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Report on Innovation landscape and motives for establishing operations in India

INDIA GATE

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"Increasing the dialogue between India and Europe by improving EU awareness and access to Indian Research and Innovation technology Programmes"

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SEVENTH FRAMEWORK PROGRAMME

Capacities, International Cooperation

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1. EXECUTIVE SUMMARY

Innovation as an approach to creating solutions, products, services and process is of recent province. Yet, in last decade, it has rapidly come to prominence and has occupieda significant position in public discourse. Innovation has become an inevitable tool for gaining competitive advantage for commercial firms and for governments a method for finding solutions to pressing social problems. In India the usage of term innovation entered the official discourse, as recently as 2007 and with the declaration 2010-20 as a "Decade of Innovation" it has become a major government policy initiative.

Although conceptual framing of new and creative solutions to address the unmet needs as innovation is new for India, innovative solutions as such, especially the ones that are frugal are not unknown in India. Some of the most prominent innovations include world's cheapest car, Tata Nano, whose development resulted in over 30 new patents. Mac 400, a portable electrocardiograph from GE, priced 610 EUR delivers a report for less then a euro. A water filter, Tata SWATCH, that uses rice husk and other low-cost filtering materials and can provide a month of clean water for a family of five at 60 cents. At Narayana Hrudayalaya patients are charged flat 1144 EUR for heart surgeries compared to 3432 EUR that other heart hospitals charge on average. Aravind Eyecare does cataract operations for an extremely low cost. Despite these and many other success stories India still lags behind many other nations in Innovation.

India's ranking on several international indices that measure the innovativeness of nations is very uneven. On some it is making a study progress on others India performs extremely poorly. However, a consistent picture emerges insofar as the innovation inputs and innovation efficiency are concerned. For example, India scores, across the board, very low on innovation inputs and innovation environment, which include R&D expenditures, infrastructure, transport, energy, government policy and other innovation enablers. Despite these low quality inputs and poor innovation environments, India continues to be innovative; hence it receives high marks for innovation efficiency. Indians are extremely good at overcoming the weakness of innovation inputs and producing quality innovation outputs. This leads us to believe that India's potential for innovation is yet to be fully harnessed and improvements in innovation inputs and innovation environment will probably result in an explosion of innovations.

INNOVATION INDICATORS

India is one of the largest economies in the world. 2012 data from International Monetary Fund (IMF) shows that India's gross domestic product in purchasing power parity (PPP) terms stood at 3.4 EUR trillion in 2011, marginally higher than Japan's 3.38 EUR trillion, making it the third-biggest economy after the United States and China. Nevertheless, the economic growth does not present a uniform picture for whole of the nation. There are

regions such as state of Maharashtra where the financial capital of India Mumbai is located with GDP comparable to Singapore and other states like Tripura in Northeastern part of India, which has a GDP equivalent to Somalia.

India spends under 1% of its GDP on R&D activities. Although this amount has increased from 0.62% in 1990-91 to .92% in 2007-08, it still represents a very small portion compared to China and developed nations in the world. Government of India is the biggest contributor of research money with 75% of share and all of it channeled through government agencies such as Council for Scientific and Industrial Research (CSIR), Indian Council for Agricultural Research (ICAR), Indian Council for Medical Research, Department of Science & Technology, Indian Space Research Organization, Department of Atomic Energy and others. The private sector contributes 20% of expenditures on R&D. Most of the private R&D expenditure is incurred in the pharmaceutical industry, which saw a fivefold increase from 2000 to 2005. This is followed by automotive industry, which increased the R&D spends from under 500 million Rupees in 2001 to over a Billion Rupees in 2006. In R&D output measures, India has been progressing well compared to its earlier performance, but well below other nations such as China. The number of research publications increased studiedly over last decade. Similarly, the patents granted both abroad and in India to research and commercial organizations have also increased substantially. Interestingly, the patents granted to foreign nationals in India are three terms higher than the ones granted to Indian nationals.

Foreign corporations R&D centers play a very important role in research and innovation activities in India. There are estimated to be 851 foreign R&D centers as of 2010 spending over Rs 28830 million on R&D activities. The foreign R&D centers have been extremely active in patenting the work done in their Indian R&D centers. In total 1969 patents were granted by the US patent office to foreign companies with active R&D in India. Vast majority of these patents are in ICT and most of the companies who received patents are of US origin.

With 17.1% world population share India is the second most populous country in the world. It is expected to surpass China in next two decades. Some analysts consider the population as India's "Demographic Dividend", especially considering that 50% of India's population about 600 million are bellow 25 years of age.

Universities and university-level institutions in India include 20 Central Universities, 215 State Universities, 100 Deemed Universities, 5 institutions established under State Act and 13 institutes of national importance apart from around 17,000 colleges including 1800 women's colleges. In the last decade, there has been a significant rise in enrollment at all levels. As per a 2012 summary report on higher education in India released by the University Grants Commission (UGC), the number of universities rose to 634, and affiliated colleges rose to over 33,000. By 2010, gross enrollment in the university system had reached almost 17 million (not including students enrolled in technical diploma institutes

and other informal vocational institutes where overall annual intake has crossed 1 million.). Engineering enrollment was roughly 2.8 million in 2010 although first year engineering enrollment touched a million in 2012.

There are nearly 200 thousand people engaged in R&D activities in India. Of these roughly 63% were working in the institutions, academia as well as publicly supported R&D organizations and 31% in the private sector. Over 50% of those working on R&D activities have post-graduate or higher degree and the 30% graduate degree. Of the total R&D personnel the public institutions employ 76% of the PhD and 50% of post-graduates.

FUTURE OF INNOVATION: POLICY & INITIATIVES

The government of India spends large amount of money on R&D activities channeled mainly through several different government agencies and departments. The policy maker believe that the government could do more by becoming an enabler of an innovation ecosystem and develop a comprehensive strategy for knowledge creation diffusion application, and commercialization, development of skills and education,re-engineering of processes and service delivery methods, and to address information infrastructure needs along with finance. The preeminent focus of this innovation strategy is on inclusive innovation, with the view of meeting the needs of India and its challenges of demography, disparity and development. In order to realize this strategy articulated as a "Decade of Innovation" the government of India constituted National Innovation Council (NInC) under the leadership of Sam Pitroda and well-known people from corporate and social sectors and the academia as its council members.

The role of NInC is to serve as a forum to bring together multiple stakeholders to create an inclusive innovation movement in India. The NIC's innovation roadmap for 2010-20 focuses 5 key parameters:

Platform: Develop a broader platform that facilitates application of technology to create innovative products, services, processes, organizations, governance methods, research & development and social &cultural mindset.

Inclusion: India is a nation of contrasts and large divisions between the haves and have-nots. The objective of an innovation strategy is to bridge this divide to generate inclusive growth with sustainable and quality solutions that employ innovation as a tool.

Eco-system: An innovative eco-system of dynamic interactions within and across multiple players to facilitate the conception of new ideas and also provide platforms for the successful exploitation of these ideas.

Drivers: A successful inclusive innovation strategy driven by some key ideas and goals such as, multidisciplinary and collaboration, generational change vs. incremental change,

durability as opposed to disposability, needs vs. demand dichotomy, and environmentally sustainable and locally relevant solutions

Discourse: Expand the discourse of innovation in order to give room to alternative dialogue. Involve many divergent voices, views, and mode of doing things to impact the end result qualitatively and quantitatively.

The aim of NInC is to redefine innovation looking beyond the research and Development (R&D) and to generate new and creative solutions for inclusive growth. With the view of realizing its vision NIC has undertaken major initiatives, which include:

- **India Inclusive Innovation Fund:** A billion euro fund to invest in world-class enterprises engaged in developing products and solutions for the problems of poor.
- **Sectorial Innovation Councils:** Aligned to central government ministries to enable innovations within the sector.
- **State Innovation Councils**: For each of the states and union territories to create an innovation ecosystem in the state.
- **Industry Innovation Clusters & Cluster Innovation Centers**: To bring together different stakeholders for collaboration and promotion of innovation
- **Innovation in Education & University Clusters:** Enable innovation in creativity in education system and create university clusters as hubs of innovation.

The NInC is moving aggressively to realize its agenda. So far the India Inclusive Fund has begun its operations with 100 crore rupees seed money from government of India. Seven pilot Cluster Innovation Centers have been established in different parts of the country covering different industry segments. Twenty-two State Innovation Councils and 24 Sectorial Innovation Councils have been constituted. And in the area of education, the Ministry of Human Resources Development has accepted the NInC proposals to award 1000 innovation fellowships at the school level; Mapping of local history, local ecology and local culture and heritage by high school students and setting up the first Meta University of the world for multi-disciplinary learning. Additionally, Pilot University Cluster Innovation Centers have been established at University of Delhi and Maharaja Sayajirao University of Baroda.

EUROPEAN UNION AND INDIA COOPERATION

Research cooperation between EU and India started in mid 80s, which was further reinforced with the signing of the first S&T Agreement in 2001 and extended in 2009. Science and Technology bilateral cooperation opened doors for Indian participation in collaborative research with Europe in their largest research-funding program for science and technology development: The Framework Program (FP). Since its inception there were seven Framework Programs, including the ongoing FP7. India began participating from FP6

onwards and has become the fifth largest international partner for the EU under FP7. One of the salient achievements of FP7 is India's full partnership in the International Thermonuclear Experimental Reactor (ITER) nuclear fusion project.

Between 2007 and 2011, nearly 250 Indian partners received around 30M euros EC funds. Total EC contribution to proposals involving Indian partners wasaround 350M euros. Of total 147 projects executed, 23% are in health sector, and 13% each in environment, energy and ICT sectors. Space has received just 2 grants although space and aeronautics are one of the most innovative and promising sectors in India.

The first India EU coordinated call was launched with the Department of Science and Technology on computation materials science, with co-funding of 5 million euros from each side. The call attracted 25 proposals of which six have been funded. The Second Coordinated Call, launched with the Department of Biotechnology with co-funding of 3 million euros each on food, health and well-being, again attracted 25 proposals, of which two have been funded. The third Coordinated Call for proposals was launched with the Department of Science and Technology, on solar energy systems. This call with a co-funding of 5 million euros from each side attracted 23 proposals, of which three will be funded. Two Coordinated calls for proposals on Water technology, research and innovation have also been launched with the Department of Science and Technology, in July 2011 with a total budget of €32m funded equally by the two sides.

The EU India cooperation, joint projects and bilateral cooperation are of vital importance for India and EU region as a whole. With India declaring 2010-20 as a "Decade of Innovation" and EU's emphasis on Innovation, especially social innovation there are many mutually beneficial opportunities to jointly develop and exploit innovative products, services and processes, especially in the areas of clean energy, water & waste management, foreign universities, global R&D centers and others.

OPPERTUNITIES FOR EU ENTERPRISES AND ORGANIZATIONS

India as one of the fastest growing economies in the world and with a large internal market across all income scales offers a tremendous opportunity for both public and private organizations from EU nations. There are risks and challenges such as slow and inefficient government bureaucracy, lengthy and time consuming regulations and poor infrastructure. However the risk out way the benefits, especially considering that in 10-15 year time frame all the investments in infrastructure, deregulations and liberalizations would have borne fruits. Some of the areas that offer immediate and long-term opportunity are the following:

Innovation Centers: MNC R&D in India is dominated by US companies who moved here early and continue to expand their R&D centers every year. EU organizations too can

harness the available talent in India to undertake R&D activities both for global audience as well as create new products for Indian consumers.

NInC Initiatives: The National Innovation Council and its various initiatives offer a great opportunity for both public institutions and private companies in the EU. For example, the billion-euro India Inclusive Innovation Fund offers a chance to invest into the fund as well as seek funding to establish enterprises, especially the ones focused on social innovation. EU nations can offer their expertise to NInC in establishing cluster innovation centers at state, sector and university level; given that EU has a long-standing tradition of developing clusters successfully.

Opportunities in Industry Sectors: There are significant opportunities in different industry sectors including highly competitive sector as automotive, which is open to 100 FDI, Aerospace that is highly restrictive and Pharmaceuticals. Major opportunities remain in sectors that are vital for India's growth and future such as Water and Waste Management, Clean energy and transportation. These opportunities are yet to be fully explored and realized by EU organizations.

2. INDIA INNOVATION LANDSCAPE

Innovation as a concept and term has come to occupy a prominent position in the global discourse. It is very frequently used in the business forums, social conversations, public discourse and media.

The word innovation is used, often, to signify different things. However, innovation in a broad sense refers to creation of new products, services and processes to resolve business, commercial, economic and social problems. The term innovation is also used more recently in conjunction with other words to mean innovative solution to address the needs of a sector, a group or a section of population. For example, "Social Innovation" refers to new solutions that emphasize the social dimensions of both the end goals to be addressed by the solutions as well as the means used to arrive at the solutions and their implementation. Another term "Inclusive Innovation" underscores resolutions of problems afflicting the marginalized population through innovative solutions. "Design Innovation" another phrase that has come into vogue highlights the design approach to coming up with innovative products, services and process. Despite its varied uses either as a single word or in combination with others, innovation has become critical instrument of competitive advantage for commercial enterprises and essential for governmental policy makers to bring about the desired growth.

In India, the usage of expression Innovation is fairly recent and quickly occupied a prominent position in public discourse. It entered the official policy vocabulary only 2007 with the publication of National Knowledge Commission study on innovation in India. Since the declaration of 2010-20 as the "Decade of Innovation" it has become a major policy objective with the view of reaching the benefits to more then half of India's population, which remains in the margins of economic growth. Although the word innovation to mean new products, services and process to resolve commercial and social problems is a recent phenomenon, India had been actively producing innovative solutions, within constraints, to address the unmet needs.

Bellow is the brief summary of some of the most prominent and innovative solutions to have emerged from India. They try to address the most pressing problems that a vast majority of Indians face: health, water and electricity, with solutions that are affordable.

FRUGAL INNOVATIONS

SELCO SOLAR LAMPS

SELCO India is one of the best examples of inclusive innovation. SELCO has played an unparalleled role in providing energy access to millions of underserved and inaccessible households in remote villages across India.

Close to 50% population of India, mostly in rural areas, lack electricity; and in most of these areas the supply is unreliable.SELCO India, a solar electric lamp company and a social enterprise based in Bangalore, has pioneered the art of "social innovation" in the sustainable, renewable energy sector. SELCO India has installed solar light systems in 125,000 houses and aims to reach over 200,000 households by 2014. SELCO's products ranges from solar energy based interventions like solar lamps, solar thermal heaters and solar inverters, to low smoke cook stoves.

Founded in 1995 by a social entrepreneur Dr. Harish Hande, with a seed fund of 15,000 rupees, from the co-founder Mr. Neville Williams, SELCO now operates through 28 service centers in Karnataka and Gujarat. While more than 135,000 home lighting systems have been installed, one of SELCO's greatest achievements include installation of the largest solar water heating system, with an approximate capacity of 400,000 liters for a client in India.

A typical SELCO system that uses 35 Wp PV Module to supply four 7W compact fluorescent lights costs about EUR € 228.76. Local SELCO service centres cater to customer demand, provide surveys, installation, after-sales service and spare parts. Local banks or microfinance organizations are looped in to provide affordable loans for purchase, usually requiring a small down payment and monthly installments over five years. The Solar system replaces about 8.5 million liters/year of kerosene (around 120 liters per year is used by a family for lighting), and the emission of about 22,000 tones/year of CO2. The improved biomass cook stove is approximately 40% more fuel efficient, emits 70%-80% less smoke (from traditional cook stoves) and is designed to meet the cooking requirements of rural households.

In recognition of their service, SELCO India was awarded the prestigious Ashden Awards, also known as the *Green Oscars*, in years 2005 and 2007. SELCO was recognized not only for its innovation in developing sustainable energy products, but also in building links with end-user finance institutions that enable people to buy them.

JAIPUR FOOT

One of the best and world famous frugal innovations from India is the Jaipur Foot, an artificial limb named after the locality of the inventor - Jaipur. The foot was developed by an orthopedic surgeon Dr P K Sethi, in 1968. However, it was Dr D R Mehta, whose philanthropic ideals, to fix the foot free of cost, to the physically challenged, that enabled the innovation to reach millions of people. Dr Mehta rendered this great service through his charitable trust, Bhagawan Mahaveer Vikalang Sahayata Samiti (BMVSS), Jaipur. In 34 years time, Jaipur foot has provided limbs to 360,000 people, and around 600,000 got calipers, crutches and tricycles across the world. On account of this large turnover of BMVSS, it has been the largest organization in the world. BMVSS does the charitable work in India and abroad. BMVSS`s devices are low cost, locally produced prosthetic devices.

Jaipur foot's uniqueness lies in its novel technology which comes in an unbelievably low price – real frugal innovation! It is light and one can run, climb trees, pedal bicycle while it is on and with all these features included, it is priced as low as *3 euros which will cost 1900 euros.* Limb made with this technology are closest to a normal human limb which has got the same range of movements which a normal human foot has. Its dorsiflexion inversion, eversion and axial rotation facilities allow amputees not only to walk comfortably but also squat (sitting on hunches), kneel, crouch, sit cross legged, walk on undulated terrain, run, climb a tree and also drive an automobile making it an all functional, all terrain limb.

Jaipur foot and BMVSS can also be quoted as an example for "inclusive, process innovation". In order to reach out to the poorest, BMVSS kept the administrative cost as low as 4%, while elsewhere it is 50 to 80% of the cost of limbs. Thus BMVSS was able to serve 70,192 patients in the year 2006-07. While in 1975, 59 artificial limbs were fitted in a single year, in 2009, after 35 years, every year BMVSS fits 17,000 to 20,000 artificial limbs adding up to around 350000 artificial limbs fitted in 35 years. Jaipur foot has reached to people outside India as well. In 22 countries, from Afghanistan to Zambia, 16,783 Jaipur foots have been fitted, maximum being 3,051 in Afghanistan.

NARAYANA HRUDYALAYA

India records higher cardiac diseases in a year than most countries and in addition, the cost of medical interventions/treatment is also very high. Narayana Hrudyalaya, founded by a renowned cardiac surgeon Dr Devi Shetty in 2000, has broken this cost barrier through internal process innovation. It boasts accessible and affordable open-heart surgeries, which makes it a good case study subject on frugal innovation. This Hospital located in Bangalore, made use of "economies of scale" to obtain the cost advantages due to expansion. In addition, it was able to contain cost by fine-tuning processes, driving hard bargains and negotiating creative partnership deals.

At Narayana Hrudayalaya patients are charged flat EUR 1143.81 for heart surgeries compared to EUR 3431.4 that other heart hospitals charge on average, and in the US, the costs go as high as EUR 34314! Added to that Narayana Hrudayalaya has an innovative medical insurance scheme under which people who can't afford to pay can be covered. This low price doesn't come with compromised quality; it has amazing 95% success rate in heart surgeries and has become one of the well renowned hospitals for pediatric cardiac care.

The hospital's super-specialization approach, by employing highly specialized cardiology doctors, who can perform a specific aspect in a much better and faster way than others with generic skills, sets it apart from popularly known 'multi specialty hospitals' treating variety of diseases. Besides, the hospital has recruited and trained women with high school education in taking echocardiograms of patients, which is generally carried out by trained doctors. This has brought more time for doctors to perform higher complex activities. With these innovations around internal processes, Narayana Hrudayalaya conducts around 30 cardiac surgeries per day compared with four to five in other major hospitals. This 'high volume' in turn has helped the business grow and charge 'low cost' for their patients.

Narayana Hrudayalaya's yet another innovative process is their telemedicine services. The hospital's partnership with Indian Space Research Organziation (ISRO) has enabled its telemedicine services to reach even the remote areas of Tripura and Nagaland in addition to areas in south of Karnataka by connecting them using INSAT satellite.Now around 170 hospitals provide telemedicine network, thanks to the advanced technology and innovative ideas of Narayana Hrudayalaya which has made "affordable" healthcare a reality.

ARAVIND EYECARE

Aravind Eye Care System in the southern state of Tamil Nadu has revolutionized the healthcare sector through its systematic and detailed process innovation. A brainchild of Dr G Venkataswamy, Aravind eye care came into existence in 1976, with the sole mission of eliminating unnecessary blindness, mainly through cataract, in Tamil Nadu, and across India.

India has 12 million blind people, more than any other country. Simple cataract surgery can restore vision to around 9 million blind people. Though providing treatment and surgery did not seem problematic, the cost associated with it came as a big hurdle. Treating cataracts in Indian hospitals cost around €228.8 and in US around €1907. For a country like India where the rural population earn less than €2/day, such a cost made the treatment unreachable. Aravind Eye Care succeeded in removing this barrier. Through developments and refinements in the system, the average cost in Aravind Eye care system was brought down to €19, with over 60% treated free. Today, the Aravind Eye Care System is the largest and most productive eye care facility in the world.

Aravind eye care's innovation includes 'standardization' and 'engineering' cataract surgery for high volume production. To ensure high volumes it went out to rural locations offering advice and diagnosis, feeding patients into the core hospitals where they are treated. High attention given on training ensured adequate supply of key skills. With focus on continuously improving and extending their system models, the Aravind Eye Hospitals gradually shifted to become the Aravind Eye Care *System with a* dedicated factory for producing lenses, a training centre to provide key skills, specialist ophthalmic research centres, and an international eye bank.

These detailed process innovations led to high productivity. In a conventional hospital an eye operation would typically take 30 minutes; yet the Aravind system needs only 10. Each surgeon works on two operating tables alternately, with 70% of activities carried out by a team of 4 nurses supporting the surgeon, enabling 200,000 plus cases per year, with each doctor carrying out around 2600 operations/year against an Indian average of around 400.

Aravind Eyecare System is now grown into a network of eye hospitals that have seen nearly 32 million patients in 36 years and performed nearly 4 million eye surgeries, majority of them being very cheap or free making it a landmark example world over, for frugal innovation.

SWACH: TATA WATER FILTER

Tata Chemicals' 'Swach' – meaning 'Clean' in Hindi, is an innovative water purifier made from rick husk ash, a natural material and one of India's most common waste products, and silver nano particle filter made out of cutting edge technology is an outstanding example for affordable innovation. Swach priced 50% cheaper than its nearest competitor was launched in Dec 2009. Priced 999 Indian Rupees, it is the cheapest water filter in the world with a benchmark cost of Rs 30 per month for a family of five.

Swach makes a good case study topic for frugal and inclusive innovation, and can be considered as an excellent example of how high quality engineering and design can transform an idea into a good, affordable consumer product. One of the prominent features of the filter is that it *does not requireelectricity or running water to operate* which gives it an added advantage of penetration to remote, economically disadvantaged villages where almost no household enjoys running water facility and suffer from shortfall of electricity most of the time. Besides, the cartridge that enables purification could be replaced easily by any householder without any technical assistance. All these conveniences, coupled with the fact that it is the world's cheapest water purifier, at 10 paise per litre, makes it a model example for frugal innovation.

Another important ground-breaking approach adopted includes collaboration of different kinds of organizations and internal resources for facilitating this innovation. Several Tata group of companies partnered in this novel effort. While the idea was originated in TCS, the product was created by a joint team of Tata Chemicals and TCS, and development of nano technology came from Tata Research Development and Design Centre, a subsidiary of TCS. Mass production of the product was handled by Titan industries, watches and precision equipment manufacturer, and after sales service and support was rendered by Tata Business Support Solutions and Tata Teleservices. With each partner lending their expertise to the Tata Swach, the product comes at a reasonable value to the customer.

Tata Swach has been voted the 'Product of the Year 2012' on the basis of a survey conducted by Nielsen with 30,000 consumers across 36 markets in the country. It won gold at Asian Innovations Award 2010, and several other accolades.

GE MAC 400 ELECTROCARDIOGRAM

GE Medical Systems Group in 2008 launched an affordable, portable Electro Cardio Gram (ECG) machine - 'MAC 400' for rural India at one tenth the cost and one third the weight of previous units. MAC 400 priced at around €800 delivers ECG reports for less than a euro! The machine weighing 7 lb compares with a large 65 lb. machine which sells in the USA for over €10,000. The machine uses just four buttons, unlike the usual dozen, and has an inbuilt tiny portable printer, which makes it small enough to fit in the physician's backpack. It runs on batteries for up to a week or 100 ECGs on a single charge enabling cardiac assessments even in rural areas, thus making it accessible to a larger section of society.

GE Healthcare engineers combined technology and creativity to develop the device appropriate for the Indian market. The engineers who worked on this challenging project had to squeeze the technology used in a 15 lb ECG machine costing 5.4 million euros and which took 3 and a half years to develop, into a portable device that would weigh less than three pounds and can be held with one hand, to be developed in 18 months for just 60% of its wholesale cost.

The engineers adopted some natural cost advantages. The new device has lower material costs, uses less plastic and sports a smaller LCD screen. The labor cost was reduced considerably as eight of the nine engineers were based in India. For the machine's printer, the team adapted the one used in bus terminal kiosks in India. A commercially available chip was purchased at one-fourth the price instead of the conventional procedure followed - to customize processing chips which requires 18-week advance order.

Other in house products like portable ultrasound machine, semi-portable ECGs in the '90s with outdated technology were studied to understand low-cost source for technology and printer jamming problems. Plastic mold prototypes were cut far earlier in the process than usual, which enabled early feedback from doctors. Software algorithm was simplified to reduce the memory it was drawing and the battery was modified to prevent wear-out problems when stalled at distributor's outlets.

In addition to being an illustration for creativity and technology innovation, this compact device has now become a case study in reverse innovation; a strategy of innovating in developing markets, and selling them in developed world. This ECG machine, very successful in rural India, was launched as an improved version a year later in 2009 in US as MAC 800.

INDIA ON INNOVATION INDICES

There are several indices that measure innovativeness of countries and rank them accordingly. All the indices take the following into account for their measurements

Direct innovation inputs: Research and Development (R&D) expenditures as a percentage of Gross Domestic Product (GDP), Company spending on R&D, quality of research infrastructure, educational levels & technical skills of the workforce, quality of IT & communication infrastructure, and broadband penetration

Direct Innovation outputs: Number of research and scientific publications and number of patents awarded.

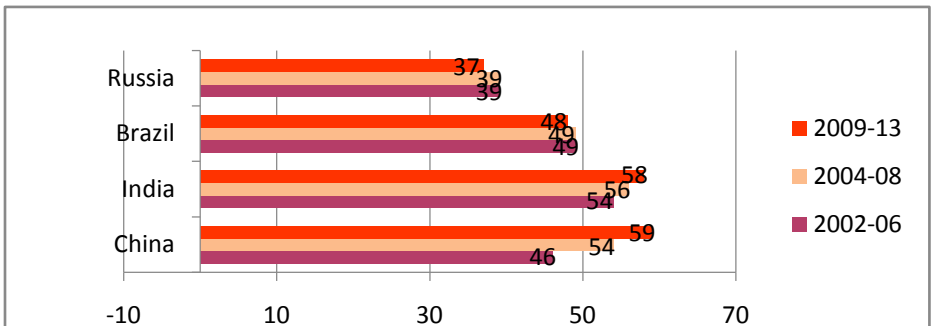
Innovation Environment: Political environment, market opportunities, government Policy towards free enterprise, competitiveness and foreign direct investment, foreign trade and exchange controls, tax policy, financing, labor market, Infrastructure and others.

India presents a very mixed and uneven picture across three different indices taken into consideration in this report

1. A New Ranking of World's most innovative countries from Economist Intelligence Unit
2. Global Innovation Index jointly published by, INSEAD and the World Intellectual Property Organization (WIPO, a specialized agency of the United Nations)
3. Global Competitiveness Report published by The World Economic Forum's Centre for Global Competitiveness and Performance

In the EIU rankings India has been making study progress over the last decade. It has advanced studiedly from 58th position in 2002-06 to 56th position in 2004-2008 and in the latest rakings for 2009-213 it is ranked 54th. China in comparison has been making great strides. It jumped from 59th to 54th position between 2002-06 to 2004-08 and to 46th position in 2009-13 rankings. The reason for China's rapid accent through the rakings is its concerted effort to increase R&D and infrastructure.

Following figure illustrates comparative ranking of BRIC nations.



Source: Economist Intelligence Unit

In the innovation component of WEF Global Competitiveness Index that also measures innovativeness of a country India ranks 40th in2011-2012 and 42 in 2010-11, which is a two point improvement in one year. However, in 2009-10 India was ranked 28th in Innovativeness and Sophistication that means India had dropped 14 positions between 2008-09 and 2010-11. Similar wild fluctuations in the rakings can be observed in the Global Innovation Index (GII) rakings as well. The following figure illustrates the WEF and GII rankings of India. Other BRIC nations are also included for comparison.

GII/WEF Rankings – BRIC Countries

		2008-2009	2009-2010	2010-2011	2011-2012
Brazil	GII	50	68	47	58
	WEF	42	38	38	35
Russia	GII	68	64	56	51
	WEF	73	73	80	97
India	GII	41	56	62	64
	WEF	27	28	42	40
China	GII	37	43	29	34
	WEF	32	29	31	31

Given that India's position keeps swinging like a pendulum on the innovation indices it is very difficult to know what truly India's position is in Innovation relative to other countries. However, a consistent picture emerges insofar as the innovation inputs and innovation efficiency are concerned. For example, India scores, across the board, very poorly on innovation inputs and innovation environment, which include R&D expenditures, infrastructure, transport, energy, government policy and other innovation enablers. Despite these low quality inputs and poor innovation environments India continues to be innovative, hence it receives high marks for innovation efficiency. In the GII Innovation efficiency Index 2012 India is ranked 2 in the world improving its position from previous year, which was 9th.

Rank	Country/Economy	Efficiency Score	Input Rank	Output Rank	Income Group	Rank	Region Group	Rank	Population (US $ million)	GDP per capita (current PPP $)
1	China	1.13	55	19	UM	1	SEAO	1	1348.1	8394.1
2	India	1.1	96	40	LM	1	CSA	1	1206.9	3703.5
3	Moldova, Rep	1.08	79	30	LM	2	EUR	1	3.6	3383
4	Malta	1.03	27	4	HI	1	EUR	2	0.4	25782.7
5	Switzerland	103	4	1	HI	2	EUR	3	7.8	43508.6
6	Paraguay	0.94	103	62	LM	3	LCN	1	6.5	5548.9
7	Seberia	0.93	65	36	UM	2	EUR	4	7.4	10661.3
8	Estonia	0.93	24	8	HI	3	EUR	5	1.3	20182.1
9	Netherlands	0.92	12	3	HI	4	EUR	6	16.7	42330.7
10	Sri Lanka	0.92	115	76	LM	4	CSA	2	20.5	5609.4

Note: World Bank Income Group Classification (April 2012): LI= low income, UM = upper-middle income; and HI = high income. Regions are based on the United Nations Classification (20 September 2011): EUR= Europe; NAC= Northern America; LCN = Latin America and the Caribbean; CSA= Central and Southern Asia; SEAO= South East Asia and Oceania; NAWA= Northern Africa and Western Asia; and SSF= Sub-Saharan Africa.

In the Global Competitiveness Innovation Capacity Index India performs well on quality of research, patents, availability of qualified workforce etc, except on government procurement of advanced technology.

Country	Capacity for innovation		Quality of scientific research institutions		Company spending on R&D		University-industry collaboration in R&D		Government procurement on advanced technology products		Availability of scientists and engineers		Utility patents (per mission of people)	
	Rank	*Score*	*Rank*	*Score*	*Rank*	*Score*	*Rank*	*Score*	*Rank*	*Score*	*Rank*	*Score*	*Rank*	*Score*
Brazil	31	3.8	42	4.1	30	3.8	38	4.2	52	3.9	91	3.8	60	0.9
China	23	4.2	38	4.3	23	4.2	29	4.5	16	4.4	33	4.6	46	2
India	35	3.6	34	4.5	33	3.7	50	3.8	78	3.5	21	4.9	59	0.9
Japan	1	5.8	11	5.5	1	5.9	16	5.1	32	4.1	2	5.8	2	352.9
Rep. of Korea	20	4.3	25	4.8	11	4.8	25	4.7	31	4.1	23	4.9	5	240.6
United Kingdom	13	4.8	3	6.1	12	4.7	2	5.8	49	3.9	14	5.1	20	69.5
United States	7	5.2	7	5.8	6	5.3	3	5.7	9	4.7	4	5.5	3	339.4

Note: Rank refers to the economy's global rank on each indicator among 142 economies. Scores range from 1, low to 7 highest, except for utility patent, where the score shows the number of patents per million people.
Source: World Economic Forum 2012

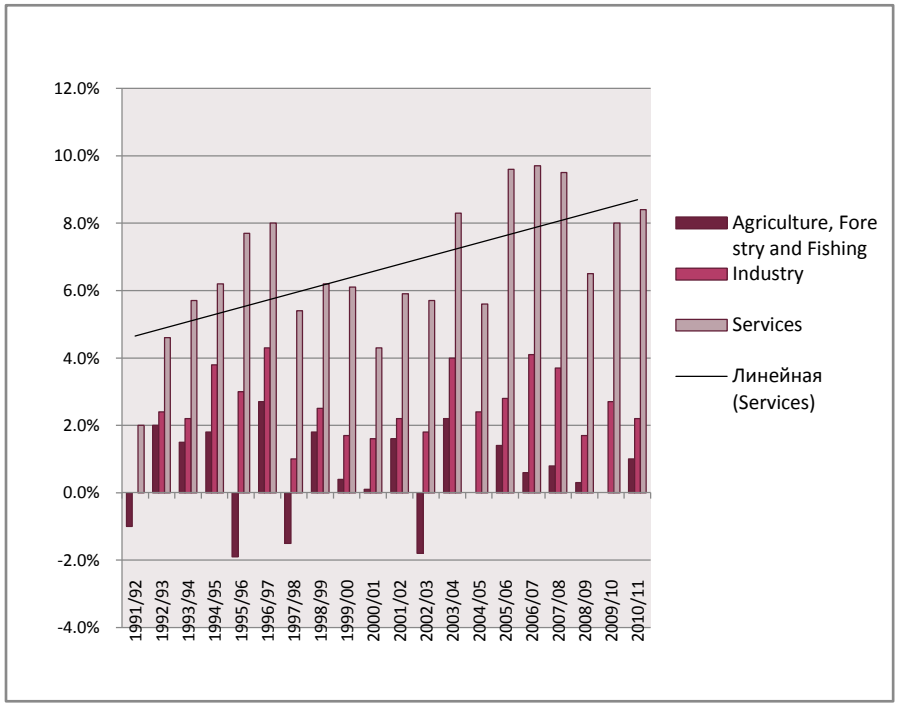
What can be concluded from these results is that the Indians are extremely good at overcoming the weakness of innovation inputs and producing quality innovation outputs. This leads us to believe that India's potential for innovation is yet to be fully harnessed and improvements in innovation inputs and innovation environment may probably result in an explosion of innovations.

INDIA'S UNEVEN ECONOMIC GROWTH

India is one of the largest economies in the world. In 2012 data released by the International Monetary Fund (IMF) shows that India's gross domestic product in purchasing power parity (PPP) terms stood at 3.4 EUR trillion in 2011, marginally higher than Japan's 3.38 EUR trillion, making it the third-biggest economy after the United States and China.

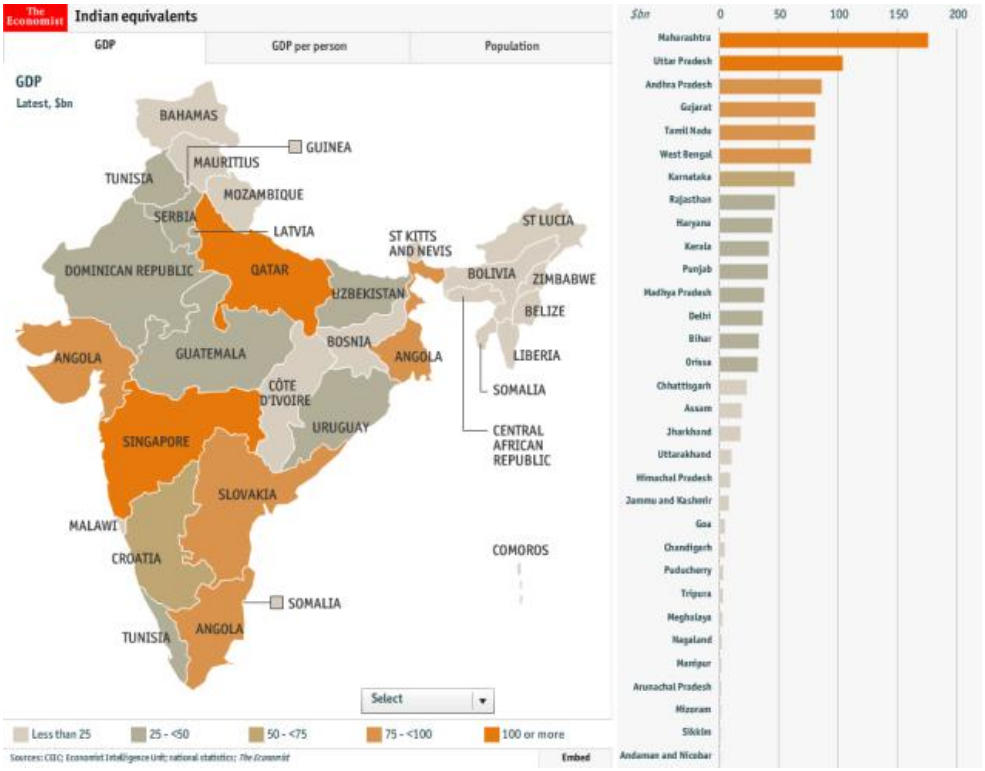
From 1991, the year liberalization had begun; Indian economy has performed exceptionally well with an average growth of 7% a year since 2005. Marginally effected by the global economic crisis of 2007-2009 Indian economy recovered quickly to perform impressively until 2011. However, the growth has slowed down in 2012 owing largely to the policy paralysis of Indian central government, a coalition of Indian National Congress and several small regional parties with desperate agendas. The experts and the analysts have downgraded growth forecast for the financial year 2012-13 from 6-2-6.4% to 5.1-5.3%.

Real GDP Growth Rate



The economic growth dose not presents a uniform picture for whole of the nation. The Economist magazine rendering of India states and territories GDP map comparing to countries that match the GDP and population of countries presents a very interesting

visualization of growth in India. There are regions such as state of Maharashtra where the financial capital of India Mumbai is located with GDP comparable to Singapore and other states like Tripura in Northeastern part of India, which has a GDP equivalent to Somalia and Karnataka has the GDP of Croatia.



TECHNOLOGICAL INTENSITY OF MANUFACTURED EXPORTS

One of the measures that can indicate how well a country is doing on innovation is the technological intensity of manufacturing and exports. In the manufacturing, the share of knowledge intensive production has increased considerably from 8.57% of GDP in 2005 to 11.55% in 2009.

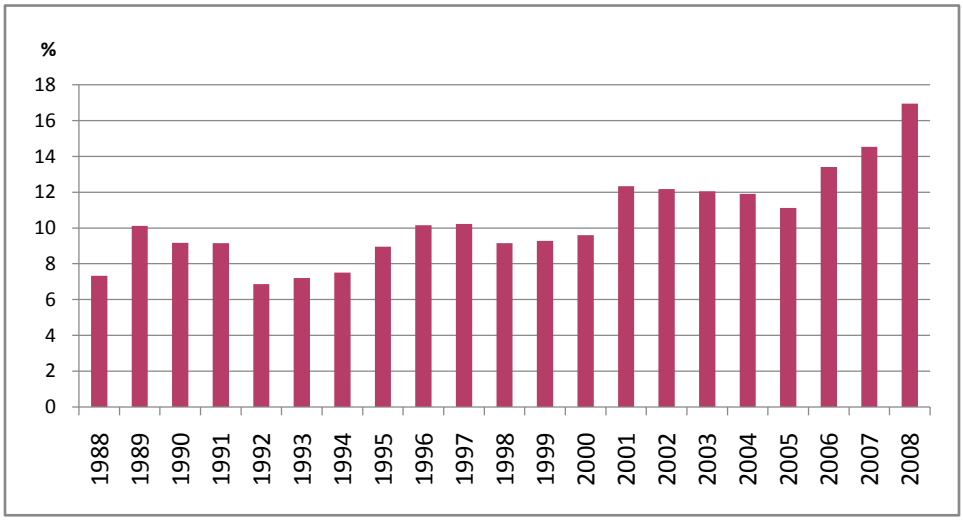
	GDP	Knowledge Intensive Manufacturing	Knowledge Intensive Services	Knowledge Intensive Production	Knowledge Intensive Production (%)
2005	29675990	1207670	1334650	2542320	8.57
2006	32491300	1454220	1651780	3106000	9.56
2007	35646270	1677740	2034320	3712060	10.41
2008	38843570	1822770	2483210	4305980	11.06
2009	41549730	1926630	2873500	4800130	11.55

Note: Knowledge-intensive manufacturing refers to chemical and metal products and machinery, including electrical machinery and means of transport. Knowledge-intensive services refer to

telecommunications and computer-related services plus R&D services. The data for 2006 exclude telecommunications, as the Central Statistics Organization did not report this information for this year.
Source: Indian Central Statistics Organization, 2010; cited in S Mani 2010

In the export of technologically intensive products from India has also doubled during a decade spanning 1998 to 2008. According to the cited study, the data may not present the true picture of technological intensity of exported products since India is increasingly diversifying its exports into services. Approximately 40 per cent of India's exports are in the form of services and within the service exports, four services IT, R&D services; Architectural, engineering and technical services; and Communications services have increased their share from 55% to 80%.

High tech content of India's Manufactured exports, 1988- 2008 (%)



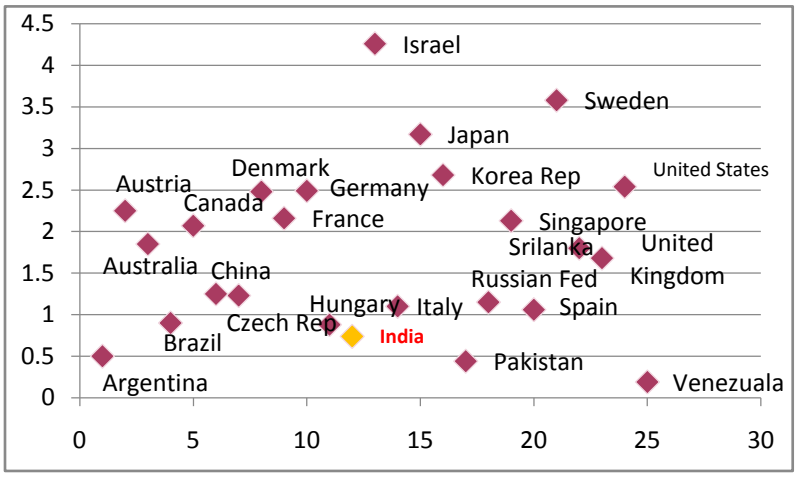
Source: United Nations Comtrade Database, applying the UNIDO (2009) definition of high-tech exports; cited S Mani 2010

RESEARCH AND DEVELOPMENT EXPENDITURES

India spends .88% of its GDP on R&D activities. Although this amount has increased from 0.62% in 1990-91 to .92% in 2007-08, it still represents a very small portion compared to China and developed nations in the world.

International comparisons of R&D expenditures of both developed and developing nations, including India.

R&D Expenditure as % of GDP for selected countries 2004-2007

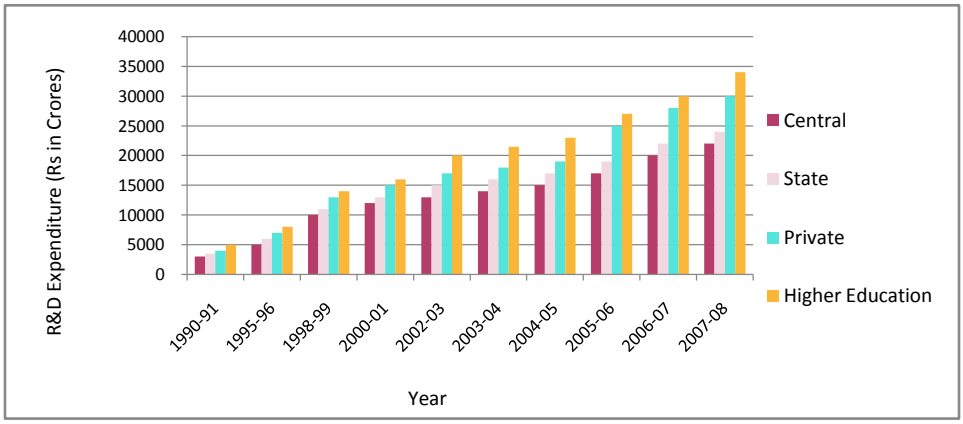


Note: The year of Information available for different countries varies between 2004-05 and 2006-07.
Source: Department of Science and Technology, Research & Development Statistics at a glance, 2007-08

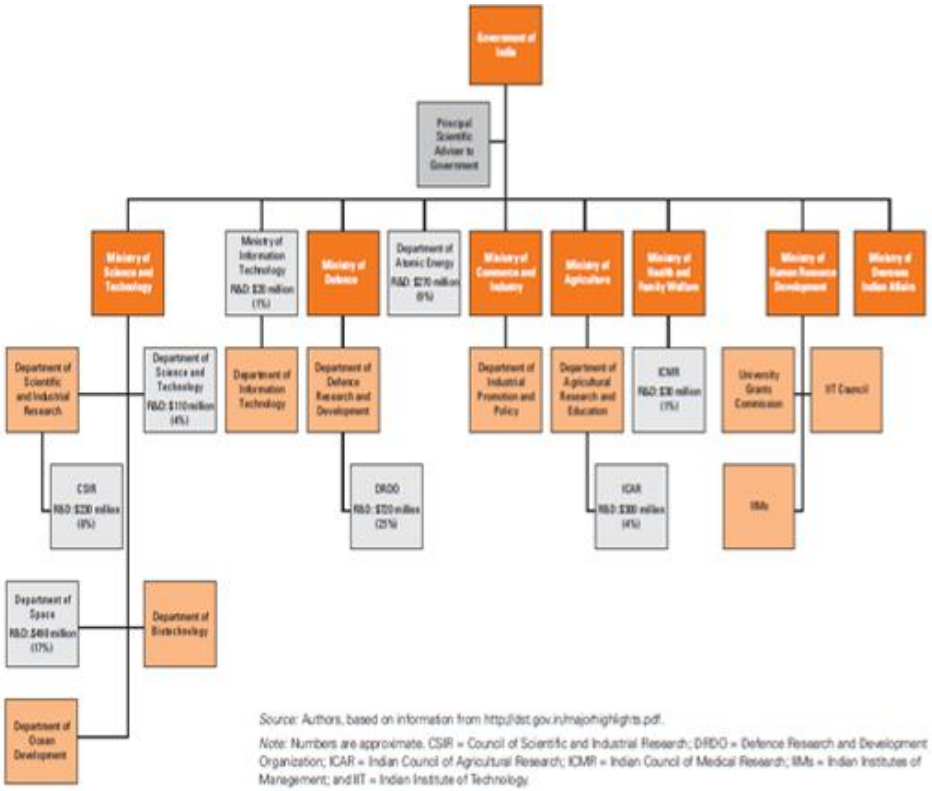
CHANNELING R&D EXPENDITURES

Since independence in 1947 until trade liberalization of 1990's the only source of financial support for innovative activities under the rubric of R&D was government of India. The government sill continues to contribute a lion's share of R&D expenditures. The central and State governments and government owned entities public sector industry combined contributed nearly 75% of the money spent of R&D activities. The higher education expenditures on R&D activities were minimal at 4.4%.

Sector-wise growth of R&D Expenditure

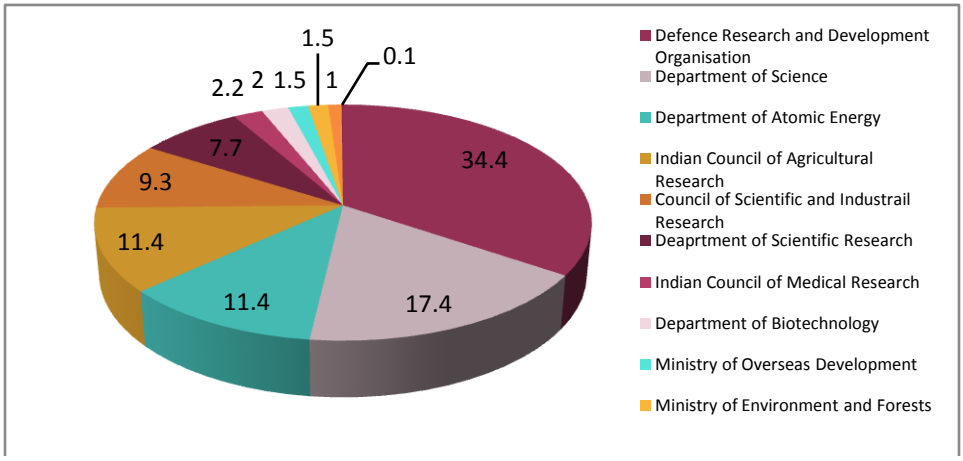


All government investments in R&D activities are channeled through government agencies such as Council for Scientific and Industrial Research (CSIR), Indian Council for Agricultural Research (ICAR), Indian Council for Medical Research, Department of Science & Technology, Indian Space Research Organization, Department of Atomic Energy and others.

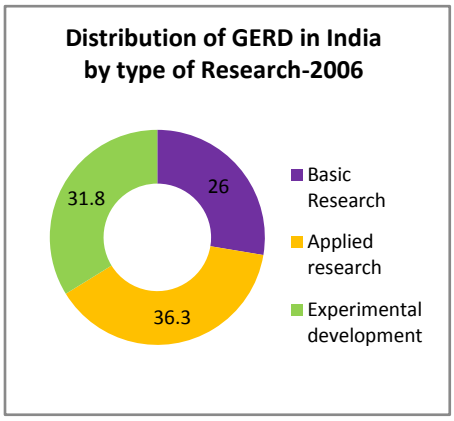


The following graphic illustrates the percentage of R&D expenditures through different government agencies. It is interesting to note where the R&D money is being spent. Applied Research receives highest amount at 36.3%, followed by, Experimental Development 31.8% and Basic Research receives 26% of the R&D money.

Fig: Government outlay for the major science agencies in India, 2006 (%)



Source: Department of Science and technology, 2009, R&D Statistics, cited S Mani 2010

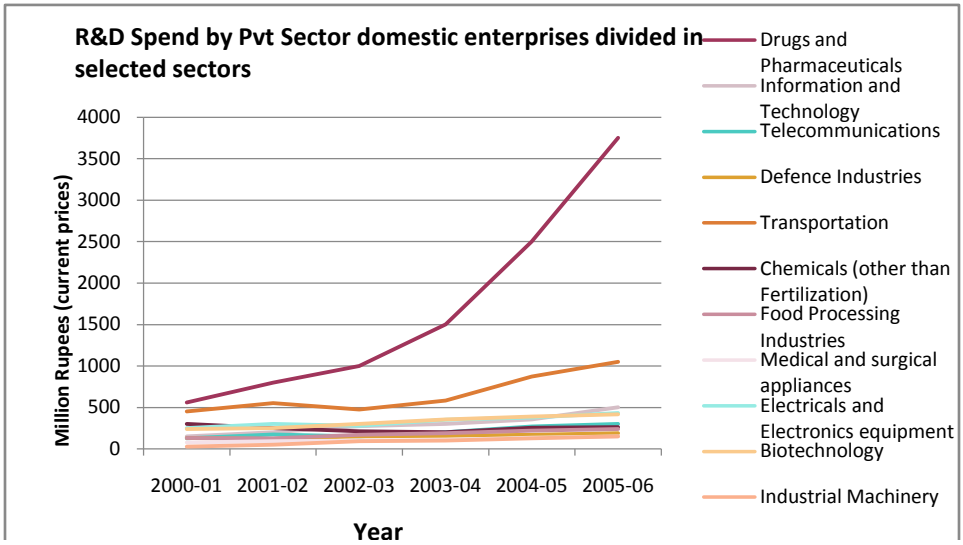


Source: DST (2009) R&D Statistics

THE PRIVATE SECTOR EXPENDITURES ON R&D

The private sector expenditures on R&D accounts for 20% of total R&D expenditures Although a small sum compared to government spending, it is substantial compared to earlier periods. Most of the private R&D expenditure is incurred in the pharmaceutical industry, which saw a fivefold increase from 2000 to 2005. This is followed by automotive industry, which increased the R&D spends from under 500 million Rupees to over a Billion Rupees.

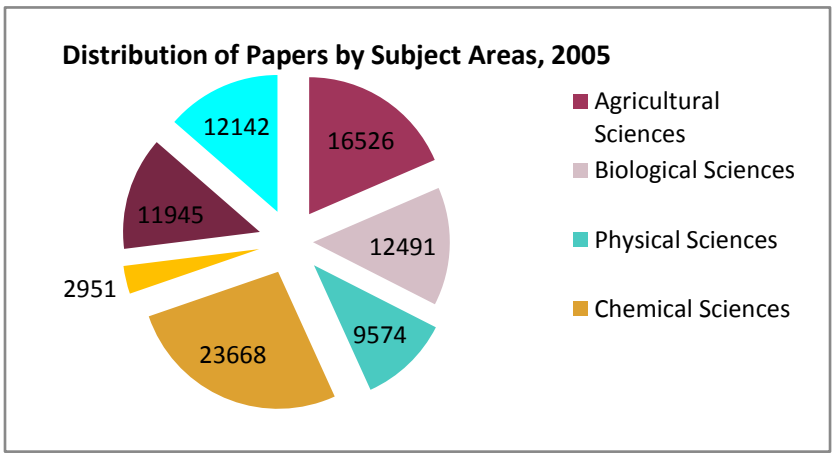
The following graph illustrates the private R&D expenditures by important industry/sector.



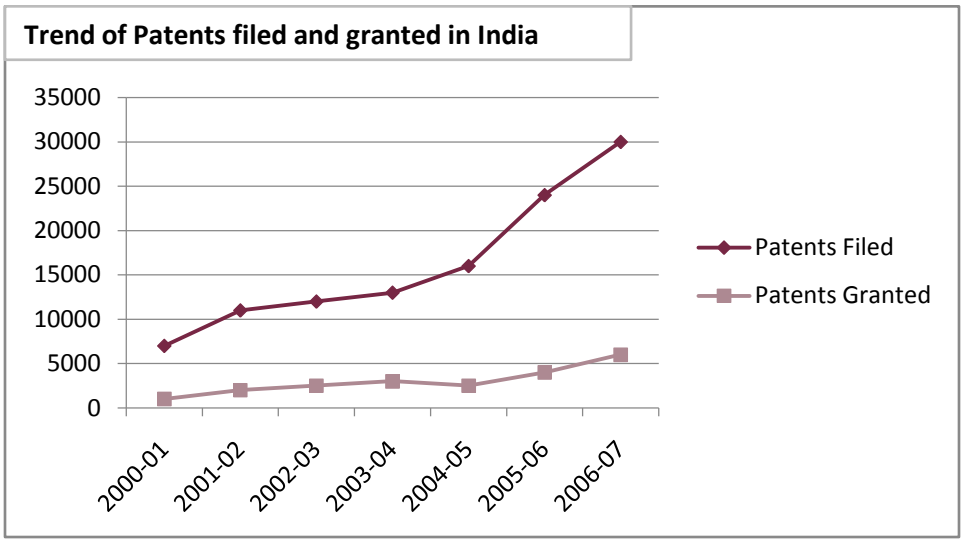
RESEARCH AND DEVELOPMENT OUTPUT

Normally the R&D Output is measured in terms of peer-reviewed publications in scientific journals and patent applications and patents granted. Along with the R&D expenditures there has been tremendous growth in the number of research publications which increased from close to 60 thousand in 2001 to 90 thousand in 2006. The maximum numbers of publications were in Chemical Sciences followed by Agricultural Sciences and Biological Sciences. Least number of publications were in Mathematics and Earth sciences.

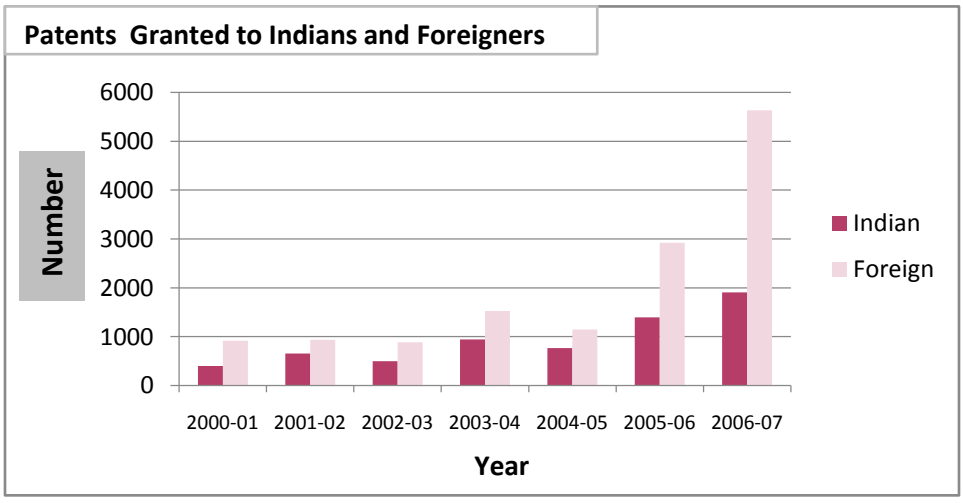
Following graph illustrates subject wise distribution of published papers.



Along with research publications patents in the area of patents too India has been making study progress. Number of patent applications increased from about 8000 in 2001 to nearly 30 thousand 2006. Number of patents granted too has increased.



However, interestingly the patents granted to foreign nationals are three terms higher than the ones granted to Indian nationals.



MULTINATIONAL CORPORATIONS ROLE IN R&D ACTIVITIES

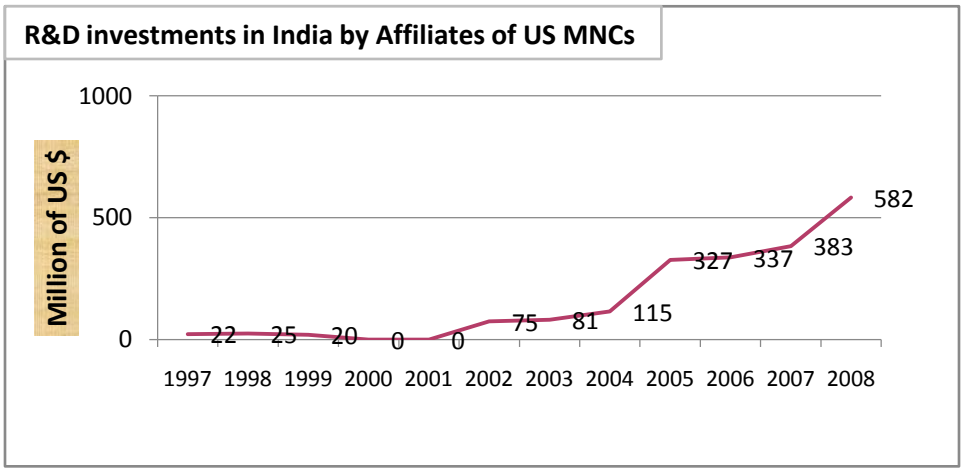
Foreign corporations R&D centers play a very important role in research and innovation activities in India. Establishment of MNC R&D centers started with Texas Instruments, which opened its R&D center in Bangalore in 1984. Since then there has been an explosion of R&D activities by the multinational corporations. There are estimated to be 851 foreign R&D centers as of 2010. The expenditures incurred by foreign R&D centers has increased from Rs. 286 million in 2002-03 to Rs 28830 million in 2009-10.

R&D expenditure by FDI companies in India (Rs in Million)

	FDI Companies	Total Private sector companies	Share of FDI companies (%)
2002-03	2860	34983	8.18
2003-04	3100	44713	6.93
2004-05	3570	60390	5.91
2005-06	5290	74442	7.11
2006-07	6680	91281	7.32
2007-08	22230	111929	19.86
2008-09	26010	NA	NA
2009-10	28830	NA	NA

Source: RBI (various issues), DST (2009)

The most active MNC in the R&D activities in India are from the US. Investments by the US MNC in R&D centers have increased sharply from 2004 onwards.



Source: National Science Board (2012)

The foreign R&D centers have been extremely active in patenting the work done in their Indian R&D centers. In total 1969 patents were granted by the US patent office to foreign companies with active R&D in India. Vast majority of the patents are in ICT and unsurprisingly most of the companies who received patents are of US origin.

Foreign MNC are also active in patenting in India. As seen in earlier graph. Foreign national received 3 times more patents than the Indian nationals. Between the patenting figures of US patenting office and Indian patenting office, it is interesting to note that most of the patents granted in the US are in ICT and majority of patents granted in India are in electronics.

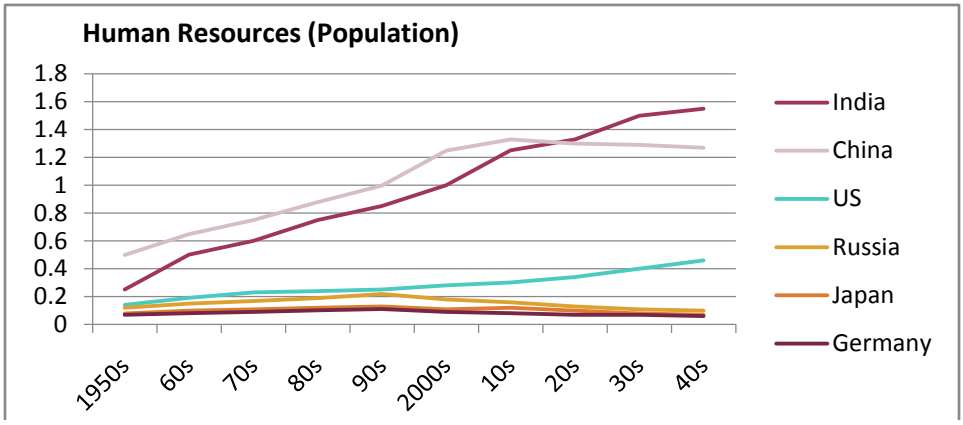
Sl No	Name of Foreign Company	Industry	Number of patents granted in 2009-10
1	Qualcomm	ICT	230
2	Samsung Electronics	Electronics	79
3	BASF	Chemicals	66
4	Siemens	Electronics	65
5	Thomson Licensing	Service	62
6	Motorola	Electronics	52
7	Philips	Electronics	49
8	LG Electronics	Electronics	49
9	Honda Motor	Automotive	47
10	LM Ericsson	ICT	41

Source: Controller General of Patents, Design and Trademark (2010)

HUMAN RESOURCES

With 17.1% world population share India is the second most populous country in the world. It is expected to surpass China in next two decades.

The following graph provide a comparisons of current population numbers and projects for next 2 decades for China, India, Russia, US, Japan and Germany.

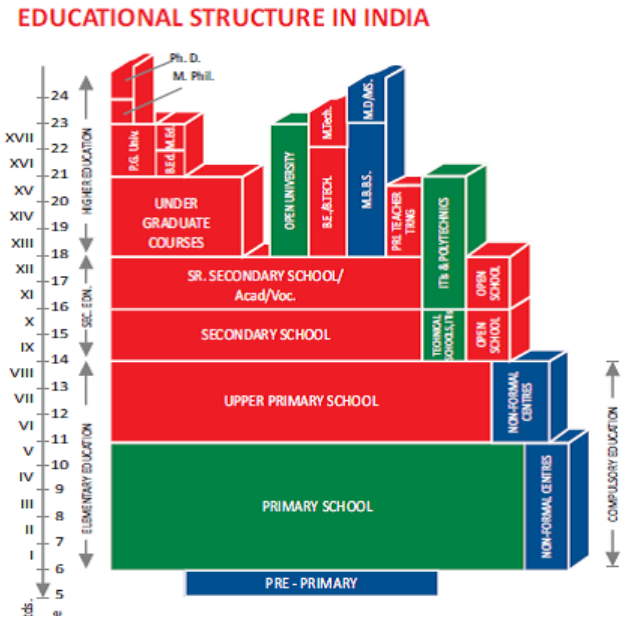


Source: US Census Bureau's Database

Some analysts consider the population as India's Demographic Dividend, especially when 50% of India's population about 600 million are bellow 25 years of age. The literacy rate in India stands at 74% of the population.

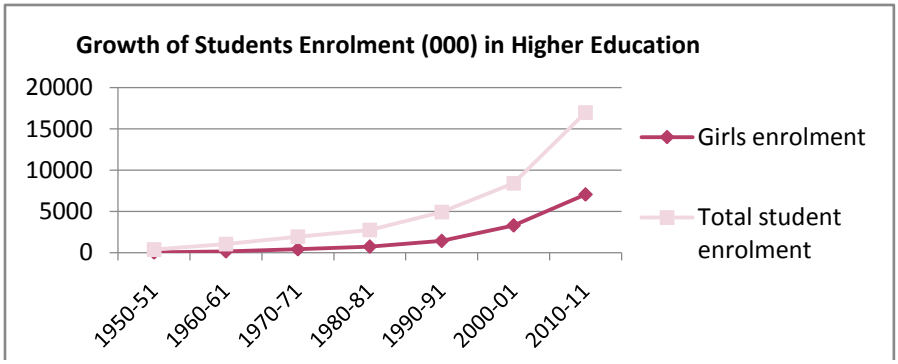
INDIA'S EDUCATIONAL STRUCTURE

Education structure in India is multi-tier. The first twelve years of education is split in 4 levels - primary, upper primary, secondary and senior secondary. While the primary education is 5 years long, the upper primary is 3 years. Secondary and senior secondary schools are each 2 years long. Following that the students have the option of either entering into 3 years long under graduate courses in science (basic science, home science, computer science, etc), arts(humanities, social sciences, languages, etc) or commerce, or they can opt for professional/technical education (engineering or medicine) which run for 4 and 5 years respectively. Upon completion of UG program, the students have the option to get into Post Graduation courses (2 years), followed by PhD.

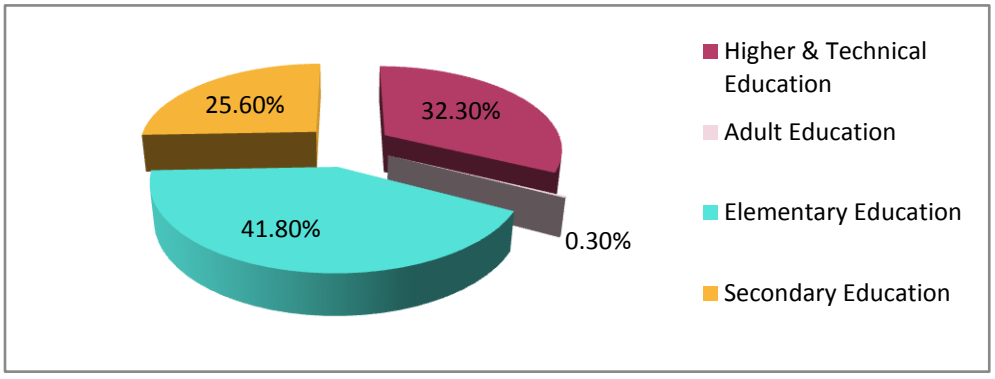


Universities and university-level institutions in India include 20 Central Universities, 215 State Universities, 100 Deemed Universities, 5 institutions established under State Act and 13 institutes of national importance apart from around 17,000 colleges including 1800 women's colleges

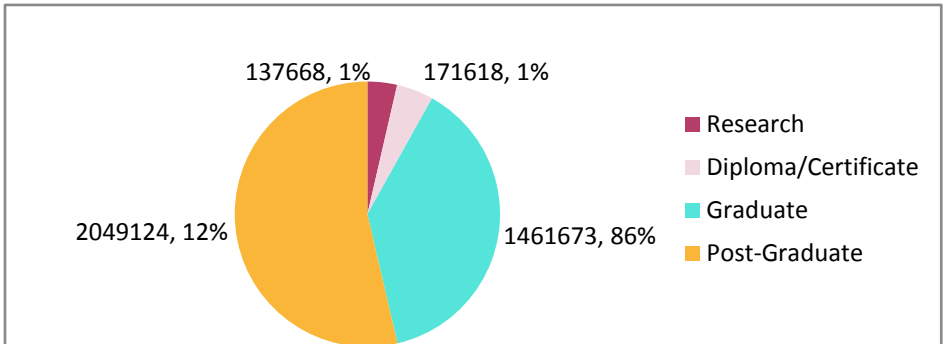
In the last decade, there has been a significant rise in enrollment at all levels. As per a 2012 summary report on higher education in India released by the University Grants Commission (UGC), the number of universities rose to 634, and affiliated colleges rose to over 33,000. By 2010, gross enrollment in the university system had reached almost 17 million (not including students enrolled in technical diploma institutes and other informal vocational institutes where overall annual intake has crossed 1 million). Engineering enrollment was roughly 2.8 million in 2010 although first year engineering enrollment touched a million in 2012. 38% of students were enrolled in different branches of science, engineering, medicine and agriculture.



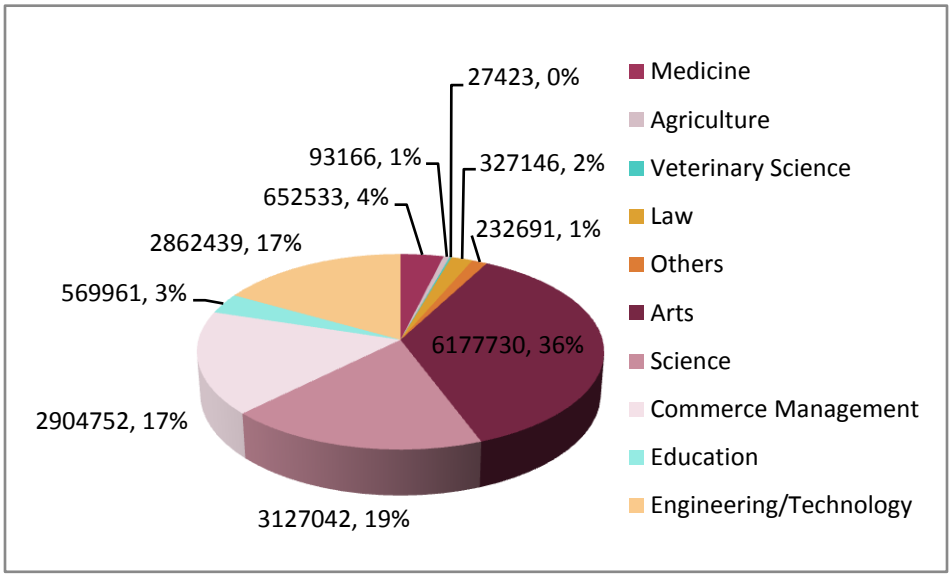
In 2010-2011, public expenditure towards elementary education is the maximum (42%); reason for this could be attributed to the importance given by the government towards "right of child to free and **compulsory education act**", 2009. Government of India's emphasis towards knowledge capital building is explained by their increased expenditure towards technical and higher education, which stands at 33%.



In the academic year 2010-2011, 86% of students who passed out of secondary education level enrolled for undergraduate courses. However, at the postgraduate level, the enrolments saw a sharp decline at just 12%. They reduced even further, to a meager 1% for research and PhD courses. Vast job opportunity for degree holders with lucrative salaries offered by private industries and MNCs could be one of the reasons why students take up jobs soon after college.



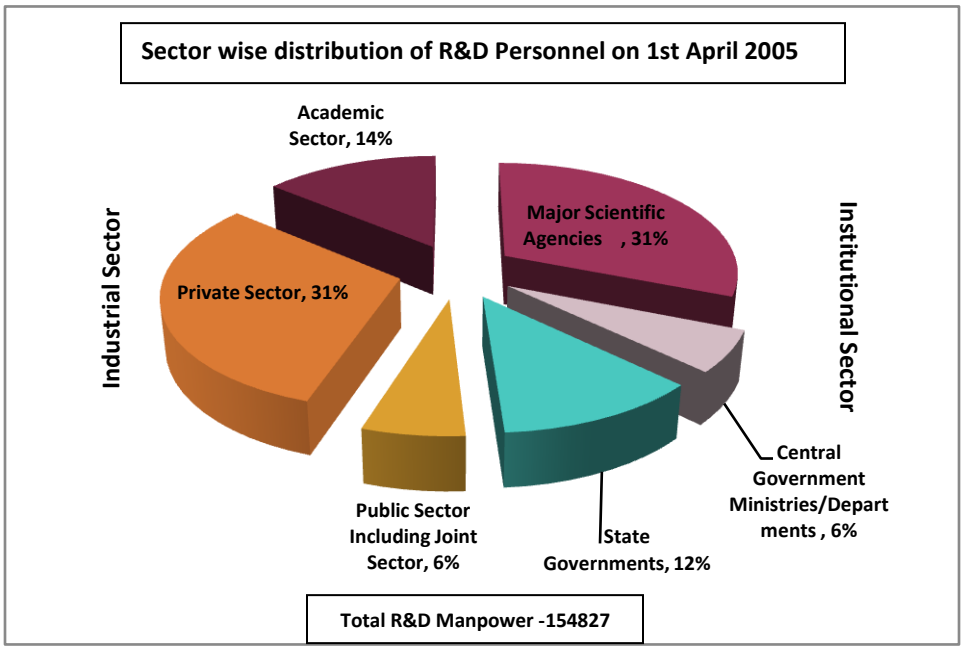
72% of the total enrolment has been in the three faculties of Arts, Sciences and Commerce & management, while the remaining 28% in the professional courses with engineering and technology recording the highest percentage (close to 3 million enrolments), followed by medical courses. However, agriculture, which is one of the main occupations in the country, saw minuscule enrolments at 0.5 %.



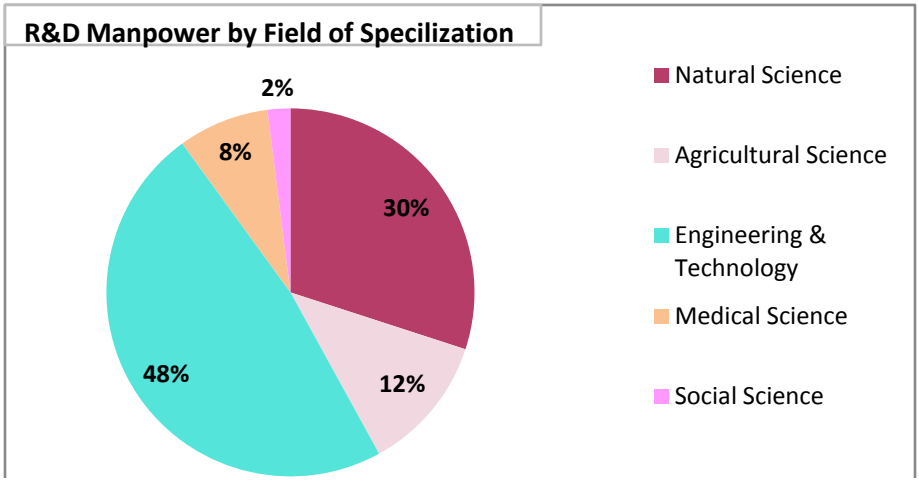
The Faculty of Arts records the highest number of Ph.D degrees at 34%, followed by the faculty of Science at 31% in 2010-2011. These two faculties together account for 65% of the total number of research degrees awarded. In the professional faculties, the faculty of Engineering & Technology has topped with as many as 1007 Ph.D. degrees, followed by Agriculture, education and medicine faculties at 573, 469 and 337.

R&D WORKFORCE IN INDIA

As of 2005 there were over 150 thousand people engaged in R&D activities in India. Of these roughly 63% were working in the institutions, academia as well as publicly supported R&D organizations and 31% in the private sector. Over 50% of those working on R&D activities have post-graduate or higher degree and the 30% graduate degree. Remaining are diploma holders. Of the total R&D the public institutions employed 76% of the PhD and 50% of post-graduates.



It is interesting to observe the subject and sector wise distribution of R&D personnel in India, because it correlates with industry sectors with most active innovation activities. Engineering and Technology has the majority share with 47.6% of the total personnel in R&D followed by Natural Sciences 29.8% and Agriculture 12.1%. The industrial sector employed 53% with Engineering & Technology specialization and 27.5% with advanced degrees in Natural Sciences. The R&D institutions, on the other hand, employed 32% of R&D personnel with Natural Sciences specialization and 19.6% with Agricultural Sciences degrees.



Despite a large number of well-educated Indians, the number of people engaged in R&D activities is small. Compared to China, it is less then half and among the people working in R&D those who are engaged in research activities is even smaller.

CONSLUSIONS

Over all India Innovation Landscape is an uneven and rugged terrain. There are peaks of success and valleys of depravity. Although there have been remarkable innovations of quality and low cost their mass impact is yet to be visible, especially given that India possesses huge population. In economic terms, India has had impressive growth story, but this growth has been uneven and has not reached all sections of the population. In terms of innovation inputs such as infrastructure, investments and others India continues to lag behind China and western nations. The innovation output is also not remarkable; however India is a very good in Innovation Efficiency. Despite the challenges, India continues to be a preferred destination for MNC R&D centers, which are utilizing local talent to support their research activities.

3. FUTURE OF INNOVATION: POLICIES &INITIATIVES

The Indian Government declared 2010-20 as "Decade of Innovation." In order to realize the decade of innovation by defining and driving an ambitious agenda the government established the National Innovation Council (NIC) under the Chairmanship of Sam Pitroda. The council members include well-known people from corporate and social sectors and the academia.

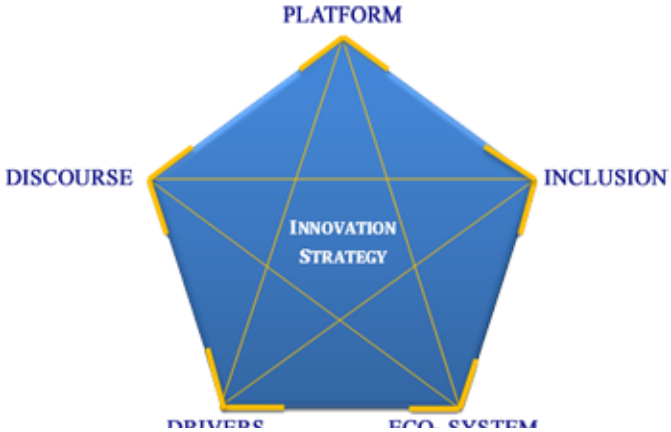
The government of India spends large amount of money on R&D activities channeled mainly through several different government agencies and departments, each with its own objectives and priorities that are often overlap and contradict. The policy maker believe that the government could do more by becoming an enabler of an innovation ecosystem and develop a comprehensive strategy for knowledge creation diffusion application, and commercialization, development of skills and education, re-engineering of processes and service delivery methods, and to address information infrastructure needs along with finance. The preeminent focus of this innovation strategy is on Inclusive Innovation, to meet the needs of India and its challenges of demography, disparity and development.

NATIONAL INNOVATION COUNCIL: INCLUSIVE INNOVATION

Innovation is often discussed and used as a tool for gaining competitive advantage for commercial enterprises. However, innovation cannot simple be an instrument of commercial advantage, especially in a nation like India where hundreds of millions of people live without the basic services such as food, water, housing, health and education. In this context innovation can be an important device to solve challenges and create sustainable growth. The NIC innovation approach intends to extend beyond R&D, products, patents and focus on inclusive innovation for the people at the bottom of the pyramid to find affordable, quality services & products and create mechanisms&platforms that can scale grassroots innovations to generate sustainable livelihood and employment.

THE INNOVATION STARTEGY

The role of NIC is to serve as a forum to bring together multiple stakeholders to create an inclusive innovation movement in India. The NIC's innovation roadmap for 2010-20 focuses on 5 key parameters: **Platform, Discourse, Inclusion, Drivers and Eco-System**.



1. Platform

Develop a broader platform that facilitates application of technology to create innovative products, services, processes, organizations, governance methods, research &development and social & cultural mindset. The focus is on creating policies at the Government level, which would then have a cascading effect in fostering an innovation economy.

2. Inclusion

India is a nation of contrasts not only in the social, cultural and linguistic dimension but also in economic sphere. On the one hand the country's GDP is growing at an average of 8-9 % per year, and on the other hand there are 300 million people living below the poverty line with insufficient access to services such as food, health, power and education. The objective of an innovation strategy is to bridge this divide to generate inclusive growth with sustainable and quality solutions that employ innovation as a tool. The focus is on more 'frugal innovations' that produce low-cost safe, efficient, and useful products that are affordable at low levels of incomes.

3. Eco-system

A strong innovation eco-system is critical for creating an innovation society. An innovative eco-system must facilitate the conception of new ideas and also provide platforms for the successful exploitation of these ideas. In this ecosystem dynamic interaction within and across multiple players such as Government, firms, schools/education and research institutions, finance, individual innovators, customers/users, NGOs and media is essential.

4. Drivers

A successful innovation strategy that benefits the needs and challenges of the Indian system must be driven by some key ideas and goals.

- Should be multidisciplinary and collaborative
- Focus on Generational Change vs. Incremental Change
- Support durability as opposed to disposability
- Should address the needs vs. demand dichotomy
- Create environmentally sustainable and locally relevant solutions
- Globally competitive solutions that us global resources.

5. Discourse

The NIC Innovation strategy aims to expand the discourse of innovation in order to give room to alternative dialogue. The aim is to involve many divergent voices, views, mode of doing things to impact the end result qualitatively and quantitatively.

The impact of this five-pronged strategy would result in

- Democratizing Information
- Identifying and empowering domain experts at National, State & District levels
- Ensuring institutional autonomy, freedom, flexibility, accountability and transparency
- Increasing community and public participation at all levels
- Improving Governance & Planning

Budhaditya Chattopadhyay invents artificial kidney

Budhaditya Chattopadhyay, a medical electronic engineering student from Dr Ambedkar Institute of Technology, Bangalore, has come up with transplantable artificial kidney (TAK).

Once people reach the end stage of renal failure, frequent dialysis and kidney transplantation is the only way out.But, the non-availability of matching donors and the complexity involved with regular dialysis have left patients with less chance of survival chances.Chattopadhyay decided to devise a treatment which would filter blood like a natural kidney.Chattopadhyay devised a machine called the Transplantable Artificial Kidney (TAK); which can be implanted in the body.

Transplantable Artificial Kidney can efficiently perform all the functions like original kidneys in respect to its excretory and homeostatic functions with lasting effect for about 18 years. A battery to support the TAK has to be worn around the waist supported by a kind of belt." The product will be launched in several phases like basic cost effective haemodialysis, home dialysis, pocket dialysis and implantable transplantable artificial kidney."TAK is slightly larger than natural human kidney and patients with either both or single malfunctioning kidneys can undergo the transplantation," he added.The system provides round-the-clock purification of blood, just like natural kidneys, thus keeping down the toxicity level in cells due to metabolic waste.

THE NATIONAL INNOVATION COUNCIL INITIATIVES

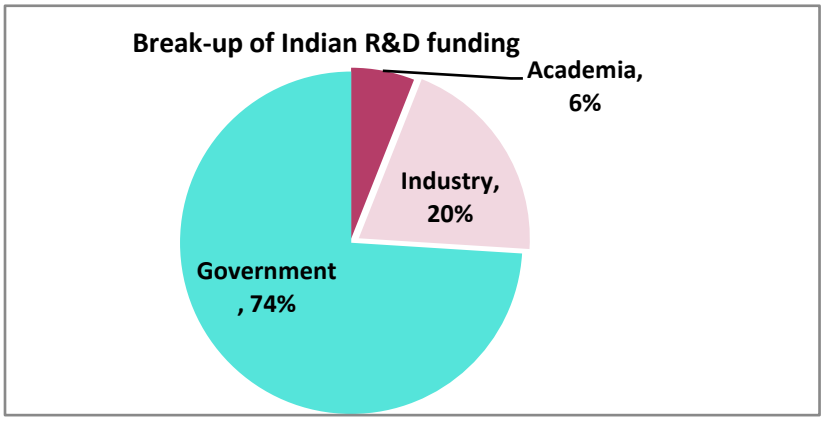
As articulated above, the aim of NIC is to redefine innovation looking beyond the research and Development (R&D) to new and creative solutions for inclusive growth. With the view of realizing its vision NIC has undertaken major initiatives, which include:

1. **India Inclusive Innovation Fund:** A billion euro fund to invest in world-class enterprises engaged in developing products and solutions for the problems of poor.
2. **Sectorial Innovation Councils:** Aligned to central government ministries to enable innovations within the sector.
3. **State Innovation Councils**: For each of the states and union territories to create an innovation ecosystem in the state.
4. **Industry Innovation Clusters & Cluster Innovation Centers**: To bring together different stakeholders for collaboration and promotion of innovation
5. **Innovation in Education & University Clusters:** Enable innovation in creativity in education system and create university clusters as hubs of innovation.

INDIA INCLUSIVE INNOVATION FUND

One critical support required to translate innovative ideas into tangible products and services is finance. There is need for both private and public funding organizations and individuals who are willing to take risks fund the new enterprises.

Most of the money for innovation in India comes from the government and is channeled through various government agencies. Despite recent spike in private industry investment in R&D government accounts for two thirds of the expenditure on R&D.



Source: R&D Magazine Dec 2009, Indian Dept of Sci & Tech

Availability of Venture Capital (VC) is relatively new for India. Only since 2005 there has been significant amount of VC funding flowing into the country. Although VC investments stand at 1.5 billion in 2011 it is a paltry sum compared to the investments by VCs in the US or other developed countries.

Normally, VCs tend to look for high-growth and high-return opportunities to fund. As a result enterprise, which may have larger social impact, but with lower returns do not attract the VCs interest. In order to overcome this inherent lacuna in the financial dimension of innovation eco system the NIC has established a billion euro India Inclusive Innovation Fund.

The fund is focused on investing in startups that provide solutions and products to meet the needs of the poor citizens at the bottom of the socioeconomic pyramid. Targeting mainly core sectors such as education, healthcare and agriculture, the India Inclusive Innovation Fund has 4 objectives:

1. Focus on India's poor. Invest in companies and startups that are providing solutions to the problems of India's 500 million poor.
2. Combine Social and Commercial returns: The fund will invest in for-profit entities with social impact so that there is a healthy return on investment.
3. Drive Employment and Livelihood Generation: Fund enterprises that generate employment for the poor.
4. Establish a Model for Wider Inclusive Innovation Funding: By investing in social focused commercial enterprises become models for other funds to follow.

The India Inclusive Innovation Fund structured as a autonomous and professionally managed entity has ten-year duration with 20% of the USD 1 billion contributed by the government and the remaining 80% from private sources, philanthropists, and bilateral and multilateral institutions.

The fund will source investment opportunities for direct investment in social enterprises through open broadcast; seek early and mid-stage investment prospects through Angel and Venture capital networks; Community Organizations such as NGOs and non-profits as a source for entrepreneurs and enterprises with social impact focus; and invest through or co-invest with other funds that are concentrating on social enterprises.

The Ministry of Micro, Small and Medium Enterprises (MSME) and sanctioned 100 crores as seed money and the fund is expected to be fully operational by the end of financial year 2012-13. An active search is on for the CEO of the fund.

INNOVATION CLUSTERS

For innovative ideas to germinate and to grow into meaningful products and services there is need for an ecosystem of interconnected knowledge banks, financial institutions, industry, support systems and others that are located in geographical proximity. These innovation ecosystems are known as clusters.

The most well known cluster of successful innovations in the world is the Silicon Valley in California. Clusters of similar nature have emerged in other parts of the world such as Cambridge cluster in UK, biotechnology clusters in Sweden and Switzerland.

In India, although there are concentrations of industry such as diamond cutting in Surat, there are no such clusters that act as hubs of continuous development of new products and services. In last 10-15 years cities such as Bangalore, Hyderabad and Chennai have emerged to function partly as clusters, but none can match the capability or productivity of Silicon Valley, especially in the area of innovation.

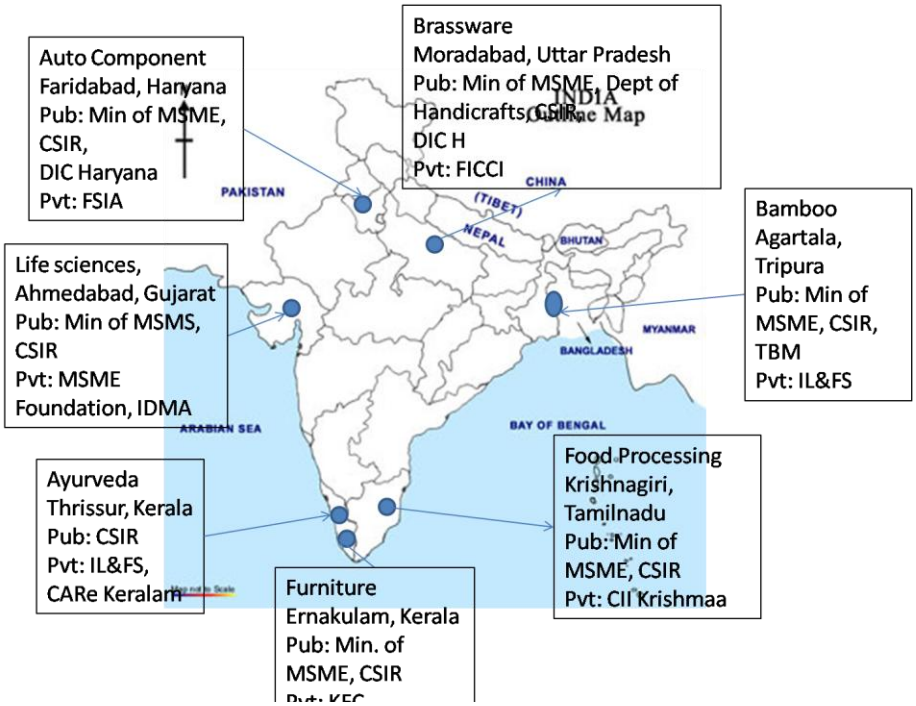
Recognizing the critical role played by the cluster in fostering and sustaining innovation the NIC is actively pursuing the development of The Cluster Innovation Centers (CIC) with the responsibility of promoting collaboration by brining together various stakeholders, including the government agencies, research institutions, industry, academia, professional service organizations and local players. The CICs exist in physical spaces or as virtual entities that are staffed by dedicated individuals who will be responsible for carrying out the activities of CICs.

The CICs are entrusted with there critical roles:

1. The Connector: Function as a hub for networking and sharing the internal units of the cluster as well as the external organizations of the industry
2. The Innovator: Act as a catalyst for innovation and manage the day to day activities in the cluster
3. The Channel: Facilitate resource delivery to innovation, including research and development, financial support, expertise and others.

In 2011-12 financial year NIC seeded 7 CICs in different parts of the country covering different industry segments.

The following graphic illustrates the details of the pilot CICs and their activities.



Automatic Food Making Machine: By Abhishek Bhagat

Abhishek Bhagat of Bhagalpur, Bihar created an automatic food making machine. He conceived a rough idea about a machine, which would have boxes to hold different ingredients of a particular recipe. The machine would be operated using a recipe card, which will be programmed as per the cooking style of the person for that particular dish. He took help of his Physics books and using a normal watch, he designed a card, which could be programmed. The first version of this machine made successfully in 2009 could make tea and kheer (kind of rice pudding).I be programmed as per the cooking style of the person for that particular dish.

The contraption contains 12 boxes of different ingredients, with a display screen to select options to cook different items. The required quantity of each ingredient will be fed into the machine in the sequence and one has to be preplanned to cook the desired dish. This machine has lessened the efforts of human beings. Christened `Kitchen King', the gadget is powered by electricity and has a capacity to prepare dishes that require a maximum of 12 ingredients. There's a card with which the order can be placed. For now, Abhishek has prepared three cards, each separately equipped to order this innovative machine to make tea, fry flattened rice and prepare `chhole'.The inspiration to design the machine came to Abhishek from home when he was helpingmother in kitchen sometimes.

AUTOCOMPONENET CLUSTER, FARIDABAD HARYANA

Faridabad auto components cluster is located in Faridabad district of Haryana State. The cluster comprises of 2500 small and medium sized firms (SMEs) with around 10,000 workers. Major products of the cluster include sheet metal, rubber and plastic components, and major markets are Delhi, Haryana, Maharashtra, Tamil Nadu and Uttar Pradesh. Faridabad industries association and Bata Chowk are two large associations connected to the cluster. Technical institutions, R&D labs and testing labs associated with the cluster include DIC (District Innovation Centre), Faridabad, Government Industrial Training Institute, Faridabad, MSME-DI, Okhla, New Delhi and MSME-TC, Okhla, New Delhi.

With an annual turnover of 32,500 million rupees, the Faridabad cluster was chosen by the National Innovation Council as one of the Pilot clusters for promotion of innovation. NInC has allotted two public entities - Ministry of MSME, CSIR and DIC (District Innovation Centre), Haryana and a private entity, FSIA (Faridabad Small Industries Association) as collaborating partners for the Faridabad cluster.

A cluster Management Committee has been constituted under the chairmanship of Deputy Commissioner, Faridabad, to enable innovation around existing industries in Faridabad. A grant of Rs 1 crore per district as District Innovation Fund (DIF) will be released in two installments between 2011 and 2015.

NInC has proposed the following two innovation initiatives for the Auto component cluster

- Information hub for SMEs in the region
- Common design centre

Institutions like SIDBI (Small Industries Development Bank of India), TiE (The Indus Entrepreneurs) and CSIR will collaboratively implement these proposed initiatives during 2012-2013.

PHARMACEUTICALS CLUSTER, AHMEDABAD, GUJARAT

The evolution of the drugs and pharmaceutical cluster at Ahmedabad, Gujarat started off with the establishment of the first unit – Alembic Chemical Works Ltd at Vadodara way back in 1907. A phenomenal growth of small firms took place during the 1970s and 1980s. This phase was further strengthened as a result of growing exports to Russian and African countries. During this growth process, a few first generation entrepreneurs graduated from small to medium/large firms and some later entrants became sizeable medium enterprises. This growth phase in turn saw further entry of new entrepreneurs in the small scale sector.

There are now around 450 drugs and pharmaceutical manufacturing units in Ahmedabad, Vadodara and nearby areas. Seven firms in the clusters are big, around 20-25 medium-sized and the rest are small. The major products manufactured in the cluster include (a) pharmaceuticals— both allopathic and ayurvedic formulation, in different dosage forms (including tablets, liquid, capsules, externals and injectables) and (b) medical disposable products like IV sets. Around 50 manufacturing units produce medicaldisposables and the rest are in formulations including ayurvedic products.

The Ahmedabad cluster has a strong manufacturing base for active pharmaceutical ingredients (APs), formulations, biological and contract manufacturing. Leading pharma companies in Ahmedabad include Cadila Pharmaceuticals, Dishman Pharmaceuticals, Intas, Zydus Cadila, Torrent, Concord, among others.

The development of the Ahmedabad pharmaceutical cluster has been actively supported by various technical training institutions, industry associations and Government agencies. The presence of technical training institutions like the L M College of Pharmacy and the B V Patel Pharmaceutical Education and Research Development (PERD) Centre have ensured the consistent supply of skilled manpower essential for this knowledge-driven industry.

Cluster approach based Innovation promotion initiatives at Pharmaceutical cluster of Ahmedabad have resulted in institutionalization of a one year, partially self funded Techno-Bio-preneur program for mentoring aspiring life science technology based entrepreneurs. This is first such programme in the country among Entrepreneurship Development Institute of India, Gujarat State Bio Technology Mission and Foundation for MSME Clusters.

The project has also strengthened a physical facility for preservation of new chemical molecules at Rajkot University. It has been connected to 10 universities and has collected 2500 indigenously made molecules of which 1500 have been screened and a select few already sold commercially leading it to sustainability. Two innovators have got partial funding support and have been connected to other resource agencies. Besides, to promote and celebrate creativity & entrepreneurship in the cluster, innovation recognition awards like best M. Pharma Thesis Award (pan India) and Sushruta Innovation Award for medical devices have been conducted and institutionalized locally. Besides more than 100 proven ready to commercialize technologies from private and public technology sources have been identified and disseminated among innovation led entrepreneurship through road shows among various Pharma clusters. Training programs on Intellectual properties, new drug delivery systems (NDDS) etc. have been undertaken for awareness creation. These initiatives have also led to formation of interconnections among relevant stakeholders.

STATE AND SECTORIAL INNOVATION COUNCILS

With multiple regions, states, languages and multiple and overlapping administrative agencies, India is a very complex nation. Although a central driving force such as National Innovation Council is critical for driving an agenda as ambitious as innovation, the efforts need to be echoed throughout the system for them to have a meaningful impact. In order to amplify at every level its agenda, National Innovation Council is setting up State and Sectorial innovation councils. While the State council focus on innovation policy initiatives and creation of ecosystem in each state and Sectorial Council will be aligned to each central ministry.

State Innovation Councils

The state innovation councils in each state are modeled after National Innovation Council. They will drive the innovation agenda in a state across different sections of the society by bringing together on a single platform. The State Councils will organize educational and awareness events on innovation, map innovation opportunities in the state, network local educational institutions, MSME, R&D institutions and local talent, and input into national Innovation Roadmap.

Sectorial Innovation Councils

The Sectorial Innovation Councils will drive the innovation agenda within an industry sector. They are responsible for harnessing the core competencies, talent, resources and

capabilities to create opportunities for innovation and provide input to Innovation Roadmap.

Both the state and sectorial innovation councils are lean and flexible bodies with 7-11 members with representation from all stakeholders. Even though the councils are setup under the aegis of the government they are autonomous and have the mandate to incorporate voices from outside the government.

22 states and 24 sectorial councils have been constituted.

INNOVATION IN EDUCATION AND UNIVERSITY CLUSTERS

In order to have a broader and deeper impact of innovation in the economy and society at large it is important to have innovative and creative educational institutions. In India, educating large and growing population, majority of who are bellow the poverty line, is a challenge that requires innovative solutions. Hence education is not only important for creating an innovation eco-system, but education as a sector is also a fertile ground for innovation.

Recognizing the fundamental role of education in nurturing and fostering an ecosystem of innovation the National Innovation Council is engaged in a series of initiatives to encourage innovations in existing educational institutions – universities, colleges and schools, as well as promoting new educational models and innovative platforms for knowledge creation, dissemination and application.

National Innovation Scholarships

National Innovation 1000 Scholarships a year awarded to talentedchildren at the High School and Secondary School level (Classes 9-12) who think creatively, laterallyand innovatively on issues that they perceive as important. Under this scheme 50% of the scholarships are earmarked for innovations by students in schools located in-urban areas and at least 33% are earmarked for children from the field of liberal arts.

Innovation Centre in each DIET - District Institute of Educationand Training

NInC has proposed creating an Innovation Centre in each DIET. A District level Innovation Centre will pool in the best teachers in Math, Science and Social Sciences to lead innovation in the schools of the district. They will develop modules for teacher education, talent spotting andimprovise on curricula for activities that promote innovation and so on.

Mapping of Local History, Ecology and Cultural Heritage

Instead of learning in the classroom, once a week in a year, the students will learn from the society about their local economy, local ecology, local history and local cultural heritage. Students, assisted bya volunteer teacher, follow a structured format to undertake a tour of the village around the school. The purpose is to piece together local history, local ecology, map local bio-diversity, local culture, and heritage. The value of this exercise is to create societal engagement for students and give them an understanding of their rootedness in their local context.

A Meta University

Creating a Meta University, as a new model for a 21st Century University where a network of institutions riding on the National Knowledge Network come together to offer students a collaborative and multidisciplinary learning experience. The Meta University will reinterpret the concept of a University as not just a traditional, physicalspace of learning, but as a repository of knowledge and information that can be delivered in multiple ways, and can be accessed from anywhere and anytime. It will seek to enhance the learning experience through new and innovative delivery models of education that allow students and institutions to collaborate in unprecedented ways.

20 Design Innovation Centers:

Setting up twenty Design Innovation Centers co-located in institutes of national importance to ensure maximum convergence, optimum utilization of existing resources and infrastructure, and to leverage a context of academia-industry interaction.

Cluster Innovation Centers (CIC) at Universities

In order to make Universities hubs of innovation the Cluster Innovation Centers (CIC) will be created at universities/institutions of national repute. This will foster an ecosystem of innovation, and connect research with application for the benefit of society. The CIC will provide a platform for the university and its partners to forge linkages between various stakeholders from industry and academia, initiate and assist innovation activities, encourage innovations in curricula and act as a catalyst and facilitator. The CIC will provide a range of services and facilities including,

- Evaluation of ideas for their innovation potential
- Advice on technical and commercial viability
- Guidance on IPR issues
- Assistance on relevant financial schemes and grants
- Help innovators find partners and collaborators including funding, business development
- Market the products and processes to end-users.

CONCLUSIONS

The establishment of NInC is a move in right direction for government of India, especially given that 2010-20 has been declared as a "Decade of Innovation." NInC indeed has a very ambitious agenda and an aggressive timeline. Since its inception, little over a year back, NInCs track record in defining the roadmap, identifying the programs and get them started has been impressive. Nevertheless, there are several risks and extremely difficult challenges. To begin with, NInC, despite its enlightened leadership aggressive business approach, continues to be a government body and several of its initiatives need to work across multiple government departments and agencies, which tend to be bureaucratic and slow. The government initiatives with large financial outlays tend to attract sectarian interests, and lead to corruption. As a result, much needed financial resources may not reach the programs that would have greater impact. Even if NInC partially overcomes the challenges and succeeds in creating innovation mindset across India its efforts will transform India into an innovation powerhouse.

TechHB Anaemia testing kit

Anemia is a major and completely preventable cause of deaths in childbirth in many places around the world, but the standard test is invasive and slow. Mr. Myshkin Ingawale and his team (Dr. Yogesh Patil, Dr. Abhishek Sen, Dr. Darshan Nayak and Mr. Aman Midha) created a simple, portable, low-cost device that can test for anemia without breaking the skin.

Mr. Myshkin Ingawale first heard about the problem from friends who worked as young doctors in remote areas of India. "One in five deaths among pregnant women was traced due to anemia". Mr Ingawale decided to put his technology background to the test and come up with a solution that would be easy for healthcare workers - often untrained - to use in the field. A similarly non-invasive device was perfect for his needs because healthcare workers in India are often not trained to conduct blood tests using needles. A hand-held, battery-operated device that can measure haemoglobin levels without the prick of a needle known as TouchHb, it comes with a probe into which the finger is inserted.

ToucHb is a platform technology: ToucHb is a hand-held needle-free battery operated device that enables screening for anaemia and simplifies monitoring of treatment on a regular basis. It democratizes healthcare by empowering health workers with appropriate technology and enables them with actionable data. Screening for anemia and monitoring treatment are vital for the health of both the mother and the child, and with ToucHb, it is now possible to do this effectively, even in low resource settings. ToucHb is a portable, non-invasive, hemoglobin estimation device that gives instant readings. ToucHb can prove to be a pertinent diagnostic solution in anaemia screening and monitoring.

ToucHb has a potential to be more effective because of its noninvasive nature, which means it does not require a finger prick. It does not require any special skill to operate, so the doorstep health worker gets an objective result to take an important therapeutic decision. That is its biggest advantage, according to co-founder Patil. "In rural areas, people will proudly tell you that they have never been pricked by a needle," he says. There are no recurrent costs (needles, use of special lancets, micro-cuvettes, blotting paper etc.) other than the batteries that can be recharged and expected to last for more than 100 tests and the probe, which requires yearly maintenance. The cost per test is low and there is no bio-waste.

ToucHb will enable the doorstep health worker to keep a track of the local health and allow him/her to place request to the primary health center / village clinic for an appropriate supply of nutritional supplements.

3. EUROPEAN UNION AND INDIA COPERATION IN INNOVATION

EU-India diplomatic relations dates back to 1960s. However the Cooperation Agreement signed in 1994 paved the way for deeper political dialogues and increased cooperation initiatives. EU is India's first partner in terms of trade and investment inflows and it continues to be one of the major partners in India's economic development. Starting from 2000 annual summits, regular ministerial and expert level meetings have strengthened the cooperation impetus between the regions in all areas of mutual interest including Science and Technology (S&T).

Research cooperation between EU and India started in mid 80s, which was further reinforced with the signing of the first S&T Agreement in 2001 and extended in 2009. Science and Technology bilateral cooperation opened doors for Indian participation in collaborative research with Europe in their largest research-funding programme for science and technology development: The Framework Programme (FP).

Since its inception there were seven Framework Programmes, including the ongoing FP7. India began participating from FP6 onwards and has become the fifth largest international partner for the EU under FP7. One of the salient achievements of FP7 is India's full partnership in the International Thermonuclear Experimental Reactor (ITER) nuclear fusion project.

The solid partnership between the EU and India in science and technology as well as the political momentum provided by the EU-India Ministerial Science Conference, are now being translated into high quality and mutually beneficial co-operative programmes, projects and dialogues. India is showing a growing degree of openness on identification of mechanisms and focus areas for co-funding joint or coordinated calls for proposals with the European Union (EU).

SECTORAL DIALOGUES AND EXCHANGES

Joint Working Groups have been set up to facilitate exchanges on several subjects including Agriculture, Telecommunications and Information Technology, Pharmaceuticals and Biotechnology, Food Processing, and Environment. One of the most important cooperative programmes between India and Europe is Climate Change. The increased importance given to Climate Change mitigation and related cooperation activities was reflected when the 2008 Summit in Marseilles adopted a Joint Work Programme on Energy, Clean Development and Climate Change. Follow-up activities were confirmed at the Summit in November 2009, when the EU and India agreed to expedite cooperation activities on Climate Change mitigation, clean energy (clean coal technology, nuclear energy) energy efficiency and renewable energy (in particular solar energy).

In recent years, migration is becoming an increasingly important subject in the relationship and is covered through regular meetings in Delhi of the EU-India Working Group on Visa and Consular Issues. Ways to strengthen cooperation on migration related issues are being explored.

INDIA IN FRAMEWORK PROGRAMME 7

Since the signature of the EU-India Agreement on Science and Technology Cooperation in 2001, India has become one of the major partners of the EU in the Framework Programs for Research and Technological Development.

In FP7, EU cooperation with India has increased compared to FP6, not only because of the bottom up opening of programs but also through targeted actions, including coordinated co-funded calls. Mobility and training of researchers is another important area of development of ties between EU research institutions and India where, currently 300 Indian researchers participate in FP7 Marie Curie actions.

Between Jan 2007 and Jan 2011, Indian partners alone have received around 30M euros of EC funds, with a total EC contribution to proposals involving Indian partners amounting to around 350M euros. Of total 147 projects, 23% are in Health sector, and 13% each in environment, energy and ICT sectors. Space has received just 2 grants although space and aeronautics is one of the most innovative and promising sectors in India.

The following table illustrates the number of programs between EU and India by sectors and participation of Indian organizations in public and private sectors as well as the academia.

Type of organizations in FP7

Sectors (Thematic areas under FP7)	No. of Projects	No. of Indian organizations	Public institutions	Private	Academia
Energy	7	10	4	2	4
Environment	18	34	10	9	15
Health	33	56	14	19	23
Information and Communication Technologies	19	29	6	14	7
Food, Agriculture & Biotechnology	19	26	9	3	14
Nano material and particles	6	10	4	-	6
Science in society	7	8	5	1	2
Space	2	2	-	-	2
Socio-economic sciences and humanities	9	12	-	-	12
Transport	7	9	-	8	1
Infrastructures	7	12	7	2	3
People (Ideas)	8	8	1	0	7
INCO (International Cooperation)	5	10	8	1	1
Total	147	224	68	59	97

Source: Data compiled from EC's CORDIS partner search database

Sector wise funding received under FP7

Sectors (Thematic areas under FP7)	No. of Projects	Funds in Mn Euros
Energy	7	24
Environment	18	54
Health	33	109
Information and Communication Technologies	19	35
Food, Agriculture & Biotechnology	19	61
Nano material and particles	6	23
Science in society	7	9
Space	2	5
Socio-economic sciences and humanity	9	24
Transport	7	18
Infrastructures	7	14
People (Ideas)	8	4
INCO (International Cooperation)	5	12
Total	147	392 Mn

Source: Data compiled from EC's CORDIS partner search database, Aug 2012

EU-INDIA COORDINATED CALLS

Five EU-India Coordinated Calls for Proposals have been launched so far from 2007 to 2011.

The first coordinated call was launched with the Department of Science and Technology on computation materials science, with co-funding of 5 million euros from each side. The call attracted 25 proposals of which six have been funded. The Second Coordinated Call, launched with the Department of Biotechnology with co-funding of 3 million euros each on food, health and well-being, again attracted 25 proposals, of which two have been funded.

The third Coordinated Call for Proposals was launched with the Department of Science and Technology, on solar energy systems. This call with a co-funding of 5 million euros from each side, attracted 23 proposals, of which three will be funded.

Two Coordinated calls for proposals on Water technology, research and innovation have been launched with the Department of Science and Technology, in July 2011 with a total budget of €32m funded equally by the two sides.

BILATERAL PROGRAMMES BETWEEN INDIA AND EU MEMBER STATES

India is running bilateral programs mainly with 7 EU member states and UK in several sectors of science and technology like agriculture, health sciences, biology, forestry, fisheries, environmental sciences, engineering and technology, mathematics, educational sciences, medical sciences, etc. UK has other independent programs.

Country responsible	Number of programs	Research programs	Scientist exchange programs	Internship & Fellowship programs
Austria	11	2		9
France	15	4	2	9
Germany	11	5	3	3
Netherland	1	1		
Portugal	1	1		
Spain	5	3	1	1
Turkey	2	2		
UK	1	1		
Multilateral	3	1		2

THE FUTURE OF EU-INDIA COOPERATION

The 12th EU-India Summit held on 10th February 2012 at New Delhi laid focused on bilateral, regional and global issues. The leaders emphasized the importance of the EU-India Strategic Partnership and endeavored to reinforce cooperation in security, in particular counter-terrorism, cyber security and counter-piracy, as well as trade, energy, research and innovation.
Joint declarations were signed for

- Enhanced cooperation on energy
- Research and innovation cooperation and
- Memorandum of Understanding on statistical cooperation

The Strategic Forum for International S&T Cooperation (SFIC) aims at making Europe's international research policy towards non-EU countries more effective and coherent through enhanced dialogue and cooperation between the European Commission, EU member states and major partner countries outside Europe. The SFIC has chosen India as strategic partner country with which to start implementing its first pilot initiative. To bring the process to a higher, more comprehensive and strategic level, the SFIC decided in 2011 to work on a draft strategic agenda outlining a broader range of common challenges, objectives, priority areas and instruments for EU/MS-India cooperation for the coming years.

This policy development process received a boost at the EU-India Summit on 10 February 2012, when, at the initiative of the Indian side, a joint declaration on research and innovation was signed. The Joint Declaration aims at enhancing the scale, scope and impact of cooperation and at building an "Indo-European research and innovation partnership", with a focus on common societal challenges and enhanced synergies between India and the EU.
At a ministerial meeting took place in Brussels on 31 May 2012 hosted by the Danish Presidency of the European Union **Ministers agreed on a Brussels communiqué** which called for:

i) Jointly defining the scope and develop a Strategic Research & Innovation Agenda – a White Paper,
ii) Establishing a Group of Senior Officials (GSO) and
iii) Setting up an industry-driven India-Europe stakeholder group for research and innovation.

In parallel to the ministerial meeting over 200 European and Indian stakeholders from the public and private sectors gathered in the EU/MS-India Stakeholders' Conference in Brussels on 31 May – 1 June 2012 organized by DG Research and Innovation to discuss common challenges, priority areas and instruments to boost Europe-India cooperation in research and innovation.

At the Brussels meeting, both governments reiterated the importance of innovation-based growth strategies identified for their regional innovation initiatives – 'Innovation Union' and 'Decade of Innovation'. Creating the paths for mutual success, engaging with both public and private stakeholders in innovative cooperation actions, and leveraging complementary strengths of partnering entities from India and Europe form the key strategies. Three pillars of the Indo-European Partnership were underlined by the Ministers at the Conference: Larger scale, scope and impact; Focus on common societal challenges and Enhanced synergies between India, the European Union and its Member States.

The following crucial steps were arrived at, which would determine the development of Indo-European Partnership:

- Jointly define the scope and develop a Strategic Research & Innovation Agenda – a White Paper - on a medium to long term India-EU/Member States Partnership for accelerated sustainable and inclusive growth, and new pathways focusing on societal challenges of common interest (such as sustainable environment and water, bio-economy, agriculture, energy and transport, health, ICT)as well as covering the whole innovation chain from research to development and the deployment of innovative and affordable solutions.

- Establish a Group of Senior Officials (GSO) composed of officials from India, the Member States and the European Commission with a view to streamline the governance of Indo-European cooperation in its bid to identify the most effective mechanisms to provide solutions to major societal challenges of common interest.

- Support setting up an industry-driven India-Europe stakeholder group for research and innovation. This group could ensure effective involvement of industry and other research actors in defining and implementing the Strategic Agenda. Particular attention may be given to promote cooperation between European and Indian SMEs notably for the co-development and for deployment of affordable and innovative products and services.

- Organize a Ministerial meeting in India in 2014.

The EU India cooperation, joint projects and bilateral cooperation are of vital importance for India and EU region as a whole. With India declaring 2010-20 as a decade of Innovation and associated policy initiatives (see previous chapter) and EU's emphasis on Innovation, especially social innovation there are many mutually beneficial opportunities to jointly develop and exploit innovative products, services and processes, especially in the areas of clean energy, water & waste management.

4. INNOVATION OPPERTUNITIES IN INDUSTRY SECTORS

India as one of the fastest growing economies in the world and a large internal market across all income scales offers a tremendous opportunity for both public and private organizations from EU nations. There are risks and challenges such as slow and inefficient government bureaucracy, lengthy and time consuming regulations and poor infrastructure. However the risk out way the benefits, especially considering that in 10-15 year time frame all the investments in infrastructure, deregulations and liberalizations would have borne fruits.

Here we focus on opportunities for both public and private EU organizations for establishing innovation/R&D centers, participate in the National Innovation Council initiatives and in selected industry sectors. We offer a broad outline of each sector's current status including market trends, major developments and investments, government initiatives pertaining to each sector and innovation. The industry sectors selected are:

- Automotive
- Aerospace
- Pharmaceuticals
- Transportation
- Energy
- Water and Wastewater Management

These sectors have been selected because of their importance in sustaining India's growth. The sectors included here represent an opportunity for innovation, especially the social and inclusive innovation agendas. For example, providing clean and potable water to hundreds of millions of India's at low cost; efficient management of water and wastewater treatment for sustainability; offering green energy and efficient public as well as private transportation at an affordable cost. Similarly, delivery of drugs and health care to millions who lack and require care at reasonable costs needs social and inclusive innovation approach to arrive at solutions. The Automotive sector is included here as a success story of deregulation and liberalization because of which the entire industry has transformed leading to explosive growth in last decade. The Aerospace on the other hand represents one of the most regulated, especially the space sector. However, indigenous and innovative India's Space sector provides and example of India's capability to achieve global recognition and standards.

LOCATING INNOVATION CENTERS/ACTIVITIES IN INDIA

The organizations large and small are strategically disaggregating the innovation activities and adopting a distributed model with global footprint for their research and development. The major reason for internationalizing the innovation is to get access to innovation infrastructure, diversified talent and lower cost for high quality work. In this regard the companies are adapting various models that include, offshoring, outsourcing,

subcontracting and captives, and which have India as preferred destination for executing these models.

As was discussed earlier India has emerged as a major destination for MNC to establish R&D centers or work with R&D partners. There are estimated to be 851 foreign R&D centers as of 2010 and the expenditures incurred by foreign R&D centers has increased from Rs. 286 million in 2002-03 to Rs 28830 million in 2009-10. The overwhelming majority of the MNCs with R&D centers in India are from the US and the US investments in R&D centers have skyrocketed from 0 in 2001 to 687 million USD in 2008.

There is a significant opportunity for EU companies both large and small to conduct innovation activities in India. The organizations can leverage what India offers currently and the opportunities that would emerge in the near horizon. The key objectives for establishing innovation centers or conducting innovation activities involving Indian partners could include:

Resources Seeking: India has a large and highly educated talent pool across different knowledge areas. The cost of these resources, in most cases is less than 50% of the cost of similar resources in the EU countries.

Knowledge Augmentation: The companies can have a strategic approach to Knowledge Augmenting by identifying areas of gap in the organizational knowledge and leverage the innovation centers in India to fill those gaps.

Development of Global Product & Services: The innovation centers in India can become and important contributor to development of products as highly talented resources are available at a lower cost and these resources can be strategically deployed to fill the knowledge gaps of the organization.

FUNCTIONS/ACTIVITIES OF THEINNOVATION CENTERS

The Indian innovation centers/partners of EU organizations can be leveraged to perform multiple types of innovation activities, which include

Basic and Advanced Research: Activities that focus of basic and advanced scientific research.
Development: Development of new products, processes and services for global markets or for Indian market.
Design: New product and process design for global as well as Indian markets.
Support: Provide support functions to other innovation centers of the organization

TYPES OF INNOVATION CENTERS

Given the choice of functions and activities that can be performed at an Indian innovation center the organization can choose from different types of centers that can be established in India. Some of these include,

Innovation Support Centers: These centers perform support activities for innovation centers located in the EU countries. The support activities can include background research for innovation, competitive intelligence, and technical and customer documentation and other low intensity activities.

Collaborative Innovation Centers: Staffed by highly qualified and talented resources would work at par with other innovation centers in the product, process and service design and development.

Integrated Innovation Centers: The major activity of these centers would be localization of international products, process and services to meet the needs of Indian market.

Independent Innovation Centers: Autonomous innovation centers that function as one of the divisions of the organization and contains Indian and International resources working together to develop products, process and services for global markets and conduct basic and advanced research.

The type of innovation center to be established and the innovation activities to be performed will depend on the strategic objectives of the organization. However, the size of the parent organizations and available capital will also determine the approach to exploiting this opportunity India offers. For example, a large corporation with access to significant amount of capital and long-term approach can establish captive innovation centers of the types discussed earlier. For a EU Small and Medium Enterprise it is more economical to work with innovation partners on a project basis.

INCENTIVES OFFERED BY THE INDIAN GOVERNMENT

With the liberalization of trade and investment policies the government of India is offering various incentives for foreign corporations to invest in India. Although there aren't any specific incentives for Innovation activities the existing schemes can accommodate the investment for establishing R&D centers. These financial incentives include:

- 100 per cent foreign direct investments (FDI) under the automatic route for R&D Services.
- Weighted deduction on expenditure incurred on in-house R&D is 200%
- Weighted deduction on payments made to national laboratories, research associations, colleges, universities and other institutions, for scientific research is 175%.

INDIA INCLUSIVE INNOVATION FUND

A billion euro India Inclusive Innovation Fund started by the National Innovation Council in India represents significant opportunities for public organizations and for venture capital funds focused on social enterprises.

India embarked on an ambitious project of turning the nation into an innovation powerhouse by declaring 2010-20 as a "Decade of Innovation." In order to realize the vision of the "Decade of Innovation: the government of India has established the National Innovation Council. One of the major initiatives of the NInC is establishment of a billion euro India Inclusive Innovation fund.

The fund is focused on investing in startups that provide solutions and products to meet the needs of the poor citizens at the bottom of the socioeconomic pyramid. Targeting mainly core sectors such as education, healthcare and agriculture, the India Inclusive Innovation Fund has 4 objectives:

1. Focus on India's poor. Invest in companies and startups that are providing solutions to the problems of India's 500 million poor.
2. Combine Social and Commercial returns: The fund will invest in for-profit entities with social impact so that there is a healthy return on investment.
3. Drive Employment and Livelihood Generation: Fund enterprises that generate employment for the poor.
4. Establish a Model for Wider Inclusive Innovation Funding: By investing in social focused commercial enterprises become models for other funds to follow.

The EU organizations both public and private that focus on funding social enterprises have an opportunity to participate in this fund as co-investors in the fund as well as beneficiaries of the funds.

EXPERTISE FOR CLUSTER DEVELOPMENT

EU nations have a long-standing experience and expertise in developing industry clusters as well as running successful academy-industry interactions for commercial purposes. Some of the EU initiatives that could be localized and replicated in India include:

Cluster-IP: The Cluster Innovation Platform

The Cluster-IP brings together cluster organizations from different countries willing to cooperate in working on the modernization of cluster support services in the EU. This includes the design and testing of new support tools, but also the experimentation with new forms of cluster cooperation. The Cluster-IP contributes to better support for innovative SMEs to internationalize and to access excellence available elsewhere. The specific needs of cluster firms as well as the potential role of clusters in addressing societal challenges and in fostering user-driven innovation need to be taken into account.

European Cluster Alliance

An open platform established to maintain a permanent policy dialogue at EU level among national and regional public authorities responsible for developing cluster policies and managing or funding cluster programmes in their countries or regions.This initiative responds to the needs and interests of many EU Member States and regions to share experiences in the field of cluster policies and initiatives. It will enable them to pool resources and address the problems they face, avoiding duplication of efforts and reducing fragmentation of cluster initiatives in Europe.

European Cluster Observatory

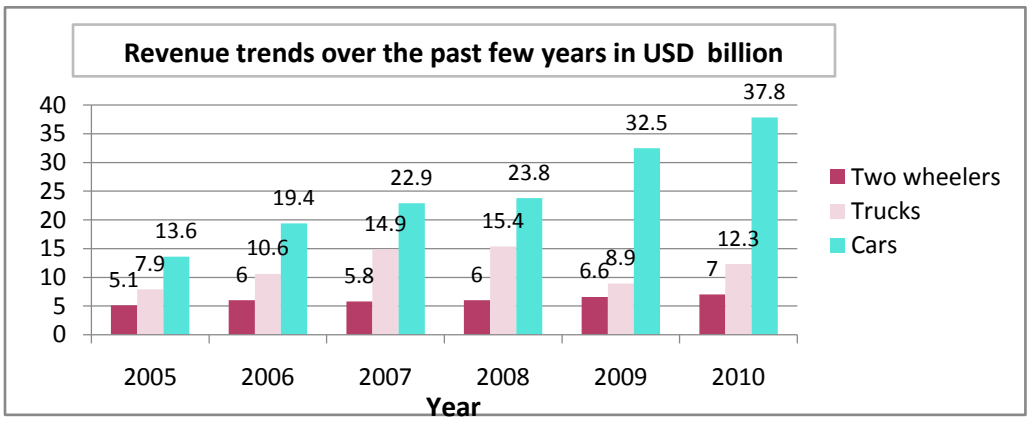
The European Cluster Observatory develops a flexible and user-friendly web platform for cluster organizations, firms and other users in Europe. Data about regions is collected through surveys and other sources. Activities include, among other things, web development, surveys, conferences, and reports.

AUTOMOTIVE INDUSTRY

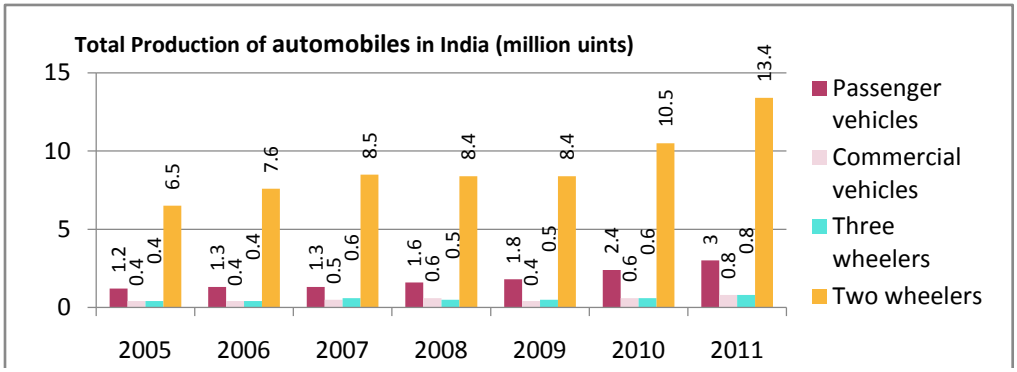
Automotive industry is one of India's largest industries. It forms approximately 7% of India's GDP. The industry has shown a growth and stability over the past 20 years.

According to the recent data released by the Society of Indian Automobile Manufacturers (SIAM), the cumulative production for April-June 2012 registered a growth of 7.65 per cent over April-June 2011, manufacturing 1,700,675 vehicles in June 2012. While Passenger vehicle segment grew at 9.71 per cent during April-June 2012, overall commercial vehicle segment registered an expansion of 6.06 per cent year-on-year (y-o-y). Two Wheelers sales registered a growth of 10.51 per cent during April-June 2012.

The following graph depicts that revenue of automotive sector has been growing steadily



The following graph depicts total production of automobiles in India from 2005 till 2011.



MARKET TRENDS

Utility vehicles are a major success in Indian markets these days. Automakers are proactively bringing new models to attract consumers who are highly enthusiastic about multi-utility vehicles (MUVs). However, with large number of players and variants, the market for MUVs is getting competitive day-by-day.

Mahindra & Mahindra (M&M) is the market leader with 49.31 per cent of the share, followed by Toyota Kirloskar Motor India Pvt with 20.08 per cent, Maruti Suzuki India Ltd (MSIL) with 16.7 per cent and Tata Motors with 7.87 per cent at the end of May 2012.

MAJOR DEVELOPMENTS & INVESTMENTS

- Ford India has expanded its diesel engine production capacity at its plant in Maraimalainagar, near Chennai. The plant now has an annual capacity to produce 3.4 lakh engines - up from 2.5 lakh in 2010 - along with a production capacity to make 200, 000 cars.
- The Volkswagen Group aims to increase output by 10-15 per cent on a €100-million investment at its production facilities in Aurangabad and Chakan in Maharashtra.
- Japanese auto firm Isuzu Motors Limited, is considering entering fast growing Indian small commercial vehicle and MUV segments.
- Just after four years of its debut in the two-wheeler segment, M&M Group has set a target of EUR € 3 billion in revenue by 2020.
- India's largest auto maker MSIL has agreed to merge group unit Suzuki Powertrain India Ltd with itself with a view to bring all diesel engine manufacturing facilities under a single management.

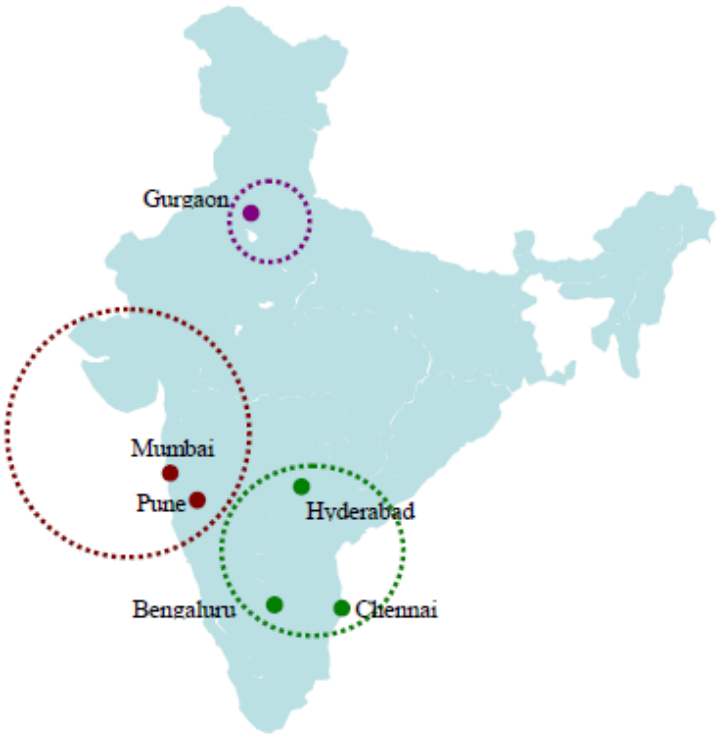
INNOVATION IN AUTOMOTIVE INDUSTRY

Innovation in the automotive industry is driven by two factors – legislative requirements and competitive requirements. More recently, India has seen establishments of several automotive R&D centers and they are well positioned for growth. Indian automotive industry started its pursuit of green technologies with CNG and LPG. The new products development in the automotive industry can be divided into – Designing, Development (engineering/detailing & production) and testing.

AUTOMOTIVE INNOVATION CLUSTER

The state of Maharashtra and Tamil Nadu have been always been the hubs for Automobile industry in India. Currently, Pune is largest geographical concentrate for automotive industry in India. Also there are other regions which act as pockets for the automotive industry – Indore (MP), Kolkata-Jamshedpur belt (West Bengal). As per SIAM statistics, 81% of the total R&D expenditure of the country is made in the west zone.

The following India map shows Innovation clusters in automotive industry. Of these, the southern cluster acquires major share of the industry, which is followed by the western cluster and then followed by northern.



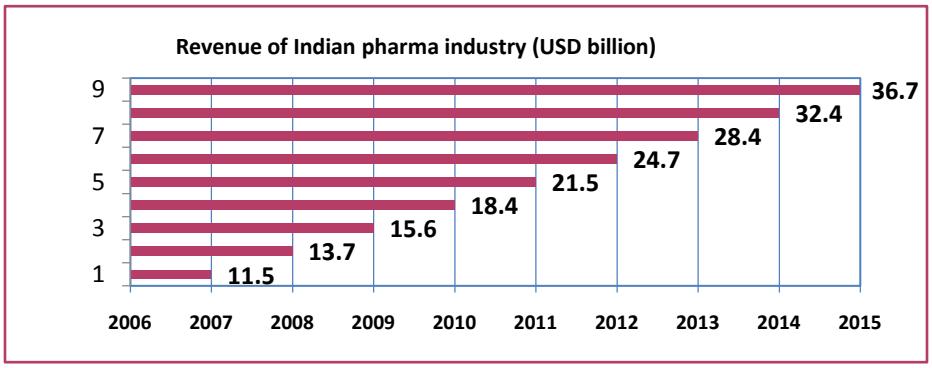
PHARMACEUTICALS

Globally, Indian Pharmaceuticals industry stands third in terms of value and tenth in terms of volume. According to PricewaterhouseCoopers (PWC) in 2010, India joined among the league of top 10 global pharmaceuticals markets in terms of sales.

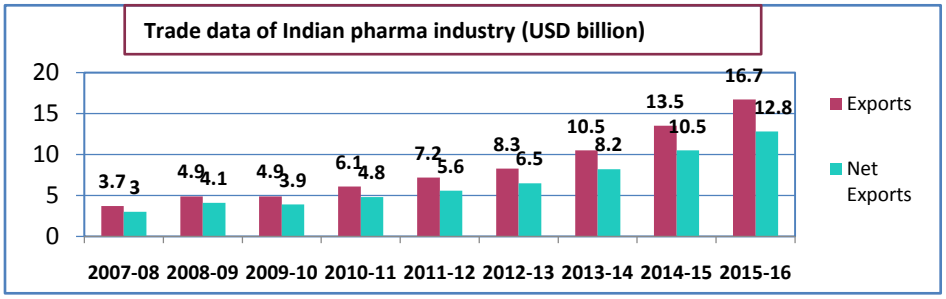
Indian pharma industry has been at the vanguard in a wide range of specialties relating to complex drugs manufacture, development and technology. According to a Barclays Capital Equity Research report on India Healthcare & Pharmaceuticals, the Indian pharma market is expected to grow at a CAGR (Compound Annual Growth Rate) of 15.3 per cent during 2011-12 to 2013-14.

The India pharma revenues are estimated at USD28.4 billion during 2013andexpected to double in two years reaching USD36.7 billion by 2015.

The following graph depicts revenue of Indian pharma market.



The pharma exports from India have been steadily increasing till date and have forecasted to further increase to USD12.8 billion by 2015.



PROMOTING RESEARCH ACTIVITIES

Both the private sector and the public funded research institutes have been performing the research activities in India. Some chief government institutes such as Indian Council of

Medical Research (ICMR), Department of Science & Technology (DST), Council of Scientific and Industrial Research (CSIR), Department of Biotechnology (DBT), Central Drug Research Institute (CDRI) have allocated certain amount of funds for promotion of research activities specific to the industry. Some of the well-known private organizations executing research activities are Dr. Reddy's Laboratories, Ranbaxy, Cadila Healthcare, Glenmark, Biocon, Panacea Biotech, Shantha Biotech, Serum Institute of India and others. Mutually public and private sector enterprises are increasing their focus on R&D activities.

MAJOR INDIAN PHARMA COMPANIES

During the year 2011-12, India's top 10 pharma companies complete a net sales growth of 21 per cent with the sales worth over Rs.4, 000 crore. The following table shows the latest sales in Euros millions of Indian top 10 pharma companies.

Company Name	Sales in EUR million	Year End
Cipla	4868.68	March 2011
Ranbaxy	4335.97	December 2010
Dr. Reddy's Laboratories	4029.83	March 2011
Sun Pharmaceutical	1513.93	March 2011
Lupin Ltd	3451.49	March 2011
Aurobindo Pharma	3278.32	March 2011
Piramal Healthcare	1234.91	March 2011
Cadila Healthcare	1687.75	March 2011
Matix Labs	1444.24	March 2011
Wockhardt	496.88	December 2011
Source: Based on reports from Corporate Catalyst India		

GOVERNMENT INITIATIVES

Indian drugs and pharmaceuticals sector has allowed 100% FDI under the automatic route. "Pharma Vision 2020" has been prepared by the Department of Pharmaceuticals for making India one of the leading destinations for end-to-end drug discovery and innovation. In next two years, the government plans to open 3000 Jan Aushadhi stores which sell unbranded generic drugs at heavy discounts to branded drugs. Indian pharma companies like Cipla, Ranbaxy, Dr. Reddy's Labs and Lupin may hastily be part of the government's motivated 'Jan Aushadhi' project.

INVESTMENTS

The pharma, healthcare and biotech sector has witnessed 5 merger and acquisition (M&A) transactions worth EUR 190.6 million. Some of the major investment developments in the sector include:

- Hyderabad based Natco pharma plans to raise EUR 16.94 million to fund its expansion plans and research activities.
- Chennai based Bafna pharmaceuticals palns to raise around 3.37 EUR million for its future expansion by issunace of warrants and shares.
- Mankind Pharma Ltd has been laid for an important turnaround over the next two to three years.

PHARMACEUTICAL INNOVATION CLUSTERS

In the pharmaceutical industry, the private sector is one of the key participants in innovation activities. Most of the top pharma companies such as Rnbaxy, Dr. Reddy, Cadila and Wockhardt have been focusing and investing deeply in research & development activities.

In India, the key pharmaceutical and biotech innovation hubs can be segregated into three central clusters: western, southern and northern cluster. The northern cluster covering of NCR (Delhi, Gurgaon and Noida) is also an emerging location for pharmaceutical companies.

The following India map shows Innovation clusters. Of these, the western cluster acquires major share of the industry which is then followed by the southern cluster.

The western cluster with states of Gujarat and Maharashtra is the major hub for Pharmaceutical activities because of the government incentives & support, infrastructure and resource availability.

RECENT TRENDS AND OPPORTUNITIES

Some of the recent trends and opportunities being exploited by the Indian and foreign pharmaceutical companies are the following

- Israel's Teva Pharmaceutical Industries and Procter & Gamble (P&G) plan to enter India through a joint venture (JV) by setting up their first manufacturing facility at Sanand, Gujarat, with an initial investment of Rs 250 crore.
- In 2006, Dr Reddy's acquired Betapharm, a generic-drug maker in Germany.
- Lithuania says it is open to Indian investments in the info-tech and pharmaceuticals sectors. According to Mickeviciene, Minister Counsellor, Republic of Lithuania ""We are developing Free Economic Zones especially to attract investments in sectors like IT, financial and business consulting and pharmaceuticals sectors. India should increase its share of trade with Lithuania,".
- Bio-pharmaceutical and health science sector representatives from the UK are to explore and expand partnerships with Indian companies. UK-India Innovation and Leadership Meeting at IIM Bangalore held in March encouraged IP-protected research and innovation in health science, explore entrepreneurial opportunities.

- Indian healthcare major Piramal, which had taken over Bayer HealthCare's molecular-imaging pipeline, has been investing in German molecular imaging technology.
- As per a report by research firm Credit Suisse, the growth of Indian pharma companies will be driven by the fastest growing molecules in the diabetes, skincare and eye care segment. The market share of a drug company is directly related to the number of fast growing molecules in the company's pipeline.
- Government offers a number of tax incentives both for manufacturing and research activities of pharmaceutical companies.
- The government has also proposed to set up a venture capital fund amounting to INR 30000 million which will be used to promote drug discovery and also strengthen the Pharmaceutical infrastructure in India.
- Indian pharma and biopharma industry moving towards conducting high end research projects, the need for such collaborations will keep increasing and open up huge opportunities for European agencies and companies.
- The Indian clinical trial market is estimated to be worth USD1.5 billion. According to various studies, India is among the leaders in the clinical trial market.

Deepening EU-India cooperation

In FP7 Health sector/theme, there are currently around 33 EU-India FP7 projects running. As compared to other sectors such as ICT, Environment, Energy etc Indian organizations participation is high in healthcare sector.

R&D: Joint partnership and Innovative licensing representation

In the recent years, many Indian companies such as Ranbaxy, Dr. Reddy's Sun Pharma, Glenmark and few others have made New Chemical Entity (NCE) research a vital part of their growth strategy & have scaled up operations in this sector. Even though Indian companies are equipped with extensive knowledge in chemistry, they lack experience & financial resources to conduct full-fledged activities in this area. Germany on the other hand, has excellent background and experience in R&D field, above all in areas such as cardiovascular diseases, oncology, inflammatory diseases, auto-immune deficiencies etc and there is good opportunity for German companies to invest in R&D operations in India either by introducing subsidiaries or through joint research and collaboration with Indian companies.

Key Players

Some EU Pharma organizations partnering with Indian organizations: Reckitt Benckiser, Fresenius, Research Institute for Development, Bayer, Wageningen University, Research Centre Jülich GMBH, Ministry of Health - Italy, Technical University of Denmark, University of Pavia, St George''s Hospital Medical School, Institute Pasteur, Medical Research Council

UK, University of Glasgow UK, Charité - University Medicine, AstraZeneca, Sanofi, GlaxoSmithKline, Novartis, Novo Nordisk, UCB, Merck KGaA and others

Technology that gives control back to the paralyzed: By Mr. Sushanth Patnaik- A breath-sensor device to provide communication power to the disabled

Mr. Susant Pattnaik from Bhubaneshwar, Orissa, is helping differently-abled individuals with his range of innovations. The 'Breathing Sensor Apparatus' assists physically challenged people to operate an electronic wheel chair that uses changes in the breathing. Mr. Sushanth Patnaik has made an effort to address the need of the disabled and has invented a breath-activated wheelchair for the disabled. He created a breath-sensor device for those who use wheelchair. The device could help them do normal chores/tasks just by breathing into the sensor.

He once saw a completely paralyzed person who was unable to see clearly. For a moment he began to think of developing a technology which can allow them to do all types of work just as normal human beings do. He began wondering about the most common aspect between a normal human being and a paralyzed person. The answer was brain and breathing," says Pattnaik.

The wheelchair device has four components: sensor, controller, transmitter, and a receiver. The breath sensor is attached to a headphone-like device. This battery-operated device uses wireless signals to communicate with the wheelchair. The sensor senses the breath and gives signal; the controller has pretimed LED bulbs (each one for specific function) based on which the user breathes into the sensor; the transmitter transfers the signal; and the receiver receives it. When a user breathes into the sensor, a pulse is generated activating the transmitter. The transmitter actuates the receiver which in turn activates a relay. The process triggers the controller to light up the LED bulbs (each LED bulb on the device can remain lit up for two seconds). When a bulb corresponding to a particular function lights up it is a signal to the user to breath into the sensor. When the user breathes into the sensor, the signal gets transmitted and the controller starts performing that particular function, which may signal food, water, washroom, moving the wheelchair, or even to turn on/ off an electric switch. According to Pattnaik, if the electronic switch panel is integrated with his system, then it will be possible to use breath to operate the switches wirelessly.

Pattnaik says his breath-sensor apparatus technology can even be implemented in a tractor to allow a paralyzed person run the tractor on a field by just breathing. Thus, there are bright prospects of the application of this technology.

AEROSPACE

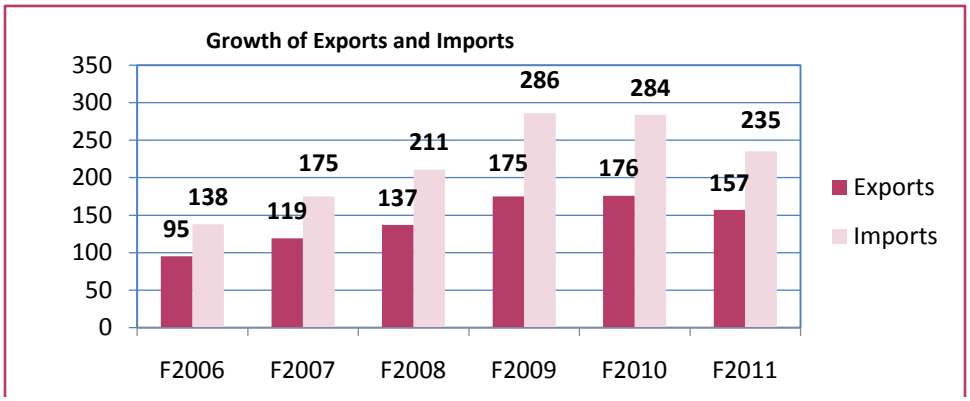
Globally, the Indian aerospace industry is one of the rapidly growing markets with an expanding customer base comprising of airlines, businesses and high net worth individuals. The rapid growth of the aerospace industry has attracted major global aerospace companies to India. All the segments in aerospace industry like civil and military aviation and space are showing a significant level of growth. The growth has allowed a number of automobile manufacturers to exploit forward and backward linkages with the aerospace industry. Additionally, India is also expected to become a hub for maintenance, repair and overhauling (MRO). The MRO market in India was valued at EUR 740 million in 2008, and can absorb massive investments.

Hindustan Aeronautics Limited (HAL) is the leading aerospace company fully owned by the Government of India. HAL has played a major role in the defense aviation through design, manufacture and overhaul of fighters, trainers, helicopters, and transport aircraft, engines, avionics and system equipment. HAL is now ranked 34th in the list of world's top 100 defense companies. It is a major partner for the Space programs of Indian Space Research Organization (ISRO) and manufactures structures and assemblies for the launch vehicles and satellites at its dedicated Aerospace Division in Bangalore.

AVIATION SECTOR

According to Dr Nasim Zaidi, Secretary, Ministry of Civil Aviation, India is on the edge to come forward as the third largest aviation market in the world by the end of this decade. The aviation sector in India has been growing at a fast pace. As per data released by Department of Industrial Policy and Promotion (DIPP), air transport (including airfreight) has attracted FDI worth EUR330.48 million from April 2000 to March 2012. Passengers carried by domestic airlines during January-May 2012 have been recorded at 25.81 million as against 24.49 million during the corresponding period of previous year.

Between 2006-2011, India's exports have expanded at a CAGR of 13.3 per cent and imports have been registered a 14.2 per cent CAGR. The following graph shows growth of exports and imports in EUR € billion in freight movement.



Source: Ministry of Commerce, Aranca Research

SPACE SECTOR

India Space industry, which is worth approximately EUR 96 billion, has made giant strides in the past several years due to its notable achievements in the fields of broadcasting and telecommunications satellite technology and application of space technology for civilian uses. The increased encouragement for private company participation in the industry has widened the opportunity of large international players looking to outsourcing manufacturing of critical components or to set up captive units in India.ISRO, a government agency,as the sole space industry player in India has always tried to balance its goal between becoming a leading commercial player in the global market and working toward bringing self-reliance to the nation.

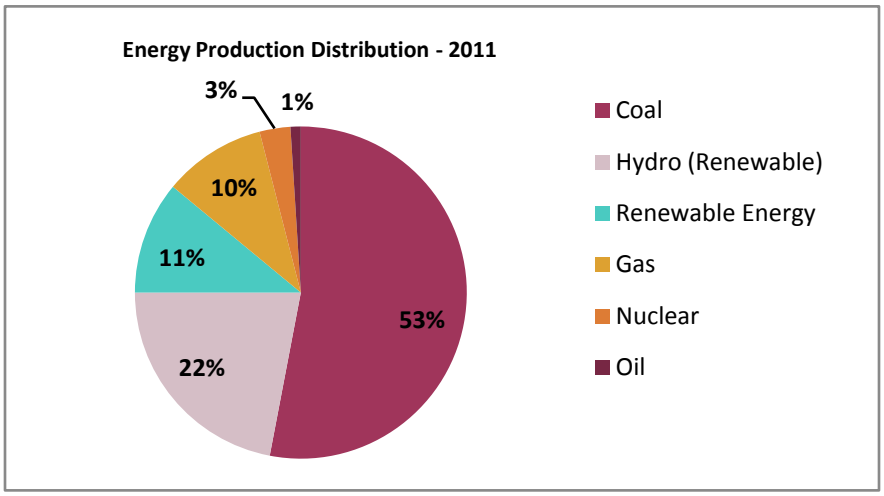
GOVERNMENT INITIATIVES

On the whole, the government encourages private investment in both the civil and defense aerospace sector with the purpose of encouraging technology transfers and achieving indigenization. The Indian Government has significantly liberalized the civil aviation sector. It promotes domestic private participation in manufacturing and R&D in the aerospace sector with 100% FDI allowed in most areas, the exceptions being air traffic services. The defense sector is limited to 100 % domestic private investment only.

ENERGY

India stands in eleventh place in terms of production and in the sixth place in terms of consumption globally. With an installed power capacity of 164,835 MW, India has 4% of the global capacity. In the past, the Indian power sector has been driven by fossil fuel power, predominantly coal. Though fossil fuel based power plants are expected to be the dominant source over the next few years, the industry has also started focusing towards renewable and alternate energy sources.

The following graph summarizes energy production in India:



The energy sector comprises of two main segments namely renewable (wind, solar, biomass, small hydro and waste to energy) and non-renewable (coal, natural gas, oil, nuclear power) sources of energy with non-renewable segment occupying the major share of the current production. Renewable energy currently has been growing very rapidly in last 5 years especially in wind and solar power.

According to an analysis by The Energy and Resources Institute (TERI), the annual primary energy and electricity growth rates are expected to be between 3.7-4.4% and 5.1-5.7% respectively. The energy demand is expected to grow to 5.2%, to keep up with the GDP growth rate of 8-10% in the coming years.

R&D ACTIVITIES

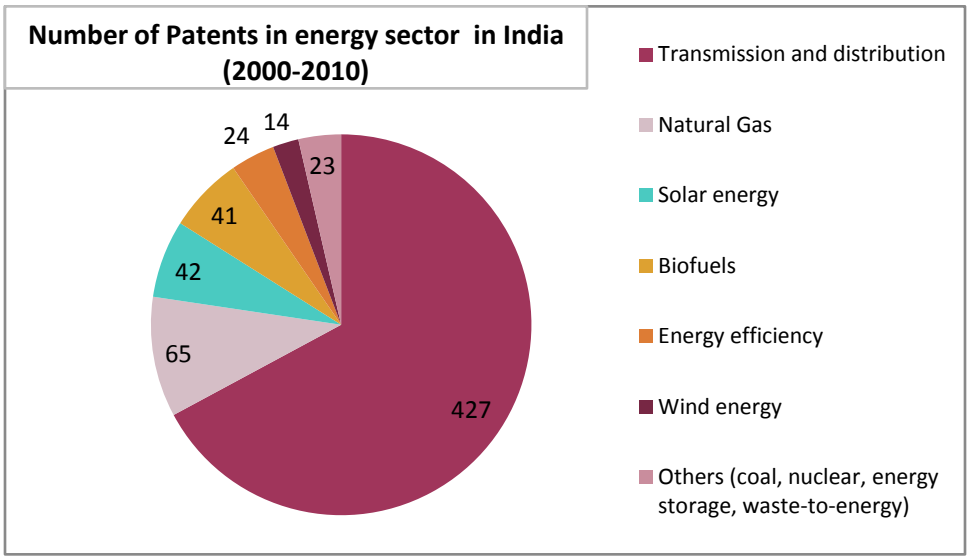
In India, state-owned enterprises are the most heavily involved in coordinating R&D activities, with the Ministry of Science & Technology (MST) in charge of R&D programs, along with the Department of Science and Technology (DST) and the Department of Scientific and Industrial Research (DSIR).

The execution of India's energy policy and energy research and development activities (R&D) are undertaken by five different ministries: Ministry of Power (MOP) Ministry of Coal (MOC) Ministry of Petroleum and Natural Gas (MPNG) Ministry of New and Renewable Energy (MNRE) Department of Atomic Energy (DAE).

The energy industry is dominated by public sector enterprises, which constitute more than 82% of the installed capacity. However, with the 11th five year plan, the Indian government has been encouraging research and development activities for alternative sources of energy. The major government bodies funding research activities are MNRE, Department of Science & Technology, Department of Atomic Energy, Ministry of Power

and Department of Bio-technology. As a result of these and other initiatives more than 600 patents were filed in the energy sector in India during the period 2000-2010, of which about 70% have been in the arena of energy transmission and distribution.

The following graph depicts number of patents in energy sector in India (2000-2010)



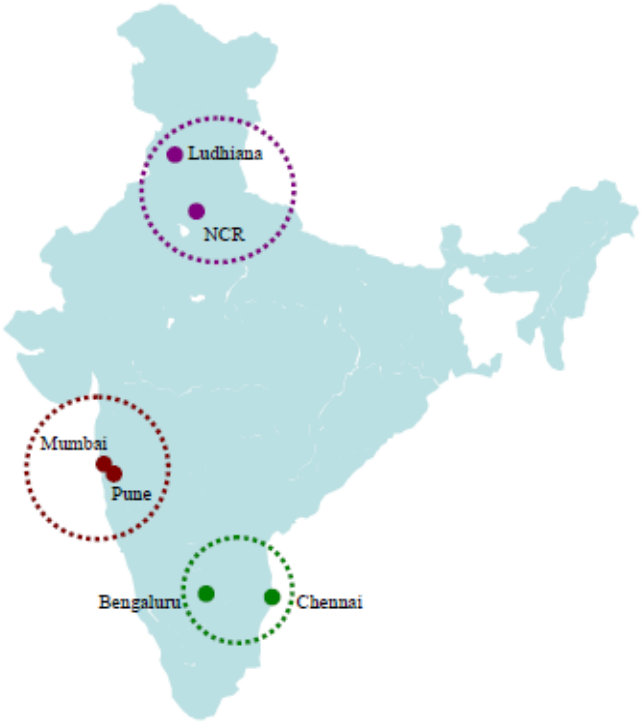
GOVERNMENT SUPPORT

Currently, Indian government plays a critical role in increasing the research activities. Supported by the government's policies and funds, premier research institutes like CSIR and BARC and academia like IITs and IISc have been leading the way. The government also launched an Accelerated Program on Energy Recovery from Urban Wastes, which aims to develop waste-to-energy technology through MNRE's financial support. The government has also been promoting grassroots innovations through NIF (National Innovation Foundation) and GIAN (Grassroots Innovations Augmentation Network). Moreover, the government is also making a lot of efforts to promote research activities in universities and other institutes. Along with the government bodies, the private sector is also ramping up its investment in the energy sector. A number of companies are now undertaking research projects to develop technologies for power sector.

INNOVATION CLUSTERS IN ENERGY SECTOR:

India, as a whole, possesses a relatively high abundance of solar radiation, moderate wind speeds, and hydro and biomass energy resources. Coupled with the presence of academia and government support, the innovation centers in India are evenly spread throughout the country.

The following India map shows Innovation clusters in Energy sectors. The three main clusters are: northern, western and southern clusters.



The northern cluster includes NCR and Ludhiana, western cluster Mumbai and Pune, and the southern cluster includes Bengaluru and Chennai. These are considered as major hubs for energy related research activities.

EU-INDIA COOPERATION IN ENERGY SECTOR

- EU and India have jointly identified a scope for enhanced co-operation leading to better governance and policy-making, such as trade and industry, energy, environment and transport and these have to be further encouraged.
- EU-India has set up an – **"Energy Panel for dialogue and cooperation on energy issues"** and is interdependent particularly in terms of energy supply and the cooperation has to be further expanded in both regions.
- In FP7 Energy sector/theme, there are currently around 7 EU-India FP7 projects.
- EBTC European Business and Technology Centre (EBTC) plans to initiate a pilot project to demonstrate 'smart city concept' at the industrial town of Haldia in West Bengal. "The Copenhagen Cleantech Cluster and EBTC will together work to identify projects, undertake their execution, and facilitate research and innovation related to green technology initiatives in the energy and environment sectors" (Poul V Jensen, Director,).

KEY RESEARCH TECHNOLOGY DEVELOPMENT AND INNOVATION (RTDI) PLAYERS

- Energy policy and energy research and development activities (R&D) activities take place in five different ministries: Ministry of Power (MOP) Ministry of Coal (MOC) Ministry of Petroleum and Natural Gas (MPNG) Ministry of New and Renewable Energy (MNRE) Department of Atomic Energy (DAE) and Indian Renewable Energy Development Agency (IREDA) and some Indian organizations involved innovation are: Indian Institute of Petroleum (IIP), Dehradun Mechanical Engineering Research & Development Organization (MERADO), Ludhiana The Solar Energy Centre (SEC), Gurgaon Central Salt & Marine Chemicals Research Institute (CSMCRI), Bhavnagar Central Mechanical Engineering Research Institute (CMERI), Durgapur.
- Some key players in power sector: National Thermal Power Corporation, Tata Power, Reliance Power, Community Energy Services Corporation and National Hydroelectric Power Corporation, Nuclear Power Corporation of India. Some key players in renewable energy sector: Suzlon Energy, Moser Baer, Tata Power and Orient Green Power.
- Indian research institutes with active EU-India collaboration include, The Energy and Resources Institute, Council of Scientific and Industrial Research, Foundation for Innovation and Technology Transfer Aquagri Processing Private Limited, IIT Delhi, IIT Kharagpur and Central Mine Planning & Design Institute Ltd.
- EU research institutes with active EU-India collaboration: Aerothermal Limited, Greenfinch Limited, Eco-Solids International Limited, University of Verona, University of Southampton, Technical University of Denmark, Cener-Ciemat, Acciona Energy S.A., Complutense University of Madrid.

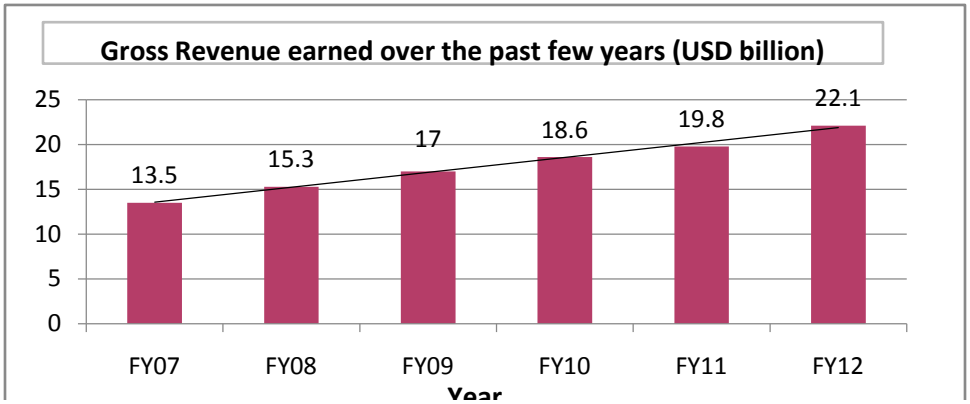
TRANSPORTATION

India has a large and diverse transport sector. Transport industry contributes considerably to the growth of gross domestic product (GDP), while creating opportunities for employment and investment. Over the last decade, there were several improvements in roads & highways, ports, railways and airports. Moreover, a better the policy and regulatory framework has been implemented resulting in significantly increased investment in infrastructure.

RAILWAYS

Indian Railways is the world's fourth largest rail and the second largest organization under a single management in the world. With a network of 64,000 kilometer (km) of railway tracks and7, 000 stations, Indian Railways operate more than 18,000 trains every day.

The following graph shows gross revenue earned over the past few years in US billion euros



Source: Ministry of Railways

Railway projects have usually been in the public sector domain. Private players have been involved in allied activities such as track laying and maintenance, maintenance of coaches and wagons, construction of bridges, stations, signaling and telecommunications works.

Government initiatives

The government is investing in heavily in construction of rail infrastructure. Under Adarsh station scheme, a total of 929 stations have been identified for development during 2009-10 to 2012-13 and so far, 550 stations have been developed.

ROADWAYS

In India, roads are the preferred mode of transportation. At present, India has the world's second largest road system with 4.1 million km of roads of which National Highway Authority of India's (NHAI) share is 71,722 km.

Government initiatives

- Priority has been accorded to 3,300 km of highways designed to guarantee smooth transportation of goods considered as the future backbone of India's economic activity.
- The government has set a goal of covering a length of 8,800 km under NHDP in 2013.
- In order to encourage public private partnerships in road construction projects, external commercial borrowings (ECBs) have been allowed, for capital expenditure.
- Full exclusion from import duty on equipment imported for road construction including, tunnel boring machinery and parts for assembly and maintenance.

URBAN TRANSPORTATION

India is experiencing rapid urbanization. According to a recent study, the population of Indian cities has increased significantly from 62 million in 1951 to 285 million in 2001 and

is estimated to grow to around 540 million by the year 2021. This growth in population has placed increased demand for urban mass transportation systems.

The first modern rapid transit in India was the Kolkata Metro, followed by Delhi Metro in the capital city of New Delhi, which was executed in 2002.The Namma Metro in Bengaluru is India's third operational rapid transit started operations in 2011. Currently several metro rail projects are underway to improve connectivity within the cities.

ACTIVITY AND OPPERTUNITIES IN TRANSPORT SECTOR

Roadways and Railways represent 2 key verticals of infrastructure sector. India has embarked on ambitious projects to modernize existing road and rail infrastructure and build new roads. In this regard EU companies and public organizations have been quite active in taking advantage of the opportunities and position themselves for the future.

Railways

The Railways budget 2011-12 earmarks an outlay of EUR € 9.14 billion, the highest ever so far. The cumulative FDI inflow into the sector stood at EUR € 101.25 million during April 2000-March 2011.

- Indian Railways is soon to sign MoU with German Railways very soon for active participation by German companies in Indian Railways' to achieve the goals of Vision-2020 and some major activities to be undertaken by railways include safety, Train Protection and Warning System, high speed, speed upgradation on existing network, station development, dedicated freight corridors, logistics parks and Public Private Partnership.
- In June 2012, Texmaco Rail & Engineering has entered into 50:50 joint venture with a French group Touax Rail, for a new venture in freight car leasing business.
- French company “Thales” is bidding for upcoming metro and rail projects across the India especially major cities such as Mumbai, Hyderabad, Chennai either independently or as a consortium.
- Spain's Constructions y Auxiliar de Ferrocarriles (CAF) plans to launch a manufacturing unit in India to tap the increasing demand for railway vehicles and equipment due to its rising opportunities. It won Rs 780-crore order to manufacture 14 rakes (each rake consists of six coaches) for Kolkata Metro Railway Corporation Ltd (KMRCL). It is also bidding for all upcoming metro projects such as Jaipur, Hyderabad etc.
- By 2016, Indian Railways will roll out coaches using German technology. Four coach factories will replace the indigenously-designed carriages with 4,000 Linke Holfmann Bush (LHB) coaches.
- Fairwood, the company that is introducing the pod car in India in a tie-up with the UK-based Ultra, plans to set up a manufacturing factory in the National Capital Region in Noida, Greater Noida or Gurgaon over the next four or five months.
- Chennai Metro Rail Ltd has awarded contract for power supply and Overhead Equipments (OHE) to Siemens AG of Germany and its Indian arm Seimens Ltd India Consortium for Rs 305 crore.

- Germany-based multinational company, Bernard Engineers has won the consultancy contract for designing and preparing a detailed project report for three major road tunnels in Himachal Pradesh, according to officials.

Key Players in Railways related Research

Some EU organizations partnering with Indian organizations in research activities in Railway area: Cartif Foundation, Railway Infrastructure Administrator, Bernard Engineers, Mer Mec Spaitalia, University of Granada, Quotas GMBH, Alstom Transport S.A., Autonomous Regie Des Transports Parisiens, Siemens AG, Milan Public Transportation Company etc.

Roadways

Currently, India has the world's second largest road system, with 4.1 million km of roads, of which National Highway Authority of India's (NHAI) share is 71,722 km.

- Ministry of Road Transport & Highways is encouraging international participation to expedite road projects in the country. British construction companies have formed the British India Roads Group (BRIG) to ensure the greater involvement of the UK highways construction industry in India's National Highways Development Project (NHDP).
- Policy Initiatives for attracting Private Investment: NHAI / Government of India (GoI) to provide capital grant up to 40 per cent of project cost to enhance viability on a case to case basis 100 per cent tax exemption for five years and 30 per cent relief for next five years, which may be availed of in 20 years & concession period allowed up to 30 years.
- More than 60 percent of the estimated investment requirement under NHDP is expected to be privately financed
- Duty free import of high capacity and modern road construction equipment
- The Government of India has approved 2,389 projects under the Integrated Action Plan (IAP) for construction of 9,070 kilometer (km) of roads in rural Bihar, at an estimated cost of 487.9 million. The project has been approved in a phased manner.
- Maharashtra State Road Development Corporation (MSRDC) in India is modernizing the state's border checkpoints with a new fully automatic border control system provided by Confidex, a Finnish supplier of specialty RFID Tags. The system marks the beginning of the modernization of all border checkpoints across India, as mandated by the government.
- India & Italy to Sign MoU for Greater Co-Operation in Road Infrastructure Sector: India and Italy have agreed to sign a Memorandum of Understanding for enhancing bilateral technical cooperation in road infrastructure sector and greater involvement of Italian Infrastructure companies in the highways sector in India.

Key Players in Roadways Research

Some EU organizations partnering with Indian organizations in research activities in Roadway area: University College London, AlgoeFrance, Retevision I, S.A., Masternaut, Quantum S.R.L.Italia, Centro Ricerche Fiat Scpaitalia, Magneti Marelli SPA, Ford-Werke

Gmbhdeutschlan, Atlantia, FINCO, ASTRAL, Network for integrated security Association, Volkswagen AG Germany, CEO Maire Tecnimont, Delphi France SAS, Tata Steel UK Ltd, Eurnex E. V.Deutschland , Mer Mec Spa, Network Rail Infrastructure Ltd, Trenitalia Spa, Ecocat Oy Suomi/Finland, Ansaldo STS S.P.A.

EU-INDIA COOPERATION IN TRANSPORTATION SECTOR

- In FP7 Transport sector/theme, there are currently around 6 EU-India FP7 projects.
- EU's "Innovation Union" and the Indian "Decade of Innovation" strategies for achieving inclusive, sustainable and affordable innovation, towards finding solutions to growing societal challenges include sustainable transport and mobility.
- EBTC working on EU-India cooperation in the following Transport area:
    - Improving the efficiency of existing transport modes
    - Introducing cleaner transport technology solutions to save energy
    - Reduce space requirements for transport and diminish pollution
    - IT services to the transport and logistics community like Intelligent Transport System, Port development, road networks, air cargo routes and railroad infrastructure opportunities.

C Mallesham - An automatic loom

Chintakindi Mallesham who, moved by his mother's suffering, innovated an automatic loom, which is also reviving the dying tradition of the Pochampally silk sari weaving. C Mallesham from Andhra Pradesh was driven by his mother's pain made him to invent an automatic loom that would ease her pain at the same time allow her and others like her to keep spinning the silken threads of the famous Pochampalli saris.A number of machines caught C Mallesham's attention. He started observing each one of them. He rushed toa workshop, and got a component manufactured to suit the requirement. He reached his room, fitted the component to themachine, and started the operation. The machine worked and he disassembled the machine and reassembled and Mallesham demonstratedthe Asu process. The quality that came out was better than the one obtainedthrough hand operated Asu process. Till date Mallesham has sold over 1000 Asu machines. His mother does notcomplain of pain in her arms any more.Employment, productivity and marketability have visibly increased in Nalgonda andWarangal districts of Andhra Pradesh.His machine was named "LaxmiAsu Machine" after her mother and dedicated to her. Many local and national newspapers and TV channels have covered this 'Asu automatic machine' invention. The possibility of introducing his machine for differentweaving styles in other parts of India is also being explored.

WATER AND WASTEWATER MANAGEMENT

India has 4% of water resources of the world whilst it has to support 16% of world population as a result India needs a comprehensive plan for water and wastewater management. Typically the water sector in India has been owned and operated by the government. Of late, the government is encouraging the private sector to participate and introduce regulatory reforms.

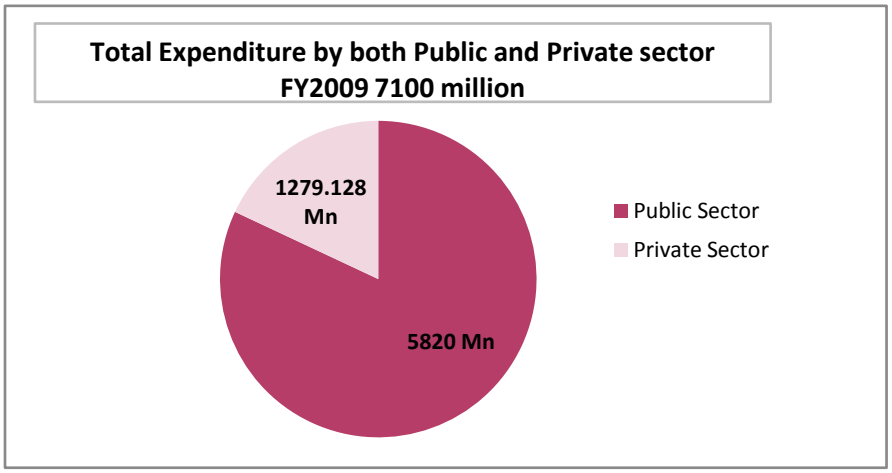
Water Availability: India receives a total rainfall of about 4000 Billion cubic meters (BCM). However, rainfall in India shows a very high degree of spatial and temporal variability. Demands on Water Irrigation,Drinking Water/Domestic, Industrial usage, Energy production and Others.

GOVERNMENT INITIATIVES AND POLICIES

Government of India has recently approved National Water Mission's main objective of conserving water, minimizing wastage and ensuring more equitable distribution across the entire country through integrated water resources development and management. National Water Mission has set the following five goals:

- Comprehensive water data base in public domain and assessment of impact ofclimate change on water resources;
- Promotion of citizen and state action for water conservation, augmentation andPreservation;
- Focused attention to over-exploited areas;
- Increasing water use efficiency by 20%; and
- Promotion of basin level integrated water resources management.

The following graph depicts total expenditure by both public and private sector on water supply and sanitation.



Source: Planning Commission, Ministry of Rural and Urban Development Department of Drilling water supply

At present, drinking water investments constitute about 3% of the national budget. Today 85% of the urban and 75% of the rural population has access to public water supplies. 48% of the urban population and 36% of the rural population has access to sanitation services. The water treatment industry in India is seeing immense expansion.

KEY DRIVERS FOR WATER INDUSTRY GROWTH

- Increased awareness about drinking water quality and health
- Decreasing water quality and users having to go for ground water
- Environmental pressures on wastewater discharge from govt. pollution control boards
- Reducing availability of water forcing users to go for reuse & recycling of water
- General Industrial and Economic Growth particularly in chemical, pharmaceutical, power plants, food and textile industry

WATER INDUSTRY

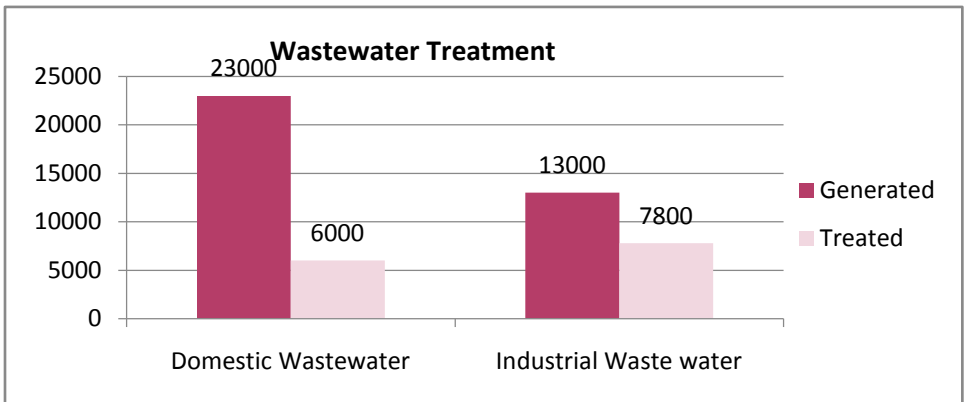
- Large Players like VA Tech Wabag, Degremont, Hindustan Dorr-Oliver, Paramount, Ion Exchange, Thermax etc
- Medium Sized Players like Doshion, Aquatech, Fontus Water, Driplex, TEAM, Ions Hydro
- Small Players over 500 in number

WASTEWATER TREATMENT

Water and wastewater treatment will remain high potential business opportunity in India. The increase in population and hasty boost in urbanization have put demands on urban cities to cater to the increasing water needs of the people. With the increased demand on agriculture to meet the growing food demands of the nation, the agriculture consumption of water has increased. Moreover, the emergence of a new industry and manufacturing has put pressure on water requirements and water treatment.

The chief end users in the water market are the municipal authorities and the Public Health Departments. The major industries connected with the water sector include cement, chemicals, fertilizers, food & beverage, paper, pharmaceuticals, power, refineries, sugar, tanneries and textiles. End user commercial establishments comprise hospitals, hotels and housing development.

Given increased demands on water, wastewater treatment as source for industrial usage has increased. The following graph depicts Wastewater generated and treated levels domestically and industrially. In Indian nearly 78000 million liters of industrial water has been treated and 6000 million liters of domestic water is treated.



India is a growing market for water and wastewater treatment.

R&D ACTIVITIES

Many public and private institutions have been performing research and development activities in water area. Lot of joint research with international organizations has been witnessing since functioning of S&T cooperation agreements between India and other countries. The World Bank finances a number of projects in urban and rural areas that are fully or partly dedicated to water supply and sanitation. Some of the ministries like Ministry of Water Resource (MWR), Central Soil and Materials Research Station (CSMRS), Central Water Commission (CWC), Central Water and Power Research Station (CWPRS), National Water Development Agency (NWDA), Central Ground Water Board (CGWB), DST, DBT, CSIR etc have been sponsoring various research activities with regard to water, waste water and other water related topics. Some intuitions like Indian Council of Agricultural Research, National Environmental Engineering Research Institute have been funded in water research activities.

KEY INNOVATION ACTIVITIES

Since 2001, number of innovative approaches to improve water supply and sanitation has been tested in India. Major innovative activity is developments in Public Private Partnerships (PPP) which can accelerate solutions and enhance operations and service:

- Provide access to utility infrastructure-improvement of living standards
- "Whole-project" funding available via appropriate finance packages – so no project delays
- Asset realization occurs at a fair price, delivery on time
- Optimal plant operation, skills & technology transfer
- Realistic tariffs and charge
- Recruiting the private sector in the water industry brings in capital and finance and reduces waste and lowers costs when supported by effective governance and transparency.

INDIA AND EUROPE – JOINT WORK

In the recent years major concerns are water shortage and water quality hence the need to find innovative solutions to overcome the shortages. The government has given priority to the revival of groundwater tables through watershed management, the conservation of rainfall, and the development of low-cost sanitation. With experience in water sector, the EU has joined hands with the Government of India, state governments and NGOs with deep knowledge of local problems and local practices of sustainability to assist in the development of water policy and the promotion of field level projects.

The EU is partnering with the Government of Rajasthan in developing and implementing statewide water sector reforms leading to sustainable and integrated water resources management. Working with the EU, the Government of Rajasthan has produced a water sector policy and action plan, which has been adopted by the State. EU's financial commitment of €80mn. comes in the form of budget support and technical assistance for the institutional development and capacity building of line departments, local governments or water user groups; implementation of community based management of water resources in selected blocks of 11 districts; increasing awareness for demand management; water campaigns; investing in water conservation and restoration of groundwater levels; and the creation of a state water regulatory authority.

WATER RELATED RESEARCH

In the EU's Seventh Framework Program, India is fourth largest international partner for science and technological development. In FP7 Environment sector/theme, there are around 18 EU-India projects of which four projects are focused on the water related topic:

- Highland aquatic resources conservation and sustainable development
- HighNoon: adaptation to changing water resources availability in northern India with Himalayan glacier retreat and changing monsoon pattern
- Coordinated Asia-European long-term observing system of qinghai tibet plateau hydro-meteorological processes and the asian-monsoon system with ground satellite image data and numerical simulations
- Enhancement of natural water systems and treatment methods for safe and sustainable water supply in India

The European Commission and the EU Member States together with the Indian Government have identified water-related challenges as the initial overarching theme offering real potential for mutually beneficial cooperation and have launched several coordinated call for proposals.

EU-India cooperation in water technology and management: research and innovation for budget of 3 million euros.

Biotechnological wastewater treatments and reuse in agronomical systems and Verification of GMO risk assessment elements and review and communication of evidence collected on the biosafety of GMO.

India-EU Partnership for a Strategic Roadmap in Research and Innovation: Several common problems faced both by EU and India in the supply of safe drinking water identified to address through collaborative R&D and educational and training activities. Additionally, the objective is to link with the private sector, including SMEs from Europe and India.

A Strategic Forum for International S&T Cooperation (SFIC), composed of high level representatives of the European Commission and the Member States, has been set up to steer the implementation of this new EU/Member States partnership. SFIC has chosen India as strategic partner country with which to start implementing its first pilot initiative focusing on water-related challenges.

PRIVATE PUBLIC PARTNERSHIP IN WATER AND WASTE MANAGEMENT

The government of India has undertaken major policy initiatives to encourage private-Public participation (PPP) in water sector. The early PPPs in the Water Sector were marked by the private sector investing in setting up basic utilities and infrastructure. That appears to be changing since Year 2000, where the private sector is getting more involved in setting up Water Treatment Plants and Sewerage Treatment Plants and not just investments in basic water utilities. The trend for PPP in the water sector slowed down since some of the initial efforts using this approach failed to deliver desired outcome. However starting from 2005 there have been success stories.
The PPP projects mainly fall under four segments of the water value chain

- Bulk Water Generation,
- Treatment (Desalination, Wastewater),
- Distribution of Water
- Network Rehabilitation.

The models suggested by the government for PPP are the following:

Model; Project Initiatives	**Duration**	**Value Chain(VC)/ Operator's Risk**	**Reasons for Success**
Model I: O&M with Limited Investment (Chandrapur, Latur, Madurai, Mysore)	Upto 10 years	**VC**: Distribution, Treatment & Bulk Water **Risk**: O&M, Collection	• Operator does not have an investment risk • Tariff curve is pre-fixed prior to bidding • All commercial risks with operator

Model II: BOT for Industrial Water Supply- Haldia	25 years, BOT	**VC**: Rehabilitation, Distribution & Treatment for Industrial Water Supply **Risk**: Investment, Design, Construction, O&M, Collection, Tariff	• Institutional clients with high credit quality. • Industrial Water Supply
Model III: Bulk Water Supply- Chennai desalination, Bhiwandi	25-30 years Bulk water BOT .	**VC**: Bulk Water **Risk**: Investment, Design, Construction, O&M	• Only production risks

RIVER AND RIVER DEVELOPMENT PROJECTS

The government of India has recently undertaken some important river and river development projects focused cleaning up of river of pollutants, ensure clean water flows and better management of river water. Some of these projects include:

Roadmap for the Pamba River

Water resources development is also the subject of an innovative exercise in Kerala. The Pamba is a small river in Kerala. At the request of the Ministry of Environment and Forests, the EU-India Action Plan Support Facility-Environment (APSF) has assisted the government of the state of Kerala to create a road map for the management of the Pamba River. This experience will be used to develop a 'replicable model' for other river basins.

Ganga Action Plan

The Ganga drains 9 states of India. Today, the 2,525 km long river supports 29 class I cities, 23 class II cities and 48 towns, plus thousands of villages. Nearly all the sewage, industrial effluent, runoff from chemical fertilizers and pesticides used in agriculture within the basin, and large quantities of solid waste, including thousands of animals' carcasses and hundreds of human corpses are dumped in the river everyday

The most popular and tried cleaning effort is for River Ganga. As of now two cleaning action plans has been launched by the Government of India. Ganga Action Plan I was 900 crore launched in April 1985. It was declared closed and failed in 2000. Second Ganga ActionPlan (GAP II) from 1993 onwards covering 4 major tributaries of Ganga, namely, Yamuna, Gomti, Damodar and Mahananda. The program was further broad-based in 1995 with the inclusion of other rivers and renamed as National River Conservation Plan (NRCP).

Ganga could not be cleaned but 34 other rivers have been taken up for cleaning with the same failed model of "GAP".

Very recently, for the third time 10,082,437.89 EUR is sanctioned for river Ganga cleaning and rejuvenation. The third plan requires inputs in following line

(1) Requirement of roadmap development for River cleaning,
(2) Assessment of riverine ecology
(3) Technological and infrastructure innovations to tackle problems of river pollution.
(4) Techno-economic solutions of sewage treatment plant design and development
(5) Management of river during peak pollution load at the time of holy dips
(6) Bio-mapping and biota conservation most important and neglected task. Many species unique to river Ganga needs conservation strategy.
(7) Problem of siltation and impacts due to dams
(8) Impact of melting glaciers and fate of river Ganga.

Yamuna Action Plan

This river conservation plan is under National River Conservation Plan. Banks major cities like Delhi and Industrial Hubs around. All the cleaning effort are gone waste. The river requires management of its water resource with proper town planning strategy.

Mandovi River

This river is affected by the mining activity on its banks in State of Goa. Due to a high content of manganese, iron, cobalt and other trace elements leaching from iron ore dumps on their banks during the monsoon season the content of metals in water column. The river is mixing with Zuari river, this has impact on the estuarine ecology. The river cleaning was undertaken under National River Conservation Plan. 2,631,974.75 EURwas sanctioned out of which 1,754,650.79 EUR are spent as of day. The Mandovi River requires roadmap for pollution control and impact due to mining activity.

5. CONCLUSION

As evidenced by its position on Innovation Efficiency Indices, India has the tremendous ability to create innovative products and solutions under difficult conditions. However, it is yet to be demonstrated if this ability can be translated into innovation capability.

The innovation capability is the capacity to produce consistently high quality services and products that are creative and innovative to solve social & business problems. This capability requires, in addition to individuals' ingenuity and perseverance, an ecosystem of innovation that fosters and continuously supports innovation. The innovation ecosystem includes and quality education to supply talent in diverse areas, government policy & initiatives that encourage and facilitate individuals, organizations and enterprises to generate solutions, finance to fund the commercial activities, infrastructure of affordable and efficient transportation and urban space for living & working, and above all a forward-looking mindset that looks at problems as opportunity to generate solutions and not as an inevitable conditions impossible to overcome.

India's performance, as outlined in this report, is below average in all the required components of an innovation ecosystem. Although India has been making progress it needs to take rapid strides to match the pace of its peers among the developing nations.

The government policy makers do recognize the lacuna in the system. Hence concerted effort is being made to overcome the drawbacks through establishment of National Innovation Council, which has an ambitious agenda of creating an innovation movement in India. The NIC rightly recognizes that the innovation, in the context of India's tremendous challenges of demography, disparity and development, needs to look beyond R&D input/output measures and focus on inclusive innovation. It has developed a comprehensive strategy for knowledge creation diffusion application, and commercialization, development of skills and education, re-engineering of processes and service delivery methods, and to address information infrastructure needs along with finance. In translating this strategy into action NIC has undertaken several important measures including India Inclusive Innovation Fund to address the financial needs, State & Sectorial Innovation Councils, establishing of Innovation Clusters and innovation in education. NIC is moving at a rapid pace and taking right steps, but it is too early to evaluate its impact.

Despite the challenges and slow progress India still offers innumerable opportunities as a source for generating innovative products and solutions for global market and as a market for innovative solutions. As discussed and outlined in section on different industry sectors, the prospects are many. Several European enterprises are active in these sectors. Some of the areas that offer opportunities for the European Union entities, both private and public are the following:

Innovation Centers: EU organizations too can harness the available talent in India to undertake R&D activities both for global audience as well as create new products for Indian consumers.

NInC Initiatives: The National Innovation Council and its various initiatives such as the billion-euro India Inclusive Innovation Fund, cluster innovation centers at state, sector and university level.

Private/Public Partnerships in water management and wastewater treatment as well as major river cleanup projects initiated by the government of India.

Transportation especially modernization projects of India railway, urban transportation and construction & management of highways.

Energy sector for alternative energy and green energy projects as well as traditional power plants.

In addition to the above, EU entities can explore research collaboration and developmental opportunities in the academic and research entities.

6. BIBLIOGRAPHY

- Basant, Rakesh and Mani, Sunil (2012) *Foreign R&D Centres in India: An Analysis of their Size, Structure and Implications*. Indian Institute Of Management Ahmedabad, India
- Department of Science and Technology (2007-08). *Research and Development Statistics at a Glance.* Ministry of Science and Technology, New Delhi, India
- Department of Science and Technology (2009) *R&D Statistics.* Government of India, New Delhi
- EIU (2012) *A New Ranking of the World's most Innovative Countries.* Economist Intelligence Unit. Available at: www.eiu.com/sponsor/cisco/innovationindex09C
- FICCI (2007) *Survey of Emerging Skill Shortages in Indian industry.* Federation of the Indian Chamber of Commerce and Industry. Available at: www.ficci-hen.com/Skill_Shortage_Survey_Final_1_.pdf
- Futron Corporation (2009) *Futron's 2009 Space Competitiveness Index. A Comparative Analysis of how Nations Invest in and Benefit from the Space Industry.* Available at: www.futron.com/resource_center/store/Space_ Competitiveness_Index/FSCI-2008.htm
- IMF (2010) *World Economic Outlook.* International Monetary Fund. Available at: www.imf.org/external/pubs/ft/weo/2010/01 /pdf/text.pdf
- Lan, Xue and Zheng, Liang (2006) Multinational R&D in China: Myth and Realities (unpublished). School of Public Policy and Management, Tsinghua University, Beijing
- Mani, S. (2010) Chapter on India, UNESCO Science Report 2010. UNESCO Publishing Paris
- ------ (2010*a*) Are innovations on the rise in India since the onset of the reforms of 1991? Analysis of its evidence and some disquieting features. *International Journal of Technology and Globalization,* Vol. 5, Nos. 1 and 2, pp 5-42.
- (2009) *High-skilled Migration from India. An Analysis of its Economic Implications*. Working Paper Series 416. Centre for Development Studies, Trivandrum, India.
- (2010*c*) *The Flight from Defence to Civilian Space: Evolution of the Sectoral System of Innovation.* Working Paper Series. Centre for Development Studies, 428, Trivandrum, India.
- National Knowledge Commission (2007) *Innovation in India*, New Delhi, India
- Nayyar, D. (2008) Internationalization of firms from India: investment, mergers and acquisitions. *Oxford Development Studies*, Vol. 20, No. 1, pp. 111-131.
- NCAER (2005) *India Science Report, Science Education, Human Resources and*

Public Attitudes towards Science and Technology. National Council of Applied Economic Research, New Delhi.

- OECD (2008) *Reviews of Innovation Policy: China.* Organisation for Economic Co-operation and Development, Paris.
- Office of Adviser to the Prime Minister (2011). *Towards a More Inclusive and Innovative India*, New Delhi, India
- *The Economist* (2009) Health care in India: Lessons from a frugal innovator. *The Economist*, 16 April. Available at: www.economist.com/businessfinance/displayStory.cfm ?story_id=13496367
- UNESCO (2010) *UNESCO Science Report 2010*. UNESCO Publishing Paris.
- World Economic Forum (2011) *Global Competitiveness Report 2011-2012*, Geneva Switzerland.
- EU-India Relations Background. EUBusiness, June 2010. Available at: http://www.eubusiness.com/regions/asia/india-eu-guide/
- INTERNATIONAL COOPERATION: India Pilot Initiative; EC European Research Area 12 June 2012. Available at http://ec.europa.eu/research/era/areas/cooperation/india_en.html
- Presentation made by Dr Philippe De Touxi, EC Delegation to India http://www.gita.org.in/pdf/eu-india.pdf