Collective institutional entrepreneurship and contestations in wind energy in India

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Abstract

With 19550 MW installed in 2013, India is considered a success story in terms of net installed capacity of wind power. Few existing studies on wind energy in India have highlighted the important role of institutions, and most lack a detailed account of how influential institutions came about through the work of advocacy groups, or tend to focus on short time periods. This paper uses the notion of collective institutional entrepreneurship to analyse institutionalisation of wind energy in India across three time periods (1985–1995, 1995-2003, and 2003-2013). The analysis shows that wind power development in India was driven by efforts of collective institutional entrepreneurs using two aggregated strategies, i.e. (1) creation of supportive techno-economic and socio-political networks; (2) creation of an indigenous innovation infrastructure. The paper highlights setbacks, controversies, contestations and tensions between various actor groups in collective institutional entrepreneurship and argues that actions must be taken for inclusion of actors who have been marginalized in the process.

Key words: wind energy, India, collective institutional entrepreneurship

1. Introduction

Wind energy is developing rapidly in India. The Indian wind energy sector began with just 2 MW of installed grid connected power in 1986 [1]. Currently India has installed over 18 GW of wind energy, which is roughly 8% of the total installed electricity generation capacity in
India. Supported by a range of national and state-level wind energy programs and economic incentives, wind energy has been growing substantially.\(^1\) 70% of the total renewable energy installed capacity in India consists of wind power [2]. Worldwide, India ranks at a fifth position of global producers of wind energy, only topped by China, US, Germany and Spain [3]. In general, prospects for wind energy in India look good even after a recent slow-down in 2012 and 2013.

The development and implementation of wind energy technology in India has co-evolved with a major institutional web of financial support schemes, technology policies, technical standards, grid-connection rules, industry organizations, international collaborations, and so on [4][5][6]. This paper aims to contribute to this field of study by developing an encompassing narrative on which institutional developments and innovations occurred, and also how they occurred, i.e. who was involved in developing and advocating for institutional changes, and through which kind of activities and strategies.

This study takes outset in the notion that actors are actively involved in shaping their institutional context and that this is largely a collective effort rather than the result of powerful individuals [7][8]. Development of novel energy technologies requires not just appropriate policies and regulations but also collaboration and collective action between the different stakeholders such as researchers, policy makers, political parties, industry organizations, lobbyists and environmental groups [9]. Furthermore the emergence of novel innovations is likely to be full of conflicting interests, power relations and political negotiations between stakeholder groups [10][11]. This paper aims to shed light on institutional changes in the wind energy sector in a balanced way, i.e. by not only discussing the positive impacts of institutional changes on wind energy in India, but also addressing the controversies and potential barriers implicated by the dynamic institutional context

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\(^1\) In particular wind power development takes place in the Indian states of Tamil Nadu, Gujarat, Maharashtra, Rajasthan, Karnataka and Andhra Pradesh.
surrounding wind energy in India. This paper does so by taking a long-term perspective focusing on the very early wind energy developments in the 1980s up to recent developments in 2013. We study the institutional changes and the role of actors behind those changes by using the notion of collective institutional entrepreneurship, which will be elaborated in the next section.

To above leads us to the following research question: How has institutional entrepreneurship shaped the development of wind energy in India during the time period 1985-2013 and which controversies can be identified? The paper is structured as follows. First we elaborate on the notion of institutional entrepreneurship. Next we discuss methods used for case study of wind energy in India. The final sections of the paper discuss and conclude.

2. Collective institutional entrepreneurship

The concept of institutional entrepreneurship was originally proposed by Dimaggio ([12][13]) to study role of agency in institutional changes and has ever since received increasing attention from a range of scholars interested in the role of actors in transforming institutional arrangements. Institutions are the rules, norms and beliefs that constrain and enable actors in their range of possibilities to take action over a range of events, i.e. their agency [14][15]. In this view, institutions are not just constraining, but also the very fabric to be used for collective action by a range of actors to transform their institutional context. Particularly in this research we try to understand how actors navigate through institutional contexts and experience phenomena in an institutionally embedded way, with adequate emphasis on ‘agency’ of (collective) actors in attempts to influence those contexts [16].

’Agency’ is not considered to be a property of an individual, but is conceptualized as relational and ‘distributed within the structures that actors themselves have created’ [17]. For
example, the web of wind energy policies, economic incentives, organizational structures and market rules – the result of over 30 years of wind energy development in India – does not just spell out the ‘rules of the game’ for the wind energy sector in India, but is also used strategically and continuously by dynamic coalitions of actors to advocate changes for the future of wind energy in India. There is a need for understanding how actors work collectively to exercise power and change the institutions, which enable and constrain their activities.

Institutional entrepreneurship is then defined as “the activities of actors who have an interest in particular institutional arrangements and who leverage resources to create new institutions or to transform existing ones” [18, p 657]. To qualify as institutional entrepreneurs, individuals must break with existing rules and practices associated with the dominant institutional arrangements and institutionalize the alternative rules, practices, or logics they are championing while also being enabled and limited by the same institutional arrangements [19][20].

Institutional entrepreneurs use various strategies such as legitimizing new ways of working, lobbying, petitioning and advocacy [21]. Research has shown that institutional entrepreneurs can be a range of actors and organizations. Examples are executives in firms, profit oriented entrepreneurs, trade associations, professionals in organizations, regulatory authorities, licensing bodies, scientists, government officials, trade and professional associations, civil servants in governmental agencies, educational institutions, media, consumers, civil society groups and the larger public [21][22][23].

The processes through which 'agency' is exercised is likely to be full of setbacks and failures with new roadblocks emerging as the innovation progresses. This forces actors to change their well-intended visions and strategies and requires continuous readjustment and

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2 Recent research has suggested that institutional entrepreneurs might not necessarily be pro-actively transforming institutions through purposeful action, but they also reactively act on opportunities presented to them from a novel innovation [24].
learning [25][26]. Institutional entrepreneurs seek change in collaboration and conflict with other actors simultaneously and may not have a clear foresight to mobilize large-scale changes with well-defined goals and their efforts may not be always successful and often result in undesirable outcomes [27][28][29].

Transforming institutional arrangements therefore requires collective action from a number of institutional entrepreneurs for wider legitimation of new rules, norms and belief systems – also referred to as 'collective institutional entrepreneurship'. This collective institutional entrepreneurship is achieved through sustained collaboration among numerous dispersed actors with different frames of reference, tensions and contradictions in order to create new institutions or transform existing institutions [30][31][32].

The next section proceeds with discussing how the notion of collective institutional entrepreneurship assisted in studying the long-term development of wind energy in India.

3. Research methods

The focus of this research is on development of wind power in India from 1985-2012. We use a qualitative case study [33][34]. Qualitative case studies are well suited for emerging phenomena by capturing detailed accounts often overlooked in quantitative data [35][36]. Yin [34] suggests multiple data sources such as documents, archival records, interviews, direct observations and participant observations for case study research.

For this paper, the data collection started with a preliminary search for written materials on the internet and electronic databases in order to sensitize us with the historical developments in the Indian wind energy sector.³ We reconstructed the development of wind energy

³ These sources included reports by government agencies, documents available from websites of regulatory agencies, publications by wind energy firms, news articles, conference reports and presentations, reports by consultancy organizations, research reports by advocacy organizations, PhD theses, journal articles, professional magazines and reports available on the internet.
energy in India by triangulating these secondary sources and developing a time line of events including demonstration projects, policies, technology assessments, establishment of key actors, conferences and research programs (Table 1).

Table 1: Chronology of important developments in emergence of wind energy in India

<table>
<thead>
<tr>
<th>Year</th>
<th>Key developments in Indian wind energy sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>Wind resource assessment programme; first grid connected wind turbine in Veraval Gujarat; thrust to wind power in the 7th National Five Year Plan</td>
</tr>
<tr>
<td>1986</td>
<td>First demonstration projects in Gujarat with collaboration between Natural Energy Processing Company (NEPC) and Danish International Development Agency (DANIDA); first wind farm with ten 55kW wind electricity generators (WEGs); installation of five wind farms; development of 550 kw wind farm by RRB Consultants &amp; Engineers Private Ltd India (RRB); Tamil Nadu was the first state to issue NOC to wind power project from 1986</td>
</tr>
<tr>
<td>1987</td>
<td>Co-operation between Indian and Danish government for demonstration projects; Indian Renewable Energy Development Agency (IREDA) established for financing of renewable energy projects; Danish grant of DKK 180 million (USD 58.99 million) for supply of wind turbines, erection, commissioning and monitoring of wind farm projects in Gujarat and Tamil Nadu; NEPC Micon as first joint wind turbine venture in India; Vestas RRB in India; first research paper demonstrating technical feasibility of grid connected wind turbine projects in India</td>
</tr>
<tr>
<td>1988</td>
<td>DANIDA establishes two 10 MW demonstration projects in Tamil Nadu and Gujarat</td>
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<tr>
<td>1989</td>
<td>First set of fiscal incentives and policy schemes for wind power; financing of wind power projects by IREDA</td>
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<tr>
<td>1990</td>
<td>Policies by Government of India to promote private investment in wind power (100% tax depreciation, wheeling, banking, third party sale, tax holidays, relaxation in custom and excise duty); first 10 MW mega-scale demo wind farm at Lamba, Jamnagar</td>
</tr>
<tr>
<td>1991</td>
<td>Electricity Laws (Amendment) Act of 1991 encouraging private sector participation in the Indian wind energy sector; Policy measures to stimulate private sector investments in wind energy; joint ventures and technical collaborations permitted with foreign entities; joint ventures between Indian and European wind energy companies; GOI abolished the clearance requirements of the Central Energy Authority (CEA) for any renewable energy projects from 1991; study by DANIDA on grid conditions in Gujarat for wind power</td>
</tr>
<tr>
<td>1992</td>
<td>DNES upgraded to Ministry of Non-conventional Energy Sources (MNES); first systematic attempt to assess the potential for harnessing wind energy for electricity generation; wind energy sector was liberalised for private participation in 1992; Target of 500 MW for wind energy through private sector participation set by MNES</td>
</tr>
<tr>
<td>1993</td>
<td>MNES guidelines to Indian states regarding fiscal incentives; procurement guidelines by respective state electricity boards for wind power; tax rule setting wind turbines exempt from excise duty and sales tax to reduce manufacturing cost; revised guidelines by MNES on accelerated depreciation, banking and wheeling and third party sales, guidelines for procurement of power from wind energy; new trade policy in 1993 which played an important role by reducing import duty for critical components such as rotor blades and electronics of controllers to zero</td>
</tr>
<tr>
<td>1994</td>
<td>Introduction of wind energy estates; MNES and IREDA setting up of first wind energy estate by K.Kasthurirangaian; Enercon India Ltd. formed in joint venture between Enercon GmbH and Mehra Group of India</td>
</tr>
<tr>
<td>1995</td>
<td>National guidelines for clearance of wind power projects; introduction of 100% Acceleration Depreciation of the Project Cost; first set of guidelines by MNRE on turbine approval and certification; 100% accelerated depreciation allowed for wind power</td>
</tr>
<tr>
<td>Year</td>
<td>Event</td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
</tr>
<tr>
<td>1996</td>
<td>Wind energy potential upgraded to 20000 MW by MNES; lowering of tax incentives for wind power producers and introduction of Minimum alternative Tax</td>
</tr>
<tr>
<td>1997</td>
<td>Introduction of minimum alternative tax; Turbine approval and certification guidelines for independent third party testing and quality assurance evaluation; prohibition of second hand imported turbines</td>
</tr>
<tr>
<td>1998</td>
<td>CWET established by MNES with the co-operation of Danish Government; Electricity Regulatory Commissions Act; change of exercise duty system set no exercise duty on first parts of wind turbines and rotor blades; Responsibility of feed in tariff transferred from State Electricity Boards to State Electricity Regulatory Commissions as a result of the Electricity Regulatory Act</td>
</tr>
<tr>
<td>1999</td>
<td>Wind energy potential upgraded to 45000 MW; The Ministry of Textile’s Technology upgrading fund Scheme launched in 1999 helped owners of textile mills to avail themselves of capital subsidies by setting up captive power plants or selling to third parties</td>
</tr>
<tr>
<td>2000</td>
<td>Turbine approval provisional scheme (TAPS) issue turbine certification based on the Indian wind and grid conditions; Introduction of turbine approval provisional scheme</td>
</tr>
<tr>
<td>2001</td>
<td>Energy conservation Act; duty exemption certification, introduction of first 1 MW wind turbine machine in India by Suzlon</td>
</tr>
<tr>
<td>2002</td>
<td>100 % accelerated depreciation benefit reduced to 80 %; reduction in excise duties for wind turbine components</td>
</tr>
<tr>
<td>2003</td>
<td>Indian electricity Act (sections 3, section 4, section 61(h), 86 (1)(e) mentioned in the Act relevant for renewable energy)</td>
</tr>
<tr>
<td>2004</td>
<td>First wind order tariff issued by Maharashtra state electricity regulatory commission based on cost plus methodology; RPO obligation passed by Maharashtra State Electricity Regulatory Commission</td>
</tr>
<tr>
<td>2005</td>
<td>National Electricity policy (Clause 5.12 stipulating conditions for development of renewable energy resources as per section 3 of Electricity Act 2003); renewable purchase obligations and preferential tariffs for purchase of electricity generated from wind power projects; first 2 MW class turbine by Suzlon; Project developers are free to get their project registered with Ministry of Environment and Forests to participate in certified emission reduction (CER) credits markets</td>
</tr>
<tr>
<td>2006</td>
<td>National tariff policy; Integrated Energy Policy; Rural electrification policy</td>
</tr>
<tr>
<td>2007</td>
<td>Working Group on New and Renewable Energy in the 11th plan specifying 10500 MW of renewable energy</td>
</tr>
<tr>
<td>2008</td>
<td>National Action Plan on Climate Change specifying 15 % renewable energy by 2020; working group on policies on renewable introduced by Forum of Regulators; introduction of generation based incentive; CERC (Central Electricity Regulatory Commission) paper on promotion of electricity from renewable energy sources; power; Open Access Regulations, 2008; Introduction of Indian Energy Exchange and Power Exchange India Limited</td>
</tr>
<tr>
<td>2009</td>
<td>Introduction of generation based incentives for wind power; CERC (Central Electricity Regulatory Commission) tariff regulations for wind power CERC (Terms and Conditions for Tariff Determination from RE Sources) Regulations; creation of task force constituted by CERC for integration of renewable energy resources into grid; report by Forum of Regulators on renewable purchase obligations</td>
</tr>
<tr>
<td>2010</td>
<td>Report on low carbon strategies for inclusive growth in India by Planning Commission targeting 30000 MW of wind power by 2020; CERC order for determination of levelled generation tariff; CERC guidelines on renewable energy certificate mechanism; IEGC (Integrated energy grid code) codes for wind energy providing must run status for wind farms; introduction of forecasting of wind power; Indian wind atlas published by CWET; Power market regulations for promoting competitive electricity markets</td>
</tr>
<tr>
<td>2011</td>
<td>Renewable Regulatory Funds mechanism for wind energy; introduction of national clean energy fund; report by MNRE on strategic plan for new and renewable energy sector; trading of renewable energy certificates on Indian Energy Exchange and Power Exchange of India; Announcement of national clean energy fund for renewable energy technologies</td>
</tr>
<tr>
<td>2012</td>
<td>12th Five year plan announcing renewable energy capacity addition; withdrawal of accelerated depreciation benefit; guidelines for mandatory forecasting of wind farms; guidelines for installation of prototype wind turbines to facilitate indigenization; introduction of zone based tariff method for wind energy in Maharashtra; scheduling of wind power introduced in the IEGC (Integrated Energy Grid Code); introduction of new land allocation policy for wind energy on foot print basis; relaxation in criteria with respect to minimum wind density of 200 Watts per square meter at 50 m hub height</td>
</tr>
<tr>
<td>2013</td>
<td>Re-introduction of generation based incentive by MNRE and IREDA; new guidelines in Electricity Grid Code (IEGC)’s for forecasting and scheduling of wind energy</td>
</tr>
</tbody>
</table>
Next, we identified the key actors and organizations in the wind energy sector in India and tried to understand the actors’ involvement, the nature of involvement, obstacles encountered by them and the ways in which they were overcome. Based on the secondary data collected we selected interviewee and carried out a number of interviews (see table 2). The interviews were carried out between May 2012 and August 2012 and took the form of in-depth semi-structured interviews. The in-depth interviews served to identify key issues and events that had not come up in the first stage of data collection. During the interviews we tried to understand the experiences of the experts by being attentive to their stories and engaging in conversations with them. The interview respondents were requested to provide details over historical and current developments in the Indian wind power sector, what they were doing to influence the on-going dynamics and how they were collectively addressing their concerns. This stage was helpful in refining and validating the interpretations developed from the initial data collection process.

**Table 1: List of Interviews**

<table>
<thead>
<tr>
<th>#</th>
<th>Designation</th>
<th>Location</th>
<th>Type of interview</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Director, Wind energy division, MNRE</td>
<td>New Delhi</td>
<td>In person/not recorded</td>
<td>2nd August, 2012</td>
</tr>
<tr>
<td>2</td>
<td>Secretary General, Indian Wind Turbine Manufacturers Association</td>
<td>Chennai</td>
<td>In person/recorded</td>
<td>24th July, 2012</td>
</tr>
<tr>
<td>3</td>
<td>Chief Economist, Suzlon energy</td>
<td>Pune</td>
<td>In person/not recorded</td>
<td>13th July, 2012</td>
</tr>
<tr>
<td>4</td>
<td>Director, Wind energy, WISE Pune</td>
<td>Pune</td>
<td>In person/recorded</td>
<td>19th June, 2012</td>
</tr>
<tr>
<td>5</td>
<td>Group coordinator, Prayas Energy Group</td>
<td>Pune</td>
<td>In person/recorded</td>
<td>13th July, 2012</td>
</tr>
<tr>
<td>6</td>
<td>Professor, Administrative staff college of India</td>
<td>Hyderabad</td>
<td>In person/recorded</td>
<td>5th July, 2012</td>
</tr>
<tr>
<td>7</td>
<td>Independent expert and first chairman, CERC</td>
<td>Bengaluru</td>
<td>In person/recorded</td>
<td>1st June, 2012</td>
</tr>
<tr>
<td>8</td>
<td>Chief of Bureau, The Hindu Business line</td>
<td>Chennai</td>
<td>In person/recorded</td>
<td>25th July, 2012</td>
</tr>
<tr>
<td>9</td>
<td>Director, Center for Wind energy technology</td>
<td>Chennai</td>
<td>In person/recorded</td>
<td>7th June, 2012</td>
</tr>
<tr>
<td>10</td>
<td>Secretary General and Executive, Indian Wind Power Association</td>
<td>Chennai</td>
<td>In person/not recorded</td>
<td>10th May, 2012</td>
</tr>
<tr>
<td>11</td>
<td>Director, ABPS Infrastructure advisory services</td>
<td>New Delhi/Chennai</td>
<td>Telephonic interview</td>
<td>26th July, 2012</td>
</tr>
<tr>
<td>12</td>
<td>General Manager, Policy and Government relations, Vestas India limited</td>
<td>Gurgaon/Dehradun</td>
<td>Telephonic interview</td>
<td>8th August, 2012</td>
</tr>
</tbody>
</table>

For the analysis of data we took a process rather than outcome view of institutional change [37]. Process analysis describes a series a sequence of events to analyse how things change, in this case the institutional context for wind energy in India, and aims to identify underlying mechanisms of observed patterns in the process of change [38][39]. Process analysis is messy in nature and requires constant iteration between the data collection, data reduction, representation and analysis [40]. Therefore, a combination of inductive and deductive techniques was used to analyse the data, i.e. the data and theory were considered together. Prior literature was used to inform data collection and new aggregated concepts were built from the data collected [41][42][43][44].

For the purpose of this paper we developed aggregated strategies of institutional entrepreneurs [45]. On the basis of this iterative process, we defined two distinct kinds of aggregated strategies pursued by institutional entrepreneurs for development of wind energy in India: creation of supportive techno-economic and socio-political networks (denoted by SNo.1, 2,3,4,5, 6 in table 3) and creation of an indigenous innovation infrastructure (denoted by SNo. 7,8,9,10,11 in table 3). Table 3 provides details of the aggregation of empirical data into the two aggregated strategies and their relation with the mechanisms identified in the existing literature on institutional entrepreneurship.
<table>
<thead>
<tr>
<th>SNo.</th>
<th>Mechanisms in the literature</th>
<th>Empirical examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Creating a vision for change by framing the problems and justifying particular innovations as solutions to the problems [19][46][47]</td>
<td>5 year plans by Government of India with likely capacity addition targets for wind energy; renewable energy targets in National Action Plan on Climate Change; targets set by the Low Carbon Group of the Planning Commission; narratives about annual value of investment into the wind sector, energy security, growth of national industry; potential for large number of jobs, economic growth and million tons of CO2 saved</td>
</tr>
<tr>
<td>2</td>
<td>Using social and political skills to mobilize collective action and co-operation between heterogeneous actors [48][49][50]</td>
<td>Expert Group on Low Carbon Strategies for Inclusive Growth; Working Group on Power; various Committees/Task forces/joint working groups formed at Centre and States</td>
</tr>
<tr>
<td>3</td>
<td>Steering through new regulations and policies such as creating appropriate public incentive structures [7][51][52][53]</td>
<td>Regulatory, policy and financing instruments such as feed-in tariffs and accelerated depreciation on investment on capital equipment; generation based incentive; renewable energy certificate mechanism; renewable purchase obligations; guidelines for forecasting and scheduling of wind power and integration of wind power into the grid</td>
</tr>
<tr>
<td>5</td>
<td>Framing new business models for exploring the potential of a new technology [21][55][56]</td>
<td>Turnkey project development model</td>
</tr>
<tr>
<td>6</td>
<td>Calculative metrics through which value of an emerging technology is debated and determined [57][58][59][60]</td>
<td>Supporting price discovery through preferential tariff or competitive bidding.</td>
</tr>
<tr>
<td>7</td>
<td>Learning through transnational networks [61]</td>
<td>Cooperation programmes with Danish government, assistance from Danish consulting organisations in planning, design and implementation of wind farms; support from international development banks and bilateral donor agencies; encouragement of formation of joint ventures; mergers and acquisitions, ease of rules and guidelines for foreign investment, joint R&amp;D activities; collaboration with EU wind energy networks.</td>
</tr>
<tr>
<td>8</td>
<td>Taking action to educate other actors, shaping the beliefs and perceptions of different stakeholders and being committed to the emerging field [46][62][63][64]</td>
<td>Exchange of information through industry magazines such as Wind Pro, Inwind Chronicle, Indian wind energy outlook by IWTMA; attempts to influence public opinion through media; training programmes by CWET and wind industry associations</td>
</tr>
<tr>
<td>9</td>
<td>Generating narratives about the future, preparing collective roadmaps, forecasts and monitoring of technological progress [23][65]</td>
<td>Measurement of wind energy potential and forecasting</td>
</tr>
<tr>
<td>10</td>
<td>Designing new market mechanisms, grid infrastructure, regulations and valuation techniques for higher penetration for wind energy [66][67]</td>
<td>Grid discipline and grid connection rules; creation of adequate transmission infrastructure for smoother grid integration of wind energy</td>
</tr>
<tr>
<td>11</td>
<td>Participation in field configuring events and hybrid forums (conferences, trade events, public forums, joint committees, workshops etc.) [51][68][69]</td>
<td>Conferences such as Wind Power India organized by Global Wind Energy Council, World Institute of Sustainable Energy and Indian Wind turbine manufacturers association; International wind conference and exhibitions; wind energy stakeholders meetings</td>
</tr>
</tbody>
</table>
We divided our analysis into three time periods when institutional context changed significantly. During 1985-1995 the first set of demonstration projects took place in the context of the liberalization of the Indian economy, which allowed an increasingly greater role for the private sector. During 1995-2003, independent regulatory agencies and wind industry associations entered the scene. Finally, the time period 2003-2013 is characterised by the passing of the Indian Electricity Act in 2003, followed by series of regulatory and policy measures which broadened the role of different actor groups.

4. Results

4.1 Early socio-technical experimentation with wind energy in India (1985-1995)

*Creation of supportive techno-economic and socio-political networks*

Efforts to harness wind energy in India were already being done as early as the 1950s. The National Aeronautical Laboratory (NAL) initiated one of the first projects on wind energy in India.\(^4\) They participated in a meeting of the wind power subcommittee of the Council of Scientific and Industrial Research (CSIR) in 1954 in order to develop the first models of wind turbines for rural applications. CSIR developed two prototype wind turbines suitable for Indian conditions useful for water pumping applications and battery charging in Indian villages [70]. In 1960 a dedicated wind power division of NAL was established in Bangalore. These initial forays made by NAL in the early 1960s demonstrated the capability of wind turbines to deliver useful energy [1][71].

A sudden increase in the international price of oil in the 1970s, uncertainties associated with its supply and the need for energy self-sufficiency led to the creation of the Commission for Additional Sources of Energy in 1981. This commission was responsible for

\(^4\) More specifically by Prof M.S. Thacker and Dr. P. Nilakatan.
formulation of policies, conducting programmes, co-ordinating R&D and implementing programs for renewable energy in India [72][73][74]. In 1982, the Department of Non-conventional Energy Sources (DNES) was established, which included a technical committee for grid-connected wind energy R&D. The committee’s aim was to contribute to the development of large-scale grid connected demonstration projects in India by reducing costs and designing turbines suitable for Indian conditions. The committee’s work contributed to several projects from the Gujarat Energy Development Agency (GEDA) in Veraval under leadership of GEDA’s director [1].

DNES also established financial incentives for grid quality power generation by wind turbine technology in the 7th National Five Year Plan (NFYP), which ran from 1985 to 1990. NFYP are key strategic economic documents that plan the national economic organisation of the country for 5 years. By the start of the 8th NFYP, wind power generation became the thrust of India’s Ministry of Non-conventional Energy Services (MNES), established in 1992 [6]. MNES initiated a national programme focusing on policy support, wind resource assessment, implementation of demonstration projects, creation of appropriate policy and financial initiatives, creating local capacity for manufacturing, increasing involvement of energy utilities and raising awareness about wind energy [73][75][Int1]. In 1987, a dedicated financing agency Indian Renewable Energy Development Agency (IREDA) was established as part of DNES for providing loans for renewable energy projects in India [6][76].

In 1987, Jami Hossain while working for The Energy And Resources Institute (TERI) in Delhi, published an influential paper on wind energy in India. The paper analysed the experiences with wind energy demonstration projects and made recommendations to improve the performance of wind farms. Most notably the paper argued for amending the electricity act to allow for private wind farming as well as numerous economic recommendations to

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5 The committee was led by J. Gururaja and Ajit Gupta.
6 The director at the time was K.S. Rao.
bring down the costs of wind energy production. Based on recommendations in this paper, the Indian government published new policies in 1990 to encourage private sector investments in wind energy [1].

As a result, MNES introduced various new fiscal and financial incentives to improve financial performance of wind turbines. Most notably these included a 1993 concessional wheeling & banking and accelerated depreciation system (AD) to attract private sector investment for wind energy development in India as well as a specific tariff for purchasing power from wind farms – a novelty at the time in India. Many state governments also encouraged wind energy with additional support mechanisms [77][78][79][80].

Next to providing financial incentives, a key strategy of the Indian government was to encourage joint ventures and financial and technical collaboration with foreign entities. Although custom duties on wind turbines were imposed, specific components were excluded from duties by providing concessional exemptions [81].

The new institutional setting for wind power in India resulted in substantial support from industrial firms who used wind power for captive consumption. These included in particular relatively small cement, smelting and textile industries, but the financial scheme also attracted investors in energy, steel and automobile industries, who wanted to reduce high power usage charges and profit from the use of the AD system [82][83][84]. The new institutional setting was so successful that MNES was worried that the accelerated depreciation measure could lead to a gold rush situation as it was seen in California for tax credits [77].

7 These recommendations included fixing of purchase rates from wind farms, qualifying investments in wind energy for accelerated depreciation, income tax concessions for wind farms and exemptions of custom duty for spare parts. Other recommendations included eliminating the tendency for reducing monopolized manufacturing, availability of grid for transmission of wind power by state electricity boards, establishment of test fields, suitable import and sales tax duties.
8 The tariff was set at INR 2.25/kWh with a 5% increase every 5 year. Other incentives included capital subsidies and tax holidays.
9 Examples are concessional land allotment, electricity duty exemption and schemes for exemption or deferment of sales tax for the industry.
Between 1993 and 1999, IREDA and the World Bank implemented the Renewable Resources Development (RRD) project for commercialising wind energy in ways that were different from previous governmental programmes [85][74]. The project, grounded in neo-liberal thinking, tried to attract private investors rather than relying mostly on public support by creating a better understanding of the risks involved in financing [85]. The idea was that this would lower risk perceptions of investors such as commercial banks.

In 1995, MNES issued guidelines to all the private wind developers in order to ensure that incentives provided by the central and state governments were used properly by wind developers for putting up quality wind turbines. These guidelines included the obligation for wind farms to produce Detailed Project Reports (DPR). These reports contained detailed information about micro siting (i.e. where to place individual wind turbines in a larger wind farm), selection of wind turbine equipment, operation and maintenance data and performance evaluation. Wind power producers had to submit DPRs together with their reports about annual energy output and costs of generation to state energy utilities. The most important reason for these reports was MNES’ desire to reduce misuse of public finance – an increasingly important critique voiced by several national and international stakeholders.\(^\text{10}\)

However, these guidelines also contributed to creating collective awareness and knowledge within and between the state electricity boards, state nodal agencies, manufacturers, developers, and investors about planned development and implementation of wind power projects [79][86].

**Creation of an indigenous innovation infrastructure**

\(^{10}\) MNES issued several other procedures including improved rules on performance estimates of projects, getting turbine approval from government agencies, obtaining a no objection certificate from state energy utilities, correct site selection, requirement of third party testing and certification and prohibition on the use of second hand turbines imported from developed countries.
In the early 1960s, NAL had systematically studied data from the India Meteorological Department and prepared a wind map for India [71]. In 1985 an extensive wind resource assessment was carried out by the Field Research Unit for wind resource assessments of the Indian Institute of Tropical Meteorology (IITM). A wind energy data book was compiled and published on the basis of data available from vast metrological stations across India. The data however had limitations as it was collected for aviation and meteorological purposes and not specifically for assessing the energy content from wind [1][Int9]. DNES subsequently sponsored a project of IITM to install 36 monitoring stations in the states of Gujarat, Maharashtra, Tamilnadu and Orissa. The first Indian monitoring station was established at Sultanpet, near Coimbatore in Tamil Nadu in August 1986 [71][75]. MNES later compiled and published a report with detailed wind mapping of India comprising 150 wind monitoring and 470 mapping stations [87]. This was followed by one of the first systematic attempts to assess wind energy potential for electricity generation in India by Jami Hossain and K. Raghavan in 1993. The authors estimated wind energy potential in India to be around 20000 MW, but the figure was later revised to 45000 MW [1][88].

The first grid-connected wind turbine was setup and commissioned in Verawal in Gujarat in 1985. It was privately owned, but financially supported by DNES. Subsequently, DNES initiated a wind farm demonstration programme in 1986 that offered substantial grants to five projects of 550 KW each [89]. In 1986, wind farm activity started with installation of the five wind farms in Mandvi, Okha, Devgarh, Puri and Tuticorn. These wind farms mostly used second-hand imported turbines [6][75].

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11 Pioneering work was done by Dr. Anna Mani, Dr. S Ragaran and Dr. D.A. Mooley from the National Aeronautical Laboratory made detailed studies on wind speeds in India by creating wind maps. Dr. Anna Mani was later involved in a comprehensive wind monitoring and mapping programme by publishing wind energy resource data books in India with support from Dr. S.K. Tewari from the National Aeronautical Laboratory based in Bangalore 47.

12 Despite increased efforts to develop an indigenous infrastructure for wind energy innovation, India still only had a few organizations such as TERI and Consolidated Energy Consultants who were available for techno-economic and project feasibility studies during this time period [91].
The Danish International Development Agency (DANIDA) was the first foreign agency to show an actual interest in the potential Indian wind power market. In December 1986, DNES requested DANIDA to assist DNES, Tamil Nadu Electricity Board (TNEB) and the Gujarat Energy Development Agency (GEDA) to develop demonstration wind farms in India. The government of Denmark and the government of India established a cooperation programme that conceived a 20 MW wind energy demonstration project. The project included a 10 MW wind farm in Gujarat and two wind farms (4 and 6 MW) in Tamil Nadu. TNEB and GEDA were responsible for preparing the respective sites, constructing access roads, foundations, transmission lines, and substations. DANIDA retained an experienced Danish wind energy consulting firm to plan, design, and oversee implementation of the project. They also contracted two well-established Danish manufacturers to supply and install equipment. All three Danish firms were required to work closely with local partners to develop indigenous technical capacity. Danish contractors manufactured and delivered the turbines and most of the towers, which were then installed at the prepared sites. Experience was gained in wind farm planning, implementation, and management by DNES and the state electricity board staff members [6][89].

The program was perceived as a major success. The demonstration projects helped provide real data on the techno-economic feasibility of wind energy generation in India and created a knowledge base for further wind turbine development in low wind speed conditions in India [80][Int2]. The demonstration projects also provided opportunities for the build-up of advocacy, establishing technical and economic viability, widening participation and creating interests among the private sector regarding the potential of wind energy.

Not the least, the program instigated new entrepreneurial and industrial activities, including co-operations between Indian and foreign firms. This included the establishment of production facilities for wind turbine generators in India [6]. The Danish-Indian joint venture
NEPC-Micon was established in 1987 as the first wind turbine manufacturer in India [90]. This was followed by Khemka business group forming a joint venture with NEPC Micon. Other Danish firms followed and established their subsidiaries in India as well as by engaging in joint ventures. A notable example is the establishment of a 1987 partnership called Vestas RRB India Ltd between the world leading Danish firm Vestas and the Indian Firm RVV. Domestic manufacturing was further set in motion by a series of licensing agreements with, among others, German firms (Enercon, Nordex, DeWind, Sudwind GmbH) [74][80]. Many firms established production facilities in India.\textsuperscript{13}

In 1995, Suzlon was started by Tulsi Tanti by diversifying from the old textile business he was running. The company entered into a technical collaboration with a German company Sudwind GmbH Windkraftanlagen to source the latest technology for production of wind turbines in India. Suzlon developed the concept to commissioning business model (turnkey project development) in which it sought complete ownership of design and technology and creating wind energy banks in advance for investors. This means that manufacturers are responsible for securing land and grid connectivity as well as the supply of turbine equipment, erection of turbines, facilitation of the power-purchase agreement and lifetime maintenance. Suzlon began providing end to end solutions where it offered full services to small scale investors in terms of identifying sites, installation of turbines and their operation and maintenance [1][Int3].

The number of wind turbine manufacturers increased steadily [79]. By 1995, 21 wind turbine manufacturers in India had tied up for joint venture or license agreements with foreign manufacturers. The size of produced and installed wind turbines increased because of these collaborations. The first 200kW class wind turbines was installed by Micon in 1989 (250kW), and the first 300kW class turbines were introduced by Nordtank in 1991. Enercon

\textsuperscript{13} NEPC Micon (NEPC India), Vestas RRB, Enercon India, Pioneer Wincon, TTG Husumer, Elecon Engineering with HZM and Turbowind, Suzlon, NEG Micon, GE Wind India, and C-WEL all
India began manufacturing and installing 500 kW gearless variable speed turbines from 1995 onwards. The new wind turbine had been specifically designed for the low wind speed conditions in India.

Nevertheless, Indian firms were still very dependent on European firms and India had limited indigenous capabilities for planning and operating wind farms. The number of people with relevant experience in wind energy was still limited. In particular, skills and know-how of project planning, site assessment, site development, operation and maintenance were low and caused many project failures in the early and mid-1990s [79]. Wind developers also faced problems with respect to approval from multiple government departments, acquisition of land, grid problems and complicated procedures often leading to high costs for wind projects. These problems led policy makers to see commercialization of wind energy in India with high degree of scepticism [90].

4.2 Wind energy hype and slow-down (1995-2003)

*Creation of supportive techno-economic and socio-political networks*

Although the wind energy industry developed substantially, several key problems continued to exist in this period, in particular in relation to a rather bureaucratic approach taken by state energy utilities [92]. In an attempt to deal with this, MNES developed proposals for organizing a more continuous dialogue between state electricity boards, wind developers and MNES by creating committees of representatives [93]. MNES also encouraged public power companies such as the National Hydroelectric Corporation, the Rural Electrification Corporation and the National Thermal Power Corporation to include stakeholder meetings.

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14 Examples of bureaucratic problems are the ways in which producers were allowed to sell wind power to third parties, high wheeling and banking charges for investors interested in captive consumption of wind energy, energy utilities’ refusal to pay wind power producers according to guidelines and buy back rates issued by MNES.
when developing wind projects.\textsuperscript{15} Despite these efforts, the wind energy industry remained critical regarding MNES’s ‘command and control approach’ as it still often took decisions without involving other stakeholders [94].

The wind energy sector started organizing themselves in sector associations. In 1996, 21 wind energy producers established the Indian Wind Power Association (IWPA), which was followed by the Indian Wind Turbine Manufacturers Association (IWTMA) in 1997. A third one, the Indian Wind Energy Association, followed in 2002. These associations over the years have played an integral role in a range of activities including both sharing information between wind power producers and turbine manufacturers as well as trying to influence the institutional context for wind energy [Int2][Int10][95].\textsuperscript{16} In 1996, the Confederation of Indian Industry (CII) supported wind energy by organizing an energy summit and proposing national goals for renewable energy in India. This meeting suggested providing a more stable investment climate and political commitment for supporting wind power [96]. Industrial groups Tatas and Bajaj as well as major public sector organisations in the energy field also started taking an interest in developing wind energy projects [97].\textsuperscript{17}

Nevertheless, several fluctuations in the Indian wind energy market occurred due to unstable policy and institutional environment. The introduction of a tax system for (previously) non-taxable companies, the so-called Minimum Alternative Tax (MAT), had the wind industry seriously fretting until the government clarified that power infrastructure development would be exempted. IREDA raised interest rate on wind energy investment loans, which slowed down the development of wind energy [93]. Speculative investor

\textsuperscript{15} In its long term vision plan, MNES also set target of 10 % share of total installed capacity by 2012 [94].

\textsuperscript{16} Examples are petitioning and fighting cases on behalf of wind energy investors, publishing wind energy generation data, dissemination of information on running of wind farms, conducting training programs for technicians and engineers, engaging in policy advocacy with energy utilities, interaction with government bodies and regulatory agencies, publishing wind industry magazines, and translating important lessons learned from wind energy development from other countries in India

\textsuperscript{17} The public sector organisations involved were the Oil and Natural Gas Corporation, the Hindustan Petroleum Corporation, Bharat Petroleum and the National Thermal Power Corporation.
behaviour and misuse of the accelerated depreciation measure also caused serious problems. Higher import duties for wind turbine components and poor financial conditions of the state energy boards in India further resulted in unfavourable conditions for wind power investors in India [80][82][98]. Finally, the Ministry of Finance reduced the tax subsidy given to wind power producers with 50 % and the accelerated depreciation benefit was reduced from 100% to 80% in 2002 [84]. Efforts from MNES to recommend policy modifications in customs and excise duties\(^\text{18}\) and to continue the 100% accelerated depreciation for renewable energy technologies failed [99].

In 1998, in an attempt to start reorganising the electricity sector, the Ministry of Power supported the formulation of the Electricity Regulatory Commission Act, which later resulted in the establishment of the Central Electricity Regulatory Commission and various State Electricity Regulatory Commissions. The Ministry of Power also started drafting a comprehensive Electricity Bill to replace all existing legislation in the energy sector. This new Electricity Bill would require Indian states to unbundel the existing state electricity boards and establish independent regulatory commissions, meter all electricity supply, remove cross subsidies and reduce transmission and distribution losses [100][101][102].\(^\text{19}\)

Civil society organizations such as the Prayas Energy Group also started to become prominent by organizing various forums for dialogue and sharing of experiences. They focused on articulating and protecting the interest of the general public in power sector reforms and regulatory processes [103]. Yet in general, civil society involvement in wind energy issues was very small, in particular in comparison with civil society involvement in leading countries such as Denmark and Germany.

\(^{18}\) Duties on import of raw materials for manufacturing of blades of wind turbines

\(^{19}\) Within the Indian Parliament, the Lok Sabha Committee on Energy and the Energy Policy Division of the Planning Commission became active for promoting renewable energy in India.
Creation of an indigenous innovation infrastructure

In 1998 a wind turbine test station was developed in Chennai with the support of the Danish agency DANIDA and Risø National Energy Laboratory of Denmark. The main role of this test centre, known as the Centre for Wind Energy Technology (CWET), was to develop standards and do testing and certification of wind generators [Int9]. CWES developed a turbine certification scheme and a turbine approval provisional scheme to issue grid connected turbine certifications in India.

MNES and IREDA also introduced the concept of "Wind Energy Estates," which were joint estate firms between state government and private developers. These firms’ mandate was to acquire land, develop necessary infrastructure and grid facilities, obtain the necessary clearances and install, operate and maintain wind turbines on behalf of the investors. The wind energy estates helped in reducing the gestation period of wind projects as well as encourage small-scale investors [79].

MNES also set up an expert committee for wind resource assessment and measurement covering 213 wind monitoring stations and 530 wind mapping stations in 25 states in India [104]. Furthermore wind measurement techniques were being developed with the use of meso-scale modelling. However, it remained challenging to prepare a comprehensive wind power density map for India [71].

MNES provided incentives to develop wind turbines suitable for the specific Indian conditions through three models (i.e. industry in-house R&D model, consortium model, and joint projects between industry and MNES with foreign institution or research laboratory) [79]. With the help of licensing agreements, domestic manufacturing of wind turbines grew in India with collaborations from Danish and German firms. Several smaller domestic wind

20 CWET also developed activities in wind resource assessment and monitoring, installation of wind mapping stations, preparing a wind atlas for India, designing and developing wind turbine components, technical assistance and training and conducting special technical courses and awareness programmes for the general public [11][82][87].
turbine firms such as BHEL, Global Wind Power, Reegen Powertech, Siwa Wind Turbine also became active with licensing agreements with foreign firms. The Indian firm Suzlon followed a route of technology licensing not only for wind turbine systems but also for key components such as blades and gearboxes from the mid-1990's [74][106]. In general, wind turbine companies in India were simply importing wind turbines and components and assembling them on the sites in this period.\(^{21}\)

Despite MNES’ efforts and increasing collaboration with foreign firms, many projects suffered from failure. This was caused by several factors. Skills and relevant know-how of project planning, site assessment and development and micro-siting in India continued to be limited. The performance of wind power installations was also poor in terms of capacity utilization factor (CUF) due to lack of monitoring of projects. In addition, the fact that investment decisions were based on availing tax incentives rather than on production incentives led to the instalment of low-quality and low-performance of wind turbines. Malpractices such as wind investors getting false commissioning certificates were quite common [82][92][107].

In the late 1990s wind turbines got destroyed in a cyclone in Gujarat. This event further reduced the image of wind turbines, painfully revealed poor installation practices of inexperienced wind entrepreneurs who were only interested in the subsidies. Wind companies often were not skilled in important issues such as negotiating with local communities, dealing with conflicts with state electricity boards and attracting sufficiently trained manpower for maintenance and infrastructure [108]. Nevertheless, in some cases local communities did support wind turbines as a result of promises on the creation of jobs and economic

\(^{21}\) The dependence on import of wind turbine parts was not reduced substantially, but activities of firms such LM Glasfiber India, Enercon India, and Suzlon helped in development of blade manufacturing technology through R&D activities in India. Special efforts were made to indigenize wind turbine components such as tower, generator, gearbox, controller and rotor blades with only a few critical components being imported have been made to indigenise the gearbox and controller [99][79].
development in rural areas adjacent to wind farms [109].

State energy utilities continued their resistance against granting third party sales to wind power producers. They saw wind power as a peripheral supply option with little consideration in long term energy planning. The believed wind energy only caused nuisance to the grid, created low network reliability and caused losses to state energy utilities [79][82]. In the Indian power sector, plagued by reliability issues and structural inefficiencies, issues of grid integration, forecasting and scheduling were especially important [74].

As a consequence, only a few manufacturers remained active in India at the end of the century. The interest of foreign collaborators reduced, due to slow market growth and low technological capabilities of Indian firms [80]. Though there was some improvement, India’s knowledge base in wind energy generation and wind turbine manufacturing was weak and needed significant growth to be competitive at an international level [6].

4.3 Towards upscaling of wind energy (2003-2012)

Creation of supportive techno-economic and socio-political networks

In 2002, the International Energy Agency (IEA), MNES and the Confederation of Indian Industry organised a workshop with over 150 different stakeholders to discuss policy goals for accelerating the deployment of renewable energy in India. This was also one of the first attempts to develop a comprehensive energy policy for India and served to include provisions in a draft of a new electricity bill [111]. The passing of Electricity Act in 2003 act streamlined and resolved many power sector issues. 23 The Electricity Act 2003 subsequently

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22 With respect to problems of integration of wind energy into the grid, the Risø National Laboratory and CWET collaborated on a research project to study wind power integration in weak grids in India and improve the penetration of wind energy in the Indian grids conditions [110].

23 The development of the Electricity Act was based on the Electricity Regulatory Commission Act of 1998 and was created as a result of a three year process with many rounds of debates, discussions and drafts.
led to the introduction of specific provisions for renewable energy sources in India [74][Int7][Int8].

The social dynamics in terms of influencing energy decision making also changed as a result of the new electricity act. Despite many efforts of MNES, energy policy making India has so far been dominated by the Ministry of Power, which had been endowed with significant political, resource and discursive power. Indeed, a major barrier for renewable energy development in India has been the overall complexity of the Indian electricity sector due to political power being distributed between the national government and state governments as well as between different ministries (in particular the Ministry of Non-conventional Energy Sources, the Ministry of Power and the Ministry of Finance). This has often resulted in conflicts in the law making process [Int7]. Co-ordination failures also included contradictions between different policy guidelines.

Provisions in the Electricity Act 2003 enabled advocacy and petitions by concerned stakeholders. It was an attempt to become more systematic in terms of advocacy for change in rules and provided guidelines on participation. The provisions allowed appeal against the orders of the Regulatory Commissions in the Appellate Tribunal of Electricity based in New Delhi [112]. For example, the Renewable Purchase Obligation (RPO), which mandates utilities to purchase renewable energy, was introduced in Maharashtra due to filing of a

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24 Prior to enactment of Electricity Act 2003 there were no specific provisions in India for promotion of renewable energy in India as the issues were left to state electricity boards, state electricity regulatory commissions and MNES [113].

25 An example is the National Action Plan on Climate Change specifying 15 % of India's energy needs from renewable energy sources by 2020, while the Integrated Energy Policy by the Planning Commission suggesting 5 % renewable energy in the overall energy mix by 2032 [74]. According to the Low Carbon report of the Planning Commission renewable energy does not play an important role in overall energy mix with the expert group assuming a moderate target of 30000MW by 2020, which is even less than the ambitious targets set by National Action Plan on Climate Change (NAPCC) by the PMO. The Working Group on Power constituted by the Planning Commission for the 12th five year plan (2012-2017) suggested greater clarity for wind power in terms of capacity addition of 11000 MW and meeting renewable energy purchase obligations [129].

26 Guidelines were included on the preparation of consultation papers on the regulation proposed, drafting of proposed regulations followed by circulation of drafts in public for receiving comments and discussions and public hearings for drafting the regulations based on comments and discussions in the public hearing.
petition by the director of Maharashtra Energy Development Agency in 2004. This subsequently led to development of guidelines for Renewable Purchase Obligations in other Indian states [114][Int4].

With respect to advocacy for wind energy in India, large firms such as Suzlon, Vestas, Gamesa, and Enercon hired dedicated regulatory and policy officers to represent their firms in public hearings organized by the regulatory commissions. These officers provided comments on regulatory orders, met ministers and policy makers in person, provided them with papers and proposals on policy and regulatory issues, expressed industry interests in media, and generally tried to convince policy makers for introducing favourable guidelines and policies for wind energy [Int2]. Consultancy organizations and rating agencies started playing an active role in advising policy makers and regulatory agencies.27 Also advocacy and research organizations also became more prominent in terms of supporting policy makers by conducting techno-economic feasibility studies, disseminating knowledge and providing advisory services for promoting wind energy.28

For example in 2005, the World Institute for Sustainable Energy (WISE) started advocacy for development of a renewable energy law in India. The draft document of the first law by WISE was developed by taking a holistic view on the gradual transformation to sustainable energy in India. To mobilize support for the new drafted law, a working group chaired by the influential Dr Pramod Deo, who was past Chairman of the Maharashtra Electricity Regulatory Commission (MERC) and chairman of Central Electricity Regulatory Authority (CERC), pursued advocacy for this imitative. In 2007, the draft document was submitted to the Ministry of New and Renewable Energy, which then sent the draft document

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27 Examples of consultant agencies active in the Indian wind energy sector are Price Water House Coopers, KPMG, A.T. Kearny, Ernst and Young, McKinsey, ABPS Infrastructure Advisory Services, AF Mercados EMI, Power Research and Development Consultants, Consolidated Energy Consultants Limited and Garrad Hassan India. Examples of rating agencies are ICRA and CRISIL Infrastructure services.

28 Examples are WISE World Institute of Sustainable Energy (WISE) Pune, The Energy and Research Institute (TERI) New Delhi, Shakti Sustainable Energy Foundation and CStep Bengaluru.
for debate in the Indian parliament. Nevertheless, the efforts to introduce the law were not satisfactory as MNRE did not pursue the initiative vigorously according to some [114][Int4][Int12].

Civil society and environmental groups also became more active in policy debates. They raised concerns on high tariffs for wind energy and undue profits by wind developers, data asymmetry issues with respect to tariff calculations and energy equity. Also foreign wind energy organizations and networks played increasingly important roles in driving policy and regulatory agendas by translating learning experiences in the form of best practice guidelines from other countries and reliable advisory services to policy makers.30

The increased possibilities for participation fuelled debates, conflicts and contestation in Indian energy policy making. From 2009 onwards, a notable debate evolved around the Generation Based Incentive and the Accelerated Depreciation benefit. In 2009, the Government of India implemented a Generation-Based Incentive (GBI) scheme for grid-connected wind power projects. The introduction of the GBI was one of the first attempts to change the dominant business model in India from an investment incentive towards a production incentive. This was expected to provide incentives for producing larger amounts of wind power at reduced costs, incentivizing the actual use of efficient wind turbines, improving operation and maintenance of wind farms and promoting competition among wind developers [115][116].

The major supporters of the previous scheme, the Accelerated Depreciation (AD) benefit, were the small and medium scale industries (e.g. cement glass and textile firms). They used AD benefit as margin money for ordering wind turbines and running their own industries with cheaper wind energy through captive mills. In this manner they were able to

29 These included Green Peace India, Prayas Energy Group, Center for Science and Environment and People's Monitoring Group on Electricity Regulation.
get low cost energy as well as recover majority of their investments early on [117][118][119]. The government of India, however, saw AD as creating major losses in the form of lower corporate tax collection, excessive profits to small scale investors and to high project costs [120][121][122]. The Government of India, and in particular the Ministry of Finance, was not pleased with too many non-serious investors in the Indian wind energy sector and wanted to focus more on actual generation based incentives [Int1]. The issue became contested to such an extent that the Government of India became prejudiced against supporters of the accelerated depreciation benefit for wind energy in India and developed a perception that wind power developers and investors were earning too much profits out of the AD measure without incentivizing actual generation of wind power [100][Int2].

Both the schemes AD and GBI, however, were discontinued on 1st April 2012. This resulted in a sharp decline in capacity addition. The Indian wind industry went into crises as the financial performance of prominent firms such as Suzlon, Vestas India was strongly affected [123]. Removal of the AD and GBI benefits in April 2012, led to subsequent requests, petitions, advocacy and lobbying efforts from the wind industry associations for re-introduction of the generation based incentive and accelerated depreciation measure. Influential representatives of wind energy firms and industry associations emphasized the fact that the accelerated depreciation benefit is a tax deferral scheme and not a subsidy causing loss to the Government exchequer. The representatives from Indian wind energy associations and wind energy firms advocated also for re-introduction of the accelerated depreciation and generation based incentive by making collective representations to Department of Economic Affairs, Ministry of Finance, Ministry of Power and Ministry of New and Renewable Energy. They joined with industry associations such as the Confederation of Indian Industry to promote priority sector financing for wind energy and requesting funds from the national clean energy initiative [124][125][126]. The advocacy succeeded and the generation based
incentive was re-introduced recently [127]. Chances are accelerated depreciation will be re-introduced in the form of a direct tax code [123].

The suitability of a feed-in tariff versus competitive bidding for procurement of wind energy is another issue that has been debated a lot. The report "Policies on Renewables" by the Forum of Regulators in 2008 recommended the Minister of Power to frame guidelines for procurement of renewable power under competitive bidding according to provisions in the Electricity Act 2003 and provisions in the National Electricity Policy.\textsuperscript{31} Competitive bidding is a scheme under which wind power producers make a bid to produce a certain amount of power against a competitive market price.

Actors favouring competitive bidding included MNRE, the Ministry of Power and civil society group Prayas Energy Group cited reasons such as the limitations of a feed in tariff mechanism in determining appropriate tariffs, poor financial conditions of energy utilities in India, reducing the cost burden on consumers, promoting competition and incentivizing higher generation [Int5][130].

On the other hand the wind energy firms and industry associations resisted competitive bidding citing reasons such as risks associated with unpredictability of wind energy, lack of accurate wind resource assessment data at the project site, difficulties associated with accurate forecasting, land issues and unpredictability of future grid availability. They also emphasised the lack of evidence of successful foreign competitive bidding mechanism for procurement of wind energy [131][132][Int12].

Wind energy forecasting and scheduling became another important area of concern. Wind power producers were directed by the Central Electricity Regulatory Commission to schedule wind power and were penalized if their input into the grid varied more than 30 % of

\textsuperscript{31} The Forum of Regulators recommended introduction of competitive bidding on pilot basis to test the feasibility of the concept as international experience in U.K. and suggested to lower of tariffs but no significant capacity addition [128][129].
their forecast. The Central Electricity Authority and Central Electricity Regulatory Commission developed new technical standards and regulations for harnessing fluctuating wind energy and specifications for grid integration. Guidelines were issued with respect to payment of unscheduled interchange charge in case generation promised to the grid by the wind developers is different from actual generation. However the guidelines were resisted by the wind industry in particular from the wind industry associations due to operational challenges and interpretation of the Indian Electricity Grid Code. The wind industry demanded implementation in such a way that wind energy generators would not be penalized for problems in the existing electricity infrastructure and cause impact on the revenue of the wind developers [133][134][Int12][135].

**Creation of an indigenous innovation infrastructure**

The new institutional context enabled India to further develop a domestic manufacturing base through joint ventures, licensed production and subsidiaries of foreign companies [136][137]. The main factors that contributed to growth with were the design of wind turbines for low wind speeds in India, which resulted in better capacity utilization. Also better site selection and rigorous wind resource assessment and micro-siting improved wind turbine performance were important. Efforts are going on for better aerodynamic design, higher towers, use of lighter and larger blade materials, variable speed gearless operation using advanced power electronics [98][138]. Repowering of old wind turbines also gained importance in recent years to improve the efficiencies of the wind turbines [Int12]. However at the same time problems occurred in number of key wind turbine components such as bearings, gearboxes, generators, main shafts, control cabinets, and complex castings such as hubs and mainframes.

A major issue is the poor status of the energy grid in India. Existing grids and transmission system were not been able to cope with rapid growth of wind energy in India [74][116]. Furthermore, despite an obligation to purchase wind power and develop
transmission and evacuation infrastructure, the state energy utilities in India have not provided the so called ‘must run status’ for wind power and often disconnected wind power during high wind seasons, causing losses to the wind developers [139][140][141].

Several proposals are developed to deal with the issue of grid connection of wind energy. The Working Group on Power recommended recently the introduction of balancing power stations in the form of pumped storage hydro stations and open cycle gas power stations to facilitate better integration of wind energy into the grids [129]. Another report, prepared by Power Grid Corporation of India Limited, recommended several measures to facilitate the high wind penetration such as enabling strong grid interconnections, establishing a new renewable energy management centre, providing priority access to wind power with amendments in the Indian Electricity Grid Code, better forecasting methods, the development of a power balance market and new pricing mechanisms and the funds required to develop this infrastructure [2].

5. Conclusions

This paper asked the question how institutional entrepreneurship shaped the development of wind energy in India during the time period 1985-2013 and which controversies can be identified. The first part of the question is answered in by presenting the narrative in section 4 in three different time periods. By discussing the changing role of multiple actor groups we showed that development of wind energy in India was a collective accomplishment of many actors over the last 25-30 years, with no single actor having control over the entire process.

The second part of the question is answered as follows. During the first period (1985-1995), major issues were negotiations over cost of grid access and integration, wheeling and banking arrangements, third party sale and feed-in tariffs paid by the state electricity boards.
Major problems included poor installation practices, lack of project execution skills, lack of repair facilities, technical quality and safety design of wind turbines and excessive dependency on imported turbine components from EU without paying attention to use of turbines in Indian conditions. These issues created a negative image of the wind industry in India.

During the second time period (1995-2003), conflicts and debates occurred over issues such as maintaining grid discipline due to fluctuating nature of wind energy, high fees charged by electricity boards for reactive power with wind developers resisting it. Also the integration of wind energy into weak Indian grids became an important issue of debate. Debates have also been identified on the lack of transparency with the use of imported technologies as well as low level of indigenization and a lack of serious investors.

During the third time period (2003-2013), debates on how to publically support wind energy were prominent. This included debates on balancing the tradeoff between creating a predictable and lucrative environment for investors on the one hand and dealing with the cost burden on consumers and the state on the other hand. This relates to managing multiple goals such as energy security, energy access, job creation and economic growth (WRI & Prayas, 2010). The sudden removal of accelerated depreciation and generation based incentive with the wind industry strongly advocating for re-introduction of these incentives was a major issues of contestation between the Government of India and the wind industry.

What may follow from the analysis is that resolving issues of conflict and contestations requires adequate representation of laypersons and non-specialists such as common public consumers, local villagers and tribal people who are not experts on energy matters. However, in India opportunities for participation in energy policy processes remain quite limited, due to expert driven nature of the process. Even if public hearings, consultations are conducted, genuine opportunities for effective participation are limited.
Final decisions are often influenced behind closed doors by powerful interests or expert organizations [142][143].

This requires re-conceptualizing the issues of conflict and contestations in such a manner that view points and interests of different actors are awarded symmetric treatment according to their different orders of worth and value metrics [144]. In Indian energy policy making, it is necessary to be open towards new actors and find ways of justifying genuine participation procedures to include marginalized concerns (i.e. concerns of marginalized groups whose concerns excluded and rights are infringed). Future research should look at how these neglected actor groups can become a part of wind energy development in India.

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