculture, textile manufacturing has the second largest employment and comprises 26% of manufacturing output. With 23% of the population in the services sector, it had a growth rate of 7.5% in 1991–2000. It accounted for 55% of the GDP in 2007. One of the fastest growing sectors is business services which includes information technology enabled services, information technology, business process outsourcing etc. In 2000, it was one third of the total output of services.

Around 7% of the GDP in 2008 was contributed by IT industries. Seven Indian firms were among the world's top 15 technology outsourcing companies in 2009. The annual revenues from outsourcing operations amounted to US$60 billion in March 2009. As of 2008, organized retail like supermarkets was 4% of the market. Tourism is also a booming industry.[11]

Environment Sustainability

While India has gone through a rapid period of economic growth in recent years, there are growing concerns with regard to many environmental parameters like deforestation, air quality deterioration and water pollution. According to the World Bank, CO2 emissions (metric tons per capita) continued to increase from 0.79 in 1990 to 1.73 in 2014 due to its industrialization and rapid urbanization (World Development Indicators database, 2016).[12] A 2013 report from India's Central Pollution Control Board found that more than 2,700 million liters per day of domestic sewage is discharged by cities located along the Ganges River.

India's current environmental policy is dominated by the country's National Environment Policy 2006. The guidelines state that environmental protections need to be integrated into development processes. India is already investing in clean technology on a massive scale. India's solar energy capacity has largely been fueled by the country's National Solar Mission and the endeavor put India on pace to be one of the top 10 solar markets in the world by the end of 2015.[13] India has achieved over 60 GW of renewable energy by end of 2017, most of which is coming from the wind and solar sector.

The National Action Plan on Climate Change (NAPCC) provides a sharper focus on required interventions. Currently, NAPCC is implemented through eight National Missions, outlining priorities for mitigation and adaptation to combat climate change. The broad policy initiatives of the government are supplemented by actions of the State Governments, Non-governmental Organizations (NGOs), initiatives of the private sector and other stakeholders. Most of the States and Union Territories have put

11 https://business.mapsofindia.com/india-economy/system.html.

12 http://databank.worldbank.org/data/Views/Reports/ReportWidgetCustom.aspx?Report_Name=CountryProfile&Id=b450fd57&tbar=y&dd=y&inf=n&zm=n&country=IND.

13 AZoCleantech.com . https://www.azocleantech.com/article.aspx?ArticleID=551

in place the State Action Plan on Climate Change (SAPCC) attempting to mainstream climate change concerns in their planning process. Many other national strategies and policies include Energy Conservation Act, National Electricity Policy (NEP) and Integrated Energy Policy (IEP).

Policies to promote actions that address climate concerns also include fiscal instruments like coal cess, cuts in subsidies, increase in taxes on petrol and diesel, market mechanisms including Perform Achieve and Trade (PAT), Renewable Energy Certificates (REC) and a regulatory regime of Renewable Purchase Obligation (RPO) (The government of India, 2015).[14]

2. Policy Landscape: Towards Circular Economy

Understanding Eco-Innovation

The Concept of eco-innovation emerged from the concept of Sustainable Development that was defined in the famous 'Brundltland Commission' Report (1987). The report defined 'Sustainable Development' as the *…development that meets the needs of the present without compromising the ability of future generations to meet their own needs*. Continued economic growth, growing human aspirations in developed and developing countries, created an unprecedented pressure on natural resources. This has led to uncontrolled extraction and use of natural resources particularly abiotic resources, for fueling economic activities leading to a serious damage to the environment as is evident with climatic changes/extremes in weather conditions, desertification, loss of forest cover, surface and ground water pollution to name a few.

This gives rise to the necessity and the consequent responsibility of the current generation to make judicious use of natural resources to sustain for the utilization by the future generations. This can take place when the conventional approach towards exploitation of these resources is replaced by innovative policy instruments, technology and processes that will prevent or reverse the trend of the damage thus caused. Thus eco-innovation, based on the existing and new knowledge will drive economic de-

14 The government of India (2015), INDIA'S INTENDED NATIONALLY DETERMINED CONTRIBUTION: WORKING TOWARDS CLIMATE JUSTICE

velopment through introduction of new processes and products as well as development of environmentally friendly technologies that will have reduced impacts on the environment. Hence eco innovation will address the three pillars of sustainable development through technological, social behaviour and institutional performance.

One of the most notable policies that India introduced a decade ago that articulated the spirit of sustainable development was the National Environment Policy (NEP) of 2006. It mentions that only such development is sustainable, which respects ecological constraints and the imperatives of social justice. The NEP highlights the consensus around the sustainable development concept through three foundational aspirations (NEP, 2006):

i. *that human beings should enjoy a decent quality of life;*
ii. *that human beings should become capable of recognizing the finiteness of the biosphere;*
iii. *neither the aspiration of a good life, nor the recognition of the limits of the biophysical world should preclude the search for greater justice in the world.*

The NEP 2006 also asserts that the most viable basis of environmental conservation is to ensure that people gain better livelihoods from the act of conservation of natural resources than from environmental degradation (MoEF 2011).

India does not have any unique definition for eco innovation. Rather the issue is addressed through the lenses of Sustainable Development strategy. However, man of the policies, programs and initiatives adopted by various stakeholders clearly reflect an emergence of the eco-innovation system and the same of the presented in the subsequent sections.

As mentioned above, the NEP underscores the importance awareness for various environment and economic development issues and addressing them based on sound regulatory reforms. The sectors and areas of emphasis in the policy include clean energy, climate change, air pollution, waste management, land degradation, forestry and biodiversity, water management, and marine and coastal environment. The successfulness of the eco-innovation system also depends on how different stakeholders reciprocate to the changing policy landscape and in certain situations is pro-active or taking the lead in taking the sustainable development agenda forward in the absence of any guiding policy or legislative framework.

Major Eco-Innovation organizations and policies

Given the multi sectoral dimension embedded in the definition of the sustainable development, it is evident that addressing the ambitious goal for India will require different institutions working in a coordinated manner. It requires not only cross sectoral, but also multi-level coordination with the active involvement of all stakeholders.

Ministry of Environment Forest & Climate Change (MoEF&CC)

The Ministry of Environment, Forest and Climate Change (MoEFCC) serves as the nodal agency of the central government for the policy formulation, planning, awareness building, coordination with relevant ministries and state departments (including autonomous bodies) for overseeing and implementation of environmental policies and programs in India. The broad objectives of the ministry include protection of the environment, prevention and control of pollution, conservation and survey of flora, fauna, forests and wildlife, afforestation and regeneration of degraded areas, etc. The objectives are met using a host of regulatory and policy measures, that include Environment Protection Act, Water (Prevention and Control of Pollution) Act, Water Cess Act, Air (Prevention and Control of Pollution) Act, Forest (Conservation) Act, etc. Based on the these the polices formulated include National Conservation Strategy and Policy Statement on Environment and Development, 1992; National Forest Policy, 1988; Policy Statement on Abatement of Pollution, 1992; E-Waste (Management) Rules 2016, Eco-mark scheme, Ozone Depleting Substances (Regulation and Control) Rules, 2000, etc.

The **Central Pollution Control Board** was established in the early 1970s under the Water (Prevention and Control of Pollution) Act, 1974 and was later entrusted with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981 (CPCB, 2017)[15]. CPCB is primarily responsible for developing environmental standards, monitor environment compliance, develop and facilitate pollution abatement and control for of the country, and work in association with the state pollution control boards.

Ministry of Micro, Small and Medium Enterprises

The Micro Small and Medium Enterprise sector in India forms the backbone of India's manufacturing sector. It provides entrepreneurial for as well as employment opportunities outside the agricultural sector thus contributing to sustainable development through creation of *non-farm livelihood at low cost, balanced regional development, gender and social balance, environmentally sustainable development, etc*. According to the official estimates, the sector generates approximately 100 million jobs across 46 million units throughout India. The sectoral contribution to GDP is nearly 38 percent and accounts for 40 percent overall exports. In 2006, the Government of India notified the Small and Medium Enterprises Development Act towards addressing policy issues that affects the vast SME sector in India. The primary objective for the same was to promote development of the enterprises in India and increase their productivity and local and global competitiveness. Although the primary responsibility for promoting and development of SME sector rests with the state governments departments, however, the central government through various initiatives and programs supplements the efforts.

Among various schemes and programs that are run by the MSME ministry, one of them is the **Technology Upgradation and Quality Certification.** This has three major programs as described below.

Financial Support to MSMEs in ZED Certification Scheme: This is based on the government's objective of promoting Zero Defect Zero Effect (ZED) across all manufacturing and service sector industries with a specific emphasis on the MSME. This includes production mechanisms wherein products have no defects as well as the production process has zero adverse environmental and ecological effects. As evinced from the above, the ZED rating scheme is a pan India drive for creating awareness in MSME clusters about the benefits of the zero defect manufacturing and how enterprises can quickly adopt theme through financial assistance. The increased productivity and reduces wastages would substantially increase India's vast MSME sector in the global production chains. India's ZED rating process in presented in figure 9.

15 http://cpcb.nic.in/Introduction.php

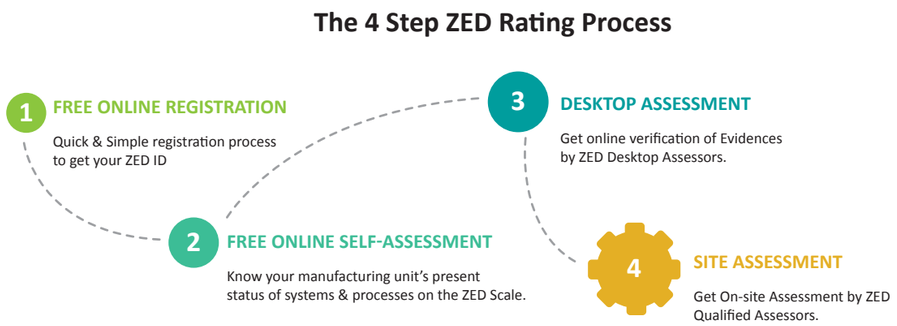

Figure 9. The Four Step Rating Process
Source: https://www.zed.org.in/

Promoting Innovation, Rural Industry & Entrepreneurship (ASPIRE): This is a scheme based on creating job opportunities thereby reducing unemployment particularly in rural areas. The program promotes grass root innovation, there boosting entrepreneurship culture and economic development. This has significant potential for promotion of business models that develops solution for various unmet social needs thus further strengthening competitiveness of SME sector in India. The support is largely provided in the form of capital subsidy for plant and machinery as well as assistance towards the training cost of human resources.

National Manufacturing Competitiveness Programme: The program strengthens competitiveness of India's manufacturing sector through various ways as mentioned in the table below. Most of these program where launched over the last decade.

Table 2. Various schemes under National Manufacturing Competitiveness Program

Sl. No	Name of the Scheme	Brief Description
1	Credit Linked Capital Subsidy for Technology Upgradation (CLCSS)	CLCSS provides 15 percent subsidy for additional investment up to INR 10 million for technology upgradation by MSEs. Technology upgradation would ordinarily mean induction of state-of-the-art or near state-of-the- art technology.
2	ISO 9000/ISO 14001 Certification Reimbursement	In order to enhance the competitive strength of SMEs, the scheme provides incentives to those SMEs/ancillary undertakings that have acquired ISO 9000/ISO 14001/HACCP certification. The scheme is enlarged so as to include reimbursement of expenses in the acquisition of ISO 14001 certification.
3	Marketing Support/Assistance to MSMEs	Under this scheme the Ministry conducts seminars and reimburses registration fees for bar coding in order to encourage MSEs to use bar-codes.
4	Lean Manufacturing Competitiveness for MSMEs	Financial assistance is provided for implementation of lean manufacturing techniques, primarily the cost of lean manufacturing consultant (80% by GoI and 20% by beneficiaries).
5	Design Clinic for Design Expertise to MSMEs	Funding support of (1) INR 60,000 per seminar and 75% subject to a maximum of INR 3.75 lakhs per workshop, (2) To facilitate MSMEs to develop new Design strategies and or design related products and services through project interventions and consultancy.
6	Technology and Quality Upgradation Support to MSMEs	The scheme advocates the use of energy efficient technologies (EETs) in manufacturing units so as to reduce the cost of production and adopt clean development mechanism.
7	Entrepreneurial and Managerial Development of SMEs through Incubators	The objective of the scheme is to provide early stage funding to nurture innovative business ideas (new indigenous technology, processes, products, procedures, etc.) that could be commercialized in a year. The scheme provides financial assistance for setting up business incubators.
8	Enabling Manufacturing Sector to be Competitive through QMS&QTT	The scheme endeavours to sensitize and encourage MSEs to understand and adopt latest Quality Management Standards (QMS) and Quality Technology Tools (QTT).
9	Building Awareness on Intellectual Property Rights (IPR)	The purpose of the scheme is to enhance awareness among the MSMEs about Intellectual Property Rights, to take measures for protecting their ideas and business strategies. Effective utilisation of IPR tools by MSMEs would also assist them in technology upgradation and enhancement of their competitiveness.

Source: Ministry of Micro, Small and Medium Enterprises
Available at: http://msme.gov.in/node/1765#A14

Ministry of New and Renewable Energy

The Ministry of New and Renewable Energy (MNRE) is the central ministry that works primarily to promote renewable energy India. In 2010, Government of India launched an ambitious renewable energy program better known as the 'Jawaharlal Nehru National Solar Mission', with the aim of deploying 20,000 MW of grid connected solar power by 2022. Large scale deployment will help in reducing the cost of power generation in the country. Large scale deployment will have multiple objectives of promoting research and development, technology transfer and enhance manufacturing capacity of various renewable energy technology components and products and achieve grid tariff parity by 2022. In the wind sector, India already is a net exporter of wind technologies. In 2015, realizing the potential and the substantial benefits of renewable energy deployment in India further revised the target of Grid Connected Solar Power Projects from its earlier target of 20,000 MW to 100,000 MW by 2022. At the same time it aimed at increasing wind power generation to 60 GW by the year 2022. This mission was a part of the eight missions that was launched under Government of India's National Action Plan on Climate Change (NAPCC), with an objective towards addressing climate change related adaptation and mitigation while promoting economic development. Apart from the solar mission, the other seven missions include (i) National Mission for Enhanced Energy Efficiency (ii) National Mission on

Sustainable Habitats (iii) National Water Mission (iv) National Mission for Sustaining the Himalayan Ecosystem (v) National Mission for a Green India (vi) National Mission for Sustainable Agriculture (vii) National Mission on Strategic Knowledge on Climate Change. The key objectives of these missions are presented table 3.

Table 3. National Action Plan on Climate Change

Sl. No	National Missions	Objective of the mission
1.	National Mission for Enhanced Energy Efficiency	India's Energy Conservation Act of 2001 provides a legal mandate for the implementation of energy efficiency measures through the institution titled 'Bureau of Energy Efficiency (BEE). A number of schemes and programmes have been initiated which aim to save about 10,000 MW by the end of the 11th Five-Year Plan.
2.	National Mission on Sustainable Habitats	The objective of the mission is to promote eco-innovation through improvements in energy efficiency in buildings, management of solid waste and a modal shift to public transport. Further it mandates promotion of energy efficiency as an integral component of urban planning through its initiatives.
3.	National Water Mission	Conserving water, minimizing wastage, and ensuring more equitable distribution and management of water resources. Optimizing water use efficiency by 20 percent by developing a framework of regulatory mechanisms.
4.	National Mission for Sustaining the Himalayan Ecosystem	Empowering local communities especially Panchayats to play a greater role in managing ecological resources. Reaffirm the measures mentioned in the National Environment Policy, 2006.
5.	National Mission for a Green India	To increase ecosystem services including carbon sinks. To increase forest and tree cover in India to 33 percent from current 23 percent.
6.	National Mission for Sustainable Agriculture	Make Indian agriculture more resilient to climate change by identifying new varieties of crops (example: thermally resistant crops) and alternative cropping patterns. Make suggestions for safeguarding farmers from climate change like introducing new credit and insurance mechanisms and greater access to information.
7.	National Mission on Strategic Knowledge on Climate Change	Work with the global community in research and technology development by collaboration through different mechanisms. It also has its own research agenda supported by climate change related institutions and a Climate Research Fund. Encourage initiatives from the private sector for developing innovative technologies for mitigation and adaptation.

Source: MoEFCC
Available at: http://www.moef.nic.in/ccd-napcc

The Ministry of new and Renewable Energy has adopted the National Bio-Fuel Policy (2008).

Bureau of Indian Standards

The Bureau of Indian Standards (BIS), India's standard setting organizations was established under the Ministry of Consumer Affairs, Food & Public Distribution, Government of India through the Bureau of Indian Standards Act, 1986. The organization is involved in promoting product standards and issuance of quality certification of goods. The support of the organization is immense for the economy through provision of safe, reliable and quality goods to consumers; ensuring minimal health hazards to consumers, promotion of import substitution, undertaking testing and certification of various products launched in the market, etc (Fig10).

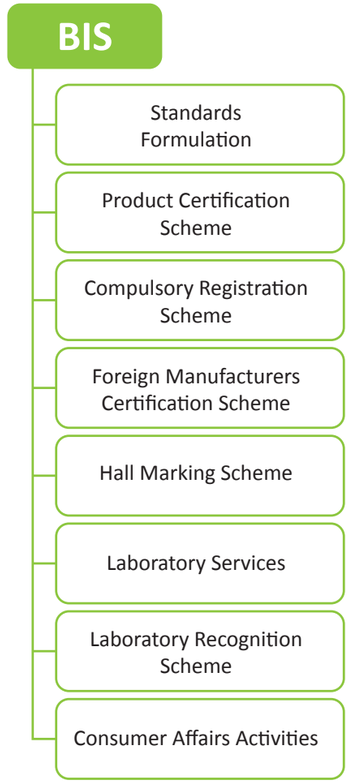

Figure 10. Various activities of BIS
Source: http://www.bis.org.in/bis_overview.asp

Ministry of Petroleum and Natural Gas

In 2002, an expert Committee on Auto Fuel Policy, was formed for laying out the road map regarding vehicle emissions and fuel norms. The aim is to promote fuel economy and is being done through levy of differential tax on two wheelers and passenger cars/jeeps (MoEF, 2011). In 2015, Auto Fuel Policy and Vision for 2025 was introduced that would promote improved fuel quality as well as stricter emission norms for the sector.

Department of Industrial Policy and Promotion (under the Ministry of Commerce and Industry)

The Department of Industrial Policy and Promotion (DIPP), under the ministry of commerce and Industry (MoCI) plays an important role to promote and facilitate investment and technology flows and monitor industrial development in India. Figure 11, presents the selected role and responsibilities of DIPP.

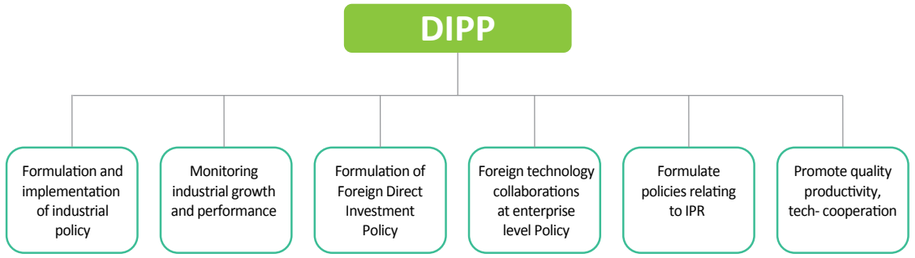

Figure 11. Various functions of DIPP
Source: http://www.bis.org.in/bis_overview.asp

The department is also responsible for developing India's Manufacturing Policy. One of the key elements of the policy is the establishment of the National Investment and Manufacturing Zones (NIMZs). These zones are large integrated industrial townships having state-of-art-infrastructure; having access to clean and energy efficient technologies; necessary social infrastructure; skill etc. that provide conducive environment for manufacturing industries.

Research institutes and universities

Research and development in eco-innovation is a basic source for addressing sustainable development issues. It helps in the transformation of knowledge into development of processes, products and services that promote economic growth, thereby generating employment. In Indi, majority of the funding for the basic research is undertaken from the support of the government through the department of Science and Technology. Department of Science & Technology (DST) in 1971with the goal of supporting basic research in areas of modern science & technology and the same time co-ordinates science and technology activities in the country. Many of the government's research and development activities are undertaken by the Council of Scientific & Industrial Research (CSIR), which is also among the largest government supported R&D organization in the world. India also has a large network of research institutes and universities (public and private) for higher education and research which provide knowledge support for various sustainable development initiatives. However, private support for research and development is emerging where there is growing number of Indian and multinational companies promoting collaborative research with various public and private universities. In 2017, India has been ranked 60 in the Global Innovation Index out of 127 countries. Although there has been improvement in India's ranking in recent years, there is substantial scope for improved R&D spending, attracting private sector spending through ease of doing business, etc. India has all the potential to emerge as a global leader in driving innovation based on strong market, tapping Indian Diaspora, and promoting culture of frugal innovation.

For supporting development and commercialization of local and indigenous technologies as well as faster adaptation of imported technologies the government of India established the Technology Development Board (TDB) under the Department of Science and Technology (DST). The board has been new enterprises for increase uptake of these technologies. There is also a 'Seed Support Scheme' that promotes startups in the field of technology development through Technology Business Incubators and Science and Technology Parks. These enterprises can explore partnership with various R&D institutions in India through collaboration and take up technologies for commercialization, (CII 2014). The DST and Ministry of Railways and developed a joint R&D initiative that aims to develop new technological solutions for fuel efficiency, alternate fuels and emission control for railways.

In 2000, DST set up the National Innovation Foundation (NIF) for strengthening grassroots innovations in technologies and outstanding traditional knowledge. Till date the foundation has a database of covering over 225,000 technological ideas and traditional practices from across 585 districts. The foundation has already recognized more than 816 grassroots innovators at the national level through various functions held across different parts of the country. One of the unique features of the foundation is the setting up of the augmented Fabrication Laboratory with support from the Massachusetts Institute of Technology (MIT). The Society for Research and Initiatives for Technologies and Institutions (SRISTI) have been augmented for initial validation of herbal technologies. Arrangement with various intellectual property firms has helped NIF file over 800 patents. This includes 27 Patent Cooperation Treaty (PCT) applications, filing of 8 patents in USA on behalf of the grassroot innovators and traditional knowledge holders[16].

There are number of business incubator models that have evolved in the India. The department of Science and Technology (DST) provides significant support for initiation of business incubation one through the Science and Technology Entrepreneurship Parks (STEP) that came up in 1990 and more recently through the Technology Business Incubators. These incubators can be for profit (i.e. commercial) or nor for profit. Figure xx, presents the different technologies being developed in these institutions and there share in total technologies. Figure 12, presents technologies that have been developed in different science and technology institutions in India in recent years.

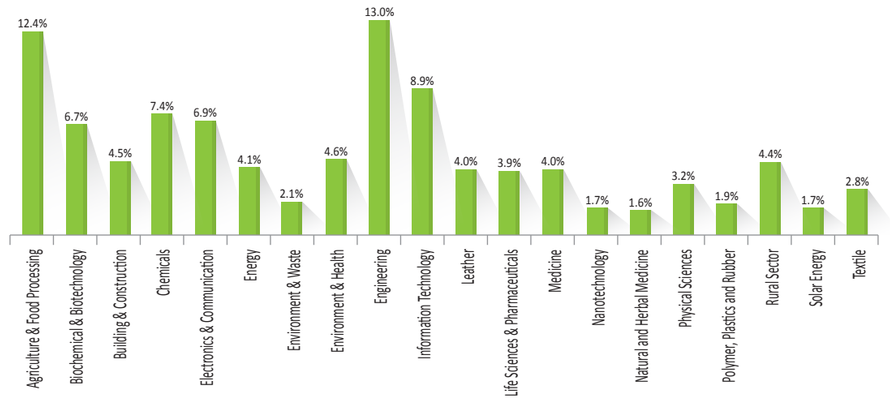

Figure 12. Technologies developed in different science and technology institutions in India in recent years
Source: http://www.nstedb.com/institutional/tbi.htm

16 http://nif.org.in/

The business incubators are hosted in different types of organizations. Around 45 percent of the incubators are from public sector host institutions and the remaining 55 percent are from private sector. Further, assessment reveals that around 75 percent of the incubators operate from academic institutions like universities and technical colleges, 7 percent from R&D Institutions, around 6 percent from IT or science Parks and the remaining 12 percent from industrial organizations.

Other schemes and programs

In 2014, the government of India a massive program called the Swachh Bharat Abhiyan (Clean India Mission) with the purpose of cleaning cities, towns and villages, improving waste management and sanitation, as well as raising awareness among citizens. The 12th Five Year Plan (2012–2017) specially emphasized on addressing social challenges, like poverty alleviation, and further that promotes growth and inclusive development. The DST along with the Ministry of Human Resource Development (MHRD) introduced Impacting Research Innovation and Technology projects have implemented (IMPRINT) that aims at addressing key societal and developmental needs like healthcare, information and communication technology, sustainable habitat, energy, water resources and river systems, the environment and climate.

In 2010, the Indian government introduced the National Clean Energy Fund for combating climate change. Initially, a cess of Rs 50 per tonne of coal produced or imported was levied. However, the cess steadily increased over the years and was doubled to Rs 100 per tonne in 2014. Further, in 2015 and subsequently in 2016, the cess was increased to Rs 200 per tonne and Rs 400 per tonne respectively. As per the guidelines issued by the finance ministry, it was clearly outlined that the Fund will support research and innovative projects in clean energy technologies.

3. Selected Circular Economy and Eco-innovation Areas and New Trends

Major Areas of Eco-Innovation

Indian manufacturing is primarily labor-intensive largely because of the dominance of the SME sector that specializes in low capital intensive industrial products engaging relatively low skilled employees. However, policy emphasis and increased symbiotic relations they enjoy with the larger companies have helped many of the small industries to achieve significant growth in recent times thereby integrating with the global value chains. The growth of the sectors that are low in the value chain is presented in figure 13.

Top five fastest growing manufacturing sector	CAGR (%, 1990-2013)
Furniture manufacturing	17.6
Transport equipment (escl auto)	12.6
Automobile manufacturing*	11.0
Electrical, optical, machinery and apparatus	9.2
Repair and installation of machinery & other manufacturing	8.2

Figure 13. Compound Annual Growth Rate (CAGR) of fastest growing manufacturing sectors in India
Source: https://www2.deloitte.com/content/dam/Deloitte/global/Documents/About-Deloitte/gx-in-dia-competitiveness-report.pdf

Eco-innovation in manufacturing sector

As evident from figure 13, apart from furniture making, and transport equipment, automotive manufacturing has emerged has a leading industrial sector in India. The sector is particularly important because of the industry contributes 7 percent to India's GDP and accounts for 7-8 percent of India's total employed population.

India's auto component manufacturing is one of the most prominent small and medium scale industries. It is undertaken both in the formal and informal sectors. While the organized sector largely caters to the equipment manufacturers, the unorganized (informal) sector caters to low value products that find

place entirely in the aftermarket category although 80 percent of the production of components (in value terms) are under the control of the organized sector with the remaining under the unorganized category.

Depending on the scale of operations, and type of components (whether intermediate, semi-finished or finished), the companies can be categorized as tier 1, tier 2, tier 3 and tier 4 manufacturers. The individual category is described in figure 14.

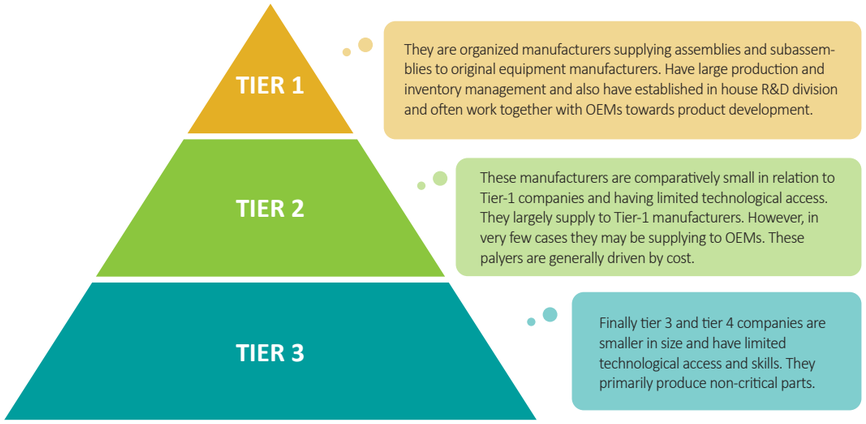

Figure 14. Different tiers in automotive manufacturing
Source: Authors compilation

Eventually, a pyramidal industrial structure evolved, where the bulk of players remained as tier three companies that also formed the base of the pyramid, followed by the tier two and tier one companies and ultimately the equipment manufacturers. Most of the tier one and tier two companies became members of the apex component manufacture association of India i.e. Automotive Component Manufacturers Association (ACMA). In order to meet the increasing needs of the equipment manufacturers and at competitive prices, technological improvement and human resource development in these companies became the need of the time.

The growing demand for technological upgradation and automation in the auto component industries, led to the formation of the ACMA Centre for Technology (ACT), with the objective of delivering knowledge and training to its members on process and product technology, manufacturing technology, and implementation of best practices in manufacturing. ACT cluster led approach is based on learning together with guidance from qualified counsellors that helps in improving skills, proficiency and know-how of the teams besides adding to a cohesive team spirit and heightened employee engagement. This further will enhance quality, productivity, cost reduction and hence profitability. The broad clusters include, SME cluster, SME advance cluster, foundation cluster, advance cluster, engineering cluster. The members ACMA, are diverse that range from very large component manufacturers to small manufacturers with limited capital and technical knowhow particularly in the context of resource use efficiency.

Major areas which are emphasized on the cluster programs include 5S, Advance 5S, Total Employees Involvement, Quality & Productivity improvement, Equipment and Inventory management, Lean Processes, Lean tooling, New Product Development, Lead time reduction, Cost competitiveness, Zero Defect Quality. These interventions have significant positive impact on energy consumption, material use productivity, and further innovation culture on manufacturing processes and systems. Many of these programs have been financially supported under various schemes of the ministry of micro small and medium enterprises. At the same, UNIDO has also supported cluster development programs as listed below.

(i) ACT UNIDO partnership cluster,

(ii) ACT ACMA – UNIDO Quality Cluster,

(iii) ACT Foundation cluster,

(iv) ACT Advance cluster,

(v) ACT Engineering Excellence cluster,

(vi) ACT Export Cluster,

(vii) ACT NPD Foundation Cluster,

(viii) ACT New product development (NPD) cluster,

(ix) ACT ZED (Zero Effect and Zero Defect) Cluster[17].

Eco-innovation for promoting renewable energy in India

Promoting use of Renewable Energy through Renewable Purchase Obligations (RPOs)

Renewable Purchase Obligation (RPO) is a key policy driver for promoting renewable energy installations and help India achieve the ambitious goal of 175 GW by 2022. RPO is a legally mandated percentage of electricity to be purchased by distribution companies from renewable energy sources as provisioned under the Electricity Act of 2003, the National Electricity Policy, 2005 and the Tariff Policy, 2006 (MoEF, 2011). In 2016, India released state specific revised targets for RPOs of 17 percent by 2022. The RPO compliance can be achieved by increasing the share of renewable energy through the purchase of renewable power or purchase of renewable energy certificates. Align RPO levels as suggested in the revised Tariff Policy and long-term RPO trajectory as declared by the Ministry of Power.

Renewable Energy Certification (RECs)

India's Electricity Act, 2003, and the various policies under the Act, as well as the NAPCC provide a clear roadmap for increasing the share of renewable in the total generation capacity in the country. Indian states having abundant renewable energy can produce excess electricity and sell it to those states where the renewable energy potential is less. In 2010, the Central Electricity Regulatory Commission (CERC) introduced Renewable Energy Certificates (REC) program so that distribution companies can meet RPO targets while incentivizing green energy generation. These RECs can be traded or exchanged where renewable energy generators can sell these certificates to buyers i.e. those states that are deficient. This provides win-win opportunities where renewable energy generators are incentivized to produce more renewable energy and timely settlement helps in supporting their overall cash flows[18].

17 https://www.digitalact.in/services/

18 https://recregistryindia.nic.in/index.php/general/publics/AboutREC

Eco-innovation for energy efficiency

Perform Achieve and Trade (PAT) scheme

In order to energy efficiency in energy intensive industries in India, government introduced the Perform Achieve Trade (PAT), a market-based trading scheme under the National Mission on Enhanced Energy Efficiency (NMEEE) and administered by the BEE. Specific targets have been assigned for energy consumption in these industries. Based on the efficiency gained by the designated consumers, these industries can trade energy efficient certificates in energy-intensive sectors The scheme is implemented in three phases (i) the first phase ran from 2012-2015 that covered 478 facilities and included eight manufacturing sectors, viz. aluminium, cement, chor-alkali, fertilizer, iron and steel, pulp and paper, textiles and thermal power plants. These industries account for approximately 60 percent of India's total primary energy consumption.

Product labeling

The energy efficiency product labeling scheme was launched in 2006 with an objective to provide consumers informed choice about purchase decisions thereby saving their electricity bills. The scheme is expected to bring a substantial energy savings in the residential and commercial buildings in the medium and long run. Key appliances that are covered under the scheme include room air conditioners (Fixed Speed), ceiling fans, colour television, computer, refrigerators, dstribution transformers, domestic gas stoves, frost free refrigerators, general purpose industrial motor, monoset pump, openwell submersible pump set, stationary type water heater, submersible pump set, tfl, washing machine, ballast, solid state inverter, office automation products, diesel engine driven monosetpumps for agricultural purposes, diesel generator set, led lamps, room air conditioner (variable speed), chiller, variable refrigerant flow, agricultural pumpset, microwave oven.

Govt. of India introduced National Electric Mobility Mission Plan 2020 that will bring paradigm shift in the automotive and transportation industry; 6–7 million EVs/hybrid vehicles on Indian roads by the year 2020. Till March 2016, 4 lakh EVs were sold across the country and the EV industry saw sales figures grow by 37.5 per cent 2015-16; Consumer payback period for compact 100-km BEVs is 5.6 years, and is expected to fall to1.8 years by 2020. With regard to the mix of the electric vehicles by type, it is perceived that the maximum demand is expected in three and/or two wheelers segment followed by commercial and four wheelers. Promotion of electric vehicles not only has environmental benefits but also will help India in saving foreign exchange in importing crude oil. India currently imports 70 percent of crude from other oil exporting countries. In order to promote faster adoption of electric vehicles Government of India is preparing to offer incentives in cities having population more than one million. This initiative is a part of FAME (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles) India scheme that aims to promote multimodal public electric mobility. Almost all the global auto players have planned to launch electric vehicles in the coming years.

Eco-innovation in building construction materials

Coal based power generation in India produces millions of tonnes of fly ash every year and disposal in recent years had become a major issue. Given the potential of this fly ash application in the construction sector, the government has issued notification for increased use in the brick making and construction activities such as road building. In 2016, Maharashtra became the state in India to introduce the policy of 100 percent utilization of fly ash, generated from thermal power stations and biogas plants, for various construction activities. It has been made mandatory for all new buildings to use fly ash.

Construction and demolition debris disposal is a major challenge particularly in urban areas. However, good practices from developed countries have revealed that construction and demolition wastes can effectively reused or recycled as secondary raw materials. Despite the challenge of adopting it in Indian context, certain urban local bodies for example in Delhi and Ahmedabad, have recently introduced pilot projects where construction wastes are recycled and reused in technically and financially viable manner, thereby reducing environment impacts.

4. Drivers and barriers to circular economy and eco-innovation

Understanding Eco-innovation drivers in India

India's environmental protection is based on the provision in Indian Constitution as a directive principle of state policy. India's regulation has played a role very important role in the context of promoting eco-innovation. As a part of the 32nd Amendment Act of the parliament, in 1976, an obligation on the part of the state and citizens was introduced for protecting and improving environment. Based on this the Government of India introduced policies that were largely based on command and control strategies in the form of emission standards, water quality standards, etc. and in certain cases were linked to fines and penalties. While there are certain advantages of command and control strategies, yet one of the disadvantages associated with this regulatory framework is the high cost of information. In certain situations, the regulator has to rely completely on information from the polluter/emitter, either in terms of emission loads or associated costs of control. As a result, the polluter/emitter may distort critical deciding information to the regulator. However, over the last couple of decades, India has gradually moved from a command and control type of regulation towards regulation based on use of economic instruments. For example, India's policy statement for abatement of pollution, by the then ministry of environment forest, aimed at giving 'industries and consumers clear signals about the cost of using environmental and natural resources. While there were several fiscal incentives for promoting eco-innovation thereby sustainability, the statement clearly mentioned that *'economic instruments will be investigated to encourage the shift from curative to preventive measures, internalise the costs of pollution and conserve natural resources*'[19]. It expects that market based price mechanisms will influence consumer and producer behaviours avoid excessive use of natural resources. India has deployed various policy instruments for supporting eco-innovation which include financial support for research and development, eco-mark/eco-labelling, standards, public procurement, tradable permits and certificates and self-regulation, etc. Even rationalization of unwarranted benefits in the subsidy reform played in instrumental role towards sustainable consumption of resources.

There is a growing recognition of fiscal and environmental implications of subsidy policies in the energy, water and agriculture sectors. In the energy sector, the government has taken steps towards removing price controls on oil and coal and lowering subsidies on energy. The petroleum product pricing reform has been one of the most interesting examples, that have significantly helped the government to withdraw subsidy on a number of petroleum products and ensure that the poor and under privileged are protected from the global price volatility. The Liquified Petroleum Gas (LPG) one of the major cooking fuels used in Indian households, carried substantial subsidies and most of the subsidies were enjoyed by people of the upper and middle income class. However, with the decision to with draw subsidy gradually will lead to fiscal disciplining. At the same time, implementation of transfer of cash benefits has helped the government in towards better targeting of subsidies to the poor, thereby reducing unwanted spending. In recent months the Indian government has also taken additional steps to reduce subsidy on kerosene, which is considered to be low cost polluting fuel used substantially in poor households. With increased electrification and increased LPG connection, the reliance on kerosene as primary fuel for household consumption is expected decline further in the coming months. Other reforms in the oil and gas sector include abolishment of the old profit sharing mechanism to revenue sharing system in the upstream sector. India's new resource exploration policy allows market price for gas to the upstream companies.

As a signatory of Trade-Related Aspects of Intellectual Property Rights (TRIPs) in the Uruguay Round agreement of 1995, India amended laws in order to make it TRIPs-compliant. India enacted fully TRIPs-compliant Trademarks Act, Copyright Act, Designs Registration Act, Geographical Indications Act and Protection of Layouts for Integrated Circuits Act. Recently, the government also launched the National IP strategy that provides measures and guidelines to encourage and facilitate *creation, protection, management and commercialization of IP for accelerating economic, social, cultural and technological development and for enhancing enterprise competitiveness*[20]. One of the focus areas highlighted in the document is the awareness generation and effective enforcement of IPRs, besides encouragement of intellectual property commercialisation through various incentives. The "National Manufacturing Competitiveness Council (NMCC)" has been extremely instrumental in building awareness particularly in the MSMSE sector. In order to ensure that the MSME sector is able to cope with the increase competitive environment in India and globally, periodic capacity development programs and training are an integral part of the initiative apart from a large number of other activities proposed (DIPP, 2017)[21].

Digital India mission has been able to improve governance as well as bring public services closer to the people at large. Through this, various government services have been made available to citizens through different online platform exploiting the growing internet connectivity in urban and rural India. Based on this program the government aims to develop secure and stable digital infrastructure, delivery of public services to remote corners, as well as increase digital literacy.

Public and Private Partnerships (PPP) have created new mode of engagement with the private across various sectors in India. It has created a lot of interest from the private sector. The country has witnessed a considerable growth in PPP projects over the last two decade decades. Government of India has set up Public Private Partnership Appraisal Committee for project appraisal and approval particularly those that are very large. PPP projects are awarded on a transparent, competitive bidding process, leading to greater transparency. The Government facilitates PPP projects through:

- **Viability Gap Funding (VGF)**: *Viability Gap Funding of upto 40% of the cost of the project can be accessed in the form of a capital grant*.
- **India Infrastructure Project Development Fund (IIPDF):** *Scheme supports the Central and the State Governments and local bodies through financial support for project development activities (feasibility reports, project structuring etc.) for PPP projects*
- **IIFCL:** *long-term debt for financing infrastructure projects that typically involve long gestation periods since debt finance for such projects should be of a sufficient.*

19 http://www.envfor.nic.in/divisions/cpoll/psap.pdf

20 https://www.mygov.in/sites/default/files/master_image/Department%20of%20Industrial%20Policy%20-%20IPR.pdf

21 http://dipp.nic.in/sites/default/files/taskForceInnovation_02November2017.pdf

- **Foreign Direct Investment (FDI):** *upto 100% FDI in equity of SPVs in the PPP sector is allowed on the automatic route for most sectors*[22].

International co-operation has helped to encourage eco-innovation across many sectors. Not only has it helped in technical knowhow, but also built capacities of young scholars, scientists as well as faculties in educational and research institutions. The EU-India Agreement on scientific and technological co-operation is one of the key pillars of research and innovation cooperation between these regions. Over the last decade several researches has been undertaken across various sectors and areas that include material science, food and nutrition research, solar energy research and water use efficiency. Member nations of the EU have been working on various pilot initiatives on water and bio-resources related challenges too[23].

Understanding Eco-innovation barriers in India

India may have significantly improved literacy rates, yet the tertiary education rate in India is very low. This is a major impediment towards availability of skilled human resources to undertake research and innovation. In many cases, innovation, particularly in public labs, remain confined at laboratories and find limited takers for up scaling and commercial scale production. In the educational sector there is a lack of innovation oriented research.

India's average R&D spending as a percent of GDP is significantly low when compared to other countries particularly China. According 2014-15 estimates, the share of R&D expenditure was less than 1 percent of GDP compared to China (almost 2 percent, South Korea (approximately 34 percent) and US (nearly 3 percent). It is estimated that India has to more than double its R&D spending share to GDP in the next two decades that can bring innovation-driven solutions to attain the growth targets[24].

In many cases, despite the presence of certain rules and regulations, there has been limited implementation. The states of Punjab, Haryana and Western Uttar Pradesh, generates a lot of agricultural wastes. However, issues with regard to effective and environmentally sustainable management of the wastes, has led to rampant burning leading to significant deterioration of air quality in certain seasons of the year. This is an extremely serious problem and has significant public health consequences. Although the state administration has strictly prohibited burning of agri-residues and created awareness drives including education campaigns the outcome has been limited.

Inappropriate pricing and valuation of natural capital often lead to their over exploitation. Although, the ministry of environment forest and climate change (MoEF&CC) government of India started an initiative few years ago to undertake pilot projects to capture the social value of natural capital and ecosystem services, it was not taken forward. This means that the market mechanism fails to account for third-party environmental costs and benefits of certain activities creating "externalities." For example, industrial processes can pollute surrounding areas and disrupt the provision of valuable ecosystem services such as freshwater to the local community. This is a negative externality which typically results in the overprovision of goods and services that pollute the environment. Conversely, maintaining public areas such as local parks carry positive externalities in the form of fresh air and recreation. However, such goods are typically underprovided since it is difficult to monetize their benefits.

The Clean Energy Fund was set to raise financial resources through coal production and import for supporting renewable energy technology development in India. While the share of cess collected to value of projects financed has risen to the some extent, i.e. from 8 percent to 41 percent in, however, there has not been a substantial rise in the number of projects approved.

There are issues with regard to inter ministerial communication and co-ordination. Further many of the subjects are under the state list. The development and implementation of policies and program on those subjects see uneven success across India, due to different priority areas that the state and local governments have.

While the government has introduced various economic incentives like Feed-in-Tariff, Generation Based Incentives, tax holidays, accelerated depreciation, in renewable energy sector, the success has been mixed. Since there have been issues with regard to no guarantees on procurement of power from RE generating stations and the financial insolvency of many utilities, the assured returns associated with various financial the tax breaks is far more effective that earlier thought. Further, the enforcement of contracts has been poor and lacks commitment on the part of the utilities in honoring them. As a result, the steps to encourage demand from renewable energy through RPOs and RECs have met the desired expectations and target.

Manufacturing linked incentives have not delivered as expected. One could argue that the complementary policies to make manufacturing attractive in India are missing and go well beyond the realm of "green industrial policy". A focus on R&D is lacking and the investments from private sector are not forthcoming.

22 https://www.pppinindia.gov.in/faqs

23 http://ec.europa.eu/research/iscp/index.cfm?pg=india

24 https://www.pwc.in/assets/pdfs/publications/2015/innovation_driven_growth_in_india_final.pdf

5. Analysis on eco-innovation using 2017 ASEI

2017 ASEM Eco-Innovation Index (ASEI)

Table 4. 2017 ASEM Eco-Innovation Index (ASEI)

Area	Index	Source	Year Collected	Remarks		
Eco-Innovation Capacity	1.1. Potential to improve national competitiveness	WEF	2016	Maintained	Global Competitiveness Index (GCI)	Index
	1.2. General innovation capacity of nation	INSEAD	2016	Maintained	Global Innovation Index (GII)	Index
	1.3. R&D Capacity for Environmental Science	SciVal(Elsevier)	2016	Replaced	Number of published articles	No. of articles/10,000 persons
	1.4. Number of Researchers in Environmental Science	SciVal(Elsevier)	2016	Replaced	No. of published article authors	No. of researchers/10,000 persons
	1.5. Awareness level of company's sustainable management	UN Global Compact	2017	Maintained	No. of companies with sustainable management	Number of companies
Eco-Innovation Supporting Environment	2.1. Government expenditure on green R&D	OECD	2015	Maintained	Gov't environmental R&D expenditure ratio	R&D expenditure ratio (%)
	2.2. Impacts of environmental regulations on corporate competitiveness	IMD	2017	Revised	IMD survey result	10-point scale
	2.3. Corporate priority level of sustainable development	IMD	2017	Replaced	IMD survey result	10-point scale
	2.4. Generation Capacity of Renewable Energy	IRENA	2016	Replaced	Generation capacity	MW/10,000 persons
Eco-Innovation Activities	3.1. Number of companies with green technology	Wisdomain	2016	Revised	No. of companies with green technology (patent application basis)	Number of companies
	3.2. Participation level in environmental management	ISO	2015	Maintained	No. patent certification per GDP(Mil. PPP$)	No. of environmental certification
	3.3. Industry- academic cooperation on environmental R&D	SciVal(Elsevier)	2016	Replaced	Biz-academic environmental R&D cooperation ratio	Cooperation ratio (%)
	3.4. Share of Green patents	WIPO	2015	Revised	Green patent ratio	Patent ratio (%)
	3.5. Level of renewable energy distribution	IEA	2016	Maintained	Share of renewable energy from total energy generation	Share of renewable energy generation (%)
Eco-Innovation Performance	4.1. Quality of life related to environmental impacts	EPI	2016	Maintained	Environmental Performance Index	Index
	4.2. Greenhouse gas emission intensity	IEA	2014	Maintained	CO_2 concentration	kg CO_2/2010 USD
	4.3. Environmental sustainability level	WEC	2016	Revised	Environmental sustainability ranking in World Energy Trilemma Index	Index
	4.4. Employment rate in green technology industry	IRENA	2016	Revised	Number of employment	No. of employees/10,000 persons
	4.5. Green Industry Market Size	Wisdomain	2016	Replaced	Ave. number of family countries per patent	Average number of countries

Calculation Methodologies for 2017 ASEI

Table 5. Calculation Methodologies for 2017 ASEI

Area	Index Name	Calculation Method
Eco-Innovation Capacity	1.1. Potential to improve national competitiveness	WEF GCI of the year
	1.2. General innovation capacity of nation	INSEAD GII of the year
	1.3. R&D Capacity for Environmental Science	No. of environmental sciences articles for the past 5 years (total) per 10,000 persons
	1.4. Number of Researchers in Environmental Science	No. of environmental sciences article authors of the year per 10,000 persons
	1.5. Awareness level of company's sustainable management	No. of companies engaging in sustainable management for the past 5 years (total), 2017 (2013~2017)
Eco-Innovation Supporting Environment	2.1. Government expenditure on green R&D	Gov't environmental R&D expenditure ratio of the year
	2.2. Impacts of environmental regulations on corporate competitiveness	IMD survey index value of the year
	2.3. Corporate priority level of sustainable development	IMD survey index value of the year
	2.4. Generation Capacity of Renewable Energy	Renewable energy generation capacity of the year per 10,000 persons
Eco-Innovation Activities	3.1. Number of companies with green technology	Number of companies with patent applications for the past 5 years, 2016 (2012~2016)
	3.2. Participation level in environmental management	Number of environmental certification of the year per GDP (based on conversion point)
	3.3. Industry- academic cooperation on environmental R&D	Average ratio of cooperation for the past 5 year, 2016 (2012~2016)
	3.4. Share of Green patents	Share of green patent of the year
	3.5. Level of renewable energy distribution	Share of renewable energy of the year from the total of primary energy
Eco-Innovation Performances	4.1. Quality of life related to environmental impacts	Quality of life index of the year
	4.2. Greenhouse gas emission intensity	CO_2 concentration per GDP of the year
	4.3. Environmental sustainability level	Indexed value of environmental sustainability rank of the year
	4.4. Employment rate in green technology industry	Number of employees of the year per 10,000 persons
	4.5. Green Industry Market Size	Average number of family countries for the past 5 years, 2016 (2012~2016)

Overview of Indian Eco-Innovation using ASEI

According to the 2017 ASEI, which analyzed eco-innovation status of ASEM countries from relevant data from 2014-2016, India showed lower than the averages of ASEM countries in the four areas of ASEI including Capacity, Supporting Environment, Activities and Performance of Eco-Innovation. In Performance, India reached 0.29 comparing to 0.54, an average of ASEM countries in 2016, which increases from 2014. When it comes to Capacity, there was a 0.04 increase from 0.14 in 2014 but index for the Supporting Environment dropped to 0.05 from 0.14, which may require more attention from Indian government.

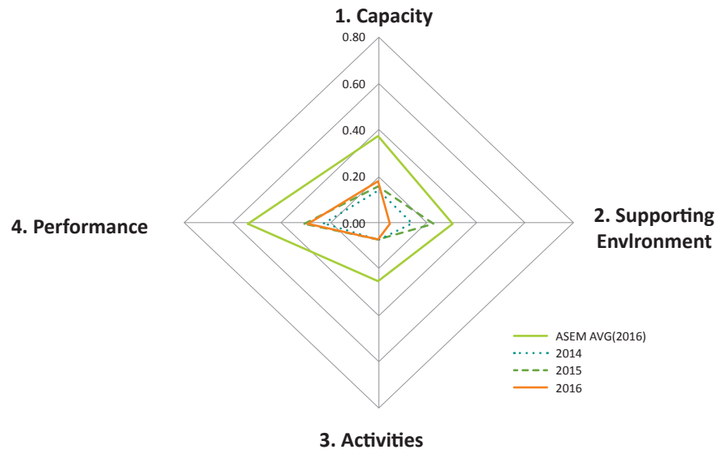

Figure 15. Overview of Analysis on India's Eco-innovation using 2017 ASEI
Source: Author, drawn from results applying 2017 ASEI of which data is specified in table 3. 2017 ASEM Eco-Innovation Index

Eco-Innovation Capacity

National Capacity of India is relatively high with 0.45 close to 0.56, an average of ASEM countries in 2016. General innovation capacity of nation also showed high with 0.32 comparing to 0.54, an average of ASEM countries in the same year. However, in R&D Capacity for Environmental Science, Number of Researchers in Environmental Science, Awareness level of company's sustainable management, India is much lower than those of ASEM countries. Therefore, more works need to be done by Indian government such as promoting high-education in Environmental Science, increasing R&D spending on Environmental Science and increasing awareness of companies in sustainable management.

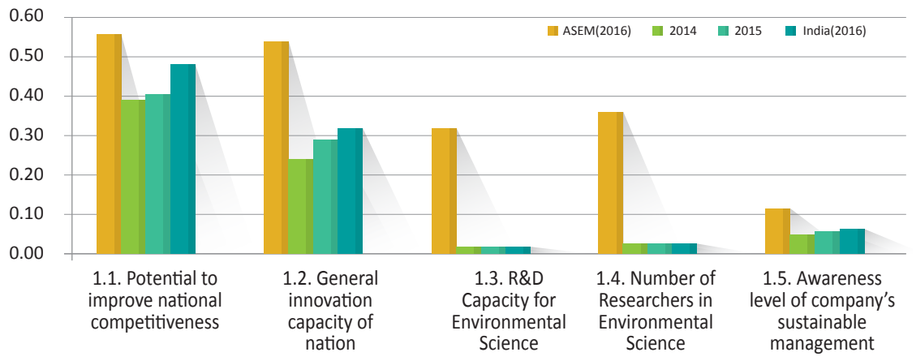

Figure 16. Analysis of India's Eco-Innovation Capacity using 2017 ASEI
Source: Author, drawn from results applying 2017 ASEI of which data is specified in table 3. 2017 ASEM Eco-Innovation Index

Eco-Innovation Supporting Environment

Government expending on Green R&D was not measurable as there was no data available for India. All four indexes under the Eco-Innovation Supporting Environment were much lower that the averages of ASEM countries. Corporate Priority Level of Sustainable Development decreased to 0.13 in 2016 from 0.36 in 2014, which could be another area for Indian government to pay attention. Corporate participation in sustainability development is one of core elements for circular economy in addition to the importance of increasing awareness of citizen on Eco-innovation.

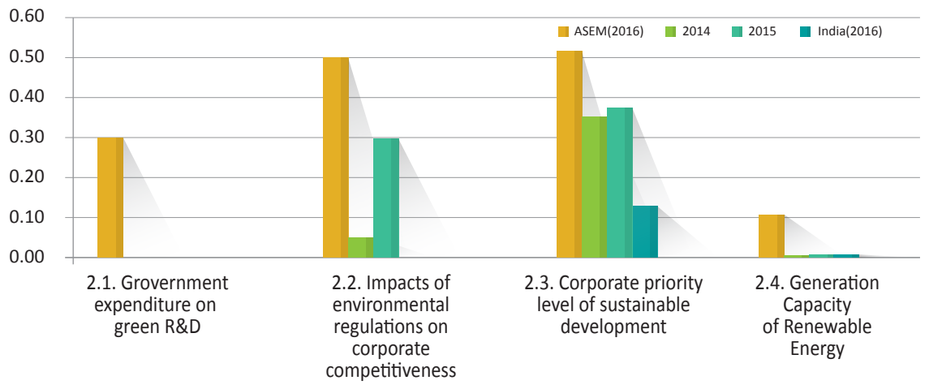

Figure 17. Analysis on India's Eco-Innovation Supporting Environment using 2017 ASEI
Source: Author, drawn from results applying 2017 ASEI of which data is specified in table 3. 2017 ASEM Eco-Innovation Index

Eco-Innovation Activities

The level of renewable energy distribution of India has a smaller gap than other indexes, which represented 0.16 comparing to 0.31, an average of ASEM countries in 2016. This is resulted from Indian government's ambitious plan to increase a share of renewable energy and also international support in renewable energy sector. Industry-Academic Cooperation on Environmental R&D has very little change from 0.08 in 2014 to 0.09 in 2016.

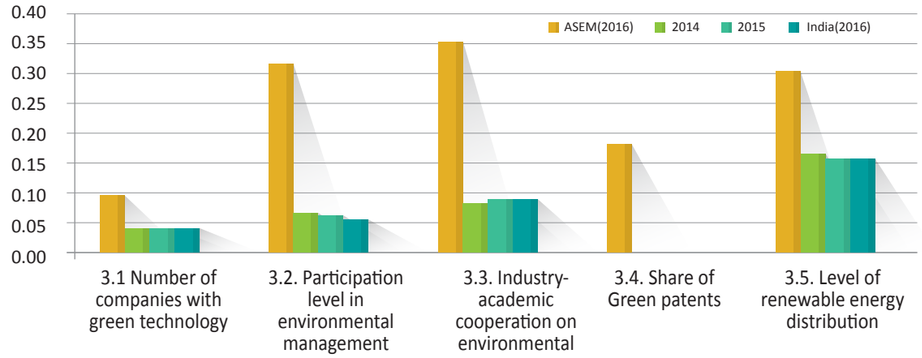

Figure 18. Analysis on India's Eco-Innovation Activities using 2017 ASEI
Source: Author, drawn from results applying 2017 ASEI of which data is specified in table 3. 2017 ASEM Eco-Innovation Index

Eco-Innovation Performance

The quality of life related to environmental impacts is poor recording 0.13 comparing to 0.71, the average of ASEM countries and India's environmental sustainability is only half to the average level of ASEM countries. However, market size of green industry is fast glowing at a 0.48 very close to 0.50, the average of ASEM countries, of which market size has doubled in 2016 from 2014.

The employment rate in renewable industry reached only 1/5 of 0.24, the 2014 average of ASEM countries. Lack of number of employees working in the renewable sector could hinder the transformation of India's economy to circular economy. Proper policy and fiscal measures should be taken In order to meet the needs of fast-growing market in green technology.

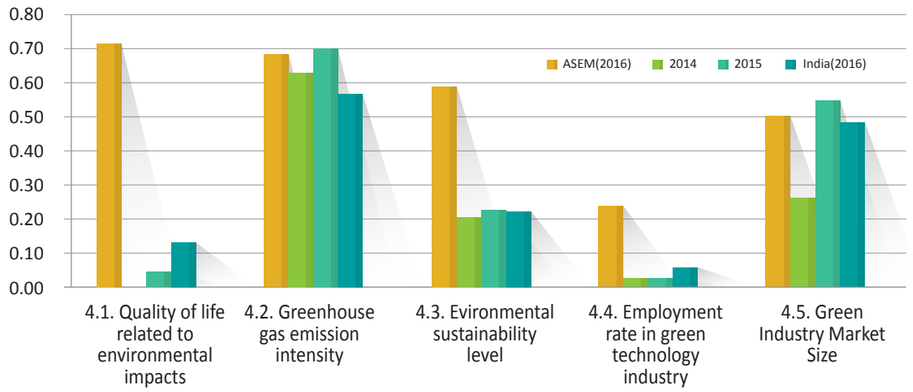

Figure 19. Analysis on India's Eco-Innovation Performance using 2017 ASEI
Source: Author, drawn from results applying 2017 ASEI of which data is specified in table 3. 2017 ASEM Eco-Innovation Index

6. Conclusion

India has emerged as the one of the fastest growing economies in the world and is currently the third largest economy in Asia. The NEP 2006, which forms the basis for many policy reforms that the country has witnessed in the last decade, underscores the importance of awareness for various environment and economic development issues and addressing them based on sound regulatory reforms.

The areas of emphasis in the policy include clean energy, climate change, air pollution, waste management, land degradation, forestry and biodiversity, water management, and marine and coastal environment, resource efficiency in manufacturing sector. The successfulness of the eco-innovation system also depends on how different stakeholders reciprocate to the changing policy landscape and in certain situations is pro-active or taking the lead in taking the sustainable development agenda forward in the absence of any guiding policy or legislative framework. To this end, India has its significant feat over the last couple of decades, through a combination of regulations and policies, addressing various environmental, social and economic issues. It has moved away from a conventional command control policy regime to one where there is increased application of fiscal and economic instruments.

However, for a country like India, where it has a long way to go in successfully meeting the aspirations of millions of people, environmental consequences can be formidable since economic growth will create significant pressure on natural resources like forest, land, water, minerals, and fossil fuels. The ability of the economy to achieve a circular economy will depend a lot on how India is able to integrate life cycle thinking across various policies and programs and use appropriate instruments to tap market signals. Further, it will depend on the ability to reduce the unwarranted quantity of resources required over time to support economic growth that leads to enhancement of social equity and job creation.

In this context strengthening eco-innovation and achieving circular will play an important role in balancing the growing human aspirations as well as the pressures on the environment. Balancing private sector incentives for eco-innovation and fiscal health through appropriate price signals will be critical for national policy making. Frugal innovation has been quite successful in particularly in developing localized solutions. Hence, it is important to explore how this can be mainstreamed with polices for supporting the larger innovation programs in India. It is essential to understand and maximize the development benefits, such as income, energy access, and trade, of green growth interventions. Together with increased education, information, awareness, among all stakeholders it will help in creating more informed consumer and producer choices in the economy. Further this will help in better integration of Indian incorporations to be a part of the global value chains.

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