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Collective institutional entrepreneurship and contestations in wind energy in India

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A B S T R A C T

With 21,136 MW of wind energy installed in 2014, India is considered a success story in terms of net installed capacity. Few existing studies on Indian wind energy have highlighted the important role of institutions, and how they stemmed from the work of advocacy groups; studies also tend to focus on short time periods. This paper uses the notion of collective institutional entrepreneurship to analyze Indian wind energy across three time periods (1985–1995, 1995–2003, and 2003–2013). The analysis shows that Indian wind power development was driven by collective efforts of institutional entrepreneurs using two aggregated strategies, that is, supportive techno-economic and socio-political networks and an indigenous innovation infrastructure. The paper highlights setbacks, controversies, and tensions between various entrepreneurship groups and argues that actions must be taken for including actors who have been marginalized.

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1. Introduction

Wind energy in India began with just 2 MW of installed, grid-connected power in 1986 [1]. Over the years, wind energy has been supported by several national and regional policies and regulations. In particular, substantial development took place in Tamil Nadu, Gujarat, Maharashtra, Rajasthan, Karnataka, and
Andhra Pradesh. Tamil Nadu has been the leading state due to good wind resources, a proactive state government, and supportive captive energy users from the cement and textile industries [2]. Worldwide, India ranks fifth in wind energy production, topped only by China, the US, Germany, and Spain [3]. After rapid growth between 2003 and 2012, problems related to withdrawal of incentives, transmission and evacuation, and regulatory uncertainty became prominent in 2013 and slowed down the development of wind energy. With the introduction of the National Wind Energy Mission (NWEM) in 2014, the Government of India is targeting 100 GW of wind energy by 2022 [4].

This study analyzes the long-term development of wind energy in India. This paper develops a narrative encompassing institutional developments and innovations, and also how they occurred. Existing studies have emphasized financial support schemes, technology policies, technical standards, grid-connection rules, industry organizations, and international collaborations [5,6]. This study adopts the notion that actors are involved in shaping their institutional context and that this is largely a collective effort rather than the result of powerful individuals [7,8]. Developing novel energy technologies therefore requires not just appropriate policies and regulations, but also collaboration and collective action by researchers, policy makers, political parties, industry organizations, lobbyists, and environmental groups [9]. Furthermore, the emergence of novel innovations is likely to prompt conflicting interests, power relations and political negotiations between stakeholder groups [10].

This paper aims to shed light on institutional changes in the wind energy sector not only by discussing their positive impacts, but also by addressing the controversies and potential barriers implicated by the associated dynamic institutional context. The paper focuses on the very early wind energy developments in the 1980s up to recent developments in 2014 and studies the institutional changes and the role of actors behind those changes by using the notion of “collective institutional entrepreneurship”. The notion of collective institutional entrepreneurship is elaborated in the next section.

Based on the literature outlined above, the following research question is asked: How has institutional entrepreneurship shaped the development of wind energy in India during the period 1985–2014 and which controversies and conflicts can be identified? We begin by summarizing key arguments from the literature on collective institutional entrepreneurship in Section 2. Section 3 elaborates on the research method used in the study. Then, we describe long-term development of wind energy in India in Section 4. Finally, in the concluding section, we answer the research question and summarize the key conflicts and contestations in the three time periods. We also draw out implications for wind energy development in India.

2. Collective institutional entrepreneurship

The concept of institutional entrepreneurship was originally proposed by Paul DiMaggio ([11]) to study to role of “agency” in creating transforming existing institutional arrangements. Institutional entrepreneurs take advantage of uncertainty in existing institutional order and often act strategically to seek institutional change through a political process [12]. Institutional entrepreneurship is 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” [13], p. 657. To qualify as institutional entrepreneurs, individuals and organizations must change dominant institutional arrangements and institutionalize alternative practices, rules and logics but by being limited by the same institutional arrangements [14,15]. According to this view, institutions are not just constraining, but are also the very fabric to be used for collective transformational action by a range of actors [16].

Institutional entrepreneurs use various strategies such as legitimizing new ways of working, lobbying, petitioning and advocacy to transform existing arrangements. Institutional entrepreneurs might not necessarily be always proactively transforming institutions through purposeful action, but instead sometimes are reactively acting on opportunities presented to them from a novel innovation [17]. Research has shown that institutional entrepreneurs comprise a broad range of actors and organizations. Examples include executives in firms, profit-oriented entrepreneurs, trade associations, professionals in organizations, regulatory authorities, licensing bodies, scientists, government officials, trade

Table 1
Overview of the research approach used for the study.

<table>
<thead>
<tr>
<th>Step 1: Collection of data from multiple secondary sources and developing an account of important events such as policies, regulations, government programmes</th>
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<tbody>
<tr>
<td>Step 2: Selecting interviewees for interviews by reading through secondary data, summarizing the data collected from semi-structured interviews, Using data from semi-structured interviews to support findings from secondary data sources</td>
</tr>
<tr>
<td>Step 3: Summarizing the data from interviews and secondary sources and developing a case narrative. Using principles of process analysis to analyze the data by forming a data structure and then developing theoretical dimensions to explain development of wind energy</td>
</tr>
<tr>
<td>Step 4: Dividing the case narrative into three distinct time periods and explaining the development of wind energy in India through the respective theoretical concepts</td>
</tr>
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</table>
and professional associations, civil servants in governmental agencies, educational institutions, media, consumers, civil society groups and the larger public [18,19].

The processes through which institutional entrepreneurs exercise their “agency” are characterized by continuous readjustment and learning as their strategies envisioned may seldom result in outcomes without facing any roadblocks [20]. Institutional entrepreneurs therefore may not have the foresight to mobilize large-scale changes with well-defined goals. Their efforts may not be always successful and often result in undesirable outcomes. Collective institutional entrepreneurship is achieved through sustained collaboration among numerous dispersed actors with different frames of reference, tensions and contradictions [21,22].

Very few studies have empirically illustrated the role of multiple actors as they transform dominant institutional arrangements. Whereas prior research has examined the role of professional elites [23], fringe actors [24], and ideologically motivated social movements [25], this paper looks at the distributed efforts of multiple actors in transforming institutional arrangements. Furthermore, the role of actors has to be seen in relation to evolving institutional context over a period of time [26]. The next section discusses how the notion of collective institutional entrepreneurship is used for studying the long-term development of wind energy in India.

3. Research method

The research focused on wind power development in India from 1985 to 2014 and used a qualitative case study approach to capture detailed accounts often overlooked in quantitative data vis-à-vis emerging phenomena. This approach also demands understanding complexities faced by practitioners and how they endogenously drive institutional change in particular institutional settings [20]. A qualitative case study approach is useful in investigating a phenomenon in detail and revealing complexities in real-world settings [27]. Table 1 highlights the approach used for collecting, summarizing, and analyzing the data used for presenting the case narrative. This process was iterative and involved going back and forth between the different stages.

For data collection, we used multiple sources of data. Yin [28] suggests using multiple data sources such as documents, secondary data sources, public records, interviews, and participant observations for case study research. For this paper, the data collection started with a preliminary internet and electronic database search for written materials vis-à-vis the history of the Indian wind energy sector. Analyzing these secondary data sources resulted in multiple opinions and different views on wind energy development in India. We collected additional information to fill in the gaps based on analysis of the summarized data until a stage was reached where no new information was needed to present the case narrative [29].

We reconstructed Indian wind energy development by triangulating these secondary sources and developing a time line of events that included demonstration projects, policies, regulations, entry of important organizations and programs initiated by the government. We constructed the time lines by focusing on what happened and who was behind the important developments [30]. Next, we identified key actors and organizations in the wind energy sector in India and focused on understanding their involvement and the obstacles they encountered. Based on the data collected, we selected interviewees and carried out a number of semi-structured interviews with a range of wind energy experts (see Table 2 for details of interviewees).

The in-depth, semi-structured interviews were carried out between May 2012 and August 2012. The interviews served to identify key issues and events that had not come up in the first data collection stage. During the interviews, we tried to understand the experiences of the experts by being attentive to their stories and engaging in conversations. 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 ongoing 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.

The data analysis was carried out by summarizing data from interviews, secondary documents, and field notes and juxtaposing details from all these multiple sources. We used principles of ‘process analysis’ for analyzing the data. Process analysis focuses on how things change, and aims to identify underlying mechanisms of observed patterns. Process analysis uses a combination of both deductive and inductive approaches iteratively. Process analysis is often messy in nature and requires constant iteration between theoretical concepts, data collection and analysis [31,32]. For the analysis in this paper, prior literature was used to analyze data collected using content analysis and new data themes were built by combining prior data themes. The themes were further revised and combined to develop relevant theoretical dimensions for explaining the case narrative [33,34]. These theoretical dimensions represent aggregated strategies of

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2 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 thesis, journal articles, professional magazines, and reports available on the internet.
<table>
<thead>
<tr>
<th>S. nos.</th>
<th>Mechanisms in the literature</th>
<th>Empirical examples from the data</th>
<th>Themes in the data</th>
<th>Theoretical dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Theorization and creating a vision for change by framing the problems and justifying particular innovations as solutions to the problems [15,36]</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 (NAPCC); 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 reduction in green house gas emissions; balancing competing narratives of economic growth, energy security, job creation, climate change and energy access</td>
<td>Creating political vision and framing imaginaries which provide shared meaning over key concerns of energy security, increased energy demand, industrial development and climate change; wind energy framed as a solution to these competing narratives</td>
<td>Creation of supportive techno-economic and socio-political networks</td>
</tr>
<tr>
<td>2</td>
<td>Using social and political skills to mobilize collective action and co-operation between heterogeneous actors [37,38]</td>
<td>Expert group on low carbon strategies for inclusive growth; working group on power; various committees/task forces/joint working groups formed at central and state governments for wind energy</td>
<td>Mobilizing political support for the emerging innovation through strategic activities such as lobbying, petitioning and information based strategies; use of evidence based techno-economic reasoning in public hearings and providing testimony for views</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Steering through new regulations and policies such as creating appropriate public incentive structures for the innovation [25,39]</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 energy into the grid</td>
<td></td>
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</tr>
<tr>
<td>5</td>
<td>Framing new business models for exploring the potential of a new technology [41,42]</td>
<td>Turnkey project development model supported by wind turbine manufacturers in India; Independent Wind Power Producer model supported by large scale investors and focussing on improving efficiency</td>
<td>Creation of supportive business models based on different user segments; balancing competing logics for valuation of wind energy in order to balance multiple objectives such as consumer costs, profits of investors and financial position of utilities; R &amp; D for wind mapping, forecasting and micrometeorology modeling for enhancing wind turbine productivity; resolving integration problems of wind energy into the grid by modifying political, economic, material arrangements associated with existing energy infrastructure</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Designing new market mechanisms, grid infrastructure, regulations and valuation techniques for higher penetration for wind energy [43–46]</td>
<td>Supporting price discovery through preferential tariff or competitive bidding; grid discipline and grid connection rules; creation of adequate transmission infrastructure for smoother grid integration of wind energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Generating narratives about the future, preparing collective roadmaps, forecasts and monitoring of technological progress [39,47]</td>
<td>Projections about potential of wind energy potential in India through techno-economic studies by industry experts; use of modeling techniques and field experiments for measurement of wind energy potential; forecasting capacity addition in form of plans and targets; measurement of wind energy potential and forecasting; development of wind energy atlas and wind mapping programs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Learning through transnational networks and contextualizing into local context [48,49]</td>
<td>Cooperation programmes with Danish government, assistance from Danish consulting organizations 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</td>
<td>Collective learning through transnational linkages and international expert communities; creation of indigenous capabilities by emphasizing localized learning processes; resolving issues of conflict and contestations between different stakeholders in forums</td>
<td></td>
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</tbody>
</table>

Table 3
Data structure highlighting relationship between mechanisms identified in the literature and empirical examples from the data collected.
institutional entrepreneurs emphasizing “collective institutional entrepreneurship” [35]. Table 3 explains the approach used for organizing the data from interviews and secondary data to data themes and finally the theoretical dimensions for explaining the development of wind energy in India.

Table 3 provides details of the aggregated strategies and their relation with the mechanisms identified in the existing literature on institutional entrepreneurship. We defined two distinct kinds of aggregated strategies pursued by institutional entrepreneurs for developing wind energy in India: (1) creation of supportive techno-economic and socio-political networks and (2) creation of an indigenous innovation infrastructure. For describing our findings, we divided our data narrative into three time periods (1985–1995; 1995–2003; 2003–2014) that emphasized when the institutional context for energy changed significantly in India. During 1985–1995, the first set of wind energy demonstration projects with international assistance took place. From 1995–2003, independent regulatory agencies were established for framing regulations and depoliticizing energy decision making processes. Finally, the period 2003–2014 was characterized by the passing of the Indian Electricity Act in 2003, followed by a series of regulatory and policy measures that broadened the role of different actor groups in mobilizing wind energy change. In the next section, we describe the development of wind energy in India in these three time periods and emphasize the role of collective institutional entrepreneurship and the ongoing conflicts and contestations.

4. Findings


4.1.1. Creation of supportive techno-economic and socio-political networks

Efforts to harness wind energy in India were being made as early as the 1950s with the National Aeronautical Laboratory (NAL) initiating one of the first projects. Prof M.S. Thacker and Dr. P. Nilakatan were particularly involved in these projects and 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 that were useful for water pumping applications and battery charging in Indian villages. In 1960, a dedicated wind power division of NAL was established in Bangalore [52,53].

The need for energy self-sufficiency and oil crises in the 1970’s led to the creation of the Commission for Additional Sources of Energy in 1981. This commission was responsible for formulating policies, coordinating R&D, and implementing programs for renewable energy [54,55]. In 1982, the Department of Non-conventional Energy Sources (DNES) was established, which included a technical committee led by J. Gururaja and Ajit Gupta for grid-connected wind energy R&D. The committee’s aim was to develop large-scale, grid-connected demonstration projects 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 K.S. Rao [1].

DNES also established financial incentives for grid-quality wind energy during the national five year plans during the time period 1985 to 1990 [6]. MNES initiated a national program focusing on policy support, wind resource assessment, implementation of demonstration projects, creating local capacity for manufacturing, increasing involvement of energy utilities, and raising awareness about wind energy (Int [1,56]). In 1987, DNES played a role in establishing the Indian Renewable Energy Development Agency (IREDA), a dedicated financing agency for providing loans for renewable energy projects in India [6].

In 1987, Jami Hossain, while working for The Energy and Resources Institute (TERI) in Delhi, published an influential paper on Indian wind energy that analyzed the experiences with demonstration projects and made recommendations to improve wind farm performance. Most notably, the paper argued for amending the Electricity Act to allow for private wind farming as well as numerous economic recommendations to bring down production costs3. Based on recommendations in this paper, the Indian government published new policies in 1990 to encourage private sector investment in wind energy [1]. These developments led to a gradual increase in installed wind energy capacity. Table 4

<table>
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<th>S. nos.</th>
<th>Mechanisms in the literature</th>
<th>Empirical examples from the data</th>
<th>Themes in the data</th>
<th>Theoretical dimensions</th>
</tr>
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<tbody>
<tr>
<td>9</td>
<td>Taking action to educate other actors and developing an emerging infrastructure; shaping the beliefs and perceptions of different stakeholders and being committed and motivated to the emerging field [50,51]</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 and educational programmes by CWET and wind industry associations Conferences such as Wind Power India organized by Global Wind Energy Council, World Institute of Sustainable Energy and Indian Wind turbine manufacturers association; wind energy stakeholders meetings; regulatory hearings organized by regulatory commissions and Forum of Regulators; events organized by civil society groups for advocating judicious use of public resources for wind energy and involving local communities in planning wind energy projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Participation in field configuring events and hybrid forums (conferences, trade events, public forums, joint committees, workshops etc.) [39]</td>
<td></td>
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<td></td>
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</table>

3 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, and suitable import and sales tax duties [1].
highlights the installed capacity of wind energy in this time period. As a result, MNES introduced various new fiscal and financial incentives to improve wind turbine financial performance. Most notably, these included a 1993 concessional wheeling & banking and accelerated depreciation (AD) to attract private sector investment 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, including concessional land allotment, electricity duty exemption, and schemes for exemption or deferment of sales tax. A key strategy of the Indian government was also to encourage joint ventures and technical and financial collaboration with firms located outside India. Although custom duties on wind turbines were imposed, specific components were excluded by providing concessional exemptions.

The new institutional setting for wind power resulted in substantial support from industrial firms who used it for captive consumption. These included in particular small cement, smelting, and textile industries. The scheme also attracted investors in energy, steel, and automotive industries who wanted to reduce high power usage charges. The new institutional setting was so successful that MNES was worried that the accelerated depreciation measure could lead to a gold rush situation. IREDA and the World Bank implemented the Renewable Resources Development (RRD) project for commercializing wind energy in ways that differed from previous governmental programs. The project, grounded in neo-liberal thinking, tried to attract private investors rather than rely on public support by creating a better understanding of the risks involved in financing wind energy.

In 1995, MNES issued guidelines to the private wind developers in order to ensure that incentives provided by the central and state governments were used properly. These guidelines included wind farms’ obligation to produce Detailed Project Reports (DPR). These reports contained detailed information about micro-siting (that is, where to place individual wind turbines in a larger wind farm), and details about operation and maintenance of wind turbines. Wind power producers were required to submit DPRs together with their reports about annual energy output and generation costs to state energy utilities. The most important reason for these reports was MNES’ desire to reduce public finance misuse—an increasingly important critique voiced by several national and international stakeholders. These guidelines also contributed to creating collective awareness and knowledge within and between various stakeholders, such as state electricity boards, nodal agencies, wind turbine manufacturers, developers, and investors, about planning wind projects.

### Table 4
Annual installed capacity of wind energy in period

<table>
<thead>
<tr>
<th>Year</th>
<th>Installed capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992–1993</td>
<td>15,575</td>
</tr>
<tr>
<td>1993–1994</td>
<td>57.44</td>
</tr>
<tr>
<td>1994–1995</td>
<td>256.515</td>
</tr>
<tr>
<td>1995–1996</td>
<td>385.04</td>
</tr>
</tbody>
</table>

4.1.2. Creation of an indigenous innovation infrastructure

In the early 1960s, the NAL (National Aeronautical Laboratory) systematically prepared a wind map for India. In 1985, an extensive wind resource assessment was carried out by the Field Research Unit for the Indian Institute of Tropical Meteorology (IITM). A wind energy data book was compiled and published on the basis of data available from vast meteorological stations across India. The data, however, had limitations as it was not specifically collected for assessing wind energy. DNES supported efforts in setting up of wind monitoring stations in Indian states. Subsequently the first wind monitoring station was set up in Sultanpet in Tamil Nadu. MNES later compiled and published a report with detailed wind mapping of India comprising details of wind monitoring and wind mapping stations. This was followed by attempts to assess the potential for electricity generation by Jami Hossain and K. Raghavan in 1993. They estimated wind energy potential in India to be around 20,000 MW, but the figure was later revised to 45,000 MW. The first grid-connected wind turbine was commissioned in Veraval in Gujarat in 1985. It was privately owned, but financially supported by DNES. Subsequently, DNES initiated demonstration projects as early as in 1986 by offering substantial financial and technical support. Wind farms were developed using second hand imported turbines in few locations such as Okha, Mandvi, Devgarh and Tuticorn.

The Danish International Development Agency (DANIDA) was the first foreign agency to show an interest in the Indian wind power market. In December 1986, DNES, the Tamil Nadu Electricity Board (TNEB), and the Gujarat Energy Development Agency (GEDA) requested DANIDA to assist in developing demonstration wind farms in India. The governments of Denmark and India established a cooperation program for projects in Gujarat and Tamil Nadu. TNEB and GEDA were responsible for preparing the required infrastructure, which included respective sites, roads, foundations, transmission lines, and substations. An experienced Danish wind energy consulting firm was even involved in planning, designing, and implementation of the project. TNEB and GEDA also contracted two well-established Danish manufacturers to supply and install equipment and work closely with local partners to develop indigenous technical capacity. Experience was gained in wind farm planning, implementation, and management by DNES and the state electricity board staff members.

The demonstration projects helped provide details about techno-economic feasibility of wind energy in India and created a knowledge base for turbine development in low wind-speed conditions. The demonstration projects also provided advocacy opportunities and increased private investor participation. The program instigated new entrepreneurial and industrial activities, including international cooperation to establish turbine production facilities in India. With respect to creation of a domestic industry, the Danish-Indian joint venture NEPC-Micon was established in 1987 as the first wind turbine manufacturer in India. This was followed by Khemka business group, which formed a joint venture with NEPC Micon. Other Danish firms followed and established their subsidiaries in India, with a notable example being a 1987 partnership between the leading Danish firm Vestas and the Indian firm RVV. Domestic manufacturing was further supported by a series of licensing agreements with

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6 Pioneering work by Dr. Anna Mani, Dr. S. Ragarajan and Dr. D. A. Mooley from the NAL made detailed studies on wind speeds by creating wind maps. Dr. Anna Mani was later involved in a comprehensive wind monitoring and mapping program by publishing wind energy resource data books with support from Dr. S. K. Tewari from the NAL.
European firms. Many European wind energy firms even established production facilities in India\(^7\) [1,6,60].

In 1995, Suzlon was started by Tulsi Tanti by diversifying from his old textile business and setting up wind energy business by forming collaboration with German firm Sudwind GmbH Windkraftanlagen. Suzlon developed the commissioning business model (turnkey project development) in which it sought complete ownership of wind turbine design and technology. In this model, Suzlon created wind energy banks in advance for investors and was responsible for securing land and grid connectivity, as well as the supply of turbine equipment, the erection of turbines, the 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, and installing, operating, and maintaining turbines (Int [3,171]). The first 200 kW-class wind turbines were installed by Micon in 1989 (250 kW), and the first 300 kW-class turbines were introduced by Nordtank in 1991. Enercon India began manufacturing and installing 500 kW gearless variable speed turbines from 1995 onwards. The number of wind turbine manufacturers increased steadily in this period. By 1995, many wind turbine manufacturers in India had joint venture or license agreements with foreign manufacturers, which also helped increase wind turbine size and production. During this time, the focus was on indigenous wind turbine development, but the focus soon shifted to a more market-driven approach [59,72].

Nevertheless, Indian firms were still very dependent on European firms and India had limited indigenous capabilities for planning and operating wind farms. In particular, skills in project planning, site assessment, site development, operation and maintenance were low and caused many project failures in the early and mid-1990s [59,60]. Wind developers also faced problems with respect to approval from multiple government departments, acquisition of land, the grid, and complicated procedures often leading to high costs. These problems led policy makers to view commercialized wind energy with a high degree of skepticism. Despite increased efforts to develop an indigenous infrastructure for wind energy, there were only few organizations such as TERI and Consolidated Energy Consultants for conducting techno-economic and project feasibility studies during this time period (Int [2,73]).


4.2.1. Creation of supportive techno-economic and socio-political networks

Although the wind energy industry developed substantially, several key problems persisted, in particular with regard to a rather bureaucratic approach taken by state energy utilities\(^8\). In response, MNES developed proposals for organizing a more continuous dialogue between state electricity boards, wind developers and MNES through committees of representatives [59,73]. In its long-term vision plan, MNES also set a target of 10 percent share of renewable energy in India by 2003. 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 when developing wind projects. Despite these efforts, the wind energy industry remained critical regarding MNES’s “command and control” approach as it often took decisions without involving other stakeholders [75].

The wind energy sector started organizing via associations. In 1996, wind energy producers collectively organized and established the Indian Wind Power Association (IWPA), which was followed by the Indian Wind Turbine Manufacturers Association (IWTMA) in 1997. A third association, the Indian Wind Energy Association, was established in 2002. These associations over the years have played an integral role in a range of activities, including sharing information between wind power producers and turbine manufacturers and influencing the institutional context for wind energy (Int [2], Int [10]). In 1996, the Confederation of Indian Industry (CII) supported wind energy by organizing an energy summit and proposing national goals for renewable energy. This meeting addressed the need for a more stable investment climate and political commitment for supporting wind power [76]. Industrial groups Tatas and Bajaj, as well as major public sector energy organizations, also started taking an interest in developing wind energy projects [77,78].

Nevertheless, fluctuations in the Indian wind energy market occurred due to instability. 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 rates on wind energy investment loans, which slowed development [79]. Speculative investor behavior and misuse of the accelerated depreciation measure also caused serious problems. Higher import duties for wind turbine components and the state energy boards’ poor financial condition further resulted in unfavorable conditions for investors [59,62]. Finally, the Ministry of Finance reduced the tax subsidy given to wind power producers by 50 percent and the accelerated depreciation benefit was reduced from 100 percent to 80 percent in 2002 [79]. Efforts from MNES to recommend policy modifications in customs and excise duties on import of raw materials for manufacturing of blades of wind turbines and to continue the 100 percent accelerated depreciation for renewable energy technologies failed [80]. These developments also led to gradual decrease in wind energy installations in India. Table 5 highlights the installed capacity of wind energy in this period.

In 1998, in an attempt to reorganize 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 energy sector legislation. This new Electricity Bill required states to unbundle the existing electricity boards and establish independent regulatory commissions, meter all electricity supply, remove cross subsidies, and reduce transmission and distribution losses (Int [7,81,82]).

Civil society organizations such as the Prayas Energy Group also started to become prominent by organizing various forums for
courses and awareness programs for the general public (Int[9]). India, designing and developing wind turbine components, technical assistance and training and conducting special technical installation of wind mapping stations, preparing a wind atlas for developed activities in wind resource assessment and monitoring, wind turbines and to test and certify wind generators. CWET also of Denmark. The main role of this test center, known as the Centre with the support of DANIDA and Risø National Energy Laboratory particular in comparison with leading countries such as Denmark and Germany.

4.2.2. Creation of an indigenous innovation infrastructure

In 1998, a wind turbine test station was developed in Chennai with the support of DANIDA and Risø National Energy Laboratory of Denmark. The main role of this test center, known as the Centre for Wind Energy Technology (CWET), was to develop standards for wind turbines and to test and certify wind generators. 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 programs for the general public (Int[5,83]). Overall, however, civil society involvement in wind energy issues was very small, in particular in comparison with leading countries such as Denmark and Germany.

4.3. Towards up-scaling wind energy (2003–2014)

4.3.1. Creation of supportive techno-economic and socio-political networks

In 2002, the International Energy Agency (IEA), MNES, and the Confederation of Indian Industry organized a workshop with different stakeholders to discuss policy goals for accelerating renewable energy deployment in India. This was also one of the first attempts to develop a comprehensive energy policy for India and included provisions in a draft of a new electricity bill [90]. The eventual passing of the

Table 6
Overview of some wind turbine manufacturers in India in period 2 (Adapted from [59], p. 191).

<table>
<thead>
<tr>
<th>Turbine manufacturer</th>
<th>Turbine capacity</th>
<th>Power control, rotor speed and generator</th>
</tr>
</thead>
<tbody>
<tr>
<td>CWEL</td>
<td>250 kW</td>
<td>Stall, 2 fixed, WRIG</td>
</tr>
<tr>
<td>Suzlon</td>
<td>250 kW–2 MW</td>
<td>Pitch, 2 fixed, WRIG</td>
</tr>
</tbody>
</table>

MNES and IREDA introduced the concept of “Wind Energy Estates”, which were joint estate firms between state government and private developers. This model focused on acquiring land, developing necessary infrastructure and grid facilities, obtaining the necessary clearances, and operating and maintaining wind turbines on behalf of the investors. The wind energy estates helped reduce the gestation period of wind projects as well as encourage small-scale investors [59]. MNES even set up an expert committee for wind resource assessment and measurements covering wind monitoring and mapping stations in different Indian states (Int[1]). Furthermore, wind measurement techniques were developed using meso-scale modeling. However, developing a comprehensive wind power density map still remained a challenge during this time period (Int[9,53]).

MNES provided incentives to develop wind turbines suitable for the specific Indian conditions through three models, that is, an industry in-house R&D model, a consortium model, and joint projects between industry and MNES with foreign institutions or research laboratories [63]. With the help of licensing agreements, domestic manufacturing of wind turbines grew with collaborations from Danish and German firms. Starting in the mid-1990s, the Indian firm Suzlon used a technology-licensing strategy to get access to key turbine components [85]. In general, companies were simply importing turbines and components and assembling them on the sites[12]. During this time, major turbine manufacturers introduced stall-regulated, as well as pitch-regulated, fixed turbines. Limited-range, variable-speed turbines and DFIG models also became quite common [59,60]. Table 6 provides an overview of turbine technologies in this period.

Despite MNES’ efforts at increasing foreign firm collaboration, many projects failed. Skills in project planning, site assessment and development and micro-siting continued to be limited. Wind power performance was also poor in terms of capacity utilization factor (CUF) due to lack of monitoring. In addition, the fact that investment decisions were based on availing tax incentives, rather than on production incentives, led to installation of low-quality turbines. Malpractices, such as wind investors getting false commissioning certificates, were even quite common [59,62,79]. In the late 1990s, wind turbines got destroyed in a cyclone in Gujarat. This event further reduced the image of wind turbines, and revealed the poor installation practices of inexperienced 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 [86]. Nevertheless, in some cases local communities did support wind turbines as a result of promises of economic development in rural areas adjacent to wind farms [87].

As a consequence, only a few manufacturers remained active in India at the end of the century. The interest of foreign collaborators subsided due to slow market growth and Indian firms’ low technological capabilities (Int[2,60]). Though there was some improvement, India’s knowledge base in wind turbine manufacturing was weak and needed significant push in order to be internationally competitive [6,88].

State energy utilities continued resisting granting third-party sales to wind power producers as they saw wind energy as a peripheral supply option with little consideration in long-term energy planning. They believed wind energy impinged on the grid, created low network reliability, and caused losses to state energy utilities [59,62]. In the power sector, which is plagued by reliability issues and structural inefficiencies, issues of grid integration, wind energy forecasting, and scheduling became especially important. With respect to problems of integrating wind energy into the grid, the Risø Laboratory and CWET collaborated on a study of wind power integration in weak grids in India [89].

12 The dependence on importing wind turbine parts was not reduced substantially, but activities of firms such LM Glasfibre India, Enercon India, and Suzlon helped in developing blade manufacturing technology through R&D activities. 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 [59,62].
Electricity Act in 2003 streamlined and resolved many power sector issues\(^{13}\). The Electricity Act led to the introduction of specific provisions for renewable energy sources in India. Subsequently, investor confidence increased and focus shifted from individual sites and small-scale wind farms to wind estates (Int [1], Int [7], Int [8])\(^{14}\).

The social dynamics in terms of influencing energy decision making also changed as a result of the Electricity Act\(^ {15}\), the provisions of which enabled advocacy and petitions by concerned stakeholders and provided participation guidelines. These guidelines were included on the consultation papers on proposed regulation, which were followed by public circulation of drafts for receiving comments and discussions. The guidelines also provided for appeals against the orders of the Regulatory Commissions via the Appellate Tribunal of Electricity based in New Delhi (Int [6,90]). For example, the Renewable Purchase Obligation (RPO), which mandates that utilities purchase renewable energy, was introduced for the first time in Maharashtra due to a petition filed by the director of Maharashtra Energy Development Agency in 2004. The regulatory agency adopted the cost-plus-based approach for setting the tariff in order to ensure decent return on investment; this led to developing guidelines for RPOs in other states (Int [4,2,92,93]). The installation of wind energy also started increasing gradually. Table 7 shows the installed capacity of wind energy in this period.

Despite many MNRE efforts, a major barrier for wind energy in India remained the overall complexity of the 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). With respect to advocacy for wind energy, large firms such as Suzlon, Vestas, Gamesa, and Enercon hired dedicated regulatory and policy officers who offered comments on regulatory commission orders, met ministers and policy makers in person to advocate for favorable regulations and policies, deliberated on critical issues, drafted position papers, and expressed industry interests in the media (Int [10, 11]). Consultancy organizations and rating agencies became important in advising policy makers and regulatory agencies on techno-economic issues (Int [11])\(^ {16}\). 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\(^ {17}\). The industry associations even started playing an important role in influencing policy debates, lobbying for tariff revision, and voicing profitability concerns (Int [2]). Media organizations started highlighting wind industry issues and raising awareness about the possible conflicts between the national government and wind energy investors, as well as the state energy utilities (Int [8]).

For example, in 2005, the World Institute for Sustainable Energy (WISE) advocated for the gradual transformation to sustainable energy in India. To mobilize support for a new drafted law, a working group chaired by the influential Dr. Pramod Deo, who was the previous chairman of the Maharashtra Electricity Regulatory Commission (MERC) and chairman of Central Electricity Regulatory Authority (CERC) was formed. In 2007, the draft document was submitted to the Ministry of New and Renewable Energy, which then sent the document for debate in the Indian parliament. Nevertheless, the efforts to introduce the law were not satisfactory as MNRE did not pursue the initiative vigorously enough (Int [4, Int [12]). In this period, civil society and environmental groups also became more active in policy debates\(^ {18}\) and highlighted concerns over high tariffs for wind energy and undue profits by wind developers, as well as data asymmetry issues with respect to tariff calculations and exclusion of local communities from participation and decision-making processes (Int [5,94,95]). International networks\(^ {19}\), such as the Global Wind Energy Council (GWEC), started playing an increasingly important role in driving policy and regulatory agendas by translating learning experiences in the form of best practice guidelines from other countries (Int [2,96]).

In 2009, the government of India implemented a Generation-Based Incentive (GBI) scheme for grid-connected wind power projects by independent wind power producers (IPPs). The introduction of the GBI was one of the first attempts to change the dominant business model from an investment incentive towards a production incentive (Int [1,2]). In the past, most of the investments were associated with small-scale investors using the AD benefit as margin money for ordering wind turbines. In this manner, they were able to get low-cost energy for captive use as well as recover the majority of their investment early on Refs. [97,98]. The main motive behind promoting GBI was to produce larger amounts of wind power at reduced costs through improved operation and maintenance of wind farms and competition [Int 2, 2].

The government of India saw the AD incentive as creating major losses in the form of lower tax collection, excessive profits to

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\(^{13}\) 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.

\(^{14}\) Prior to enacting the 2003 Electricity Act, there were no specific provisions for promoting renewable energy as the issues were left to state electricity boards, state electricity regulatory commissions, and MNES.

\(^{15}\) An example is the National Action Plan on Climate Change specifying 15 percent of India’s energy needs to stem from renewable energy sources by 2020, while the Integrated Energy Policy by the Planning Commission suggests 5 percent renewable energy in the overall energy mix by 2032 [59]. 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 30,000 MW 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 11,000 MW and meeting renewable energy purchase obligations [91].

\(^{16}\) Examples of consultant agencies active in the Indian wind energy sector are Price Waterhouse Coopers, KPMG, A.T. Kearney, 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.

\(^{17}\) Examples are WISE World Institute of Sustainable Energy Pune, The Energy and Research Institute New Delhi, Shakti Sustainable Energy Foundation, and CStep Bengaluru.

\(^{18}\) These included Green Peace India, Prayas Energy Group, Center for Science and Environment and People’s Monitoring Group on Electricity Regulation.


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**Table 7**

Total installed capacity of wind energy in period

<table>
<thead>
<tr>
<th>Year</th>
<th>Installed capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>2,125</td>
</tr>
<tr>
<td>2004</td>
<td>3,000</td>
</tr>
<tr>
<td>2005</td>
<td>4,430</td>
</tr>
<tr>
<td>2006</td>
<td>6,270</td>
</tr>
<tr>
<td>2007</td>
<td>7,845</td>
</tr>
<tr>
<td>2008</td>
<td>9,655</td>
</tr>
<tr>
<td>2009</td>
<td>10,926</td>
</tr>
<tr>
<td>2010</td>
<td>13,065</td>
</tr>
<tr>
<td>2011</td>
<td>16,084</td>
</tr>
<tr>
<td>2012</td>
<td>18,421</td>
</tr>
<tr>
<td>2013</td>
<td>20,150</td>
</tr>
<tr>
<td>2014</td>
<td>21,136</td>
</tr>
</tbody>
</table>
small-scale investors, and lower efficiency [99]. As a result, the Ministry of Finance refocused their efforts on actual generation-based incentives to support IPPs that could offer better performance of wind turbines in low wind-speed conditions (Int [1,100]). The issue became contested to such an extent that the government became prejudiced against supporters of the accelerated depreciation benefit (Int [2]).

Both the AD and GBI schemes were discontinued on 1 April 2012, which resulted in significant negative impact on capacity addition as well as reduced investor confidence (Int [2]). Removal of these incentives led to subsequent requests, petitions, advocacy, and lobbying efforts from the wind industry associations for their reintroduction. Influential wind energy representatives emphasized accelerated depreciation’s role as a tax deferral scheme and not a subsidy. After significant lobbying efforts, both by the MNRE and all industry interest groups were able to convince the government to reinstate the incentives in the form of a direct tax code [101].

The suitability of a feed-in tariff mechanism versus competitive bidding for procurement of wind energy also prompted debate as the latter allowed producing a certain amount of wind energy at a reduced price due to competition. The Forum of Regulators’ 2008 report “Policies on Renewables” recommended the Ministry of Power to frame guidelines for renewable power procurement under competitive bidding according to provisions in the Electricity Act 2003 and the National Electricity Policy. The Forum of Regulators recommended introducing competitive bidding on a pilot basis following previous experience in the UK and suggested lowering tariffs but no significant capacity addition [102].

Actors favoring competitive bidding, that is, MNRE, the Ministry of Power, and civil society group Prayas Energy Group, cited reasons such as the limitations of a feed-in mechanism in determining appropriate tariffs, poor financial conditions of energy utilities, reducing the cost burden on consumers, promoting competition, and incentivizing higher generation (Int [5,103]). 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 emphasized the lack of evidence of successful foreign competitive bidding mechanisms for wind energy procurement (Int [12,104]).

Wind energy forecasting and scheduling became another important area of concern. 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. The Renewable Regulatory Fund (RRF) Mechanism established by CERC, under the Indian Electricity Grid Code (IEGC) focused on scheduling and wind energy forecasting and penalizing wind power producers with UI charges in case their grid input was more than 30 percent of their forecast [100,105]. However, the guidelines were resisted by the wind industry associations, citing operational challenges and lack of technical competence and experience in scheduling and forecasting wind energy. The wind industry demanded implementation in such a way that generators would not be heavily penalized and cause serious impact on wind developers’ revenue (Int [12,100]).

4.3.2 Creation of an indigenous innovation infrastructure

The new institutional context helped to create a localized manufacturing base with setting up of joint ventures between Indian and foreign firms and other arrangements such as licensed production and foreign subsidiaries. Indian manufacturers gained some level of manufacturing capabilities for turbines in the range of 225 kW to 2500 kW. Until recently, the Indian turbine industry was dominated by companies such as Suzlon, Enercon, Vestas, and RRB Energy who had focused more on catering to domestic demand than international markets [59,60]. Suzlon became the dominant manufacturer by using several strategies, such as joint ventures and wholly owned subsidiaries, as well as using license agreements for specific turbine components. Suzlon focused on activities such as R&D collaborations and international and in-house R&D facilities. Other activities included acquisition of foreign companies and overseas investments in firms [89,106,107]. Table 8 shows the prominent wind turbine manufacturers in India and important turbine technologies in this period.

Due to presence of low-wind regimes in India, wind turbine manufacturers focused on producing Class II and Class III turbines. However, Indian manufacturers were still dependent on their foreign manufacturers for knowledge and complex and high-value wind turbine components, and were unable to compete internationally (Int [9,2]). During this time period, better site selection of wind turbines, rigorous wind resource assessment and micro-siting, became important. Research efforts also went into designing better turbines using aerodynamic techniques, new materials, and advanced power electronics in order to improve efficiency of wind turbines (Int [1,108]). Repowering of old turbines also gained importance in order to improve efficiency (Int [4]).

Grid problems continued as existing transmission systems were still not able to cope with the rapid growth of wind energy due to lack of long-term planning [109]. Energy utilities in India have often used their poor financial position as a means to oppose additional expenditure for wind energy. Despite an obligation to purchase wind energy at tariffs determined by state electricity regulatory commissions, the state energy utilities have often not met their promises. They have not provided the so-called “must run status” for wind energy and often disconnected turbines during high-wind seasons, causing losses to developers [110].

Several proposals were developed to deal with the issue of grid connection. The Working Group on Power recommended several strategies for better integration of wind energy into the existing grids [111]. MNRE and CERC commissioned the Power Grid Corporation of India to study and identify transmission infrastructure for renewable energy capacity addition during the 12th Five Year Plan period. Reports prepared by Power Grid Corporation

Table 8
Overview of some wind turbine manufacturers in India in the period (Adapted from [96], p. 25).

<table>
<thead>
<tr>
<th>Turbine manufacturer</th>
<th>Rating (kW)</th>
<th>Drive, speed and generator</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enercon</td>
<td>800</td>
<td>Gearless, Variable, Synchronous</td>
<td>II-S</td>
</tr>
<tr>
<td>Suzlon</td>
<td>1500/1600</td>
<td>Gear, variable, DFIG</td>
<td>II</td>
</tr>
<tr>
<td>Vestas</td>
<td>1650/1800</td>
<td>Gear, Variable, Asynchronous</td>
<td>II-B/II-A/III-A</td>
</tr>
<tr>
<td>RRB Energy</td>
<td>1800</td>
<td>Gear, Variable, Asynchronous</td>
<td>II/III</td>
</tr>
<tr>
<td>Gamesa</td>
<td>2500</td>
<td>Gear, Variable, Synchronous</td>
<td>II-A/II-B</td>
</tr>
<tr>
<td>Global Wind Power Limited</td>
<td>2500</td>
<td>Gear, Variable, Synchronous</td>
<td>III-A</td>
</tr>
</tbody>
</table>
recommended several measures to facilitate high-wind penetration, such as enabling strong grid interconnections, establishing a new renewable energy management center, providing priority access to wind energy with amendments in the Indian Electricity Grid Code, better forecasting methods, the development of a power balance market, and new pricing mechanisms with funds to develop this infrastructure [112].

5. Discussion and conclusion

The key contribution of this paper is its emphasizing the role of individuals and organizations involved in the development of wind energy in India and its explanation of what happened, how did it happen and who made it happen. This paper moves away from conventional focus on best practices, policies, and regulation, and presents a richer account by emphasizing the role of different actors, their judgments, decisions and failures as well [1]. By using the concept of collective institutional entrepreneurship, this paper highlights the changing identities and frames of reference of multiple actors engaged in developing wind energy in India and emphasizing the complexities faced by them.

The first part of the original research question is answered through presenting the narrative in Section 4 in three different time periods. Discussing the changing role of multiple actor groups showed how developing wind energy in India was a collective accomplishment of many actors over the last 30 years, with no single actor controlling the entire process. Furthermore, this account highlights a range of strategies used by multiple and heterogeneous actors to institutionalize wind energy in India.

This paper highlights that locus of agency shifted from visionary scientists, entrepreneurs, experts, government officers in the period from 1985 to 1995 to the role of regulatory agencies and industry associations in the period from 1995 to 2003, followed by a range of actors, such as civil society groups and advocacy organizations in the period from 2003 to 2014 after the passing of the Indian Electricity Act 2003. During each time period, new actors created favorable conditions for wind energy in India and the changing institutional conditions also enabled and constrained collective institutional entrepreneurship. The identified issues during the different periods are summarized in Table 9.

During the first period, major issues included negotiations of grid access and cost, wheeling and banking arrangements, and third-party sales and feed-in tariffs paid by the state electricity boards. Major problems faced by the wind industry included poor installation practices, lack of project execution skills, lack of repair facilities, grid integration, technical quality and turbine safety, and excessive dependency on imported components without paying attention to use of turbines in low wind-speed conditions. These issues created a negative image of the wind industry in India, which reduced the installed capacity of wind energy.

During the second time period, conflicts and debates occurred over issues such as maintaining grid discipline, and high fees charged by electricity boards for reactive power. The integration of wind energy into weak grids became an important issue, as there were still considerable gaps in turbine capacity and aerodynamic efficiency. Debates also occurred on lack of transparency with the use of imported technologies, the low level of indigenization, and the lack of serious investors. Increased technological complexity further widened the gap between global and Indian wind turbine manufacturers.

During the third time period, debates on how to support wind energy were prominent and addressed balancing tradeoffs 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 [113]. The sudden removal of accelerated depreciation and the generation-based incentive was a major issue. During this time, critical issues with respect to excluding local communities during wind farm planning also increased local conflicts as developers claimed benefits for local communities, but did not meet promises of wider economic and social benefits.

The result of the analysis is that conflicts require 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, opportunities for participation in energy policy processes remain quite limited due to their expert-driven nature. Even if public hearings and consultations are conducted, genuine opportunities for effective participation are limited. Final decisions are often made behind closed doors by powerful interests or expert organizations [114]. Improving the situation requires re-conceptualizing the issues in forums wherein viewpoints, identities and interests of different actors are awarded symmetric treatment [115]. It is necessary to be open towards marginalized actors and find ways of justifying genuine participation procedures to include their concerns; future research should look at how these neglected actor groups can become a part of wind energy development in India.

In terms of implications of this research, we suggest that future wind energy development requires focus on targeted support mechanisms, and withdrawing them when sufficient capability levels have been attained. Policy makers need to be careful about sudden removal of key support mechanisms and regulations as it can have an adverse impact and even promote rent-seeking activities by interest groups. They need to adapt to continuously changing global technological dynamics, and resolve emerging conflicts between different actors while anticipating new conflicts in the future. Furthermore, care has to be taken with respect to...
mapping the views and perspectives of local communities when planning wind energy projects. Finally, one essential limitation of this research is the generalization of findings beyond the context of the wind energy industry in India. We suggest the need for additional research to better understand how findings from this paper can be translated into other institutional contexts.

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