Policy brief: Science, Technology and Innovation policy in India

Some recent changes

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INDIGO POLICY

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Contents

Foreword 4

Introduction 6

1 Some general features 7

1.1 Structure of gross expenditure on Research and Development (GERD) 7

1.2 Structure of S&T research system governance 8

1.3 Main research performers 9

1.4 Intermediary organisations 11

1.5 Cluster organisations 12

1.6 Knowledge production 13

2 Methodology 15

3 Evolution of India's Science, Technology and Innovation policy 16

3.1 Science, Technology and Innovation policy 2013 17

4 New government and current changes of STI 2015 18

4.1 National flagship programmes 20

4.2 New Research and Innovation policies, schemes and instruments 2014–2015 27

5 Possible impacts on STI cooperation with Europe 31

References 33

Foreword

This report on STI policies in India from the perspective of analytic support and background to the INDIGO Policy project is broadly structured into five sections.

The purpose of this report was also to identify possible ways in which India's STI policies could have a bearing on STI cooperation with Europe. Some focus was laid on the technologies, sectors of economy and R&D areas wherein such cooperation could fruitfully be initiated or strengthened.

The first section gives a synoptic view of India's S&T and R&D structure and distribution of GERD. Even though India's real GERD increased fourfold, when compared with national GDP it relatively stagnated. A large chunk, 70 % GERD, is from public sources while the private business enterprise sector accounts for about 30 %. The section goes on to present the governing structure of S&T in the country, main research performers and knowledge production of India's S&T system. In the 15 years from 1996 to 2014, India's global share of S&T output in terms of SCOPUS database increased from 1.8 % to 4.4 %. Patents filed in India witnessed a major surge in the five years from 2006 to 2012. In 2006 there were 28,940 patent applications filed and this number surged to 34,287 in 2009 and then to 43,674 in 2013.

The second section briefly presents salient features of various methodological details employed in writing this report.

The third section is on *'Evolution of India's STI policy'*. The new government under Prime Minister Modi has already endorsed and begun to implement the science, technology and innovation policy 2013 (STIP 2013) in a much more robust manner. More than half dozen flagship programmes of the new government (digital India, smart cities, clean India, make in India etc) launched in the last one and a half years have created enormous scope on the demand side of the innovation spectrum.

India is yet to reach the committed level of 2 % of GDP for R&D from its current level of below 1 %. Even at this level, it is relatively below the OECD average and 1.9 % of GDP in R&D by China. The new government under Modi has reiterated its commitment to increase its national GERD to 2 % of GDP in the coming years.

India established a reasonable level of R&D and innovation eco-system in space launching and satellite design, atomic energy, defence, pharmaceuticals, software, telecommunication networks, among other sectors. However it is yet to attain world-class infrastructure in R&D and an innovation ecosystem to become globally competitive. The country needs to double its R&D from its present level so as to expand and strengthen its innovation eco-system, particularly in the higher education and university sector.

Research intensity and funding in the academic sector is very low at around 5–6 % of GERD compared to OECD and Chinese average of 15–20 %. The present government recognises this gap and has reiterated its commitment to increase the research intensity in the university sector and has already begun to promote innovation and entrepreneurship in the university sector.

India's R&D tax incentives lack legal underpinning and this policy instrument has not contributed to increasing the private R&D contribution in the national R&D share as in the case of South Korea or Japan.

India has a big demographic dividend as more than half of its 1.2 billion people were under the age of 35 in 2015. From extrapolations, this trend will remain like this in the coming 25 years. However, there is a big challenge to India taking advantage of its demographic dividend due to the fact that 90 % of its labour force (nearly 470 million people) is in the informal sector with low skills and education. The government has therefore come out with a plan of action to skill 500 million people by 2020.

The fourth section, *'New government and current changes of STI 2015'* mainly focuses on the new flagship programmes of the government. As a part of the STIP 2013, the government seeks to move towards a new paradigm of STI policy with a view of focusing on inclusive growth and innovation. The government in its flagship and other programmes has already identified a number of sectors such as energy and environment, health, food, water, habitat and housing, industrial corridors, among others to promote inclusive innovation and development. There is already a visible policy movement in various social sectors such as the Aadhar smart card and the recent cash transfers scheme. The digital India programme continues to progress quite rapidly with about 910 million people in 2015 being issued with smart identification cards. The other flagship programme where the government through various industrial, financial and STI policies has promoted inclusive innovation is on building toilets for rural and semi-urban India on a massive scale. The government is mobilising the Corporate Social Responsibility Funds in the PPP model to promote inclusive innovation in toilets. The other sector which has begun to implement inclusive innovation policies is the cleaning of Ganga and waste utilisation as part of the clean India flagship programme.

There are about 6,000 industrial training institutes (ITIs) which urgently need modernisation and a total revamp in teaching methods so as to meet the demands of informal sector of the Indian economy.

In an effort to boost venture capital and start-ups, the present government has taken a series of steps through financial institutions, education and skill development ministries to promote start-ups. There are three new policy measures the government announced in the last budget in March 2015. The Prime Minister in September 2015 led a large business and government delegation to promote start-ups and attract FDI at Silicon Valley. The Prime Minister's meetings in Silicon Valley were focused on linking up India's flagship programmes on clean India and Ganga cleaning, digital India, make in India, smart cities and defence manufacturing with potential investors. Well-known CEOs such as those of Microsoft, Apple, Facebook, Google, GE, Intel, Boeing, Coca Cola, Pepsi etc., committed several collaborating projects on 'Triple Helix' model to be launched in the near future.

The other important part of the fourth section — 4.2 — presented a detailed list of new research and innovation schemes introduced by the new government in 2015. As already mentioned, it is too early to make any assessments on their level of implementation. It is sufficient to comment that implementation of all these schemes has already commenced as some budgetary allocations have already been made as per the March 2015 budget statements.

The fifth section *'Possible impacts on STI cooperation with Europe'* suggests three pathways of potential impact on STI cooperation that are visible and suggest some targeted policy actions. The major point being made in this section is that the EU-India cooperation projects under the FP4 to FP7 programmes have generated research and innovation potential. These programmes have been directly relevant to India's main flagship programmes like clean India, green India, smart cities, digital India and several other

areas. In other words an enormous amount of demand exists to convert and realise the research and innovation potential within India's new policy priorities. It is suggested that in this endeavour, EBTC could play an important part provided its role is revised and expanded.

Introduction

This report on science, technology and innovation policy (STIP) with the European Union is designed to briefly review developments in the last few years, reflect upon the current status and map out the major changes in STIP under the new government led by Prime Minister, Narendra Modi. The purpose of this report is also to identify possible ways in which India's STIP could have a bearing on the STI cooperation with Europe and some Member States. Some focus will however be laid on the technologies, sectors of economy and R&D areas wherein such cooperation could fruitfully be initiated or strengthened. This report is structured into three main parts. The first one will present some general features of the Indian economy and the contemporary status of R&D expenditure, research system governance, main research performers and knowledge production. The second part traces the evolution of STIP whereas the third will present some recent changes in STIP after the new government came to power in May 2014.

1 Some general features

The Republic of India comprises 28 states and seven union territories. India is the second most populated country in the world with a population of approximately 1.25 billion people. The country is recognised as the world's largest democracy and is divided into six major zones: East India, West India, North India, South India, Northeast India and Central India. India is the 7th largest country in the world and in recent times has been characterised as an emerging economy and an important actor of the new grouping; BRICS.

After witnessing an average economic growth rate of 8.3 % per annum for the period of 2004/2005 to 2011/2012 (p. 3 of the 2013/2014 economic survey), India's growth rate decelerated during the years of 2012/2013 to 2014/2015 to around 6.4 % per annum according to the economic survey released by the government in 2014[1]. This recent survey forecasts a growth rate of 8 % in 2015/2016. The World Bank and IMF give somewhat similar growth rate forecasts. India is the fourth largest economy in the world on PPP terms and India's per capita income is USD 3,176 (PPP). The service sector is the largest contributor to the GDP accounting for 65 %, while industry and agriculture contributions accounted for 18 % and 17 % respectively in 2014. Over 60 % of India's population is dependent on agriculture and they contribute for less than a fifth of India's GDP. Given this situation, a major industrial and economic focus of the new government's policies is directed towards doubling the proportion of the industry's contribution to GDP and reducing the burden and dependency on agriculture for the bulk of the population in the coming decade. Closely related to this is the macro-economic reality of India's labour force. More than 90 % of the Indian labour force is engaged in what is known as the informal sector and less than 10 % by all counts are in the formal sector. Given that the bulk of this informal sector's labour force comes from the agriculture and related sub-sectors of the economy, the major focus of new industrial and related urban policies is on reducing the dependency on agriculture. Such initiatives are being contemplated by invoking new plans and strategies in the 2014/2015 budget announcements to promote manufacturing, develop three to four industrial corridors across the country and at the same time create several new mechanisms for skilling and upgrading technological thresholds in traditional industrial sectors.

1.1 Structure of gross expenditure on Research and Development (GERD)

A large chunk of GERD, around 68 %, is met by government sources, while 30 % comes from the business enterprise sector. India's R&D intensity increased from 0.81 % in the years 2001/2002 to 0.88 % in 2011/2012. By means of comparison, the EU's average was above 2.2 %; the USA's around 2.76 %; China's 1.8 % and South Korea's 4 % in 2011/2012. One of the major problems

1 Central Statistical Office revised the national accounts aggregates by shifting to the new base of 2011/2012 from the earlier base of 2004/2005. This happened after the new government in 2014. This entailed some changes in the rate of GDP growth rates.

for an economy the size of India is the relatively low investment in GERD compared to other leading and BRICS countries. Even though in the last decade the business enterprise sector increased its share of GERD from 18 % to nearly 30 % in 2012, both the public and private investments in R&D have not kept pace with the growth of the economy, which nearly doubled (in terms of GDP) during the decade. It may however be noted that actual GERD increased more than fourfold between 2002 and 2012. The total figures of R&D expenditure of India which was Rs 17,038.15 crores (USD 3.48 billion)[2] in 2002 and which increased to a figure of Rs 72,620.44 crores (USD 13.1 billion)[3] in 2012 showing clearly more than a fourfold increase.[4]

In the last two years, the international economic crisis had some impact on private R&D investment. The figures of GERD/GDP did not witness any major change in the last two years ending 2015. However, the government has committed to increasing the investment from the current amount which is less than 1 % to 2 % of the GDP in R&D by the 12th plan (2012–2017). The most remarkable growth in R&D intensity has taken place in the business enterprise sector, which has witnessed a substantial increase from 18 % of GERD in 2003 to nearly 30 % in 2011/2012. From a global perspective, as of 2012 India spent about 2.7 % of the global R&D, which translates to USD 40 billion[5], a number which is expected to climb to USD 46 billion per annum by the end of the 12th plan.

2001–2002	2005–2006	2011–2012	2014–2015
170,380	299,320	726,200	798,820*

* Estimated
Note: 68 % from government, 30 % from private business enterprise and 2 % from others

Table 1: National expenditure on Research and Development *(in INR million)*. Source: Department of Science and Technology of the Government of India

1.2 Structure of S&T research system governance

Under the overall administrative and executive control of the Prime Minister's Office (PMO), the structure of the S&T system operates in a coordinated and consultative mode. The top level research policy formulation, planning, coordination and advisory role in S&T from a long term perspective (generally keeping five year plans in view) is carried out by three major actors: (i) the National Institution for Transforming India (NITI Aayog), which replaced the earlier Planning Commission; (ii) the Ministry of Science and Technology including the Department of Science and Technology; and (iii) the Principal Scientific Advisor, the Science Advisory Council to the Prime Minister. In 2010/2011 the Prime Minister's Office also set up a National Innovation Council with an advisory role, but after the new government took over the reins, major functions and the advisory role of this body were taken over by other individual ministries and NITI Aayog thereby leaving it somewhat inoperative.

The PMO and NITI Aayog represent the most powerful top bodies in the governance structure of India's research system. The second level comprises ministries in various S&T sectors, industry, finance, economy etc. As figure 1

2 According to the exchange rates of USD to Indian Rupee in 2002. Historical Exchange rate taken from http://www.xe.com/currencytables/?from=USD&date=2002-06-01
3 According to the exchange rates of USD to Indian Rupee in 2012. Historical Exchange rate taken from http://www.xe.com/currencytables/?from=USD&date=2012-06-01
4 http://www.nstmis-dst.org/PDF/Table2.pdf
5 http://www.ibef.org/industry/research-development-india.aspx

shows, at this level there are S&T departments such as the Department of Science & Technology (DST), the Department of Atomic Energy, the Department of Biotechnology (DBT), etc., and science councils such as CSIR[6], ICMR[7], and ICAR[8].

Under the Ministry of S&T, whereas departments such as DST control and distribute R&D funds in almost all areas of research, science agencies on the other hand are devoted to broad areas such as industrial research (for example CSIR, which houses 38 national laboratories), agriculture research (ICAR), medical research (ICMR) etc. The third level includes the higher education sector and the fourth level consists of the private business enterprise sector with their S&T and R&D labs. This private sector includes both Indian and foreign enterprises.

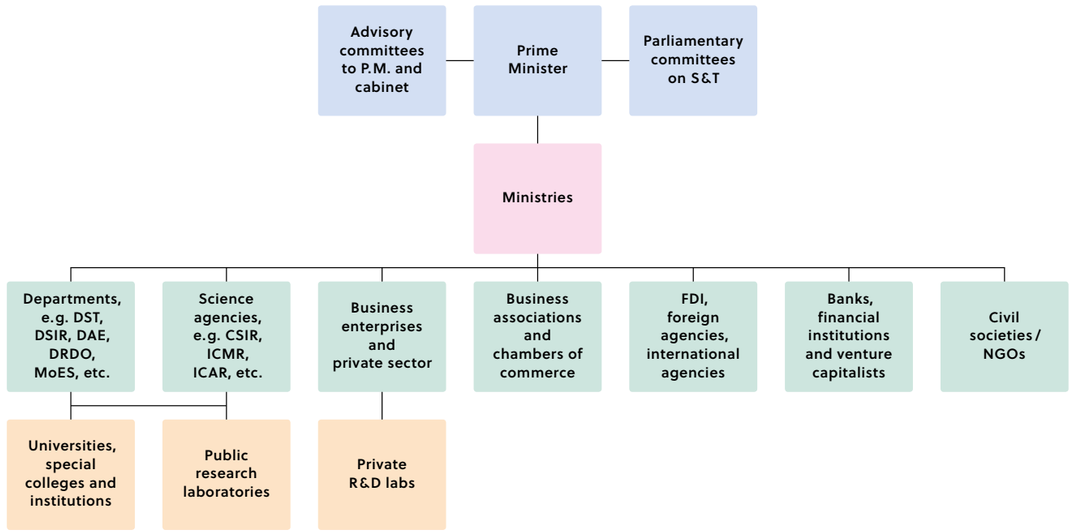

Figure 1: Overview of India's research system governance structure

The Ministry of Human Resource Development (MHRD) governs the sector of education consisting of primary, middle and higher education. Mainly four councils govern the higher education sector namely, the All India Council for Technical Education including management; the Medical Council; the University Grants Commission, which governs all public and private universities; and a body, which governs social science research and vocational education and training.

1.3 Main research performers[9]

The national innovation system is mainly constituted of a a) public research system; b) private business enterprise and transnational corporations (TNCs; both Indian and foreign); c) higher education institutions (universities and colleges); and d) NGOs and civil society organisations:

6 Council of Scientific and Industrial Research (CSIR)
7 The Indian Council of Medical Research (ICMR)
8 Indian Council of Agricultural Research (ICAR)
9 Some material for this section is drawn from Krishna and Patra (2015)

a) The public research system (PRS): This comprises national laboratories under a number of science and technology agencies from space, atomic energy, agriculture to industrial research etc, and in-house R&D laboratories in large public sector enterprises in steel, fertilisers, railways, power, transport and aviation, chemicals, petroleum and energy etc. PRS is India's main innovation system actor as it accounted for 68 % to 70 % of GERD during 2011/2012. Out of the total of 441,126 full time equivalent scientific and technical human resources in 2010, 61 % worked in major science agencies such as CSIR, DAE, DBT and in state government agencies, 14 % worked in universities and 25 % in the enterprises of private laboratories. The dominance of the PRS in India contrasts with other East Asian economies such as Korea and Japan where over 75 % of GERD comes from private sources. The role of state governments in GERD is quite marginal and the state science and technology councils created in almost all of the 28 states are just beginning to become proactive in assessing their strengths and weaknesses.

b) Private business enterprises and TNCs: This is the second major actor of the Indian innovation system, which accounted for nearly 30 % of GERD in 2012 and about 25 % of the total scientific and technical human resources of the country in 2010. In 1990/1991, the private sector accounted for 13.8 % of GERD. This figure increased to 20.3 % in 2001/2002 and to nearly 30 % in 2012. In recent years, the business enterprise sector has assumed considerable importance through the global competitive edge of Indian businesses in pharmaceuticals, automotive, software, telecommunications and biotechnology. Whereas the international economic crisis created ripples in the US and European markets and industry in so far as the auto and IT sectors are concerned, a more optimistic market scenario emerged in the Indian case. In 2009, in the midst of the crisis, Tata launched the world's cheapest car, the Tata Nano, into the Indian market. The second Indian auto firm, Mahindra & Mahindra also launched its new indigenous model 'Scorpio', a semi-utility vehicle. Another player that entered the market in 2012 is Bajaj with its mini car RE60.

The other sector, which witnessed robust growth and expansion, is telecommunications. The Indian telecom market is one of the fastest growing markets in the world. There are more than 950 million mobile subscribers in India and more than 200 million internet users. The third sector witnessing a reasonable growth despite the economic crisis is India's IT and services industry, which contributed to over 7 % of India's GDP in 2014. More than 3 million professionals work in this sector, which generated revenues to the tune of USD 110 billion in 2014.[10]

The trend of global R&D investment flow to India is sustained and grew in 2014. About 271 global TNCs operate their R&D centres or laboratories in India. The investments particularly converge in laboratories in Bangalore, Hyderabad, Delhi, Pune and Chennai. Bangalore is the preferred destination of foreign R&D centres accounting for 45 % of the firms. It is followed by NCR (Delhi) with 22 % of the centres. Much of India's FDI — foreign direct investment — in R&D has gone to major cities such as Bangalore, which have developed a functional local innovation eco-system and knowledge hubs. Compared to the situation in the 1980s known as the era of 'adaptive technology' for local markets, in the last few years TNC R&D centres in India are oriented towards 'creative technology' for high-end Indian industry and global markets.

10 Some material drawn from Krishna and Patra (2015)

c) Higher education institutions (HEIs): With over 750 universities with 35,000 affiliated colleges, much of the recent dynamism witnessed in the knowledge-based and high technology sectors of the Indian economy is as a result of the human resources, skills and the knowledge base created in the higher educational sector. In an effort to sustain this dynamism, the government increased the higher education budget threefold in 2009/2010 compared to 2004/2005. However, R&D in HEIs in India is a weak link in India's national innovation system. It accounts for a mere 14 % of scientific and technical personnel compared to 61 % of total R&D personnel of the country in PRS. Higher education R&D accounts for less than 5 % of the GERD.

However, universities accounted for over 52 % of India's total research publications in 2012/2013, which makes the sector a very important knowledge-producing actor of the innovation system. The most eminent and well-recognised HEIs are the 20 Indian institutes of technology, 6 Indian institutes of management, 12 institutions of national importance (such as the Indian Institute of Science and the Tata Institute of Fundamental Research) and about 20 central universities (like JNU). Together with these institutions, a tiny proportion of about 5 % of state-level universities may be considered as India's high-ranking research-based HEIs. By all means, a bulk of nearly 70 to 75 % of HEIs are pre-dominantly teaching universities and colleges which are yet to achieve the Humboldtian goal of being classified as teaching and research-based institutions.[11]

d) Non-governmental research institutions aided by both public and private sources: This sector plays a very important role in representing the civil society. In the last few years, NGOs have begun undertaking substantial policy oriented research relating to science and technology issues. The sector has also come to influence decision-making as regards to policy in the country. NGOs are involved in research in diverse fields like the environment, ecology, energy, rural development, women and gender, grass root innovations and small technologies research including cottage and micro enterprises. India's science, technology and innovation system has evolved over a long period of time. It may be said that this is the most stable and growing innovation system among the emerging economies. Even though it was dominated by the public research sector, the business enterprise sector was the fastest growing domain of GERD in 2011/2012.

1.4 Intermediary organisations

The role of intermediaries in technology and innovation processes has been related to the classic role of 'middlemen' in areas related to the agriculture, wool and textile industries of the 16th, 17th and 18th century Britain.[12][13] Intermediary organisations become important and more crucial when it comes to some key aspects of S&T communication and cooperation among different actors that are more specifically related to technology diffusion & transfer, innovation management, networks and service organisations.[14] In the case of India, there are various organisations which work as intermediary organisations such as the National Research Development Council (NRDC), the Technology Development Board (TDB), the Federation of Indian

11 Ibid.
12 Howells, J. (2006) *Intermediation and the role of intermediaries in innovation*, Research Policy, 35: 715–728
13 Smith, C. (2002) *The wholesale and retail markets of London, 1660–1840*, Economic History Review, LV(1): 31–50
14 Howells, J. (2006) *Intermediation and the role of intermediaries in innovation*, Research Policy, 35: 715–728

Chamber of Commerce & Industry (FICCI) and Small Industries Development Bank of India (SIDBI). The National Research Development Council (NRDC), an organisation established in 1953 by the government of India, is one of the most important intermediary organisations working in the area of technology to develop, promote, commercialise and patent the technologies which are being developed by various national R&D laboratories.[15]

The Technology Development Board (TDB) is another organisation established by the Government of India under the provisions of the Technology Development Board Act, 1995.[16] Some of the main functions of the TDB include working as a main intermediary organisation by bringing on-board different actors from industry and academia such as technocrats, scientists, experts and specialists to an interaction with the end result being encouraging innovation, entrepreneurship and creating new jobs.[17] Furthermore, FICCI, though being a business organisation, has with the help of its various initiatives and programs worked as an important intermediary organisation through the creation of an effective bridge linking R&D and innovation to the wider society: one such example is FICCI-DRDO ATAC (Accelerated Technology Assessment and Commercialisation) — a partnership by which FICCI helps to commercialise technologies developed by DRDO.[18]

1.5 Cluster organisations

Cluster organisations do not exist as such in India but there are various research associations which are similar to a cluster of industry players working and collaborating in terms of joint R&D.

Examples of such research associations include Ahmedabad Textiles Industries Research Association (ATIRA), Tea Research Association (TRA), Wool Research Association and Automotive Research Association of India (ARAI). ATIRA, founded in 1947, is one of the oldest research associations in the country related to the textile industry. Since then, it has played a major role in the textile industry by providing a platform for joint R&D related to textile technologies and manufacturing.[19] ATIRA was recognised by the Council for Scientific and Industrial Research (CSIR) two years after its inception in 1949. The Tea Research Association (TRA) traces its roots to the British colonial rule in India and dates back to 1900 when the Scientific Department of the Indian Tea Association (ITA) was established.[20] The Tocklai Tea Research Association was formed in 1964. As an important organisation, TRA helps in the transfer of technology to its members' tea estates and also engages in research and development related to almost all the aspects of tea cultivation.[21] Wool Research Association is also another example of a cluster organisation that serves its members by providing better training and scientific aspects of wool production. Wool Research Association also provides human resource training and wool testing facilities.[22] The Automotive Research Association (AIRA) on the other hand, is a research association focusing on the automobile industry in India. AIRA is also supported by the Ministry of Heavy Industries and Public Enterprises of the Government of India.[23] Some

15 http://www.nrdcindia.com/english/index.php/about-us/about-nrdc/
16 http://www.tdb.gov.in/
17 Ibid.
18 http://drdoficciatac.com/index.aspx
19 http://atira.in/AboutAtira.aspx
20 http://www.tocklai.net/
21 http://www.tocklai.net/about-tra/tra-the-organisation/
22 http://www.wraindia.com/
23 https://www.araiindia.com/

of the important functions of AIRA include R&D, testing, certification, approval and formulation of vehicle regulations.

1.6 Knowledge production

Research Publications: India's national scientific output as measured in the SCOPUS database increased more than four times from 20,625 in 1996 to 114 449 in 2014 as shown in table 2. During the same period, India's share of the world output increased from 1.8 % to 4.4 %. However, in terms of its share in the Asian region, India's output only slightly increased from 12.54 to 13.4 % for the same period.

Year	Documents	Citable documents	Cites	Uncited documents	% Intl. collaboration	% Region	% World
1996	20,625	20,335	234,797	4,303	16.90	12.54	1.80
2000	23,749	23,211	331,509	4,964	14.99	11.42	1.91
2005	40,083	37,885	498,605	9,155	19.11	9.86	2.17
2006	46,239	43,731	533,036	11,306	19.06	10.17	2.37
2007	51,569	48,614	546,369	13,103	19.53	10.49	2.50
2008	58,865	55,373	530,737	16,265	18.64	10.75	2.72
2009	66,802	62,976	523,224	18,939	18.18	10.78	2.94
2010	78,955	74,310	468,902	25,255	17.11	11.53	3.28
2011	95,979	90,199	403,544	36,585	16.19	12.45	3.75
2012	105,279	98,863	294,336	47,956	16.16	13.04	3.98
2013	111,184	104,522	158,914	64,417	16.35	13.01	4.11
2014	114,449	106,078	34,961	95,902	16.36	13.44	4.40

Table 2: Indian publication data. Source: Scopus[24]

As previously stated, most of the scientific publications emanate from HEIs and PRIs. According to the SCOPUS database, Indian institutions published 114,449 papers in all areas of science and technology in 2014. Whilst public research institutions accounted for 42 % of the total publications, HEIs on the other hand accounted for 52 % of the total publications. The business enterprise sector was a minor actor with just 3 % of the total publications. Even though Indian HEIs accounted for a mere 4–5 % of GERD they accounted for half of the national scientific publication output.

Patents

A total of 9,622 USPTO[25] patents were granted to inventors with an Indian address from 1990 to 2011. Among these patents, there were about 6,580 (about 70 %) that were granted to and are owned by foreign entities, resulting from their R&D work undertaken in India during the period of 1990 to 2011. The patents cover a wide range of technological areas. The period from 2000 to 2011 revealed a technological shift in the types of firms involved and the types of patents that were granted. Pharmaceutical, chemical and consumer goods firms were predominantly involved in patenting activity before 1995, whereas from 1995 onwards, ICT firms were more involved in this

24 http://www.scimagojr.com/countrysearch.php?country=IN
Note: Data for 2012 drawn in September 2013 from the author's Database, CSSP, Jawaharlal Nehru University, New Delhi
25 United States Patent and Trademark Office

process. This has a strong correlation with the foreign R&D units that were setting base in India over the same period. It may be noted that patenting in the software sector is only a recent trend. Much of the R&D work carried out in India in software, though of high quality, is of contractual nature feeding into parent companies. The established practice of the software firms was to obtain 'protection' through copyrights. Patents filed in India witnessed a major surge in the five years from 2007 to 2013. In 2007 there were 28,940 patent applications filed and this number surged to 34,287 in 2010 and then to 43,674 in 2012/13[26].

26 http://www.ibef.org/industry/science-and-technology.aspx

2 Methodology

This policy report has drawn from a variety of methodological tools both theoretical and empirical. At the outset it may be worth pointing out that since 2014 the new government took over the reins, STI policies, particularly relating to new flagship programmes are still in the process of being crafted and articulated. This has been the main limitation in interpreting data and information with regard to the implementation of relevant programmes. From a theoretical perspective, the aim was to undertake an explorative, descriptive, constructive and an interpretative analysis. In tracing the evolution of India's science and technology policy, historical analysis and perspective was used and found quite fruitful.

From an empirical methodological perspective, data and information was collected from three main sources, namely:

a) Primary sources: Much of the information and data for Section 4 on 'New Government and Current Changes of STI 2015' relating to various national flagship programmes and changes in science, technology and innovation policies in 2014 and 2015 was drawn from the relevant ministry websites, policy statements issued by the relevant ministers and bureaucrats and reports and news items as reported in national newspapers. Other primary sources also include brief interviews held with research managers and professionals who constitute the decision making organs in institutions such as the Council of Scientific and Industrial Research (CSIR), the Department of Science and Technology, Ministry of S&T and NITI Ayog (body which replaced the former Planning Commission).

b) Secondary sources: From 2009 to 2014 various reports were written for European Commission's platforms on research and innovation policies, namely ERAWATCH and Inno Policy Trendchart analysis. Selectively, information was drawn as was deemed relevant to this present report. These background reports were useful for Sections 1 and 3. The Ministry of Science and Technology's annual reports, R&D statistics reports and other documents were used in obtaining data and information on GERD and other quantitative indicators.

c) Much of the exploration and analysis presented in Section 5 and Section 6 are an interpretative analysis based on the interviews and examination of reports on S&T policies of India and her STI cooperation with the EU. Neither evaluation nor examination on the effectiveness of various new policies and programmes was intended as the new government had just come into power. It was too early to make any such attempts.

3 Evolution of India's Science, Technology and Innovation policy[27]

The evolution of India's STI policy may be historically traced to the 1950s. In 1958, India's first Prime Minister, Jawaharlal Nehru, in collaboration with some elite scientists (e.g. Homi Bhabha), introduced the scientific policy resolution (SPR) for the first time to the Indian Parliament. India was one of the first developing countries to pass such a document in Parliament. It demonstrated India's vision of S&T for peace, development and industrialisation and at the same time, its commitment to use S&T for solving India's social and economic problems. The period from 1947 to 1973 is generally considered as the phase of 'policy for the sciences' during which the main emphasis was on creating a basic infrastructure for S&T in the country including the expansion of the university sector for the supply of required S&T human resources (Krishna 2007).

Formal science and technology policy making in India emerged in 1974 when India's first science and technology plan (1974–1979) was announced. This plan explicitly stated the goal of attaining indigenous technology capacities in various sectors. In an effort to protect and build the local research and technology base, policies of self-reliance and import substitution were strengthened with significant implications for public research institutions in the 1970s and 1980s. These concerns were further articulated in the 1983 '*Technology Policy Statement*', which reiterated the need to strengthen institutions to build India´s indigenous technological capacity. The period of the 1970s and 1980s is generally seen as the phase of 'S&T for policy' when India entered the nuclear and space 'clubs' of the world with some remarkable technological breakthroughs in these fields of research and innovation. This is also the phase when India made some strides in green revolution through agricultural research and technology.

Major economic and liberal reforms were introduced in 1991, but no new formal S&T policy document was issued until 2003. However, the passing of the 2003 S&T policy document did not evoke much enthusiasm as reforms in various sectors of the economy including various S&T fields had taken place with the economic liberalisation of 1991. One of the major changes of S&T policy after 2003 was the shift in promoting globalisation and exports. This is the phase when India's ICT software, pharma, auto and telecommunication sectors witnessed a good deal of growth and dynamism. Indian S&T policy in this period continued to vigorously strengthen and promote the strategic sectors of atomic energy, defence and space research. 100 transnational corporations have since set up R&D centres to take advantage of the ICT capacities and relatively high economic growth rates of the country since the year 2004.

No major formal S&T policies had been introduced from 2004 to 2012 when India's 12th plan (2012–2017) was announced in 2012. This plan contained a chapter on science and technology with a number of policy goals and objectives being identified. The most important objectives endorsed by the government were as follows:

27 Some material in this section is drawn from Krishna (2007 and 2012).

- The Plan document has set the goal of attaining 2 % of GDP for R&D from the current level of 1 %. The objective here is to encourage the business enterprise to double its contribution to GERD from the current proportion of 30 %.
- In an effort to accomplish the goal of a knowledge-based society and economy, the government has given top priority to both elementary and school level education as well as higher education. The goal is to allocate 6 % of the GDP education in the XII five year plan period. This plan has earmarked a fourfold increase in GDP for education in the plan period. In terms of pragmatic goals, the aim is to increase the enrolment ratio in higher education from the current level of 15 % to 30 % by 2020:
- To strengthen the human resource skill base, particularly in nuclear, space and new technologies such as biotechnology and genetics, nanotechnology and ICT in universities and other institutions of higher education.
- To enhance India's competitiveness in micro, small and medium scale enterprises by making national laboratories' R&D relevant to the needs and demands of this sector.
- To foster research and innovation policies to accomplish the goal of a second green revolution.
- To strengthen India's intellectual property, particularly in public research institutions and the higher educational sector. The overall aim is to boost entrepreneurship and innovation potential that is currently seen as dormant in universities and national laboratories.
- To promote new modes of public-private partnerships in higher education and the commercialisation of scientific research results of national laboratories.
- To promote international science and technology collaboration by participating in international 'mega projects' as an 'equal partner' to enhance India's international reputation in the big science.

3.1 Science, Technology and Innovation policy 2013

The much awaited science, technology and innovation policy 2013 (STIP 2013) was announced by the government at the Indian Science Congress Centenary sessions held in Kolkata on the 3rd to the 9th of January 2013. Though this much awaited realisation had come a decade and a half late, India nonetheless had entered the 'club' of advanced as only a select group of emerging economies have national innovation policies. Three years before STIP 2013, the President of India declared 2010 to 2020 as the 'Decade of Innovation'. Compared to the science and technology policy of 2003, STIP 2013 is a step forward in attempting to forge the links between the science, technology and innovation policy framework. Some of the main policy objectives of STIP 2013 are as follows:

- to enhance the role of the private sector in the national science, technology and innovation system in a public-private partnerships (PPP) mode, towards attaining the target of 2 % of GDP in research and development (R&D);
- to position India among the top five global scientific powers by 2020;
- to integrate agriculture R&D policy with the national R&D system;
- to promote mechanisms such as a 'Risky Idea Fund' and a programme called 'Small Idea Small Money' to capitalise on the existing proposals of the National Innovation Council;
- to increase R&D personnel by two-thirds, within five years; and publications from the current 3.5 % of global share to around 7 % by 2020.

4 New government and current changes of STI 2015

The Narendra Modi led government was formed in May 2014. A number of changes have since taken place in the economic, political, industrial and educational as well as in other sectors which have a bearing on science, technology and innovation activities. With the coming of the new government, the most significant change in the STI policy has been a focus on innovation and economic growth that is much stronger than in any of the previous governments. Even though there has not been any significant increase in the GERD or S&T budgets, the government has generated a considerable sense of optimism to promote science, technology and higher education in the country. Compared to the 1980s and 1990s when the STIP and allocation of R&D and S&T budgets were confined to the Ministry of Science and Technology in conjunction with the Prime Minister's Office (PMO) and the Planning Commission, currently STIP is more decentralised. Under the Modi Government, besides the Ministry of S&T and the PMO, the individual ministries such as energy, railways, heavy industry, education, environment, electronics and water are allocated budgets for various flagship programmes, which include R&D, S&T and skill-related activities. The individual ministries therefore control and regulate more STI-related activities than before.

Even though the Planning Commission has now been replaced by a new body, NITI Aayog, the new government endorsed 12th plan (2012–2017) includes the goals and objectives related to STI that are noted above. Similarly, the government also endorsed STIP 2013, announced just a year back by the previous government. Secondly, the Prime Minister followed in the footsteps of his predecessors by inaugurating the Indian Science Congress Association (ISCA) in January 2015. He not only reiterated the government's commitment and support to science and technology research and higher education, but also gave a big thrust to the policy discourse on STI. He stressed that, 'there is a mood of optimism for change in the country, the energy to pursue it and the confidence to achieve it. But the dreams we all share for India will depend as much on science and technology as it will on policy and resources'[28]. The Prime Minister not only identified a number of sectors and projects where the government is likely to focus its policy attention, but also made some significant steps to eradicate red tape, bureaucratic hurdles in laboratories, increasing transparency and particularly went on to motivate the scientific community. His commitment to S&T for development, as also envisaged by earlier Prime Ministers of India, was clearly evident from his several observations made at the inaugural session of ISCA. 'To me, the arms of science, technology and innovation must reach the poorest, the remotest and the most vulnerable person. This is an enterprise of national importance in which each of us — government, industry, national laboratories, universities and research institutions — have to work together. Too often, a discussion on science and technology is reduced to a question of budgets. It is important and I am confident that it will continue to grow'. The Prime Minister underlined a number of areas where policy focus is required. The most important ones are as follows:

28 http://www.narendramodi.in/text-of-pm-shri-narendra-modis-address-at-the-102nd-indian-science-congress-2924/

- to make agriculture more resilient and yield more; to do more from every drop of water;
- to make clean energy affordable and its use more efficient;
- to find solutions to make cities cleaner and more habitable; to use technology to realize the dream of housing and sanitation for all;
- to use the internet to improve human development; to improve health care and develop medicines and devices that are at the reach of the poorest; incorporate traditional and local knowledge, systems and technologies for effective, affordable and sustainable solutions;
- to have clear regulatory policies for R&D in biotechnology, nano-science, agriculture and clinical research;
- to place the university system at the cutting edge of research and development activities in the country. Universities must be freed from the clutches of excessive regulation and cumbersome procedures. They must have a higher degree of academic freedom and autonomy and there should be as much emphasis on research as on teaching.
- to ensure a strong intellectual property regime that continues to work effectively and provides the right balance between private incentives and the public good.

The Prime Minister, who witnessed India's space mission to Mars in September 2014, made a special reference to further boosting Indian space science and technology. The three areas where special emphasis intends to be laid are making India a manufacturing hub; science, technology and innovation for the poor and most vulnerable; and promoting university, industry and government linkages (Triple Helix). Three overarching economic policy goals of the Modi Government, which radiate direct signals across a range of sectors including science and technology are:

- to achieve rapid economic growth without losing sight of equity related issues;
- to boost manufacturing in the country the Prime Minister coined the term 'Make in India' directed at sustaining and creating new employment opportunities;
- to enhance India's competitiveness both nationally and internationally to boost exports.

In the last year, Modi's Government has also identified a number of national flagship programmes and missions, which entail S&T, R&D and technological inputs and resources including financial and human skills. Each flagship programme involves a group of multiple sectors and a heavy coordination through a group of ministries. These programmes are:

1) Make in India
2) Digital India
3) Skill India
4) Green India
5) Smart Cities and Urban Development
6) Clean India *(Swachh Bharat)*
7) Creating new infrastructure.

4.1 National flagship programmes[29]

4.1.1 Make in India

The Prime Minister announced this programme on the occasion of India's Independence Day on 15 August 2014. He said 'come, make in India. Come and manufacture in India. Go and sell in any country of the world, but manufacture here. We have skill, talent, discipline and the desire to do something. We want to give the world an opportunity to come make in India'. This national programme of the Government of India is structured in a way to promote investment, innovation, enhance skill development, protect intellectual property and build the manufacturing sector in the country. The program is steered by the Department of Industrial Policy and Promotion (DIPP) and the Ministry of Commerce and Industry. It seeks to make use of India's existing talent base and at the same time envisages creating additional employment opportunities in the secondary and tertiary sector. 25 sectors were identified where the programme will be initiated.[30] As the secretary of DIPP observed, two important measures have been taken care of to promote and make it attractive to various national and international investors. The first is to make it easier to do business in India by creating measures such as a one-window clearance for proposals and the removal of bureaucratic hurdles. India currently stands at position 142 among 189 nations in the World Bank's ease of doing business index (2015). The main goal is to improve this ranking. The Prime Minister has also reiterated to foreign investors that all hurdles in doing business with and in India will be drastically curtailed and removed.[31] To this end, the government has created an investor facilitation cell (www.makeinindia.com).

Secondly, the government opened up a vast range of sectors for foreign direct investment (FDI). In some sectors such as rail, the government allows 100 % FDI and in other sectors such as defence it allows 55 % of FDI. There are already some early results of the campaign of make in India:

- The European controlled AIRBUS consortium has entered into collaboration with the Mahindra Group which manufactures jeeps, SUVs and cars in India. Both groups formed a joint venture to produce helicopters in India and jointly bid for defence projects. Guillaume Faury, Airbus Helicopters CEO observes that 'the joint venture will be dedicated to supplying the Indian Armed Forces with "Made-in-India", state of the art helicopters of high reliability, quality and safety standards based on combat-proven platforms'.[32]
- German automotive firm Mercedes Benz has decided to double its assembly capacity in India.
- Ford USA decided to export cars from India to the USA.
- Hitachi has decided to set up auto component production in Chennai's auto hub.
- Huawei, a Chinese multinational, opened a new R&D campus in Bengaluru.
- iPhone maker Foxconn is planning to set up the first Apple plant in India

29 It may be noted that this heading of 'National flagship programmes' is not the formal name given by the government. It is being used for the sake of grouping important programmes under one head. It may also be pointed out that foundations for several of these programmes such as digital India, manufacturing, infrastructure, smart cities etc were already laid by the previous government, though in a different form and strategy. The credit to concretely package and put them on the policy agenda goes to the Modi Government.

30 These include automobiles, aviation, chemicals, defence, electronic systems, IT, media, oil and natural gas, ports, thermal power, railways, food processing, auto components, space, biotechnology, food processing and a vast number of labour-intensive sectors like textiles, roads, tourism and leather.

31 The Economic Times, 3 July 2015

32 The Times of India, 4 July 2015

while LG, South Korea had already begun to manufacture smartphones in India.[33]

4.1.2 Digital India

The new flagship programme 'Digital India' aims to foster India's relative success in the ICT software, e-governance and telecommunications sectors that has been observed in the last decade. India is currently exporting about USD 100 bn worth of software and related services in engineering, health etc. In terms of mobile diffusion, India stands next to China with 950 million mobile phones being used by the population. The major thrust of this new programme is to leapfrog India to a new paradigm on the basis of the solid platform already created so as to bridge the digital divide. On the 2nd of July 2015, the Prime Minister formally inaugurated the digital India programme. He set out a very ambitious goal to deliver governance through mobile phones and to expand the internet connectivity throughout the country. In addition, a goal to deliver services relating to health, education and social welfare through 'information highways' has been set. The government has already issued unique identification cards *(Aadhar Card)* to 800 million people. These cards are based on the digital biometric information, equivalent to the national social security card in several countries. This initiative is currently ongoing in a bid to cover India's entire population. Even though the mobile penetration is quite substantial, internet penetration is still relatively low, both in a mobile and a surface mode. There are currently about 213 million mobile internet users. The broadband services user-base in India is expected to grow to 250 million connections by 2017. The sector is expected to grow at a rate of more than 15 to 20 % per annum.

There is an ongoing process under the National Knowledge Network (NKN) — a broadband network to connect all educational and research institutions in the country. This is will be extended to international gateways. The final part of this connectivity focus being championed by the present government is the goal of ensuring a last mile connectivity and internet access to the rural population through a National Optical Fibre Network (NOFN). The initiative will begin by connecting 250,000 villages.

The second important feature of digital India is the creation of platforms for all types of e-services (passports, driving license, tax bills, health, education etc) through the Aadhar card platform and other expansions of mobile broadband services. GIS services will be made use of to track mobility, progress of work, to map physical assets etc.

The third important feature of digital India is its use in applications and programmes across a range of sectors from education, health and various other socio-economic and commercial services. Closely linked to this, this programme is also making available all types of government information from development to decision-making on an open government platform (OGPL).

The fourth important feature is the creation of data centres and a framework for cyber-security to offset attacks. Four large national data centres have been set up in Delhi, Bhubhaneshwar, Hyderabad and Pune. Big data analysis features are closely linked to these centres, but are administered separately. As Sam Pitroda comments, 'Digital India is all about democratisation of information at all levels with openness, accessibility, connectivity, networking and decentralisation'.[34]

33 The Economic Times, 3 July 2015

34 See also *What it Means to Create a Digital India*, by Sam Pitroda, The Economic Times, 5 July 2015

A major thrust of digital India, as indicated by the Prime Minister, is to aggressively promote the manufacturing of electronics in India. There is an ambitious plan to manufacture all electronic needs of the country indigenously by 2020 saving around USD 400 bn in foreign exchange. Leading Indian industrialists and some foreign industrialists who gathered at the formal launch of digital India committed INR 4.5 trillion in the coming five years.[35] India's 12th plan already envisaged knowledge networks and expanding the internet and digital services, but the new government has made this an important flagship programme of the country with clear-cut goals and targets to achieve. For instance, in the 2015/2016 budget, the Finance Minister allocated a budget for the construction of a 750,000 km network through optical fibre thereby connecting 250,000 villages.[36]

Some early results

Google has entered into collaboration with Tata Trust to empower women in rural India to disseminate internet literacy through mobile 'internet carts'. Training on the usage of benefits of the internet is the major objective. The Intel Corporation has joined this initiative too.[37]

4.1.3 Skill India

As is well known by now, India is a young country with great potential to reap the benefits of the demographic dividend. As India's Finance Minister pointed out, in 2015, 54 % of India's 1.25 billion people were under the age of 25 years.[38] The demographic profile of the country is such that in the coming 25 years a predominant section of India's population is likely to be in the age group of 35–60. Thus, education, skills, training and entrepreneurship are likely to be very crucial towards the target of 8–10 % GDP growth per year in the coming decade. From this perspective, the new flagship programme skill India was launched with the creation of a new Ministry of Skill Development and Entrepreneurship (MSDE) out of the earlier Labour Ministry, which had a department dealing with skill development.

Soon after forming MSDE, the government lost no time in revising the 2009 national policy on skill development (NPSD 2009) by issuing the national policy on skill development and entrepreneurship, 2015 (NPSDE 2015).[39] NPSDE 2015's goals include:

- Making quality vocational training aspirational for youth through the simultaneous shift in the mind-set by making skills training a matter of choice, and in the mind-set of employers that skilled manpower will lead to increased productivity and will involve a payment of premium;
- Focusing on an outcome-based approach towards quality skilling those results in increased employability of individuals to available job opportunities;
- Increasing the capacity and quality of training infrastructure and trainers to ensure equitable and easy access for every citizen;
- Addressing the human resource needs by aligning supply and composition of skilled workers with the requirements of the industry and the country's strategic priorities including flagship programmes;
- Establishing an IT-based information system for aggregating demand and supplying of skills to help align efforts towards bridging the existing and expected skill gaps;
- Promoting national standards in the skilling space through active involvement of the employers in creating the curriculum, providing standards and paying skill premiums to workers;
- Operationalising a well-defined quality assurance framework aligned with global standards to facilitate mobility of labour;
- Leveraging modern technology to ensure scale, access and outreach, in addition to ease of delivering content and monitoring results;
- Recognising the value of on-the-job training, by making apprenticeships in actual work environments an integral part of all skill development trainings.

Creating an ecosystem for entrepreneurship development that would encourage self-employment and entrepreneurship can mainly be achieved through increasing support base for entrepreneurship, providing proper guidance & information and well integrated system of education & entrepreneurship and providing access to credit and investment.[40] Furthermore, this can help in fostering innovation and social entrepreneurship which can be more inclusive in terms of addressing the needs of people who are at the 'bottom of the pyramid'. This could in a broader perspective help to address the needs of the people who are both socially and geographically disadvantaged.[41]

According to the new NPSDE 2015 policy, an estimated 25.97 million people are expected to enter the workforce every year. By 2022, this figure is estimated to have clocked 181.79 million people. As the policy further points out, 119.5 million people need to be trained by 2022, which translates into 17.07 million people per year from 2015. This is the scale at which the new policy is aiming to skill India. The Ministry of Micro, Small & Medium Enterprises has three wings to implement the new policy. These are a National Skill Development Corporation under public-private partnership; a National Skill Development Agency to coordinate and harmonise the country's skill development activities; and the National Skill Development Fund for building capacities in people both in the formal and informal sectors of the economy (90 % of India's labour force is working in the informal sector).The 2015 budget launched a scheme called '*Deen Dayal Upadhyaya Gramin Kaushal Yojna*' for training, education and entrepreneurship. The Skill Development Ministry is entering into partnerships and collaborations with several EU countries such as Germany, France and other countries such as Japan, South Korea and Australia in drawing on their experiences and for developing viable collaborations for India's skill mission.

4.1.4 Green India

Green India has a major thrust focusing on renewable energy technologies and innovation. As the Finance Minister recently noted, India's 'carbon tax' on petroleum products compares favourably with international norms. The 2015 budget made special allocation to launch a new scheme called 'Faster Adoption of Manufacturing of Electric Vehicles' (FAME). This will complement the e-car being produced by the Mahindra Group under the brand

35 Mukesh Ambani 2.5 lakh crores (2.5 trillion); Tata Group to create 60,000 jobs; K. M. Birla 12,000 crores; Sunil Mittal of Airtel 101,872 crores; Anil Agarwal 40,000 crores; Anil Ambani 10,000 cores, Ping Cheng, Delta Electronics, Japan 3,000 crores of INR (The Times of India, 2 July 2015; The Economic Times, 2 July 2015)
36 The Economic Times, 2 July 2015
37 The Times of India, 4 July 2015
38 The Economic Times, 1 March 2015
39 See http://www.skilldevelopment.gov.in/National-Policy-2015.html for more details of this ministry and the work and plans in the coming decade. The list of objectives are being quoted from http://www.skilldevelopment.gov.in/assets/images/Policy%20ver3-%20final_draft.pdf
40 http://planningcommission.nic.in/reports/genrep/rep_eco2708.pdf
41 http://portaldeperiodicos.unisul.br/index.php/EeN/article/viewFile/39/39/

name REVA. Through the Ministry of New and Renewable Energy, the green India programme has announced a new target of renewable energy: 175,000 MW of renewable energy in 2022 comprising 100,000 MW of solar; 60,000 MW of wind; 10,000 MW of biomass and 5,000 MW of small hydro projects. About 700,000 jobs are expected to be created through achieving the new targets by 2022. The previous government had earlier laid a very solid foundation and framework for a sectorial system of innovation in the solar sector through the Jawaharlal Nehru solar energy mission I & II programmes. The current initiative is to further leapfrog this platform.

4.1.5 Smart Cities and Urban Development

There are two flagship programmes under this heading. The first is the pet project of the Prime Minister, aiming at building 100 smart cities with a budget allocation of INR 480,000 million for five years. The second is the new urban development scheme called Atal mission for rejuvenation of urban transformation (AMRUT) with an enhanced budget allocation of INR 500,000 million. The latter is however the continuation of the previous government's urban renewal mission programme.

There are three basic features of the definition of smart city, namely: a) a city equipped with basic infrastructure to give a decent quality of life, a clean and sustainable environment through application of some smart solutions; b) basic infrastructure such as water, electricity supply, solid waste management, urban mobility and public transport, e-governance, citizen participation and safety and security of citizens; and c) a city which will have smart solutions to services, public grievance, 100 % treatment of waste and several processes which go into managing modern cities. The government has already allocated quotas of smart cities to various state governments. Uttar Pradesh will build 13, Tamil Nadu 12 and Maharastra 10.[42] While Japan is assisting in converting Banaras into a smart city, France has evinced interest in about 3–4 cities. These initiatives have come about during the Prime Minister's visits to these countries.

4.1.6 Clean India

There are two major thrust programmes for clean India. The first is the cleaning of Ganga River, which flows from the foothills of the Himalayas and travels 2,000 km passing several states with 41 tributaries joining it and finally ending up at the bay of Bengal near Kolkata. A new flagship programme called Namami Gange programme (NGP) with a budget allocation of INR 200,000 million for five years has come into operation.[43] NGP is a multi-sectoral, multi-dimensional and multi-stakeholder Ganga rejuvenation programme. Hence, the key ministries including (a) Water Resources and Rural Development, (b) Environment, Forests & Climate Change, (c) Shipping, (d) Tourism, (e) Urban Development, (f) Drinking Water and Sanitation and Rural Development have been working together since June 2014 to arrive at an action plan. There is a group of secretaries tasked to develop a draft action plan.[44] About 17 Indian institutes of technology and other R&D and S&T institutions are linked with the NGP. The Clean Ganga Project has assumed special significance, as Benaras or Varanasi is the Prime Minister's constituency. Under the NGP the following initiatives are being implemented:

42 The Times of India, 2 May 2015
43 https://nmcg.nic.in/NamamiGanga.aspx
44 Ibid.

- ensuring sustainable municipal sewage management;
- managing sewage from rural areas;
- managing industrial discharge;
- enforcing river regulatory zones on the Ganga banks;
- ensuring ecological rejuvenation by conservation of aquatic life and biodiversity;
- promoting tourism and shipping in a rational and sustainable manner;
- managing knowledge on the Ganga through the Ganga Knowledge Centre.

The second flagship project of clean India is the Swachh Bharat Abhiyan (clean India campaign), which is mainly directed at cleaning neighbourhoods and eradicating open defecation by providing toilets. Launched in 2015, it also aims at building toilets in schools and other training institutions located in rural areas. The massive programme involves various innovations in social and technical fields. The government has set a target to eliminate open defecation by the 150th birth anniversary of Mahatma Gandhi in 2019. The mission objectives are:

- elimination of open defecation;
- eradication of manual scavenging;
- introduction of modern scientific municipal waste management;
- creation of awareness and education on healthy sanitation practices and public health;
- promoting public-private partnership through corporate social responsibility.

The clean India programme is collaborating with the Bill and Melinda Gates Foundation and EU countries such as Netherlands.

4.1.7 Creating new infrastructure

A big push for infrastructure was underscored in the 2015 budget, which allocated INR 700,000 million to infrastructure covering roads, railways, ports and a range of sectors. A notable point of this programme is the rejuvenation of public-private partnerships on a new footing. The private sector will play a major role in building India's future infrastructure in the coming five years. The Reserve Bank of India (RBI) has allowed 100 per cent foreign direct investment (FDI) under automatic route in the construction development sector. The Indian port sector is likely to witness tremendous strides, as by the end of 2017, port traffic should amount to 943.06 MT for India's major ports and 815.20 MT to its minor ports. This amounts to a 40 % increase compared to previous years. Along with that, the Indian aviation market is expected to become the third largest across the globe by 2020, according to industry estimates. The sector is projected to handle 336 million domestic and 85 million international passengers with projected investments to the tune of USD 120 billion.

The government decided to promote five industrial corridors in India stretching the length and breadth of the country. These are: Delhi-Mumbai industrial corridor (DMIC); Bengaluru-Mumbai economic corridor (BMEC); Chennai-Bengaluru industrial corridor (CBIC); Visakhapatnam-Chennai industrial corridor (VCIC) and Amritsar-Kolkata industrial corridor (AKIC). Among these, DMIC has already come into operation. This is a state-sponsored industrial development project with a budget of USD 100 billion. The project aims at developing industrial zones spanning across six states in India, which will create economic and employment potential together with

developing industries along the corridor. DMIC received support from Japan, which has entered into an agreement to set up a project development fund with equal co-investment. The initial size of the fund will be INR 10 billion (USD 158.7 million). The dedicated freight corridor is expected to be completed by 2017.[45] It would be the biggest infrastructure project India has ever attempted in its history. The project will see major expansion of infrastructure and industry — including smart cities, industrial clusters along with rail, road, port and air connectivity — in the states along the route of the corridor. Many smart cities would be developed alongside.

India and the USA have also signed a memorandum of understanding (MoU) in order to establish an infrastructure collaboration platform. The document showcases the relationship between both governments, which intend to facilitate the US industry participation in Indian infrastructure projects to improve the bilateral commercial relationship and benefit both the participants' economies. The MoU's scope envisages efforts in the areas of urban development, commerce and industry, railways, road transport and highways, micro small and medium enterprises, power, new and renewable Energy, information and broadcasting, communications and information technology, water resources and river development and Ganga rejuvenation.[46]

Indian railways and French national railways (SNCF) will co-finance a feasibility study by SNCF for a semi-high speed project on upgrading the Delhi-Chandigarh line to 200 km/h and for the re-development of the Ambala and Ludhiana railway stations in Punjab.[47]

The Indian High Speed Rail Corporation and the Rail Vikas Nigam Limited under the Ministry of Railways will sign an agreement with the China Railway Siyuan Survey and Design Group for developing high-speed trains between Delhi and Chennai at 300 km/h stretching 1,754 kms.[48]

4.1.8 Ease of doing business

The government has initiated several mechanisms to ease doing business in India, especially aimed at foreign investors. Some of the main provisions are as follows[49]:

- Set up exclusive commercial divisions in the courts to help ensure the speedy resolution of commercial disputes;
- Introduce a public contracts (resolution of disputes) bill to streamline the institutional arrangements for the resolution of such disputes;
- Appoint an expert committee to draft legislation to ensure that regulatory approval can be granted expeditiously;
- Maintain and update an e-business portal which integrates 11 regulatory permissions relating to doing business in India at one source (this portal is now active);
- Progressively expand the 'visas on arrival' scheme from 43 countries to 150 countries;
- Remove distinctions between the different types of foreign investments (foreign portfolio investment [FPI] and foreign direct investment [FDI]). Currently the aggregate foreign investment permitted in a sector has separate caps for FPI and FDI. It is proposed that all types of foreign investment will be captured under a composite cap, which will provide Indian companies with greater flexibility when seeking foreign investment and investors more clarity and certainty when investing.

45 The Economic Times, 6 May 2015
46 http://www.ibef.org/industry/infrastructure-sector-india.aspx (Government source)
47 http://indianexpress.com/article/india/france-to-partner-india-in-building-semi-high-speed-rail-network/#sthash.Oaj5GDP8.dpuf
48 Hindustan Times, 14 November 2014
49 http://www.kwm.com/en/au/knowledge/insights/indian-union-budget-what-foreign-investors-need-to-know-20150318/
See also http://indiainbusiness.nic.in/newdesign/index.php?param=investment_landing/247/1/

4.2 New Research and Innovation policies, schemes and instruments 2014–2015

Descriptions of research and innovation policies, schemes and instruments up to 2013 introduced by the previous Government led by Dr. Manmohan Singh, can be found in the India profiles at the two EU supported STI policy web directories; namely ERAWATCH[50] and InnoPolicy Trendchart analysis. References on STI policies, schemes and instruments introduced by the new Modi Government are listed hereunder.

4.2.1 New policies and instruments 2014–2015

National Policy on Skill Development and Entrepreneurship 2015[51] [52]

On the 1st of July 2015, the union cabinet of the Government of India approved the national policy on skill development and entrepreneurship 2015. This approval followed the review of the earlier national policy on skill development which was brought in 2009 by the Ministry of Labour and Employment. The policy document of 2009 provided the mechanism for a review in 5 years' time to align it with latest national and international trends. The latest 2015 policy on skills development and entrepreneurship, also relates to what Prime Minister Modi mentioned in his 2015 Independence day speech about start-ups where he said, 'start-up India; stand-up India.'[53] Furthermore, there are five major thrust areas of the latest policy. First, the policy seeks to address the major obstacles to skills development such as motivation, education and better training. Secondly, it aims to minimise the gap of demand and supply in terms of skills and works with industry to address this issue. Third, there is an emphasis on equality in skills dissemination keeping social and geographically disadvantaged sections in mind. Fourth, the policy takes into account women and their skills development as an important focus and priority area. In addition, there is a broader policy aspect related to connecting entrepreneurs to the larger ecosystem of entrepreneurship and innovation.

Self-Employment and Talent Utilisation (SETU)[54]

In line with the larger governmental commitment of providing skills and entrepreneurship, the current government announced plans to set-up a programme called self-employment and talent utilisation (SETU). The Finance Minister Arun Jaitley announced the SETU programme while presenting the country budget of 2015. He mentioned that SETU will be a 'techno-financial, incubation and facilitation programme to support all aspects of start-up businesses, and other self-employment activities, particularly in

50 http://erawatch.jrc.ec.europa.eu/erawatch/opencms/information/country_pages/in/country/ Report by V. V. Krishna, 2013
51 http://pib.nic.in/newsite/PrintRelease.aspx?relid=122927
52 http://pibphoto.nic.in/documents/rlink/2015/jul/p201571503.pdf
53 http://www.narendramodi.in/text-of-prime-minister-shri-narendra-modi-s-address-in-hindi-to-the-nation-from-the-ramparts-of-the-red-fort-on-the-69th-independence-day-211475/
54 http://niti.gov.in/content/setu.php

technology-driven areas.'[55] A special package of around USD 152 million has been allocated for this programme. This programme relates to some of the earlier mentioned flagship programmes started by the current government like make in India, skill India and development of entrepreneurship and start-ups. A special 15 member committee headed by Prof Tarun Khanna has been assigned the responsibility of outlining the details of the SETU programme along with another programme called Atal innovation mission (AIM).

Atal Innovation Mission (AIM)[56]

Atal innovation mission will be an innovation promotion platform involving academics, entrepreneurs, and researchers drawing upon national and international experiences to foster a culture of innovation and R&D in India. The platform will also promote a network of world-class innovation hubs and grand challenges for India. The main goals and objectives of the AIM programme are to provide an umbrella mechanism to look into the innovation ecosystem of the country, to bring on board and collaborate with various stakeholders and to provide and formulate policy inputs related to this area.[57]

With regard to this, the NITI Aayog set-up a 15 member committee headed by Prof. Tarun Khanna in April 2015 to provide the layout and framework of the Atal innovation mission (AIM) and SETU (self-employment and talent utilisation) programme which was due to submit its report in in December 2015.[58]

National Biotechnology Development Strategy, 2014[59]

The Department of Biotechnology in 2007 formulated the national biotechnology development strategy which was termed as the 'Biotech Strategy-I'. On reviewing the existing biotechnology strategy, the Department of Biotechnology in 2014 formulated and published another strategy document; the national biotechnology development strategy 2014 which was termed as 'Biotech Strategy-II'.[60] This updated strategy of the Department of Biotechnology has revised its 'vision-2020' goals where emphasis on the role of genetically modified (GM) crops in increased and better quality productivity has been stressed.[61] The 2014 'Biotech Strategy-II' talks about creating a world class regulatory body which can build trust and confidence with different important stakeholders like civil society, farmers, consumers and the scientific community. There is also mention and the requirement of setting up of a national regulatory body called 'Biotechnology Regulatory Authority of India' for which the bill is yet to passed and approved in parliament.

The Bioenergy Road Map – Vision 2020, November 2012[62]

The bioenergy road map – vision 2020 policy document which came in November 2012 is an important plan document for the future goals and orientations related to addressing key challenges of energy security through the use of bioenergy. This document envisages the larger future role of alternate fuels like biofuels, bioethanol and biodiesel on the growing accounts of oil scarcity, environmental concerns, climate change and sustainable development. This plan document has been prepared with the consultation of various experts in the field of academia, industry and various research institutes. One of the main points highlighted in this road map document is the provision of clean and green technology alternatives to the existing fossil fuel based options. Some of the goals which are mentioned in this road map document include: 20 % blending of biofuels by 2020, working on commercially feasible Lignocellulosic biofuels from agricultural and forest based waste, commercially viable option of algal production and working on next generation biofuels from different biomass. The major thrust for this futuristic plan document is the current unavailability of commercial second generation Biofuels in the country.

Consolidated Foreign Direct Investment Policy, 2015[63]

The consolidated foreign direct investment (FDI) policy, 2015 is a policy document related to foreign investment in the country. This policy plan encourages foreign investment in the country for the creation of domestic capital, technology & skills development and for the overall economic growth of the country. The detailed outlines and policy guidelines have been captured in the 'consolidated FDI policy, 2015' and the circular related to this policy which was issued on the 12th May 2015.[64] There are detailed accounts related to who can invest in India, calculations of FDI, foreign investment promotion board, prohibited and permitted sectors for FDI. This policy document also mentions details related to FDI in various sectors like agriculture, manufacturing, energy, service and pharmaceutical. The formulation of this consolidated FDI policy 2015 document is in alignment with the different flagship programmes and schemes which the current government has introduced. It touches on programmes related to 'make in India', 'skills India' and 'clean India' which span the manufacturing, skills and environment fields thus opening and providing a window of many investment opportunities in India.

National IPR Policy (Draft)[65]

The latest 'national intellectual property rights (IPR) policy draft which was published on the 19th of December 2014 is an attempt to update, strengthen and make the current IPR mechanisms more inclusive. This is very much related to both international and national obligations which India has towards the global world and its own people. Three important words which have been emphasised in the introductory passages of the document are *predictability*, *clarity* and *transparency* in the complete process of the intellectual property rights.[66] This in turn is given more importance to further boost India's growth in the areas of invention, innovation, R&D, trade, technology transfer and investment.[67] The future vision of the policy has been made more inclusive, where, with the importance of S&T, areas of arts & culture and traditional knowledge have also been provided with equal footage.

55 http://pib.nic.in/newsite/PrintRelease.aspx?relid=116187
56 http://niti.gov.in/content/aim.php
57 http://niti.gov.in/mgov_file/AIM%20Constitution%20of%20Expert%20Committee.pdf
58 Ibid.
59 http://www.dbtindia.nic.in/national-policy-guidelines-regulations/policies/
60 http://timesofindia.indiatimes.com/india/Draft-biotechnology-strategy-documents-highlights-importance-of-GM-crops/articleshow/31357500.cms
61 Ibid.
62 http://dbtindia.nic.in/wp-content/uploads/2014/05/BioenergyVision.pdf
63 http://dipp.nic.in/English/policies/FDI_Circular_2015.pdf
64 Ibid.
65 http://dipp.nic.in/English/Schemes/Intellectual_Property_Rights/IPR_Policy_24December2014.pdf
66 Ibid.
67 Ibid.

The importance of protecting and safe guarding food security, biodiversity resources and environment has likewise been mentioned including larger aspects of socio-economic development of the country. There are seven listed objectives of this policy document: intellectual property awareness, creation of intellectual property, legal framework, administration & management of intellectual property, commercialisation of intellectual property, enforcement & adjudication and human capital development.[68]

The larger vision and objectives of the latest IPR policy draft relates to broader aspects of the current government's initiatives related to many of its flagships programmes like 'make in India', 'digital India', 'clean India' and 'skills India'. At the time when the current government is trying to reform and boost the Indian economy, formulating this draft policy is a timely intervention in keeping up with the latest national and international trends.

4.2.2 Research and Innovation schemes introduced in 2014

i Stimulating investments in biotechnology and textiles through clusters (2014): development of biotechnology clusters in Faridabad and Bengaluru and seven mega clusters in textiles in Barelly, Luncknow, Surat, Kutch, Bhagalpur, Mysore and one in Tamil Nadu;
ii Deendayal Upadhyaya Gramin Kaushal Yojna (2015) for providing training in skills for rural youth;
iii Deendayal Upadhyaya Jyoti Yojna (2015) is meant for providing round the clock power and electricity to rural households and for agriculture.
iv Atal innovation mission (2015) will be an innovation promotion platform involving academics, entrepreneurs and researchers and drawing upon national and international experiences to foster a culture of innovation, R&D and scientific research in India. It will promote entrepreneurship among youth.
v Self-employment talent utilisation (SETU) scheme (2015) will be a techno-financial, incubation and facilitation programme to support all aspects of start-up businesses, and other self-employment activities, particularly in technology-driven areas. NITI Aayog will administer this scheme.

68 http://dipp.nic.in/English/Schemes/Intellectual_Property_Rights/IPR_Policy_24December2014.pdf

5 Possible impacts on STI cooperation with Europe

In this final section, some of the potential impacts of India's new STI policies on the EU-India STI cooperation are explored. There are a number of pathways and niche areas where STI cooperation between India and the EU as well as with individual European Member States could be enhanced or strengthened in the coming years. The change in government and the past two national budget presentations by the Finance Minister in 2014 and 2015 have infused a new sense of optimism for economic growth and development both at the national and international levels. For instance, Moody[69] has already upgraded its rating outlook for India. At the conclusion of his term in India, João Cravinho, Ambassador and Head of the EU Delegation in New Delhi, expressed considerable optimism. He observed that the 'Indian Government has managed to stabilise the macroeconomic situation, rekindle growth and curb both inflation and the current account deficit. Many of the government's initiatives to improve the business and investment environment are very encouraging and they will hopefully contribute to the ease of doing business in India'.[70] Concretely, three pathways of potential impact on STI cooperation are visible and suggest targeted policy action:

a) The EU and India have had an S&T Agreement for ten years and significant cooperation happened in the FP6 and FP7 programmes' joint projects. This decade-long collaboration has generated considerable research and innovation potential. A cursory look into the nature and type of projects under FP7 reveals the fact that the bulk of projects fall under the category of applied and oriented basic research rather than pure basic research. A good deal of research output has been produced in the EU-India cooperation projects, both in the form of joint research papers and patents in several S&T areas.[71] Much of the research output and knowledge already generated exists in fields such as water, environment, biotechnology, ICT, health, energy, among others. There is good ground to say that the EU-India cooperation projects have generated research and innovation potential relevant to India's main flagship programmes like clean India, green India, smart cities, digital India and several other areas such as infrastructure and transportation. In other words, an enormous amount of demand exists to convert and realise the research and innovation potential within India's new policy priorities. Dr João Cravinho already expressed his positive sentiments pointing to smart cities, digital India, cleaning Ganga etc. The impact of the EU-India S&T projects and cooperation will be determined by creating institutional mechanisms and instruments for promoting linkages and innovation. Presently, the innovation potential underlying the S&T cooperation projects has not been fully realised. On the other hand, new cooperation through S&T projects in the coming years could be conceptualised taking into account not only the new flagship programmes in India but incorporating institutional mechanisms to connect R&D with innovation.

69 Moody's Corporation, often referred to as Moody's, is the holding company for Moody's Investors Service (MIS), an American credit rating agency.
70 Financial Express, 8 May 2015
71 For instance see Gruber F., Piroi F. (2014) *Policy brief: Co-patenting in India*, Indigo Policy, ZSI, Austria

b) The above point directly leads to the expanded role of the European Business and Technology Centre (EBTC), which is already involved in biotechnology, energy, environment, transportation, and IPR areas. This EU coordinated platform could play a much more robust and dominant role in bridging the innovation needs and demands of India's flagship programmes with the knowledge already generated under S&T cooperation. At the same time Indian institutional mechanisms responsible for innovation, such as the National Research Development Council for instance, could play a much greater role than they are doing at present.

c) Beyond and outside the EU-India S&T Agreement and the framework programme projects, a new pathway has already emerged for the EU-India cooperation based on private firms, business enterprises and public enterprises. SNCF and Indian railways have tie-ups for developing high-speed rails. The Indian Essel Group signed a memorandum of understanding (MoU) with the German FeCon GmbH, a subsidiary company of Wind and Sun Technology GmbH, for the transfer of wind and solar energy technology to Indian partners. Mr. Ashok Agarwal, CEO, Essel Infraprojects, pointed out that the partnership will help the company deliver on its commitment to produce 12,500 MW of solar energy and 4,000 MW of wind energy in India in the coming year. Fraunhofer, a German S&T institution and Vikram Solar, an Indian firm, will collaborate to establish a solar academy in India to impart technical knowledge, expertise, and practical training in solar energy systems. The EU-India cooperation through private and public industrial enterprises is likely to witness a phenomenal growth in the coming years.

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