March, 2019
BPC Papers - V. 6 N. 1

BPC Papers

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Infrastructure Expenditure, Central Public Sector Enterprises and Electrification

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Maria Gabriela von Bochkor Podcameni and José Eduardo Cassiolato

BRICS Policy Center Centro de Estudos e Pesquisas - BRICS

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BRICS Policy Center

Rua Dona Mariana, 63 - Botafogo - Rio de Janeiro/RJ
Phone: +55 21 2535-0447 / ZIP CODE: 22280-020
www.bricspolicycenter.org / bpc@bricspolicycenter.org

BRICS Policy Center Centro de Estudos e Pesquisas - BRICS

INNOVATION SYSTEMS AND DEVELOPMENT GOVERNANCE

Coordinator
Luis Manuel Fernandes

Researchers
Paula Cruz

BPC Papers V. 6 N. 01 - January - April/2019.
Rio de Janeiro. PUC. BRICS Policy Center
ISSN: 2357-7681

32p ; 29,7 cm

1. India. 2. Energy Challenge.
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Executive Summary

In the 21st century, economic growth, increasing urbanization, demographic expansion, and advances in electrification as important drivers of energy demand have put significant pressure on the Indian energy landscape. Indeed, energy infrastructure problems are a major hindrance to India's economic growth. The central objective of this paper is to present and analyze some of the main State-led policy efforts that have been put in place to address India's energy challenge. In particular, we examine three main types of state-led energy policy in India: a) infrastructure expenditure, b) Central Public Sector Enterprises (CPSEs) investments and Research and Development (R&D) strategies, and c) electrification. Firstly, we present and examine current data on the role of the state in the development of India's energy sector. Secondly, we provide a nuanced examination of the role of public-private relations in India's energy sector, especially in contrast to the widespread advancement of the neoliberal agenda in the country recent years. We conclude that the Indian State has fostered an increasing participation of the private sector in infrastructure, especially in renewable energies in which PPPs type of procurement have been more relevant. CPSEs' expenditure in R&D has been of main importance in oil as well as in power. However, most of them tend to adapt foreign technologies instead of balancing foreign technologies with domestic technological efforts. Therefore, a main contemporary challenge for the Indian CPSEs performing in the energy sector is to deepen their connections and interaction with the other Indian NSI actors. Through the electrification process, the State has created markets for the private sector. Finally, we recommend further energy-related questions to be addressed in future research projects.

Key-words

India; Energy challenge; Public-private relationship.

Editors' Note

This publication results from the partnership between the BRICS Policy Center's Innovation and Development Governance Programme (BPC, IRI/PUC-Rio) and the Research Network on Local Productive and Innovative Systems (RedeSist, IE/UFRJ). Other joint initiatives included the colloquiums "Development and Inequality: The Role of Innovation Systems in the BRICS" (October 2014) and "The Future of Innovation Policy in Brazil: challenges and opportunities" (April 2015), and the publications of "The Evolution of India's National Innovation System and its Current Challenges: A First Reading from Latin American Thinking" (BPC Papers, v.4, n.4, May / August 2016) and "Sectorial Systems of Innovation in Emerging Countries: Software in India and Brazil in Comparative Perspective (BPC Policy Brief, v.8, n. 4, August 2018).

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Peer-reviewed by Esteban Serrani

1. Introduction

Energy-oriented technological efforts are of great relevance to the development of modern, capitalist societies. On a conceptual level, this connection between capitalism and energy infrastructure has been addressed by scholars of the neo-Schumpeterian approach, such as Carlota Perez (2001, 2002) and Freeman and Louça (2001), who focus on the centrality of energy in long-term economic development and techno-economic paradigm transitions. Recently, scholars such as Maharajh (2014) have posited that, following the decline in the use of nonrenewable natural resources, it is possible to identify the emergence of a low-carbon technological trajectory in the global landscape today.

In the Indian context, energy challenges have been present since before independence in 1947. However, in the 21st century, economic growth, increasing urbanization, demographic expansion, and advances in electrification as important drivers of energy demand have put significant pressure on the Indian energy landscape. This growing energy demand has further necessitated the use of an energy matrix that is dependent on carbon and petroleum imports. Meeting energy demands is one of the most significant impediments to India's economic growth. As a result, several technological efforts have been undertaken to address energy efficiency, renewable energies, technology transference contracts, etc. From an ecological perspective, the substitution (albeit partial) of fossil fuels by renewable sources represents a step forward for India's energy sector. This shift towards sustainable energy production has clear ecological impacts, but will also impact many other sectors of society. The construction of sustainable development models impacts a country's continuous modernization capacity for production tools, autonomy level of scientific and technological research, and sovereign participation in the international economy (Podcameni 2014).

Given this scenario, the main objective of this paper is to present and analyze some of the main State-led policy efforts and initiatives currently attempting to address Indian energy challenges. In particular, we examine three main areas related to the Indian energy scenario: **a)** infrastructure expenditure, **b)** Central Public Sector Enterprises (CPSEs) investments and Research and Development (R&D) strategies, and **c)** the electrification process. In this sense, this paper aims to provide a preliminary assessment of some of the macro-infrastructural policies that frame the Indian National System of Innovation (NSI) with respect to energy. It is part of a larger research project which has been conducted by the Research Network on Local Productive and Innovative Systems (RedeSist) with the goal of understanding and discussing the Indian development path and, more specifically, the evolution and challenges of the Indian NSI.[1] Here, we draw on existing literature on the energy challenge in India, relating it to a number of official reports, statements and data, including the Twelfth Five-Year Plan, the Public Enterprise Survey 2015-2016, the Integrated Energy Policy (2006), and the New Energy Policy Draft (2017). The focus on official documents serves not only as a way to analyze the recent policies regarding the country's energy sector, but also to assess the positioning of the public sector in this realm and the discourse mobilized to justify such a positioning.

The main contribution of this work is, first, to present and analyze a good deal of updated data on the role of the Indian State in the energy sector and, secondly, to provide a more nuanced view of the public-private relations in India, in contrast to the widespread advance of the neoliberal agenda in the country. In the first section of our analysis, we present and contextualize the Indian energy challenge. Next, we analyze data on infrastructure expenditures and different types of procurement, CPSEs privatization processes and R&D strategies, as well as the electrification process. We highlight the need to deepen the interrelationships between the Indian NSI and the energy imperatives of the Indian society and conclude with some final remarks.

2. The Indian energy challenge

From a historical perspective, the Indian State's efforts to deal with energy issues has configured the Indian NSI profile (Joseph el al. 2008; Gonzalo and Cassiolato 2017; Gonzalo 2018). Indeed, the increase in public investments in the energy sector has gone hand in hand with the country's economic growth acceleration process (Nagaraj 2013). Broadly speaking, despite having oil reserves, the oil price spikes of 1973, 1979 and 1990 had a severe impact on the Indian internal prices and external accounts, causing significant stress in the Indian policymaking sphere. After independence, especially during the Nehru administration, heavy industry and electric power were seen as main economic growth and technology drivers. Several hydro-electrical plants were set up, the department of Atomic Energy was created, a state monopoly for both electricity and nuclear sectors was established, different technology transference contracts were signed with the URSS related to nuclear and petroleum development, and many CPSEs were launched and supported, such as the National Coal Development Corporation, the Indian Refineries and the Indian Oil Corporation.

Since the late 1960s, with Indira Gandhi, fertilizing industries related to Green Revolution emerged as main priorities. In a context of different geopolitical shocks, droughts and domestic political stress, between 1970 and 1978, several nationalizations were pushed. For instance, we could mention the Indo-Burma Petroleum Corporation, the Indian Cooper Corporation, and several refining companies, such as the Indian Oil Blending, Esso and Burma-Shell. Fertilizer capabilities were partially indigenized. In addition, given India's military defeat to China in 1962 and the confrontations with Pakistan in 1965 and 1971, nuclear development with military objectives was stimulated, culminating in the first Indian nuclear detonation in 1974. During the 1980s, power public investment jumped.

(1) See, for example, Gonzalo (2018), Martins et al (2018), Gonzalo and Cassiolato (2017), and Gonzalo and Cassiolato (2016).

According to Chakravarty (1987), public investment went from an average of 18% of the total public expenditure during the 1970s to around 29% during the 1980s. The petroleum peaks of 1973 and 1978 and the beginning of the Indian growth acceleration turned necessary to reinforce power domestic investments (Gonzalo and Cassiolato 2017).

However, it is in the 21st century that urbanization, GDP growth, and rural electrification as main drivers of demand have turned energy into a pressing national priority and the main hindrance to India's GDP growth. In 2006, the Indian Prime Minister Manmohan Singh said in an interview with Financial Times that, 'the quest for energy security is second only in our (India's) scheme of things of food security' (quoted in Pardesi and Ganguly 2009: 309). According to the Integrated Energy Policy (2006: xiii),

> To deliver a sustained growth rate of 8% through 2031-32 and to Central Public Sector Enterprises (CPSEs) investments and Research and Development (R&D) strategies meet the lifeline energy needs of all citizens, India needs, at the very least, to increase its primary energy supply by 3 to 4 times and, its electricity generation capacity/supply by 5 to 6 times of their 2003-04 levels. With 2003-04 as the base, India's commercial energy supply would need to grow from 5.2% to 6.1% per annum while its total primary energy supply would need to grow at 4.3% to 5.1% annually. By 2031-32 power generation capacity must increase to nearly 8,00,000 MW from the current capacity of around 1,60,000 MW inclusive of all captive plants. Similarly requirement of coal, the dominant fuel in India's energy mix will need to expand to over 2 billion tonnes/annum based on domestic quality of coal. Meeting the energy challenge is of fundamental importance to India's economic growth imperatives and its efforts to raise its level of human development.

According to the International Energy Agency (2015), although India today uses only 6% of the world's primary energy, energy consumption has more than doubled since the 2000s. The organization projects that India will contribute more than any other country to the global rise of energy demand. A large expansion of coal output makes India the second-largest coal producer in the world, but rising demand also means that by 2020 India will become the world's largest coal importer, overtaking Japan, the European Union and China. Although a large and efficient refinery sector gives it a surplus of oil products for export, India is the world's third-largest importer of crude oil. India's power system needs to almost quadruple in size by 2040 to catch up and keep pace with electricity demand which, pushed by rising incomes and new connections to the grid, increases at almost 5% per year.

Clearly, this big picture is part of the challenge of dealing with the Indian energy transition. There are several studies discussing and highlighting the relevance of the Indian transition to a more sustainable energy matrix (e.g. Mishra and Kumar 2012; Tranum 2013). Addressing this larger discussion exceeds the aims of this paper. Therefore, here we simply rely on the existing literature to posit that, according to most of the projected energy scenarios, it will not be possible to fulfill the Indian energy demand for the next 50 years based only in solar and wind energy. In this sense, the relevance of gas, nuclear and hydro sources will be of main importance.

This energy scenario creates several geopolitical, technological and institutional challenges for the Indian State. The Twelfth Five Years Plan (2012-2017) calls for several efforts and actions such as: **a)** to step up the domestic production of coal, oil and gas and other energy sources implementing energy efficiency technology and R&D efforts, **b)** to provide a stable policy regime in order to ensure substantial private investment including foreign investment in oil and natural gas blocks

and new capacities for renewable energy, **c)** to emphasize investments in renewable energies, **d)** to invest in energy assets in foreign countries, especially for coal, oil and gas and uranium, **e)** to meet any possible disruption in oil supplies, having in mind the import-dependent, storage capacities that need to be created.

Energy security has become a central aspect of the Indian foreign policy, in what Sacheva (2011) calls "energy diplomacy". For Pardesi and Ganguly (2009), the Indian energy security strategy includes: **a)** diversification of suppliers and sources of energy, trying to harness hydroelectricity to reduce dependence on fossil fuels by developing several joint power projects with her neighboring countries such as Bhutan, Nepal, Myanmar and Afghanistan, **b)** to purchase equity on coal, oil and gas abroad, both by the Power CPSEs and the national private companies, in countries such as Indonesia, Australia, Bangladesh and South Africa, **c)** to promote investment in oil refining infrastructure and capabilities in order to emerge as an "energy outsourcing hub" in the Indian Ocean, **d)** to increase the energy reserves, **e)** to promote cooperation with China, in order to reduce competition and increase cooperation for energy security, and with the USA to develop civil nuclear energy, **f)** to boost military capabilities, mainly navy and air force, in order to enforce energy trade in the Indian Ocean.

In this context, it seems clear that India needs to encourage both public and private investment and efficiency efforts around the energy sector. In the next section, we explore some main initiatives related to this challenge.

3. State-led responses to the Indian energy challenge

In this section, we analyze three main energy-related areas, namely: **(1)** infrastructure expenditures, **(2)** CPSEs privatization, investments and R&D expenditures, and **(3)** the electrification process.[2]

3.1 Infrastructure expenditures: Public procurement, Public Private Partnerships (PPPs) and Private Investment

According to the Twelve Five Years Plan (2012-2017), for the period between 2007 and 2012 the total investment in infrastructure in India was 7.21% of the GDP,[3] with the public sector contributing 4.57% (Centre 2.5% and the States 2%) and the private sector 2.64%. Electricity, renewable and oil and gas investment totaled around 2.7% of the GDP, comprising more than one third of the total investment in infrastructure in India. Electricity was, by large, the main sector in terms of investment, totalizing around 30% of the total infrastructure expenditure, or 2.2% of the GDP (total investment in the electric sector was more than 10 times the one in oil and gas). Public sector investment contribution was greater than private sector contribution in the electricity sector, with 1.24% and 0.92% of the GDP, respectively, as well as in oil and gas, with 0.12% and 0.07%, respectively. However, private sector was the main investor in renewable energy, with 0.23% of the GDP, in contrast with only 0.03% of the GDP by the public sector.[4]

(2) We will mainly deal with figures since 2000s, because they are the most disaggregated ones and, as shown in the previous section, these have been years in which the private sector increased its participation in the infrastructure sector.
(3) In line with the Twelve Five Years Plan, infrastructure figures include Electricity (including RE), Roads and Bridges, Telecommunications, Railways (including MRTS), Irrigation (including WS), Water Supply and SN, Ports (including ILW), Airports, Storage, Oil and Gas Pipelines.
(4) See the Report on India's Renewable Electricity Roadmap 2030 (2015) for further details on the renewable sector.

For the period between 2012 and 2017 the figures are projected.[5] However, for the purpose of this paper, we will simply note that the State's intentions were to increase the private investment in infrastructure, in order to reach a "fifty/fifty" relationship between public and private sectors. The general trend of the public sector investing around 4% of the GDP in infrastructure has continued.

Table 1. Investment in infrastructure.
Centre, States, Total Public and Private. 2007-2017.[6] Rupees crore and %.

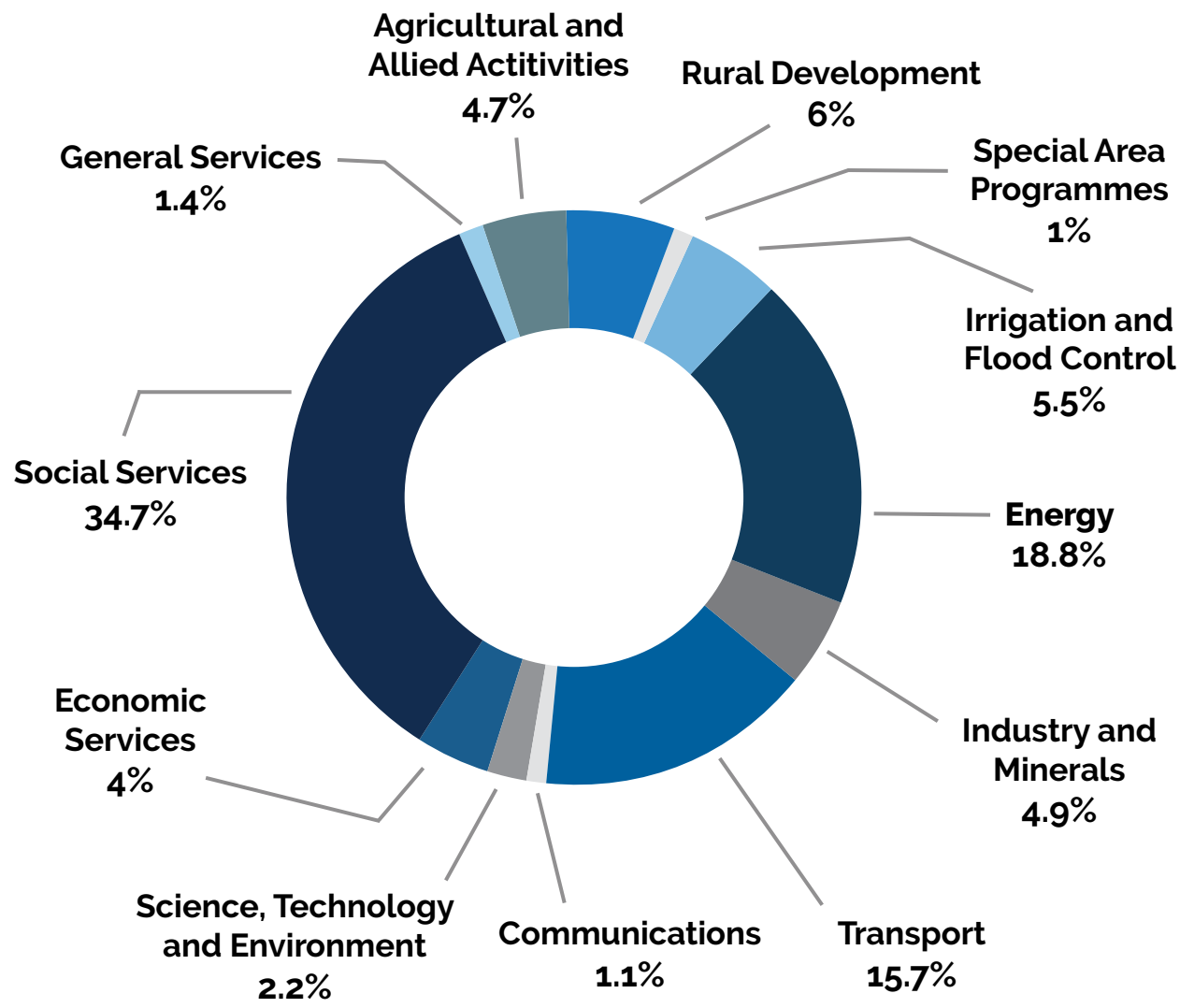
Sectors	11th Plan (2007-2012)	% of Total Infrastructure	% of GDP	12th Plan (2012-2017)	% of Total Infrastructure	% of GDP
	(Total)			**(Projection)**		
Grand Total	**2,424,277**	**100.00**	**7.21**	**5,574,663**	**100.00**	**8.18**
Centre	856,717	35.34	2.55	1,601,061	28.72	2.35
States	680,056	28.05	2.02	1,289,762	23.14	1.89
Total Public	1,536,773	63.39	4.57	2,890,823	51.86	4.24
Private	887,504	36.61	2.64	2,683,840	48.14	3.94
Electricity	**728,494**	**30.05**	**2.17**	**1,501,666**	**26.94**	**2.20**
Centre	233,501	9.63	0.69	440,796	7.91	0.65
States	184,696	7.62	0.55	347,043	6.23	0.51
Total Public	418,197	17.25	1.24	787,839	14.14	1.16
Private	310,297	12.80	0.92	713,827	12.80	1.05
Renewable Energy	**89,220**	**3.68**	**0.27**	**318,626**	**5.72**	**0.47**
Centre	9,630	0.40	0.03	33,003	0.59	0.05
States	1,018	0.04	0.00	5,425	0.10	0.01
Total Public	10,648	0.44	0.03	38,428	0.69	0.06
Private	78,572	3.24	0.23	280,198	5.03	0.41
Oil and Gas Pipelines	**62,534**	**2.58**	**0.19**	**148,933**	**2.67**	**0.22**
Centre	35,179	1.45	0.10	71,594	1.28	0.11
States	4,070	0.17	0.01	5,969	0.11	0.01
Total Public	39,249	1.62	0.12	77,563	1.39	0.11
Private	23,284	0.96	0.07	71,370	1.28	0.10

Source: authors' elaboration based on the Twelve Five Years Plan (2012-2017).

(5) According to Azad et al (2017), these figures have finally been smaller for both private and public sectors.
(6) The figures for the 2007-2012 period are confirmed. The ones for the 2012-2017 period are estimated according to the Twelve Five Years Plan (2012-2017).

In order to give an idea of the relevance of energy in the Indian public expenditure, in the next chart we present the total outlay of the Eleventh Five Year Plan (2007-2011) including Center, States and Central Public Sector Enterprises (CPSEs) by major sectors. We observe that energy is the second main sector, centralizing around 19% of the outlay, only surpassed by social services. The third main sector of expenditure is transport, mainly related to highways and route construction.

Figure 1. Total outlay (Center + States + Central Public Sector Enterprises) by major sectors. % of the accumulated outlay of the Eleventh Five Years Plan (2007-2011)



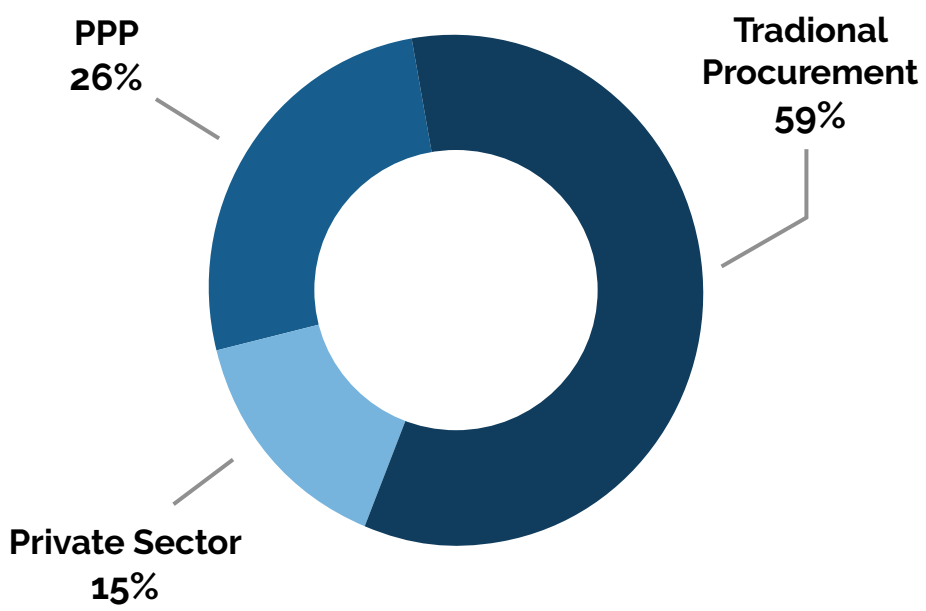
Source: authors' elaboration based on the Twelfth Five Years Plan (2012-2017).

There are three main ways to mobilize infrastructure projects: PPPs (Public Private Partnerships), private investment, and traditional (public) procurement.[7] The Department of Economic Affairs' database presented a total of 9,137 projects in infrastructure between 1991 and 2016. Of the total amount of projects executed in this period, 6,131 (around two thirds of the total amount) were contracted as traditional (public) procurement, 1,678 were PPPs and 1,318 were private investments.

(7) According to the official web page of the Indian Department of Economic Affairs on PPPS (https://www.pppinindia.gov.in/), PPPs are defined as infrastructure projects owned, developed and implemented jointly by the Government and private sector, through a partnership arrangement. Public Private Partnership means an arrangement between government or statutory entity or government owned entity on one side and a private sector entity on the other, for the provision of public assets and/or related services for public benefit, through investments being made by and/or management undertaken by the private sector entity for a specified period of time, where there is a substantial risk sharing with the private sector and the private sector receives performance linked payments that conform to specified and pre-determined performance standards, measurable by the public entity. Government Infrastructure Projects (Traditional Procurement) are defined as infrastructure projects owned, developed and implemented by the Government and Private Sector Infrastructure Projects are infrastructure projects implemented by the private sector.

With respect to the total expenditure, the proportions are similar, 59% of traditional procurement, 26% of PPPs and 15% of private investment. Of the total infrastructure expenditure in energy between 2000 and 2016, electricity generation, electricity transmission and renewable energy are the top three, concentrating more than 90% of the total infrastructure expenditure.

Figure 2.
Total expenditure in infrastructure projects. Private, PPPs and traditional (public) procurement. 1991-2016. %.



Source: authors' elaboration based on the Indian Department of Economic Affairs database on infrastructure projects.

Despite public procurement having been the main form to mobilize infrastructure expenditure, since the early 2000's the Indian Government redirected its focus from disinvestment and privatization, prioritizing instead the PPP model, especially as a preferred method for financing new infrastructure projects (Nagaraj 2006). According to data from the Indian Government, from the total PPPs expenditure between 1990-1 and 2016-17, 68% went to transport projects, 28% to energy, and less than 5% to social infrastructure and water and sanitation. Among the energy PPPs, according to the Report on India's Renewable Electricity Roadmap 2030, renewable energy accumulated around 25% of the expenditure.[8]

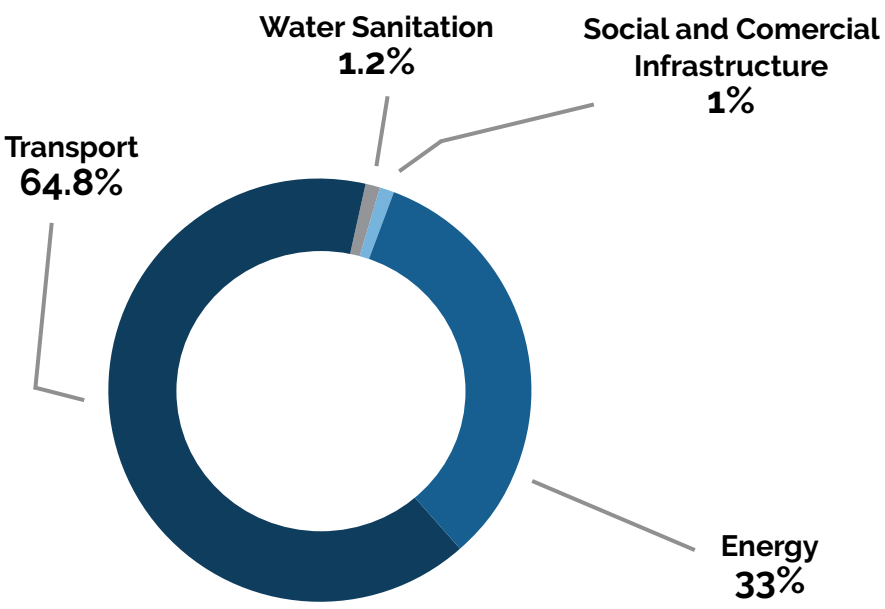


Figure 3.
Accumulative PPPs expenditure between 1990-1 and 2016-7. In % of total rupees.

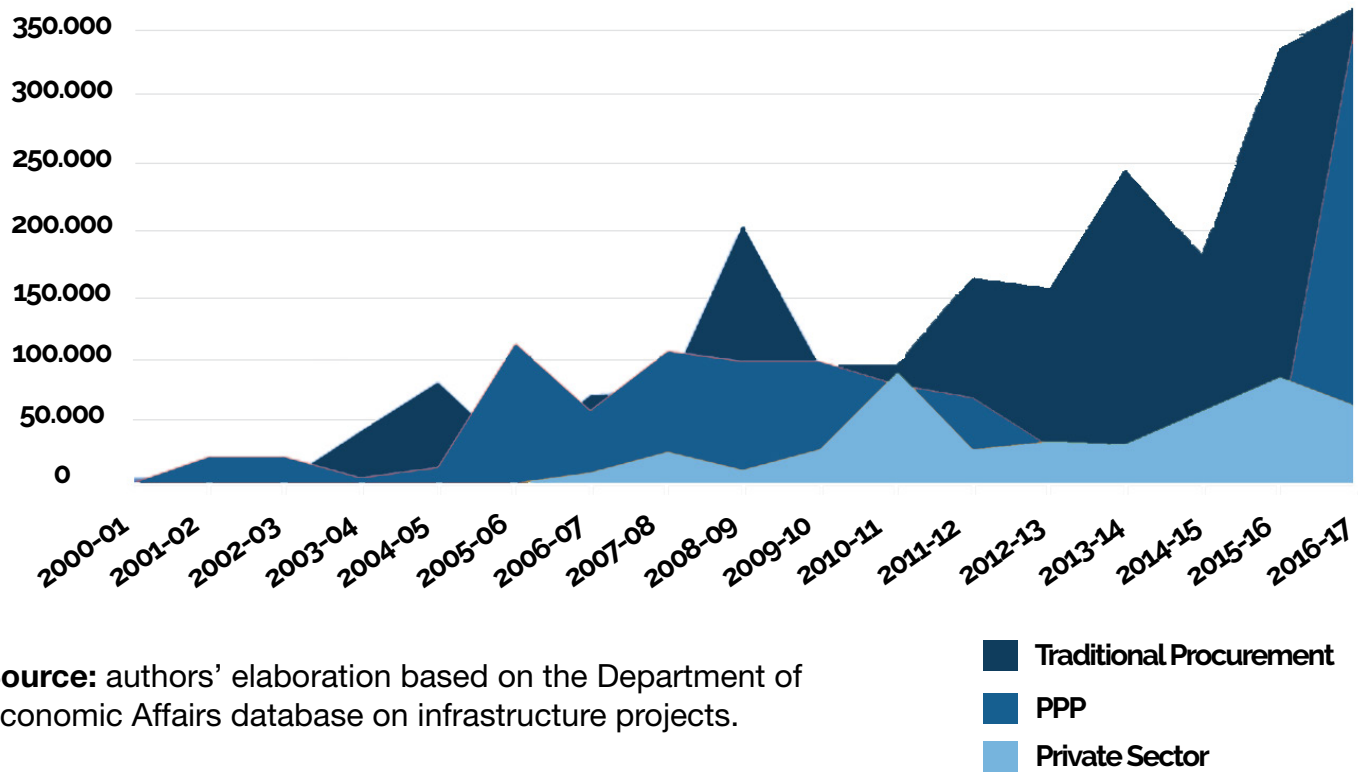
Source: Indian Government (https://infrastructureindia.gov.in)

(8) Unfortunately, we did not have access to more reliable data on the disaggregated PPPs expenditure by energy sources.

As the role of development banks has been reduced in India as part of the liberalization agenda, with several development finance institutions being closed and replaced by commercial banks, financing to infrastructure and PPPs increased. Some notable examples of this process are the incorporations of the Infrastructure Development Finance Company (IDFC) in 1997, a private company responsible for fostering the growth of private capital flows for infrastructure financing, and of India Infrastructure Financing Company Limited (IIFCL) in 2006, a wholly owned government company responsible for long-term financing of infrastructure projects and the prioritization of PPPs.

At the same time, new institutional and regulatory frameworks were created in order to build an environment considered attractive by the private sector to encourage it to invest in PPP projects. Some examples are the creation of several public entities to oversee the establishment of PPP projects, the formulation of standardized contracts, the sectoral reforms in infrastructure, the guarantees given by the central government to the private sector and the encouragement of state level policies.[9] These endeavors resulted in India becoming one of the largest PPP markets in the world, with the largest amount of investment in infrastructure from the private sector between the years of 2006 and 2011 (Twelfth Five Year Plan, 2012-2017). The trajectory of India's expenditure in PPPs, compared with other types of infrastructure investment (traditional procurement and private procurement) can be seen in the graph below.

Figure 4. Infrastructure Expenditure by type of contract. 2000-2016. In rupees crore.



Source: authors' elaboration based on the Department of Economic Affairs database on infrastructure projects.

(9) We highlight the creation of the Public Partnership Approval Committee (PPPAC) in 2005, the PPP Cell of the Department of Economic Affairs (DEA) in 2006 and the India Infrastructure Project Development Fund (IIPDF) in 2007 among the institutions created by the central government, and the viability gap funding (VGF) among the guarantees given to the private sector.

Clearly, there has been a rise in PPP expenditure since the early 2000's, with a peak during the 2008 global crisis. This peak lasted until about 2011, when this type of investment started to decline, before resuming growth in 2015-16. The new rise in recent years can be attributed to a new round of policies implemented in order to provide a new boost in PPPs, out of which we highlight the Committee on Revisiting and Revitalizing Public Private Partnership Model of Infrastructure (2015) and an increase in government expenditure on the PPP type of model.[10]

There are two more aspects of the aforementioned graph that are worth mentioning. The first is that, since the mid 2000's, the private sector has been entering the infrastructure sector, with its participation at points rising above that of the PPP system. The second point, and perhaps most important, is that despite all government efforts to increase private participation in the sector, the rise in private expenditure did not replace public investment, which despite some fluctuation has maintained its upward trajectory throughout the period in question.

Focusing on the energy sector, the main relevant fact is that renewable energies stand out for its private participation: while PPPs amounts to 20.4% of the total investment in energy between 1991 and 2017, they represent 53% of the total investment in Res.[11] The Report on India's Renewable Electricity Roadmap 2030 attributes that to the fact that, unlike traditional types of energy, the renewable sector is newer, having emerged in a time when private investment was already favored over traditional procurement, so all regulation that does exist was already developed to accommodate the private sector, without the same need for extensive reform of traditional energy.

Thus, the Indian needs in terms of the magnitude of the energy challenge helps to explain why energy is the sector with most projects receiving government support, both in absolute terms and in relation to the total number of projects. Energy is the only sector where government-paid contracts prevail (as opposed to user-paid contracts), adding up to over 70% of the total contracts. And while most of PPP projects in India are financed domestically, mostly through state-owned banks, foreign participation in energy projects is even lower than average, with only 15% of all projects including any kind of foreign participation.

3.2 CPSEs: disinvestment process and R&D

CPSEs have historically played a main role channeling public investment in India (Nagaraj 2008, 2006; Khanna 2015; Kapila 2013). In this sense, the Indian CPSEs experience in dealing with the global privatization agenda of the 1990s is an interesting and particular case. With the implementation of the New Economic Policy (NEP) in 1991, the privatization and disinvestment agenda entered into the Indian political-economic debate mainly pushed by multilateral organisms, local lobby groups, some areas of the bureaucracy and political parties with the intellectual support of some (neo)liberal scholars.[12] However, as detailed in the works of Nagaraj (2008) and Khanna (2015), the advances in the privatization and disinvestment process have been from partial to modest, with four main phases:

a. From 1992 to 1998: The Congress Party-led government pushed a policy of disinvestment up to 20% of shares to mutual funds, the general public and workers (since 1993-4 foreign investors were also allowed to participate). However, only one CPSE was privatized: the automobile com-

(10) PPP expenditure is expressed in the national accounts divided between private and public expenditure, according to the share of investment attributed to each sector in different contracts.
(11) Since around 2011, the importance of "pure" private investment in financing RE has also grown significantly.
(12) The privatization framework can be read in the works of World Bank (1990), Bhagwati and Srinivasan (1993) and Bhandari and Goswami (2000), among others.

pany Maruti was sold to Suzuki (the petroleum marketing company IBP was sold to another CPSE, the Indian Oil Corporation).[13] In 1997, the Disinvestment Commission recommended to restructure the CPSEs before disinvestment, to strength the well-functioning CPSEs and to utilize the disinvestment proceeds to create a fund to restructure CPSEs. The well-functioning CPSEs were declared *Navaratnas*[14] ("jewels in the government's crown") and were granted a greater managerial and financial autonomy.

b. From 1998 to 2004: a coalition led by the Bharatiya Janata Party (BJP) now led the government, pushing privatizations and "strategic sales". Twelve CPSEs were privatized including the Indian Petrochemicals, VSNL (it had the monopoly of long distance communications and it was the largest provider of internet), Bharat Aluminium, and several hotels that were run by the Indian Tourism Development Corporation. In parallel, there were several allegations of corruption and malpractice.

c. From 2004 to 2014: a Congress-led government, in alliance with two communist parties, reached power. The disinvestment process was frizzed and a Board for Reconstruction of Public Sector Enterprises was launched with the objective of restructuring the "sick" CPSEs. The Board recommended restructuring 60 CPSEs, closing two and selling other two.

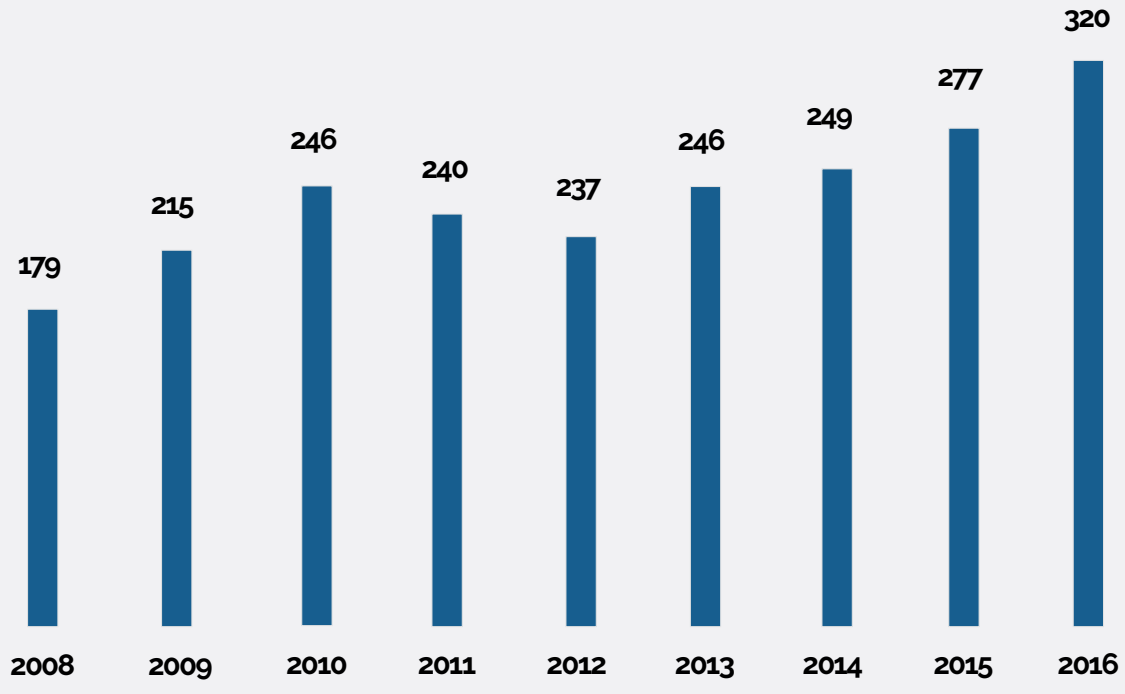
d. Since 2014: a BJP government has led the government, headed by current Prime Minister Narendra Modi. Some initiatives have gone in line with a strengthening of the privatization process. For instance, Bharat Earth Movers Limited (BEML), one of the nine defense public sector units, Salem, Durgapur and Bhadravati plants of Steel Authority of India Limited (SAIL), Bridge and Roof Company, Dredging Corporation of India and Hindustan Fluorocarbons, among others, were identified for strategic sale. However, there have not been massive sales and the role of some CPSEs in some sectors has been reinforced.

To summarize, less than 25 CPSEs were fully privatized from 1990 until 2017. In fact, they have even increased. If we observe the evolution in the number of CPSEs[15] in Figure 5, we see that the number of CPSEs went from 246 in 1992 to 320 in 2016.[16] This means that new CPSEs were created during the post-NEP years. Some of these new CPSEs have been created to establish PPPs with the private sector or to finance the private sector. However, it does not look like a process of reduction of the role of CPSEs in the Indian economy.

Some of these new CPSEs have been created to establish PPPs with the private sector or to finance the private sector. However, it does not look like a process of reduction of the role of CPSEs in the Indian economy.

(13) According to Nagaraj (2008), a corruption scandal with the stockbroker Harshad Mehta led to a slowdown in the Indian stock market that stayed depressed until the mid-1990s, critically discouraging the CPSEs sales in the stock market.
(14) Navratnas, along with Miniratnas and Maharatnas constitute what is sometimes referred to as the "ratna" system. These titles are awarded to public enterprises that are considered "jewels" of the Indian State due to their performance and to which are granted enhanced autonomy in order to facilitate their continued expansion.
(15) A Government company is defined as any company in which not less than fifty-one per cent of the share capital is held by the Central Government, or by any State Government or Governments, or partly by the Central Government and partly by one or more State Governments and includes a company which is a subsidiary company of such a Government company. The Public Enterprises Survey covers those Government companies wherein more than 50% equity is held by the Central Government. However, the subsidiaries of these companies, if registered in India, wherein Central Government has more than 50% equity are also categorized. The Survey does not cover departmentally-run public enterprises, banking institutions, or insurance companies. Finally, there are several Public Sector Enterprises that belong to the states level. Although quite relevant both in terms of amount and investment, these enterprises are not included here given the data restrictions.
(16) These numbers include the CPSEs under construction which are being launched but are not yet in the market.

Figure 5. Amount of CPSEs. 2008-2016. Selected years.



Source: Public Enterprise Survey, various issues.

According to Khanna (2015), there are some political economic reasons that explain the low advance of the privatization process in India: **a)** although most of the governments since the 1990s have expressed their commitment to the privatization process, the majority of the voters were against the privatizations, **b)** trade-unions and middle class groups have resisted the reforms, **c)** there were many government changes during this period, causing different re-adjustments in the privatization strategy, **d)** a number of cases of privatization received severe critics of corruption and malpractice, and **e)** there are some strategic sectors where the government do not want to lose control.

All in all, as reported in the Public Enterprise Survey 2015-2016, as of March 31st 2016 there were 320 CPSEs (excluding 7 Insurance Companies). Services and manufacturing, with 113 and 87 each, represented the main sectors of presence of CPSEs. In terms of investment, the 14 electricity CPSEs (11 of generation and 3 of transmission) totalized around 25% of the total CPSEs investment between 2013 and 2015. Moreover, it is interesting to highlight that there were 76 CPSEs under construction.[17]

(17) Of those enterprises, 41 are in the power sector, approximately 54% of the total, though they only amount to 17.2% of the authorized capital for those companies. They are all subsidiaries to existing CPSEs mostly in the area of transmission.

Table 2. Central Public Sector Enterprises (CPSEs). March 2016. Quantity and Investment. In rupees crore.

Cognate Group	Total CPSEs	Financial Investment During*			Average 2013-4/2015-6	% of total investment
	31/03/2016	2013-14	2014-15	2015-16		
Agriculture	**5**	**1,181**	**1,302**	**1,443**	**1,308**	**0%**
Agro-based Industries	5	1,181	1,302	1,443	1,308	0%
Mining	**25**	**62,389**	**86,249**	**88,523**	**79,054**	**7%**
Coal	8	15,843	17,375	17,379	16,866	2%
Crude Oil	5	41,929	64,178	66,174	57,427	5%
Other Minerals & Metals	12	4,618	4,697	4,970	4,761	0%
Manufaturing	**87**	**158,679**	**154,565**	**150,657**	**154,634**	**14%**
Steel	5	24,914	23,616	29,006	25,845	2%
Petroleum (Refinery and Markets)	8	87,753	84,333	72,316	81,467	7%
Fertilizers	7	16,074	15,566	7,170	12,937	1%
Chemicals & Pharmaceuticals	16	6,294	6,885	15,283	9,487	1%
Heavy Engineering	7	2,640	1,617	1,593	1,950	0%
Medium & Light Engineering	20	11,096	12,519	12,912	12,176	1%
Transportation Equipment	8	2,446	2,382	2,210	2,346	0%
Consumer Goods	12	3,682	3,828	6,305	4,605	0%
Textiles	4	3,781	3,817	3,862	3,820	0%
Electricity	**14**	**236,035**	**269,456**	**300,402**	**268,631**	**25%**
Power Generation	11	154,013	174,849	194,930	174,597	16%
Power Transmission	3	82,022	94,608	105,471	94,034	9%
Services	**113**	**509,971**	**555,254**	**601,507**	**555,577**	**51%**
Trading & Marketing	22	19,420	16,543	16,494	17,486	2%
Transport Services	15	66,350	70,463	72,604	69,806	6%
Contract & Construction Services	17	10,607	11,231	11,541	11,126	1%
Industrial & Tech. Consultancy	23	1,193	1,388	1,625	1,402	0%
Tourist Services	9	388	326	406	373	0%
Financial Services	21	389,670	431,714	470,721	430,702	40%
Telecommunication Services	6	22,344	23,589	28,117	24,683	2%
Enterprises Under Construction	**76**	**23841**	**28,729**	**29,313**	**27,294**	**3%**
TOTAL	320	992,096	1,095,554	1,171,844	1,086,498	100%

Source: authors' elaboration based on the Public Enterprise Survey 2015-2016.

In general, several CPSEs are leading companies with significant market-shares in sectors such as petroleum (Oil and Natural Gas Corporation (ONGC), GAIL, Hindustan Petroleum Corporation Limited (HPCL), Bharat Petroleum Corporation Limited (BPCL) and Indian Oil Corporation), mining (Coal India Ltd. and National Mineral Development Corporation (NMDC)), power generation (NTPC Limited and National Hydro Power Corporation (NHPC)), power transmission (Power Grid Corporation of India Ltd.), nuclear energy (Nuclear Power Corporation of India Ltd.), heavy engineering (Bharat Heavy Electricals Limited (BHEL)), aviation (Hindustan Aeronautics Ltd. and Air India Ltd.), storage and public distribution (Food Corporation of India and Central Warehousing Corporation), shipping and trading (Shipping Corporation of India Ltd, and State Trading Corporation of India Ltd.), steel (Steel Authority of India Ltd and Rashtriya Ispat Nigam Ltd) and telecommunications (Bharat Sanchar Nigam Limited (BSNL) and Mahanagar Telephone Nigam Limited (MTNL)).

Particularly, Table 3 below shows that, out of the top ten CPSEs in terms of investment during 2015-6, eight were from the energy sector (five from oil and gas and three from power), one from steel, and one from telecommunications.

Table 3. Top 10 CPSEs in terms of investment in 2015-2016. Rupees crore and % of total CPSEs investment.

CPSE Name	Sector	Investment	% of total CPSEs investment
Oil & Natural Gas Corporation Ltd.	Mining – CrudeOil	25,6597.89	12.7
NTPC Ltd.	Electricity – PowerGeneration	21,3273.09	10.5
Power Grid Corporation of India Ltd.	Electricity – PowerTransmission	19,3861.88	9.6
BharatSancharNigam Ltd.	Services - Telecommunications	173,738.80	8.6
Indian Oil Corporation Ltd.	Manufacturing – Petroleum (Refinery and Marketing)	171,581.22	8.5
ONGC Videsh Ltd.	Mining – CrudeOil	124,217.81	6.1
Steel Authority of India Ltd.	Manufacturing - Steel	100,201.74	5.0
Nuclear Power Corpn. of India Ltd.	Electricity – PowerGeneration	59,725.68	3.0
Bharat Petroleum Corpn. Ltd.	Manufacturing – Petroleum (Refinery and Marketing)	59,148.57	2.9
Hindustan Petroleum Corpn. Ltd.	Manufacturing – Petroleum (Refinery and Marketing)	56,925.52	2.8
Total		**1,409,272.20**	**69.6**
Grand Total		**2,026,315.31**	**100.0**

Source: authors' elaboration based on the Public Enterprise Survey 2015-2016

In regard to the disinvestment process up to the fiscal year 2015-6, for the top ten CPSEs in terms of investment, we observe that the Government of India (GoI) still has around 60% of the shares (Table 4). In some cases, such as nuclear sector, it maintains 100% of the ownership. The participation of foreign investors, in general, is not superior to 20% of the shares. A little more of 20% of the shares are distributed between different national investors.

Within the national investors, the "others" column in Table 4 below includes Indian business groups such as Tata, Mahindra & Mahindra and Birla, which have been the main benefited of the disinvestment process. To illustrate this, we can mention the acquisition of Videsh Sanchar Nigam Ltd by the Tata group, which later renamed the company to Tata Communications. Another example comprises the acquisition of the Delhi Vidyut Board (DVB) by Tata Power. In general, Indian business groups are the dominant actor of the Indian entrepreneurial structure. Since the 1990s liberalization, rather than losing their economic dominance, Indian business groups, were able to create new business opportunities by leveraging their expertise, knowledge, relations and financial strength. Relations between the political class, the bureaucracy and business groups have continued during liberalization, and pecuniary benefits (such as tax advantage, direct subsidies and favorable transactions related to disinvestment and privatization of CPSEs) were there to strengthen them (e.g. Abrol 2013; Sarkar 2010).

Table 4. Top 10 CPSEs in terms of investment.
Shares ownership at 2015-2016 fiscal year.

CPSE Name	Shareholders (%)					
	GoI	Others	Mutual Funds	Financial Institutions	Insurance Companies	Foreign Investors
Oil & Natural Gas - Corporation Ltd.	68.9	13.5	0.9	1.2	8.3	7.2
NTPC Ltd.	63.0	3.3	6.4	16.1	0.6	10.7
Power Grid Corpn. of India Ltd.	57.9	7.5	4.8	0.8	2.8	26.3
BharatSancharNigam Ltd.	100.0	0.0	0.0	0.0	0.0	0.0
IndianOilCorporation Ltd.	58.6	24.9	1.6	0.5	10.2	4.2
ONGC Videsh Ltd.	Wholly owned by another CPSE					
Steel Authority of India Ltd.	-	-	-	-	-	-
Nuclear Power Corpn. of India Ltd.	100.0	0.0	0.0	0.0	0.0	0.0
BharatPetroleumCorpn. Ltd.	55.8	14.6	5.7	0.1	2.7	21.1
HindustanPetroleum-Corpn. Ltd.	51.1	15.6	9.9	4.1	0.0	19.3

Source: authors' elaboration based on the Public Enterprise Survey 2015-2016 and on available information at each CPSE's webpage.

At the same time, CPSEs in India have played a leading role in R&D expenditure. This is especially true for the energy sector: the Department of Public Enterprises (DPE) has prescribed a minimum expenditure in R&D for the "ratna" companies. While some CPSEs develop in-house R&D, many others (including most of the smaller ones) meet their quota through sponsored research at universities and other R&D facilities. Another strategy these companies adopt to enhance their technological know-how is establishing collaborations and joint ventures with international leading companies in their respective fields. In the commercial year of 2014-15, CPSEs have been responsible for 5.5% of India's R&D expenditure (Department of Science and Technology 2018).

In terms of R&D expenditure, Bharat Heavy Electricals Ltd. and Bharat Electronics Ltd. are at the top. After them, five CPSEs in the top ten relate to energy: four operate in the oil and gas sector and one in power generation. These figures are in line with the work of Mishra et al (2013) that highlights the relevance for India of CPSEs expenditure in R&D, especially in oil and gas, defense, heavy equipment, power and electronics.

Table 5. Top 10 CPSEs in terms of R&D expenditure in 2015-2016. Rupees crore and % of total CPSEs expenditure.

CPSE Name	Sector	Expenditure in R&D (in ₹ crore)	% of total CPSEs investment
BHARAT HEAVY ELECTRICALS LTD.	Manufacturing – Heavy Engineering	893.07	24.7
BHARAT ELECTRONICS LTD.	Manufacturing – Light and Medium Engineering	704.27	19.5
OIL & NATURAL GAS CORPORATION LTD.	Mining – CrudeOil	539.74	14.9
STEEL AUTHORITY OF INDIA LTD.	Manufacturing - Steel	277.00	7.7
INDIAN OIL CORPORATION LTD.	Manufacturing – Petroleum (Refinery and Marketing)	235.27	6.5
HINDUSTAN PETROLEUM CORPN. LTD.	Manufacturing – Petroleum (Refinery and Marketing)	180.32	5.0
NTPC LTD.	Electricity - PowerGeneration	129.68	3.6
BHARAT SANCHAR NIGAM LTD.	Services -Telecommunications	79.47	2.2
GAIL (INDIA) LTD.	Manufacturing – Petroleum (Refinery and Marketing)	76.49	2.1
BEML LTD.	Manufacturing – TransportationEquipment	66.63	1.8
Total		**3,181.94**	**88.1**
Grand Total		**3,611.84**	**100.0**

Source: authors' elaboration based on the Public Enterprise Survey 2015-2016.

In particular, Bharat Heavy Electricals Ltd. (BHEL) stands out from other CPSEs for its innovation-led growth strategy and its investment in R&D efforts. BHEL is responsible for almost a quarter of all R&D expenditure made by CPSEs. In 2016-17, its R&D expenditure reached 2.75% of its turnover and led to the filing of 508 patents and copyrights in that year alone, adding up to a total

of 3,915. It is important to notice that while BHEL is categorized as a heavy engineering company, it acts primarily as a power plant equipment manufacturer directly connected to the energy sector. During the Twelfth Five Year Plan Period (2012-2017), BHEL contributed with an addition of 45,274 MW of installed capacity, surpassing its target by 9% and reaffirming itself as the major contributor to the country's power generation capacity addition. The enterprise is also known for its international network, having collaborated with leading global companies such as General Electric (USA), Siemens AG (Germany) and Mitsubishi (Japan). Domestically, BHEL has also established projects in association with universities and other R&D institutions and acted under technology missions, namely the National Solar Mission and the National Mission for Enhanced Energy Efficiency.

As said, many of the other top CPSEs in R&D expenditure are also in the energy sector. Most of them in oil and gas, the exception being NTCP (the only representative of the power sector), which has its own in-house R&D center and offers R&D support to several other institutions in India, both public and private, including: NSPCL, PSPCL-Bathinda, NHPC, HPGCL, APGCL, NTPC Joint Ventures, Tata Power, Ukai thermal power station, Adani Power, etc.

As for the companies in oil and gas, most of them have their own in-house R&D departments (e.g. ONGC and HPCL), while others outsource most of their research activities to institutions under the Council of Scientific & Industrial Research (CSIR) (e.g. GAIL). ONGC's technology policy, for instance, is focused on keeping itself up-to-date and scouting new technologies. This strategy has allowed the company to significantly improve its success rate in acquiring, processing and interpreting seismic data. It has collaborated with universities and other research institutions, adding up to over 30 projects in a dozen countries. This policy of prioritizing technology procurement, with R&D efforts being focused on absorbing and adapting exogenous technology is similar to most companies in the oil and gas sector, including HPCL, IOCL, OIL and BCPL.

Overall, although CPSEs have a main role in the Indian R&D efforts, when it comes to the energy sector, in most cases these efforts are primarily focused on absorbing and adapting exogenous technology rather than developing actual new technology.[18] This conclusion is consistent with the National Energy Policy Draft (2017: 72) which states that, 'India has been at the forefront of technology deployment but not development'. This explains the fact that, while the country has been very successful in absorbing and adapting foreign cutting-edge technology, the same cannot be said for the development of new technology. A direct implication of this is that not always are absorbed technologies suited for India's reality, both in terms of needs and advantages. Therefore, the National Energy Policy Draft (2017) states that there should be a balance between absorbed and developed technologies, by both extending support for R&D in new technologies where required and by keeping the existing environment conditions favorable to absorption. In other words, more indigenization efforts and more links with the Indian NSI actors are needed in order for India to develop new technology more autonomously.

Although CPSEs have a main role in the Indian R&D efforts, when it comes to the energy sector, in most cases these efforts are primarily focused on absorbing and adapting exogenous technology rather than developing actual new technology.

Regarding this process of technology transfer, Lema and Lema (2012) highlight the importance of "unconventional" means, especially transfers that involve a higher degree of effort from the recipient or larger cross border interactions, such as overseas R&D, collaborations, and acquisition of

(18) Nonetheless, some of these companies do develop new technology. Most notably, BHEL stands out not only among other CPSEs in the energy sector, but among public enterprises, more generally.

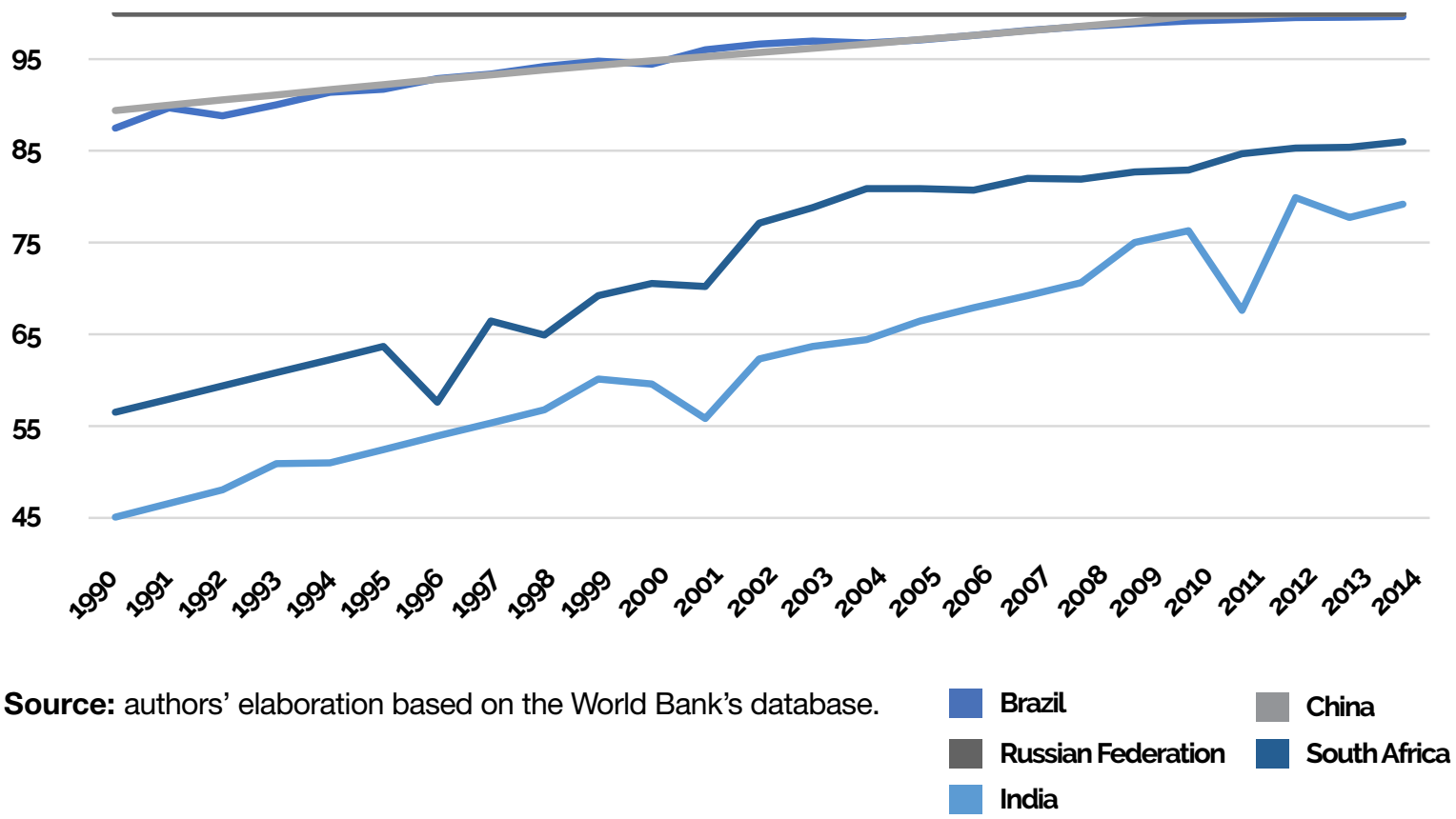
foreign firms. While the literature has often overlooked these types of transfer in favor of the more traditional ones (i.e. FDI, capital imports and joint ventures), unconventional transfer methods have been increasingly important in the development of renewable energy technology in India and other developing countries, especially after the industry take off period. They have also helped leading companies set up their own in-house R&D facilities. In short, innovation and technological transfers cannot be viewed as two independent processes. The capacity building involved in adapting, absorbing and using technology creatively is as much a part of the innovative process as is "traditional" R&D (Cassiolato and Lastres 2005).

3.3 The electrification process

The electrification process in India has advanced significantly since the 1990s. According to the World Bank, in 1990 less than 45% of the Indian population had access to electricity, but in 2014 the electrification rate reached 80%. In particular, rural electrification went from around 30% to 70% in the same period. Although it is true that the Indian electrification rate is still much lower than the other BRICS countries, the rate of increase is remarkable (Figures 6 and 7).

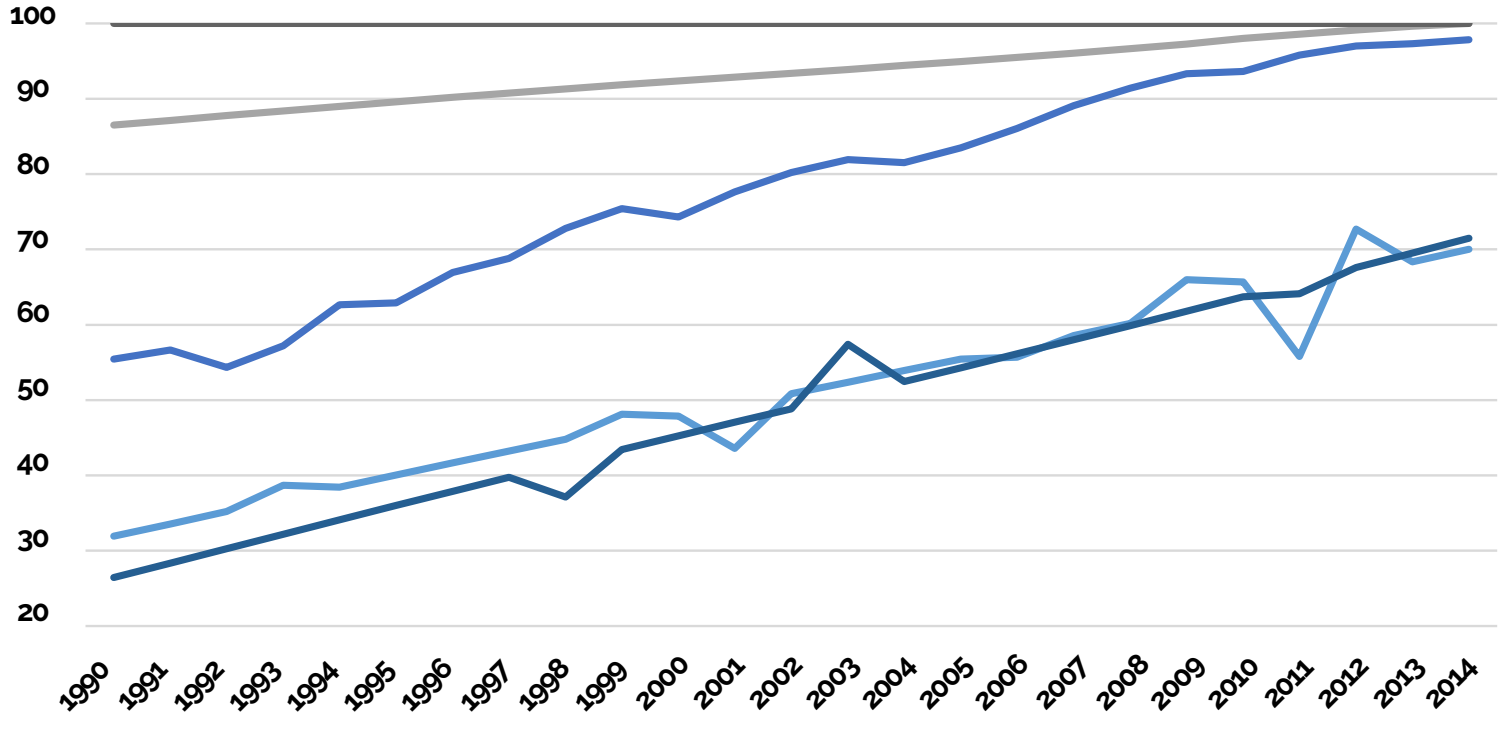
In 1990 less than 45% of the Indian population had access to electricity, but in 2014 the electrification rate reached 80%. In particular, rural electrification went from around 30% to 70%.

Figure 6. Access to electricity. % of total population. BRICS countries. 1990-2014.



Source: authors' elaboration based on the World Bank's database.

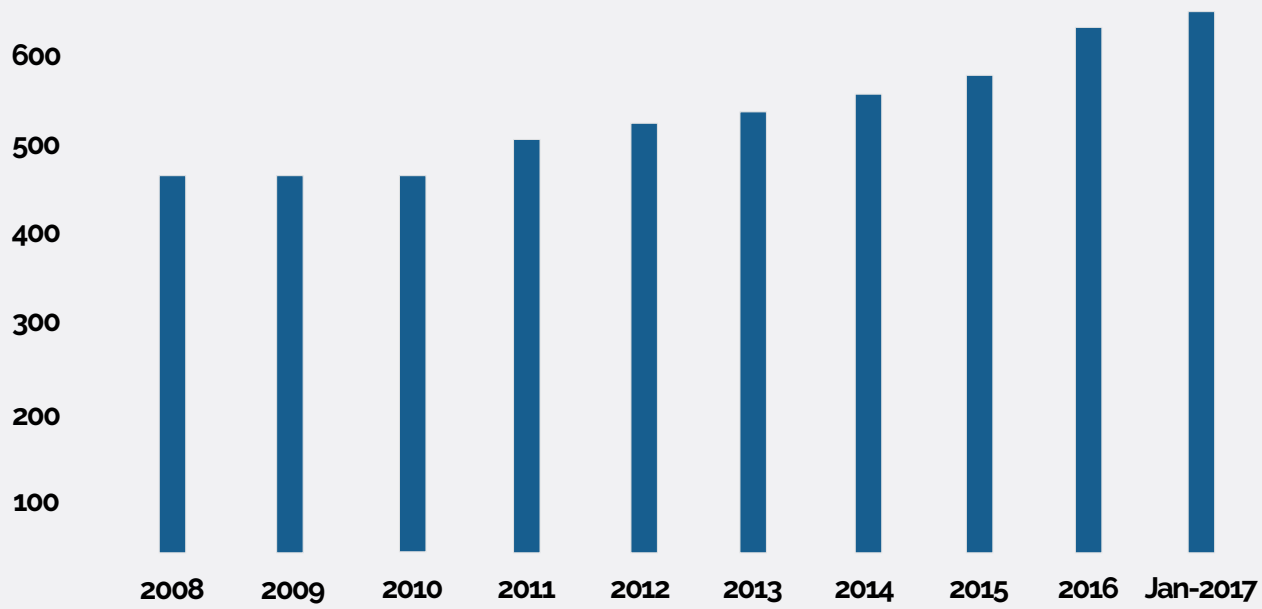
Figure 7. Rural access to electricity. % of rural population. BRICS countries. 1990-2014.



Source: authors' elaboration based on the World Bank's database.

A main push on the Indian electrification process came in 2005 with the launch of the Rajiv Gandhi Grameen Vidyutikaram Yojana (RGGVY), a scheme mainly funded by the Central government, with the Rural Electrification Corporation Limited (REC) acting as a nodal agency under the Ministry of Power. RGGVY was created through the merging of several ongoing schemes with the aim of electrifying all villages and habitations, providing access to electricity to all rural households, and providing free electricity connection to Below Poverty Line (BPL) families. In 2010-11, there was a significant increase in budgetary outlay for the RGGVY. As a consequence, in Figure 8 we see a marked increase in the amount of electrified villages in 2011. With Narendra Modi as Prime Minister, the program changed its name to Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY). REC was maintained as the nodal agency for the scheme, acting as the coordinator of the implementing agencies, which include different states governments and several state level companies, both public and private.

Figure 8. Number of electrified villages in India. 2008 - Jan 2017. In thousands.



Source: Chandrashekar and Ghosh (2017).

According to the DDUGJY's webpage, in January 2018, 596,167 out of 597,464 Indian villages were electrified. This figure represents 99.7% of village electrification. However, it is important to notice that village electrification is not the same as household access to electrification. Village electrification is defined as: a) basic infrastructure such as distribution transformer and distribution lines provided in the inhabited locality as well as the Dalit basti/hamlet where it exists, b) electricity is provided to public places like schools, health centers, dispensaries, community centers, etc. c) the number of electrified households is at least 10% of the total number of households in the village. Importantly, village electrification requires only the provision of the electricity line, not actual continuous access to electricity. Thus, even if a few houses in a village receive only a couple hours of electricity per day for a few days in a year, the village is still considered electrified.

According to the National Family Health Survey (NFHS-4) carried out in 2015-16, the average percentage of electrified rural households in India was around 90%, with some states holding a low level of rural household electrification (e.g. Bihar (54,1%), Assam (75%) and Odisha (83,8%)) and others (such as Goa, Sikkim, Punjab and Puducherry) having around 99% of rural household electrification. In contrast with these figures, Chandrasekhar and Ghosh (2017) state that between 71% and 60% of all households in India have electricity (even if not regularly), with rural access lower than urban.

The Twelfth Five Year Plan points to other areas of deficiency in the electrification process under the RGGVY. It argues that even some of the villages considered to be electrified do not get sufficient electricity hours per day, and that the socioeconomic impact expected from this process has not yet been verified. It also highlights the need for R&D that is specific to rural electrification and distribution, and the important role Renewable Energy plays in the electrification process, mainly through off grid electrification.

As a result of this process of electrification, according to the Twelfth Five Year Plan (2017-2012), the demand for non-commercial energy is expected to decline due to the increasing expansion of the power network and access to commercial energy. According to Mishra and Kumar (2013), under growth average scenarios of 8% and 9%, electricity consumption in India is going to multiply more than 8 times by 2030, displacing non-commercial firewood and chips and kerosene.

Table 6. Demand Scenario of Various Energy items for Household Consumption in India under Various GDP Growth Rates. Totals in Mtoe (Million Tonnes of Oil Equivalent).

Year	Firewood and Chips		Electricity		Dung Cake		Kerosene		LPG	
	8%	**9%**	**8%**	**9%**	**8%**	**9%**	**8%**	**9%**	**8%**	**9%**
2000	79.62	79.62	8.43	8.43	29.61	29.61	10.07	10.07	6.42	6.42
2006	88.64	88.78	18.17	19.26	36.97	37.33	12.98	12.77	15.85	16.87
2011	94.11	94.05	27.17	29.68	40.42	40.48	14.01	14.02	23.94	26.07
2016	98.44	98.50	38.38	42.28	41.93	41.35	14.84	14.70	33.11	35.93
2021	102.06	102.46	50.39	54.78	41.79	40.87	15.16	14.93	41.63	44.16
2026	104.64	105.07	61.37	64.95	40.95	40.28	15.17	14.93	48.11	49.63
2031	106.39	106.59	69.72	71.80	40.47	40.21	15.12	14.96	52.27	52.89

Source: authors' elaboration based on Mishra and Kumar (2012)

Even when one considers the different figures and regional heterogeneities, there is no doubt that the electrification process has advanced significantly since 1990s. This process has been pushed by huge Central and State level public financed programs. As a consequence, the advance in electrification implies several changes in the household consumption (for instance, opening new markets for home appliances), a wide range of new business opportunities for the private power sector, the Indian entrepreneurs and the informal sector and it is a potential booster for the Indian productivity. Clearly, the Indian State, despite implementation problems and heterogeneities, is creating several electrification-related markets, especially in the rural areas.

Main National Missions in Power Sector

National Missions appeared in the **Indian STI policymaking** in the 1980s. Since then they have constituted a main policy mechanism in the country. A national mission generally implies that Central government projects have clearly defined objectives, scopes, implementation timelines and milestones, as well as measurable outcomes and service levels. To this day, a number of national missions were launched to address the power sector. Among others, these include:

National Mission for Enhanced Energy Efficiency (NMEEE): one of the eight missions under the National Action Plan on Climate Change, NMEEE aims to strengthen the market for energy efficiency by creating conducive regulatory and policy regime. The Mission seeks to upscale the efforts to unlock the market for energy efficiency and help to achieve total avoided capacity addition of 19,598 MW, fuel savings of around 23 million tonnes per year and greenhouse gas emissions reductions of 98.55 million tonnes per year at its full implementation stage.

Jawaharlal Nehru National Solar Mission (JNNSM): launched in 2010, the Mission has set the ambitious target of deploying 20,000 MW of grid connected solar power by 2022. It is aimed at reducing the cost of solar power generation in the country through long-term policy; large-scale deployment goals; aggressive R&D and domestic production of critical raw materials, components, etc.

Indian Electrical Equipment Industry Mission Plan: the aim of this Mission Plan is to make India the country of choice for the production of electrical equipment and to reach an output of US$ 100 billion by balancing exports and imports.

National Smart Grid Mission (NSGM): the NSGM is the institutional mechanism for planning, monitoring and implementation of policies and programs related to Smart Grid activities.

Source: authors' elaboration based on the Twelfth Five Year Plan (2012-2017).

4. Final remarks

The main objective of this paper was to examine some main contemporary State-led policy efforts and initiatives that have been implemented in response to the Indian energy challenge. As explored in the first section, the energy challenge is not a minor issue for India. Indeed, the high-growth path continuity is closely related to the ability to deal with the energy bottlenecks. As a consequence, energy has turned into a main foreign policy issue for India, leading the country to make adjustments in its external relations in order to reach new sources of fuel from foreign countries. Furthermore, as it has been showed, a main amount of the public investment and R&D efforts are currently advocated to address the energy challenge. This fact indicates the need to deepen the interrelationships between the Indian NSI and the energy imperatives of the Indian society.

First, with respect to infrastructure, India is currently aiming to achieve a fifty/fifty relationship in terms of infrastructure investment between public and private sectors. This trend reveals an increasing participation of private sector in infrastructure, particularly in renewable energies in which PPPs type of procurement have been more relevant. We understand that the magnitude of the energy challenge has driven public policymaking to look for an increment of the private investment. In this context, different institutional arrangements have been aligned with the private sector's needs and practices. Among these institutional arrangements, PPPs are the most significant ones, assuring and guaranteeing private sector minimum levels of profit and reducing risks. Financing has also ben oriented to finance private sector involvement in infrastructure. Overall, public procurement is the main infrastructure driver instrument and public investment is the one that stabilized (public) infrastructure investment at a minimum level of around 4% of the GDP.

Secondly, CPSEs have great relevance in the Indian energy landscape. The disinvestment process has been reduced. Indian business groups have benefited the most from it, and the PPPs scheme has been adopted as the second best option. CPSEs' expenditure in R&D has been of main importance in oil as well as in power. In particular, Bharat Heavy Electricals Ltd. (BHEL) outstands among the CPSEs as the most dynamic entrepreneurial actor in terms of technological indigenization efforts, networking with both foreign and national partners. It also stands out with respect to the magnitude of its R&D expenditure. In oil and gas, ONGC and HPCL have their own in-house R&D departments at the top of their R&D expenditure. However, most of the CPSEs tend to adapt foreign technologies instead of balancing foreign technologies with domestic technological efforts. A main contemporary challenge for the Indian CPSEs performing in the energy sector is to deepen their connections and interaction with the other Indian NSI actors.

Thirdly, despite local heterogeneities in the levels of access to electricity, electrification is a main feature of contemporary India. Broadly speaking, this process implies launching modern capitalism to around 500 million Indians, an effort that has been clearly led by the Indian State (both at the central and the state levels). By doing so, the Indian State is not only improving the country's rural quality of living but also, paraphrasing Mazzucato (2013), creating markets for the private sector.

To conclude, this paper recommends further inquiries into several energy-related questions to be addressed in greater detail in future research projects. With respect to the Indian NSI, more efforts are needed in order to deal with the Indian energy transition, gaining energy efficiency, reducing petroleum and carbon dependence, increasing indigenization of technologies, contemplating the needs of rural and minority groups, increasing the relations and interactions between the Indian NSI institutions and organizations and the CPSEs, among others. With respect to the Indian public-private arrangements, as we have seen, the Indian privatization process did not advance much, putting doubts about the degree of advance of the liberalization agenda in India. As a consequence, PPPs could be understood as a second-best option to privatization, configuring explicit or/and implicit arrangements between the Indian bureaucracy and the Indian national business groups, which have been the main beneficiaries of both the privatization process and PPPs contracts and public financing. In this sense, the Hindu-framed Indian State-building is not a new trend in India, but it is a constituting fact of the Indian State (Gonzalo and Cassiolato 2017; Gonzalo 2018; Gonzalo and Crespo, in press). It is in this broader context that the neoliberal times, in general, and the relationship between private and public sectors, in particular, should be understood in India.

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About the Authors

Manuel Gonzalo is researcher-professor at PRODEM, Instituto de Industria, Universidad Nacional de General Sarmiento (UNGS), Argentina, and researcher at REDESIST, Instituto de Economia, Universidade Federal de Rio de Janeiro (UFRJ), Brazil. He graduated in Economics (UBA) and has a master's degree in Economics and Industrial Development (UNGS) and a doctoral degree in Economics (UFRJ). His main research topic is innovation and entrepreneurial systems in the Global South, focusing on India, Brazil and Argentina. He is professor at the undergraduate and graduate levels at different universities, teaching courses mainly on comparative development, industrial organization, and innovation and entrepreneurial systems. He is member of GLOBELICS, LALICS, RED PYMES MERCOSUR and YOUNG SCHOLAR INITIATIVE networks. Email: gonzalo.manolo@gmail.com.

Elisa Possas Gomes graduated in Economics at the Instituto de Economia, Universidade Federal de Rio de Janeiro (IE/UFRJ), Brazil. She is currently a Master's candidate in Economics at the IE/UFRJ. Her research mainly focuses on sustainability, energy and innovation. Email: elisapossas@gmail.com.

Maria Gabriela von Bochkor Podcameni is professor of Economics at the Federal Institute of Rio de Janeiro (UFRJ), senior researcher at REDESIST (research network on local productive systems and innovations), associate researcher at GEMA (environment and sustainable development research group) and member of NUMAS (environment and sustainability transdisciplinary research group). Currently, she integrates the secretariat of GLOBELICS (Global network for innovation). She graduated in Economics (2004) and also has a master's degree (2007) and doctoral degree (2014) in Economics. From 2006 to 2007, she worked in the Brazilian Fund for Biodiversity (FUNBIO) as Financial Analyst for biodiversity projects. Her main research fields are: Innovations and sustainability; LIPS (Local Innovation Systems); and Energy. Email: gabriela.podcameni@gmail.com

José Eduardo Cassiolato has a PhD in Development, Industrialization and Scientific and Technology Policy from the Science and Technology Policy Research Unit (SPRU), University of Sussex, UK and a Post-Doc at Université Pierre Mendes-France. He is professor and researcher in the Instituto de Economia of the Universidade Federal de Rio de Janeiro (UFRJ) and coordinator of REDESIST (Research Network on Local Productive and Innovative Systems). He is currently the general secretary of GLOBELICS and a member of the Superior Council of FIOCRUZ. He was Secretary of Planning in the Brazilian Science and Technology Ministry and Director of the Brazilian Society for the Promotion of Science (SBPC). Email: cassio@ie.ufrj.br.

BRICS Policy Center Centro de Estudos e Pesquisas - BRICS

Rua Dona Mariana, 63 - Botafogo - Rio de Janeiro / RJ - Brazil
Phone: (+55 21) 2535-0447 / ZIP CODE: 22280-020
www.bricspolicycenter.org / **bpc@bricspolicycenter.org**

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