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Transitions to Renewable Energy in Industrializing Countries

A comparative case study of the Indian states Maharashtra and Tamil Nadu

Simen Storm Berger

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Abstract

A key challenge for future climate change mitigation efforts will be to ensure that industrializing countries make a successful transition from a fossil-heavy energy system to a more sustainable one, where renewable energy sources are predominant. Yet, great variation is observed in the degree of renewable energy spread in industrializing countries. What explains this variation? This report aims to shed light on the determinants of variation in renewable energy transitions in one key industrializing country: India, in hopes that explanations for renewable energy spread here can be applied to this group of countries in general. Through a comparative case study of the electricity sector of the Indian states Maharashtra and Tamil Nadu, propositions derived from two different theoretical perspectives on societal transitions are tested, and linkages are drawn between proposed explanatory mechanisms and the degree of renewable energy spread in the two states.

The report concludes that in the analyzed cases, clear and direct support policy instruments aimed at facilitating renewable energy greatly help its spread, as long as other contending political issues are not more salient and are taking precedence. One such contending political issue is rapid growth in energy demand. Differences in renewable energy spread in Maharashtra and Tamil Nadu can largely be traced back to the more pressing energy demand situation in the former state, and the greater political saliency of renewable energy in the latter. At the end of the analyzed period, when these two aspects become more similar across cases, the differences in renewable energy spread also dissipate. A directly observed process is that higher power deficits and higher energy demand growth leads to pressure towards the ability of renewable energy to provide enough electricity. This in turn forces a shift in state priority towards fossil energy sources. Empirical observations throughout the analysis further indicate that a high coal dependency is linked to a generally lower spread of renewable energy

Key Words

Renewable energy, renewable electricity, transition theory, India, Maharashtra, Tamil Nadu, Carbon Lock-in, Multi-level Perspective, Institutionalism

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Acronyms and Abbreviations

AIADMK	All India Anna Dravida Munnetra Kazhagam
BJP	Bharatiya Janata Party
DMK	Dravida Munnetra Kazhagam
EIA	U.S. Energy Information Administration
GDP	Gross Domestic Product
GW	Gigawatts
HDI	Human Development Index
INC	Indian National Congress
IRENA	International Renewable Energy Agency
MDF	The Democratic Front
MERC	Maharashtra Electricity Regulatory Commission
MLP	The Multi-Level Perspective
MW	Megawatts
NCP	Nationalist Congress Party
NGO	Non-governmental Organization
OECD	Organization for Economic Co-operation and Development
REC	Renewable Energy Certificates
RPO	Renewables Purchase Obligations
SERC	State Electricity Regulatory Commission
TERI	The Energy and Resources Institute
TNERC	Tamil Nadu Electricity Regulatory Commission
VOC	Varieties of Capitalism

1 Introduction

It is expected that by 2040, developing countries will account for two-thirds of the world's energy consumption. Nearly all future growth in energy consumption and production will therefore take place in non-OECD countries, while levels within the organization are predicted to remain largely constant (U.S. Energy Information Administration 2013)[1]. These energy development trajectories constitute significant challenges to the mitigation of climate changes and other fossil-related environmental problems, because the continuing economic growth in developing countries will largely be supported by increases in fossil energy (EIA 2007). In spite of rhetoric by heavy carbon-emitting industrializing countries such as China and India that renewable energy will be given more priority in the coming decades, they have simultaneously emphasized that carbon emissions will have to go up before they can be reduced, in order to maintain their high rate of economic development (Davenport 2014).

This highlights one of the main issues related to securing renewable growth in developing countries; many show a general unwillingness to take necessary action to cut increasing emissions caused by their economic growth. Appeals to not further exacerbate climate changes by investing in carbon-intense energy systems have been called hypocritical by state leaders in developing countries. The west got where it is today by the help of carbon-intensive industries, and developing countries should not be denied the same opportunity. An additional objection is that the brunt of global warming so far has been caused by western emissions, and as such, the west should also bear the majority of the responsibility for mitigating its consequences (The Guardian Environmental Network 2012). Mitigating harmful climate changes resulting from fossil energy emissions while at the same time allowing developing countries to achieve continued economic growth, will therefore be one of the most crucial challenges for energy and environmental policies in the decades to come. Moreover, because of the future position of these countries as the main energy consumers globally; the developing world will arguably be the main focal point of future climate change mitigation efforts. Understanding how transitions from carbon-intensive energy systems to renewable ones are being hindered or facilitated in these countries can therefore be an important step towards enabling effective and fair policies to facilitate these efforts.

This report aims to shed light on the determinants of variation in renewable energy transitions in one central industrializing country – India, in hopes that linkages uncovered here may provide answers that can be applied to this group in general. This will be done by looking at two large and influential federal states in the country, whose decisions and developments within energy politics is likely to greatly influence and reflect the choices made and developments seen in India in general. The study is further limited to one sector of the energy system: the electricity

[1] The U.S. Energy Information Administration will hereby be referenced as EIA

sector. This delimitation is done out of a plausible expectation that different factors may influence developments in completely different ways within different sectors of the energy system. Focusing on a singular energy sector can therefore secure the comparative validity of the analysis.

1.1 Research Question

In addition to being the world's largest democracy, India is also the second most populous country in the world. In effect of this position, it is arguably one of the leading representatives of rapidly industrializing countries globally, and their actions and efforts in terms of renewable energy developments could therefore have ramifications well beyond their own borders. Understanding what influences India's efforts in terms of renewable energy developments can therefore contribute to understanding how industrializing countries in general relate to renewable energy. In addition, with its large population and high contribution to global emissions, understanding renewable energy variations in India is important in its own right. However, the country exhibits substantial internal variation in the degree and success of renewable energy developments. This report aims to understand these variations.

The report will address the question of w*hat explains variation in transitions to renewable energy in the electricity sector of the Indian states Maharashtra and Tamil Nadu.*

The report will test propositions derived from several theoretical perspectives on societal transitions. Gauging the explanatory power of these perspectives on a specific energy sector in a large industrializing country may form the basis for further and possibly more general studies of the topic of renewable energy transitions, where mechanisms uncovered in this report could be applied to and tested on a broader set of countries. The empirical application of these theoretical perspectives can serve to fill a potential gap, as most theories on societal transitions are purely conceptual and have yet to be tested empirically. Moreover, much of the literature on transition dynamics are developed by and for developed countries, and a further gap could be filled by applying these theories on the presently understudied group of developing countries. This is not to say that developing and industrializing countries have not received their share of scholarly attention. However, existing research on these countries could benefit from a stronger conceptual and theoretical framework for understanding observed empirical patterns.

One of the central contributions to applying the concept of carbon lock-in on actual energy systems for instance, uses the opinions of 27 experts as the basis for constructing their variables, without any mention being made of previous literature on the topic (Brown et al. 2008). Similarly, Pandey et al. (2012) aim to uncover determinants for variations observed between Indian states in solar power investments, yet do so with only a limited review of previous research on the same issue area, and no mention of scholarly contributions to proposed determinants of renewable energy spread. Hess and Mai (2014) on the other hand, carries out an extensive literature review of proposed explanations for renewable energy transitions, but disregard these explanations in deriving their own independent variables, which are largely based on aggregated measures, such as level of democracy and GDP per capita. It is evident that very few of the reviewed scholarly contributions on energy transitions in developing countries actually take into account the existing body of theoretical literature on what causes transitions when they establish their proposed explanations. While it in no way is claimed that the conclusions reached by these analyses are erroneous or wrongful due to the lacking attention to previous literature, it is arguably a scientific weakness to not sufficiently take such literature into account, as one might overlook mechanisms and determinants deemed important in earlier studies.

The research question will be investigated and answered through a comparative case study of variations in renewable electricity developments between the two Indian states Maharashtra and Tamil Nadu. Congruence analysis will be applied to derive explicit expectations regarding how renewable energy developments should transpire in the two states, given how they score on explanatory factors derived from two separate theoretical perspectives. How these expectations match up with actual developments in renewable energy is considered a test of the explanatory power of the proposed influencing factors. Conclusions can therefore be drawn regarding what explains the observed variation between the two states.

1.2 Outline of Report

The report consists of five chapters. Chapter two introduces India, with emphasis on the political situation in the country in general, and the position of renewable energy nationally as well as in Maharashtra and Tamil Nadu in particular. The chapter will contribute towards answering the research question through providing a general overview of the main differences in renewable energy spread in the two states – in other words the dependent variable – which will help contextualize the discussions in the following chapters.

Chapter three presents and discusses the analytical framework for how the research question is to be answered. Two main theoretical perspectives for what factors influence transitions are identified, and these perspectives are further reduced into a set of measurable independent variables representing the central propositions of the two perspectives. The chapter then argues for the appropriateness of the two cases for comparison within a most-similar systems design, before it moves on to detail the research method of this report: congruence analysis supplemented by process-based pattern-matching. The chapter ends with a discussion of how the operational indicators will be measured, and the types of data used to acquire these measurements.

Chapter four presents and discusses the empirical results of the comparative case study of Maharashtra and Tamil Nadu. The chapter first presents the scores of the cases on the dependent variable, before it does the same with the independent variables. In light of the uncovered patterns in the two previous sections, the congruence between developments in the dependent and independent variables are assessed through four distinct phases of renewable energy facilitation in the states. On the basis of this pattern-matching, inferences are made regarding the explanatory power of the independent variables relative to each other. The chapter concludes with an overarching discussion surrounding how the independent variables have affected renewable energy transitions in the two states.

Finally, chapter five draws the patterns uncovered in the previous chapter together, and on the background of the results, concludes the report with regards to what may explain variations in renewable energy transitions in the Indian electricity sector, thus answering the research question. It further discusses some empirical implications of the results, and how further research could gain from what is uncovered here.

2 Renewable Energy in India

To explain variation in transitions to renewable energy in the Indian electricity sector, operational indicators must be developed. This chapter will introduce the dependent variable and discuss how it will be measured empirically. The chapter's first section presents and discusses the dependent variable. Second, a brief introduction of renewable energy and the political environment in India follows, providing a necessary background for the case studies that follow in the next section. Last, the two cases; Maharashtra and Tamil Nadu are presented, highlighting the most important differences and similarities between the two states in terms of their energy situation, as well as in political developments within the states over the scope of the analyzed period.

2.1 Dependent Variable – Renewable Energy Spread

The goal of the dependent variable is to provide an operational measure for variation in the spread of renewable energy. The most straightforward way of achieving this could be to simply look at changes in the share of renewable energy in an energy mix over time, and take this as an exhaustive measure of variation for each state seen in isolation. However, even though the construct validity of this measure would be high, the observed results would not necessarily be comparable across the two cases. Because the two cases are located at different points along the scale when it comes to the share of renewables in the total energy mix, observed variations that are similar in total percentage points are not necessarily similar in substance. To illustrate, an increase of one percent-point is arguably much more substantial for a state with a ten-percent share of renewables, than for a state with a thirty-percent share of renewables. Strict caution would therefore be needed to make any comparison across cases.

What is needed is an indicator that is comparable across cases, and that can be measured over an adequate span of time. Furthermore, it is paramount that the constructed indicator for the dependent variable picks up the *spread* of renewables within the electricity sector of the case. In other words, how much ground has renewable energy gained relative to other energy sources over a given period of time? The most direct way of measuring this is to see how high of a share renewables make up of total new additions to electricity generating capacity. This gives an indication of the relative standing of renewables compared to other energy sources, and it is a transparent and valid measure that easily can be compared across cases and over time. What one risks when employing such a measure however, is that the share is in danger of being insubstantial. If renewables make up all of the total capacity additions in an energy mix over the course of one year, but the volume of these additions is very small, renewables seem to be spreading to a great extent, without any notable spread actually taking place. A way around this issue could be to include a *de minimis* threshold requirement of total added volume in order for the spread of renewables to be considered substantial. By including and empirically justifying such a lower threshold, both the transparency and validity of dependent variable could be maintained, with the added benefit of a control for actual substance.

The dependent variable is thus a relative measure of the share that renewables occupy in annual total added power generating capacity, with a lower threshold requirement for the share to be considered substantial. The indicator will be measured over a period of time ranging from 2002 to 2014. The 2002 cut-off point is chosen for two reasons. First, data availability is severely limited before the turn of the century, and renewable energy developments were at such a generally low level before this time, that it adds little in the way of substance. Second, 2003 marks the start of the modern renewable energy era in India, with the passing of the Electricity Act. It thus seems natural to start the analysis just prior to the adoption of this watershed policy. While the indicator will measure the share of renewables in total capacity additions in percent, the dependent variable is made up of four scores ranging from low, through fairly low and fairly high, to high. This enables a more intuitive indication of the states' scores on the dependent variable over time, without sacrificing too much substance. The score range is divided into four instead of three, to avoid the potential pitfalls of a medium-category that is too broad, does not pick up sufficient amounts of variation, and does not sufficiently indicate the direction of this variation, for it to enable proper assessment.

2.2 India – Politics and Renewable Energy

As India is a federal republic, its states enjoy considerable freedoms of legislature and policy making, but are still subjugated to varying degrees of federal control. Legislation is divided between the federal and the state level, and one further distinguishes between national parties and state parties, where the former type competes for seats in the National Assembly (the Lok Sabha), and the latter for seats in the State Legislative Assembly. State parties often spring out of and form local branches of larger national parties, although they often display significant variations in terms of both ideology and political standpoints from that of their national counterparts, in order to reflect the political climate of the different states they are competing for power in. In addition to state-branches of national parties, a host of completely autonomous state parties with no direct affiliation to any national party exist in all Indian federal states. These autonomous parties can either be single- or multi-state based, and if an autonomous party is represented in the State Assembly of four or more federal states, it qualifies to run for the national elections as well. As of now, there are six recognized national parties in India, while each state has between two and ten registered state parties.

For the last three decades, two political parties have dominated both national and state politics in India; the center-left Indian National Congress (INC) and the right-wing Bharatiya Janata Party (BJP). While the INC emphasizes social justice and economic development through a social liberal and social democratic ideology, the modern incarnation of the BJP is typically neoliberal and socially conservative, with an emphasis on nationalism, privatization and economic growth

(Elections.in 2015a, 2015b).[2] These two parties have also dominated state politics in most federal states, either forming single-party majority governments or coalitions with other parties. These multi-party coalitions have often developed into long-running alliances between parties that have taken on their own identity, with their own names and monikers, and in some cases a completely different political focus than that of their sister parties in other states (Elections.in 2015c, 2015d).

Figure 1: Political map of India (source: cdc.gov)

In the electricity sector, all activities are state regulated, but ownership of electricity production is split fairly evenly between the central government, the state governments and private companies. The latter sector has emerged rapidly over the last two decades as severe inefficiencies in both production growth and financial management by the central and state governments forced the Ministry of Power to allow for a degree of privatization of electricity production (Banerji 2011, Dubash 2005). One can expect that variations in the buildup of this division between states can have major impacts on prospects to execute deep-seated transitions in

[2] Pre-1998, the party had a much stronger emphasis on nationalism and the importance of uniform national standards relating to religion, culture and language. To broaden its appeal and to enable coalitions with a broader set of state parties, these elements of its ideology have been toned down.

the electricity generation system, so it will be important to control for this background variation when discussing inter-state variations between the two cases in this analysis.

India is the world’s second most populous country, and will by the end of the next decade probably attain the number one spot. Keeping pace with the fast rate of economic growth the country has seen since the mid-1990s, India’s energy consumption rate is now the fourth largest in the world (U.S. Debt Clock 2014) and it is the world’s third largest electricity producer (British Petroleum 2014). The rapid growth in energy demand that has followed recent developments in modernization and industrialization has left India in an almost perpetual state of energy deficit. In an attempt to curtail the growing disparity between supply and demand, India is making itself increasingly more dependent on fossil fuel imports which constituted 38% of the country’s total fossil fuel consumption in 2012 and is predicted to rise above 50% by 2030 (Yep 2011, Dunn 2014). India’s energy deficit is especially critical for the electricity sector, with growing popular pressure to reduce the frequent power outages that plague urban and rural areas alike with any means necessary. The challenges of keeping energy production up with rising demand are further exacerbated by the ongoing process of rural electrification which has been a key focus point of the Indian government for decades. According to the Indian government, nearly 96% of all rural villages are electrified as of September 2014 (Pandey 2014), up from 85% ten years prior (Central Electricity Authority 2004: 4). While constituting an important achievement in securing human development and economic growth in the country, the increasing access to electricity has put enormous strain on an already underdeveloped and aging Indian electricity grid. Poor stability and reliability in addition to frequent blackouts in periods up to 8 hours a day are cited as common in many rural areas of the country (World Bank 2010).

There are no indications that point towards a slowing or reversal of these trends, and it is predicted that the subcontinent will be the second-largest contributor to energy demand increases in the world for the coming decades, making up nearly 20% of global demand rise. Being challenging enough for Indian energy politics in itself, this scenario is set against the backdrop of the country committing to cut its emissions intensity to 25% of 2005 levels by 2020, through an ambitiously high renewable energy portfolio increase target of 15%. These targets are in part spurred by the increasing perilousness of a shortening fossil fuel supply, as well as the government’s explicitly stated goal of becoming a front-runner among developing countries in the use of renewable energy (Yep 2010). To accomplish this goal, the Renewable Purchase Obligation regulation was adopted in 2008, which imposes requirements on states to increase their share of renewable energy in the electricity production energy mix. The RPOs are imposed on states in accordance to the assessed renewable energy potential of each individual state, and the obligation percentages are set to increase each year until the 15% goal is reached nationally in 2020 (Pratap et al. 2013).

To abate the increased costs of renewable energy production in relation to conventional energy sources, incentives to invest up to, and beyond, the obligated renewable percentages are to be facilitated by Renewable Energy Certificates, which are a market-based mechanism to increase the competitiveness of renewable energy sources (Renewable Energy Certificate Registry of India 2010). RECs are awarded to states that produce renewable energy and can either be sold for preferential tariffs, or to other states that struggle to achieve their own RPOs. The latter will enable states without any significant renewable energy generation to surpass their RPOs by financing production in other states (Shrimali 2013). Furthermore, interstate REC trading can also help states that have a significant renewable energy potential harness this far beyond what is put forth in the RPO regulations. However, the effectiveness of the RECs have not yet reached their full potential, and a high volatility in tariffs, as well as uncertainties regarding future policy developments have made the incentives to fulfill or expand on RPOs to remain low (Mercados Energy Markets India 2012: 15). Although the RPO is a federal policy that defines national goals pertaining to renewable energy developments, it is to be planned, carried out and enforced on state-level, with State Electricity Regulatory Commissions (SERCs) being in charge of carrying out the RPO goals in each state. Lacking compliance mechanisms as well as considerable freedoms for each state has severely hampered the effectiveness of the RPOs, allowing considerable freedoms for states to reduce the scope and ambitiousness of their own goals.

2.3 Maharashtra – “The Laggard”

Maharashtra is a state in the western part of India. It is the 3rd largest in area, and the 2nd most populous state in the country. As of January 2015, it had a total installed power capacity of 36097.37 MW, of which non-hydro renewable energy constitutes just above 15% (5630.19 MW), somewhat higher than the national average of 12%. In light of substantial expansions over the last years, wind energy is now the dominant renewable energy source in the state. It was previously divided roughly half-and-half between wind and solar power, but solar achievements in the state have been severely lagging during the last decade (Government of India 2015, Indian Wind Energy Association 2012).

2.3.1 State Politics

In Maharashtra, the INC, together with various collaborative parties, has won most State Assembly elections since the inception of Indian party politics. Since the start of the 1990s however, their outright dominance as the largest political party in the state has waned, paving the way for some important changes in the political landscape in the state (Singh 2014, Elections.in 2015c). Since the 1995 Assembly elections, BJP and the right-wing ultranationalist state party Shiv Sena have sailed up as the major contenders to the INC for political power, and although they have only won two state elections, they have proved to be a formidable power in opposition, forcing the INC to modify and moderate its politics to appeal to a shifting political landscape (Mallick 2013: 105-107, Merchant 2013). The INC in Maharashtra has however, always been more elite- and right-oriented than what has characterized the party in the rest of the country, illustrated by criticisms directed towards the party already more than three decades ago regarding their alleged catering to “big business” instead of the broader populace (Kamat 1980). Following national developments in the ideology of the party, the INC in Maharashtra has moved further towards a more market-oriented focus during the last two decades, and while not becoming a right-oriented party *per se*, they have pushed for increasing privatization and liberalization of public institutions and services, orienting themselves towards a similar political rhetoric as that of their right-wing opponents (Indian National Congress 2014, Maharashtra Pradesh Congress Committee 2014, Mookerjee and Upadhayaya 2014, Elections.in 2015c).

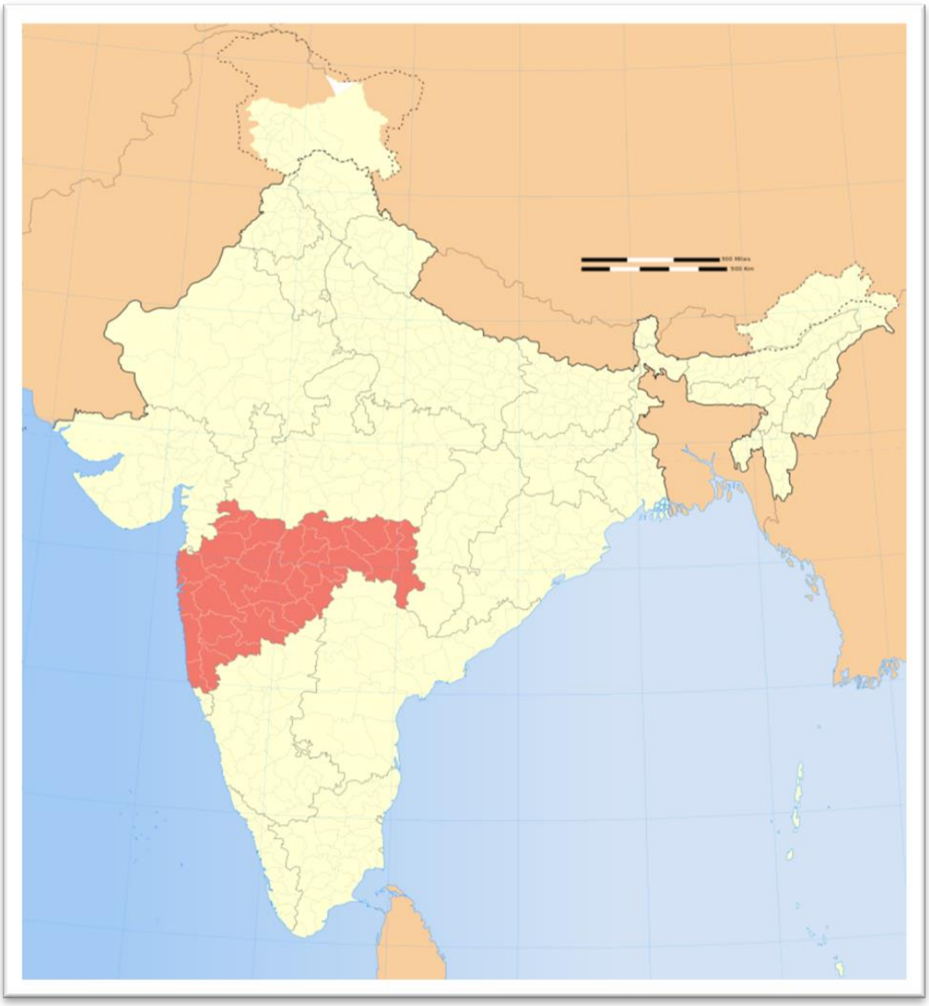
The alignment of the INC towards the right of the political spectrum in Maharashtra may, however, have taken its toll on their prospects for political power in the state, as arguably became evident when the 2009 coalition between the INC and the social liberal Nationalist Congress Party (NCP) – which also went under the name The Democratic Front (MDF) – collapsed a month before the 2014 State Assembly elections (Gagdil 2015).[3] Following the collapse of the decade-spanning coalition between the two parties, the INC and the NCP may even sever ties for good, following increasing ideological and political differences (Banerjee 2015). The 2014 State Assembly elections further marked the first time in the political history of Maharashtra that the INC was not the largest political party in the state. In spite of the collapse of the MDF however, the coalition enjoyed a broader political scope during their reign than most state governments predating them. Holding exactly half of the State Assembly seats, the MDF could practice near-majority rule, only relying on the help of minor supporting parties to gain full majority for their policies. As a result of this, the 2009 to 2014 MDF state government had more political clout than any one since the 1980s.

This helped little in light of the political turmoil that characterized the end of their elected period however, and in the 2014 State Assembly elections, the right-wing coalition of the BJP and Shiv Sena went on to win by an unprecedented landslide, snagging nearly 65% of the Assembly seats, claiming their first state election victory in two decades. Moreover, this was the first time in over three decades where a majority government was formed following an Assembly election in Maharashtra. Although this new right-wing coalition government is still in its infancy, and any evaluation of its performance so far is preliminary at best, the coalition seems to have some initial issues linked to finding common ground between far-right and more moderate center-right sentiments. Despite being outspoken election allies in Maharashtra state politics since the start of the 1990s, there is a considerable gap in ideology between the classical neo-liberal BJP and the right-wing Shiv Sena, which could result in some challenges now that they are together in government instead of in opposition (Unhale 2014). Nevertheless, the clear majority that the present right-of-center government holds could lead to an interesting

[3] The NCP is a state-party prominent in Maharashtra and Kerala that split from the INC in 1999.

change in direction and pace for state politics in Maharashtra, for which the consequences in terms of renewable energy policies have yet to be seen.

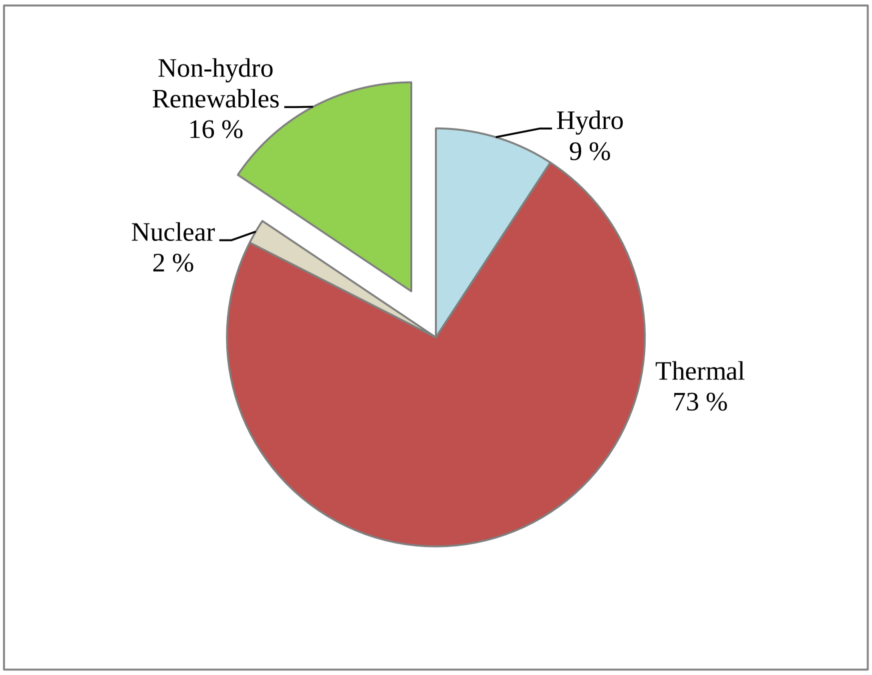
Figure 2: Outline of Maharashtra within India (source: wikipedia.org)



2.3.2 Renewable Energy

The RPO target for Maharashtra started out at 6% in 2010, increasing annually up until a 9% target in 2013. The 9% target is to stay flat until the RPO period ends in 2016 (Maharashtra Energy Development Agency 2010). For the 2012 RPO period, the state had an obligation to achieve a 7% increase in renewable energy power generation capacity from 2009 levels. In the same period, it achieved only a 3.56% increase, which corresponds to a 51% compliance rate. This relatively low achievement level has drawn criticism towards the state's efforts, as it has one of the largest renewable energy potentials in the country (Pratap et al. 2013). Maharashtra has a particularly unique potential for solar energy, receiving some of the highest solar irradiance in India, and in light of this, the lack of both ambition and achievement in the developments of solar power in the state is especially striking (U.S. National Renewable Energy Laboratory 2011, Choudhury et al. 2014). Its RPO targets concerning solar power were set at a modest 0.25% from 2010 until 2013, with an increase to 0.5% from 2013, which is to remain at a flat level until the RPO period ends in 2016. Even in spite of these unambitious targets, the solar development achievements of the state during the same period have been completely negligible, with a zero percent target achievement rate during the first RPO period of 2010-2011 and a miniscule 0.07% achievement rate the period after (Raja and Sonavane 2013: 12-13).

Figure 3: Electricity energy mix in Maharashtra, as of 31.01.2015 (Government of India 2015: 15)



2.4 Tamil Nadu – "The Frontrunner"

Tamil Nadu is a state in the southern-most part of India. It is the 11th largest in area, and the 3rd most populous state in the country. It has a total installed power capacity of 22370.14 MW, of which non-hydro renewables constitute just over 36% (8075.38 MW). This is substantially higher than the national average of 12%. Tamil Nadu is the leading Indian state on wind energy, which makes up the vast majority of its renewable energy capacity (Government of India 2015, Indian Wind Energy Association 2012).

2.4.1 State Politics

The political climate in Tamil Nadu is somewhat different from that in Maharashtra and India in general, due to the fact that all major political parties in the state trace their origins and ideology back to the Dravidian movement. This movement springs out of the presence of powerful ethnic, lingual, and cast-based cleavages between the north and south of India, where the Aryan ethnic group in the north has traditionally asserted dominance over the predominantly Dravidian south. In Tamil Nadu, a southern state, the Dravidian movement and affiliated Dravidian parties have been dominant within state politics for nearly half-a century (Wyatt 2014). The major aim of this movement, which also goes under the name The Self-Respect Movement, is to achieve social equality for Dravidians in India, and to even out the perceived socioeconomic differences and inequalities between northern and southern parts of the country. In effect of this, Dravidian parties have tended to be located on the left-of-center side of the political spectrum, often socialist in ideology, and thus both of the two dominant political parties in Tamil Nadu for the last fifty years – the All India Anna Dravida Munnetra Kazhagam (AIADMK) and the Dravida Munnetra Kazhagam (DMK)[4] – are located to the left in the political specter (Hodges 2005, Gorringe 2015).

Both the AIADMK and the DMK are located close to the political center, their ideologies somewhere between democratic socialism and social democracy. They are also both highly populist in regards to the Dravidian movement, and both parties are labour progressive and were in the forefront of the movement towards greater state autonomy and the transition to a true federal system of government in India during the 1970s (Wyatt 2010: 17-49, Ziegfeld 2012: 282-288). Since 1984, every single State Assembly election has seen power being switched back and forth between AIADMK and DMK, none of the parties having managed to stay in office for more than one consecutive term. In spite of the tug-of-war tendency between these two parties for the last three decades however, both parties have managed to form majority coalition governments in every single election. The DMK has traditionally formed coalitions with the INC when establishing state governments, but prior to the State Assembly election in 2011 they cut their ties with the party because of a perceived hostility of the INC towards the cause of the Tamils on Sri Lanka (Iyer 2013). Albeit a close competition, the AIADMK has arguably been the dominant political party in the state throughout the analyzed period, gaining a higher portion of State Assembly seats than the DMK in all elections except in 1996. This narrow dominance has allowed the party to assert its influence to a greater extent both when it has been in power and when it has been in opposition. AIADMK-led governments have tended to be stronger and to have had greater freedom in terms of exerting their policies and they have also used their influence in opposition to force DMK-led governments into conceding more compromises (Elections.in 2015d).

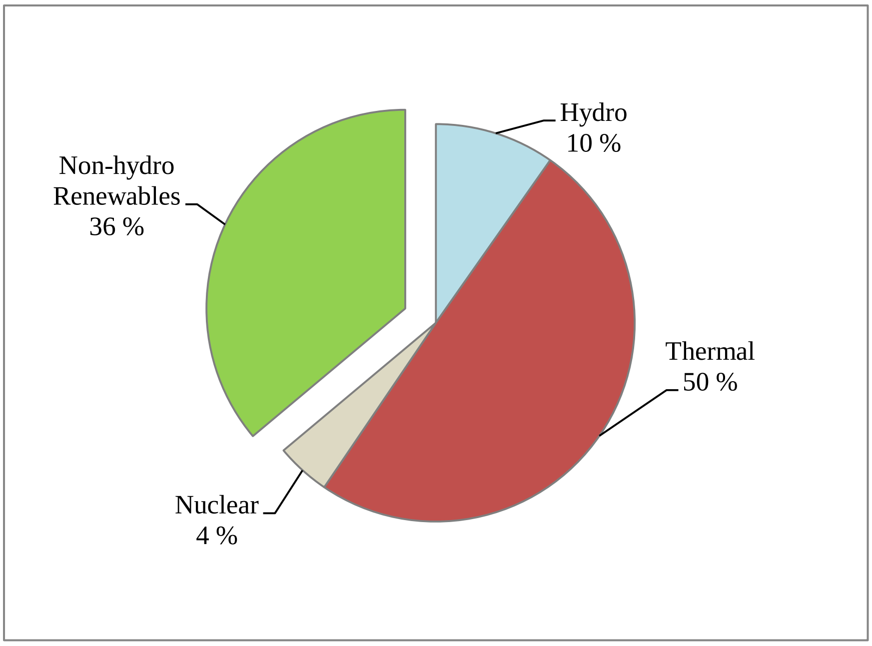
[4] The AIADMK formed in 1972 as a breakaway faction of the DMK, due to political differences between key top-politicians in the DMK.

Figure 4: Outline of Tamil Nadu within India (source: Wikipedia.org)

2.4.2 Renewable Energy

The RPO targets of Tamil Nadu have undergone large revisions and changes since their inception in 2009, including several contradictory and conflicting targets being issued around the same periods of time by different official agencies (Government of India Ministry of New and Renewable Energy 2013: 12). Overall however, Tamil Nadu has over-achieved in terms of RPO target compliance and is one of the leading states in India when it comes to renewable energy investments (Pratap et al. 2013: 6). Initially, Tamil Nadu had an obligation to achieve a 14% increase in renewable electricity generation capacity from 2009 levels by 2012, but this was reduced to 9% in 2011 by the Tamil Nadu Electricity Regulatory Commission (Gambhir et al. 2013). In the same period – in spite of the RPO target reductions – the state achieved a 19.14% increase in renewable electricity capacity, which corresponds to a compliance level of 213% relative to the 9% target[5]. Criticism has been aimed, however, at the lackluster effort of the state in achieving the target of an increase in solar power by 0.05% that they committed themselves to (Pratap et al. 2013). Nearly all of Tamil Nadu's renewable energy capacity additions over the time period in question have come from wind energy, and for the 2012-2013 RPO period, the state further reduced their solar RPO target to 0.01%, following a similar reduction from 0.15% to 0.05% in the previous RPO period (Gunasekaran 2011 Government of India Ministry of New and Renewable Energy 2013: 12).

Figure 5: Electricity energy mix in Tamil Nadu, as of 31.01.2015 (Government of India 2015: 16)



2.5 Summary and Implications

This chapter has established a context as well as a limitation for how the research question will be answered in this report. The dependent variable will be measured within two federal states that are later argued to represent India in an adequate manner, and the scope of the analysis is limited to a twelve-year period. The main conclusion drawn from the preliminary review of the two cases in this chapter is that while one case appears as a laggard in terms of renewable energy developments, the other stands out as a frontrunner. The observation of such variation within the common context of India has implications for choices regarding the optimal research methods and design to employ for

[5] The compliance-rate relative to the initial 14% target would be 134%, still one of the highest achievement-levels in the country.

answering the research question. Furthermore, the theoretical and methodological delimitations that follow in the next chapter are affected by the topical framework and limitations provided here, and operationalizations will be made in light of the overarching context of India and the states of Maharashtra and Tamil Nadu.

3 Analytical Framework

This report aims to answer the research question through a comparative case study of the two Indian states Maharashtra and Tamil Nadu, utilizing congruence analysis to assess the explanatory power of two distinct theoretical perspectives on what determines variations in transitions to renewable energy. The chapter first presents the two perspectives, and it maps out how they will be employed. Second, three main independent variables are constructed, representing the main explanatory factors highlighted by the analytical perspectives. The independent variables are then operationalized into a set of indicators that provide explicit measures, which thus allows empirical testing. Third, the research method of this report is introduced, which is congruence analysis with a particular process-focus. Section four elaborates on the choice of cases, in regards to data availability, transferability, and comparativeness. This section will also discuss some important background factors that need to be controlled for in order to ascertain whether the cases can be compared in a valid and substantial manner. The fifth and last section discusses the measurement of the variables, and present how they will be scored, and why.

3.1 Analytical Perspectives

There is a notable lack of consensus on what factors determine observed variation in transitions towards renewable energy. Three main contributions to the literature on transition determinants can be highlighted: the Carbon Lock-in thesis of Gregory Unruh; the Multi-Level Perspective;[6] and Matthew Lockwood's Institutionalist perspective on transitions (Unruh 2000, Grin et al. 2010, Lockwood 2013, Lockwood et al. 2013). In spite of the lack of consensus within renewable energy transition theory, two relatively distinct explanatory patterns seem to be predominant. The first pattern focuses on the technological attributes of energy systems, and theories and assumptions regarding the relationship between innovation and stability. These types of explanations will here be labeled as *techno-innovational explanations.* The second one on the other hand, focuses on social, political and economic institutions and how they facilitate or impede renewable energy transitions, labeled here as *socio-institutional explanations*. Different aspects of these two patterns are usually somewhat interchangeably employed in the literature on transitions when scholars propose mechanisms that presumably influence the degree of transitional success. However, these supposed influencing factors are very rarely tested empirically, nor are they usually ascribed any hierarchical order in relation to their criticality, importance or strength.

Although it is expected that – as most research suggests – it is a combination of the two explanatory patterns that is best suited at explaining

[6] The Multi-Level Perspective will hereby be termed the MLP.

variable transformative success, it can nonetheless be argued that it can be valuable to separate them analytically. Through such a separation, their explanatory strength can be assessed individually with careful empirical analysis by the use of a process focused pattern-matching method, based on the empirical implications derived from the theoretical perspectives. The purpose of separating the two perspectives is thus not to prove that one outperforms the other in explanatory prowess, but rather to explore how all aspects of the two explanation patterns relate to each other empirically, both in space and time. Gaining a better understanding of what type of factors are important under different conditions can also contribute to future studies in the field of renewable energy transitions.

3.1.1 The Techno-Innovational Perspective

The techno-innovational perspective draws its main assumptions from Unruh's carbon lock-in thesis as well as the logic of the MLP. The perspective argues that the shape of transitions in an energy system is in large determined by three factors: first, the degree of carbon lock-in in the system; second, the maturity and alignment of competing modes of operation; and third, the amount of exogenous pressure that is put on a dominant regime.

Carbon lock-in is a state of self-reciprocating path dependence, where central societal institutions have co-developed to the point where they are deeply entangled, and the carbon energy industry is embedded in all other aspects of a society (Unruh 2000). There are a plethora of mechanisms that contribute in creating the snowball-effect that characterizes lock-in, but literature on the topic is fairly concerted in arguing that industrial heaviness is the most crucial characteristic of a locked-in energy system (Knot et al. 2001: 337, Shackley and Thompson 2011: 113-115, Vergragt et al. 2011: 283-284). Heaviness relates to the intensity of capital investments[7] coupled with the large scale and long lead times that characterize large energy systems. This combination of factors creates a large economy of scale that favors the current technological incumbent (the dominant regime) and bars the entry of competing technologies. Heaviness is the basis of the self-reciprocating nature of lock-in, and the longer this mechanism reciprocates, the more inflexible the economic system becomes (Collingridge 1992). It further contributes to the rise of other sub-criteria, such as learning effects of both producers and consumers, network externalities that arise as more and more actors choose to employ the dominant technology, as well as an increasing embeddedness and interrelatedness between technologies and institutions. All in all, lock-in makes it so that major infrastructural changes are required in order to make a transition from fossil to renewable energy, creating inertia in the system and an inability in governments to correct market failures. The presence of these factors can result in a very strong dominant socio-technical regime, which makes landscape pressure and

[7] In spite of progress on the area, the fossil energy sector continues to receive the lion's share of subsidies and investments, compared to renewable energy (Worstall 2014).

challenges from radical innovations all the less likely to destabilize it sufficiently for other energy sources to replace it.

The second main factor considered influential for the shape and pace of transitions to renewable energy is the maturity of a niche-innovation and its level of alignment towards landscape pressure. Niches relate to protected spheres where radical innovations can grow and mature without being subjected to market conditions that they would not be able to compete under. In the case of the energy sector, one such radical innovation could be a specific form of renewable energy technology, and the niche could be any specific application where the innovation is subsidized or in another way protected so that it becomes the dominant practice for that specific application. This process of active and coordinated sheltering of an innovation over a period of time is thought to mature the technology to the point that it becomes competitive and able to challenge an existing dominant regime.

The maturity of an innovation however, is not sufficient for it to be able to overthrow a regime – it also needs to be properly aligned to exogenous pressure asserted on to the regime. Innovations can arise to address problems or issues that are not adequately addressed by the current regime (such as the impact of fossil fuels on climate change), but unless exogenous pressure on the regime is directed at the same issues that an innovation aims to resolve, the innovation cannot effectively challenge the regime. Thus it becomes apparent that an innovation needs to be both sufficiently matured and properly aligned in order for it to be able to challenge and replace a regime (Grin et al. 2010).

Several implications for what one would expect to observe empirically given the presence or absence of the factors mentioned above can be deduced. The first and most straight-forward of these implications is that a greater level of carbon lock-in will lead to greater inertia in transitions. The second implication is somewhat more complex and states that transitions are more likely to take place in situations where landscape pressure and niche innovations are aligned to a high degree. Furthermore, transitions will happen more rapidly when the innovations that are aligned to the landscape pressure are better developed and mature, and the exogenous pressure is of a sufficient magnitude. In developing countries, the somewhat elusive term landscape pressure can to a large degree be separated into two aspects; requirements to mitigate climate changes, and requirements to achieve or maintain socio-economic development. The dynamic between the two aspects can, however, vary greatly, and will be further detailed when operational indicators are devised.

3.1.2 The Socio-Institutional Perspective

Drawing on the logic of Lockwood and his associates (2013), the socio-institutional perspective argues that it is the characteristics of a state’s political, institutional and economic organization that serves as the main determinant of the degree of success in transitions towards renewable energy. The value and importance ascribed to specific issues by pivotal political and institutional actors will furthermore influence the shape and form that political, economic and social institutions take, and thus potentially have large impacts on the success of transitions. One can sum up the socio-institutional perspective as emphasizing factors that are related to *institutions* and *ideas* (Harrison and Sundstrom 2010: 1-3). These two factors each contribute to influence the variation patterns of transitions towards renewable energy.

The concept of *institutions* can usefully and adequately be characterized as the "rules of the game". From this particular point of view, institutions can be defined as formal or informal social structures that serve to lower interaction and cooperation costs and reduce collective action problems. It does this by governing the behavior of individuals and by laying down common rules of conduct within a society, both politically and economically (Miller 2011). As institutional design governs the rules of conduct in a society, it follows that institutions can both bar and facilitate the transition to renewable energy technologies, depending on their structural characteristics.

The concept of *ideas* on the other hand relates to how politicians and other actors think about the need for transition or policy change – and the way they prioritize this in comparison to other policy areas – and how this can have large impacts on the success of the transition in question. The priority given to and the saliency of renewable energy politics can greatly affect how well implemented support policies aimed towards it are (Harrison and Sundstrom 2010: 19). In developing countries the narrative of ecological conservation has usually been neglected in favor of a discourse of development and bettering economic and social conditions. But in recent years, as people in poorer countries have started to experience the direct consequences of climate change, the environmental narrative has started to gain momentum. Discourses that manage to frame development and sustainability as complementary to each other (such as "green growth") has been shown to be more powerful than that of a singular environmental focus that does not take economic concerns into consideration (Lockwood 2013: 27).

Although the socio-institutional perspective is fundamentally non-structuralist in its understanding of transition dynamics, it presupposes and accepts the dynamics of lock-in and that large energy systems suffer from these mechanisms. The reason for this is that, even though the potential for renewable energy within an energy system might be considerable, the design and localization of infrastructure, as well as market conditions – all of which favor incumbent fossil technologies – can create investment risks that effectively bar transitions to renewable energy under free market conditions (Lockwood 2013: 28). It is thus acknowledged that structural factors can impinge upon the ability of institutions to carry out their intended functions effectively. Such structural factors are believed to be particularly present in the energy system, which has been dominated by fossil energy for a long time.

The socio-institutional perspective posits that the debilitating effect of carbon lock-in can be counteracted if incentives to facilitate renewable energy transitions are both strong enough, and properly implemented. This suggests that active management and regulation of renewable energy incentives is necessary and a key factor in ensuring the competitiveness of renewable energy technologies, and in drawing private investments to it (Gross et al. 2007: 17, Gross et al. 2012: 18-21). Furthermore, since facilitation of renewable energy requires active management, it follows that three additional factors also need to be in place. First, a proper institutional framework needs to exist within which renewable energy facilitative policies can be formed; second, these facilitative policies need to produce clear and specific incentives, to draw private investments and secure the competitiveness of renewable energy technologies; and third, policy makers must have the will to actually formulate, adopt, and implement these policies and the subsequent spread of renewable energy in a proper manner. The requirements thus incorporate both institutions and ideas, and as such, these requirements can be used to form a set of implications that form an exhaustive representation of the claims of this perspective.

Two specific implications can be derived from these requirements, regarding what is expected to influence the degree of transitional success. First, one can expect that a political climate in which the salience of renewable energy facilitation policies is higher will be better predisposed at enabling transformative change towards renewable energy. Conversely, if the saliency of renewable energy policies is low, one cannot expect pivotal actors to be willing and focused on introducing and maintaining the incentives needed for its facilitation. Second, this political will towards renewables spread must be backed up and supplemented by actual support policies aimed at facilitating renewables spread. This is thought to be particularly so because of the detrimental effect of carbon lock-in, and because risks and uncertainties towards renewable energy spread needs to be minimized and counteracted as much as possible in light of this. Lastly, the political saliency of renewable energy is thought to interact with and greatly reinforce the effectiveness of policy instruments aimed at facilitating renewable energy transitions, because such facilitating policies need continuous focus and priority in order to remain effective.

3.2 Independent Variables and Indicators

The two synthesized analytical perspectives have now been presented and the main factors that are thought to influence renewable energy transitions within each perspective have been discussed. This section introduces the independent variables that represent the central propositions of the two analytical perspectives presented above, as well as the operational indicators that will provide precise empirical measures for these variables. There are two critical aspects that need to be ensured when constructing independent variables and the indicators that subsequently represent them. First, they need to have adequate construct validity; and second, they need to be operationally distinct from one another. Both aspects will be ensured by a clear and explicit deliberation regarding what the actual contents of the implications and propositions presented above are, and how these are best represented and measured, so that they pick up the essence of the perspectives, while at the same time representing separate dimensions. Three independent variables are constructed based on the two analytical perspectives, where the first two represent the techno-innovational perspective and the third represents the socio-institutional perspective. These independent variables are discussed in the following subsections and are called *coal dependency; innovation challenge;* and *political facilitation of renewable energy*.

Coal dependency embodies the principles of carbon lock-in and the strength of the dominant technological regime. It relates specifically to coal due to the predominance of this resource within the Indian context. The variable thus aims to measure the impact of the heaviness of the coal industry upon prospects for renewable energy spread. Alignment challenge represents the claim that innovations need to be as good or better fit than the dominant regime at meeting requirements posed to the energy system. The variable assumes that the greater the challenges posed, the lower the prospects for successful spread of the actual innovation. In the Indian context, these challenges relate to the ability to provide sufficient volumes of electricity to a country in the midst of both rapid population and economic growth. Political facilitation of renewable energy represents the entire socio-institutional perspective and measures to what extent renewable energy is a salient political issue in state politics, and to what extent clear and specific policy instruments aimed at facilitating renewable energy spread are present.

3.2.1 Coal Dependency

The first independent variable relates to the structural characteristics of the fossil energy system; coal in this case. It will be represented by two indicators: *heaviness* and *scale*. Both of these factors are central to carbon lock-in theory, as they proxy for industrial inflexibility. It is expected that the higher the coal dependency in the energy system, the harder it is for change to come about, and the lower the observed spread of renewable energy should be (Knot 2001: 336).

Heaviness will be measured as the relative share that coal occupies in the energy mix at a given year. The higher the relative share of coal in total energy capacity, the heavier it is assumed to weigh down upon decisions made in regards to all aspects of the energy mix. While this indicator does not pick up all of the complex mechanisms that underlie the concept of heaviness, it is transparent and easily comparable across cases. Given time-constraints and data availability, measuring heaviness as relative share of a resource in the energy mix is arguably sufficient, as it does not sacrifice too much construct validity, while it provides an operationally simple measure for which data is available throughout the period of analysis.

The dependency of coal however, is not adequately picked up simply by looking at the share it occupies in the energy mix. To what degree vital infrastructure is designed around the resource, and to what degree a case has made itself dependent on singular or few sources of energy generation are important in deciding on the degree of dependency, which leads to the next operational indicator. The scale of the coal industry is argued to have an important constituting effect on the dependency of an energy system towards the resource. An energy system can have a relatively small share of coal in its energy mix, but if installations are big and the electricity grid is largely built around these installations, dependency is higher than what one would assume by just looking at the share. Conversely, if an energy system has a relatively high share of coal, but the infrastructure is well spread out to accommodate several sources of energy generation, and the coal installations are fairly small, the dependency is lower than what one would assume by just looking at the share.

The logic and rationale behind this claim is that the more large-scale and centralized the coal industry is the heavier and more inflexible the technological regime is. This is because more intrusive measures would need to be taken in order to replace them, as opposed to if the system was decentralized and small-scale. This is due to two mechanisms. First, the larger the output of electricity from a singular source is, the harder it will be to incrementally and gradually substitute it with other sources of energy. Furthermore, the greater the extent to which vital infrastructure such as transport routes and the electricity grid is laid out to accommodate coal power plants, the more expensive and time-consuming it will be to incorporate other energy sources into the energy mix and thus diversify it. Scale will be measured as the average output volume of coal power plants, as well as a more qualitative assessment of the degree to which vital infrastructure is structured around accommodating coal energy.

3.2.2 Alignment Challenge

The second independent variable relates to the claim that in order for renewable energy to gain ground relative to other energy sources in the total energy mix, it needs to be as good or better posed to meet requirements than the other energy sources. In the Indian context, there is a dual requirement that needs to be met by any energy source, first; avoiding large climate and environmental externalities through its use, and second; allowing for continued economic growth. As mentioned earlier, the requirements posed to renewable energy technologies usually consist of two main components, the ability to mitigate climate changes, and the ability to maintain socio-economic development. The reason for this component structure is that renewable energy innovations first arose as the answer to the specific challenge of mitigating climate change. Additionally however, a main requirement of any energy system in a developing country will also be to supply adequate amounts of energy for sustaining industrialization and socioeconomic development. It is not sufficient therefore, only to mitigate the harmful effects of climate change.

The first main component – reduction of climate externalities – should be automatically fulfilled given the characteristics of the innovation. A possible exception to this is of course if the innovation, in spite of having no direct emissions, leads to significant negative climate consequences through its operation or facilitation. Large hydro-plants for instance, have been known to cause damage to surrounding eco-systems due to the damming and disruption of water flows. The renewable energy technologies analyzed in this report however – solar and wind – have no such negative externalities, save perhaps for the visual eye-sore it is perceived by some to be. The issue of "not-in-my-backyard" problems will of course be present, especially for wind power installations, but will not be discussed here, due to a fair expectation that this will not vary significantly across the two cases or over time.

The most important requirement that renewable energy technologies must meet is therefore the latter – to be able to maintain socioeconomic growth. For energy technologies, this requirement in large boils down to providing sufficient volumes of electricity in light of rapidly growing demand. Because of the lacking maturity of renewable energy sources however, it is hypothesized here that, at present, renewable energy technologies are ill-posed at responding to rapid energy demand growth with sufficient volumes of electricity (Salvatore 2013: 39). Therefore, high power deficits and rapid energy demand growth does not bode well for the expected spread of renewables in the two cases. The first indicator is thus power deficit, and it will be measured as the percentage disparity between the demand of electricity and actual supply.

When discussing the relationship between electricity demand and supply, it is important to compare the appropriate indicators. Up until this point, electricity generation in the two states has been discussed in terms of total installed generation capacity. In relation to this variable however, electricity will be referred to in terms of *peak supply of electricity*. The difference between the two is critical, and while installed electricity generation capacity represents how much electricity can theoretically be generated under optimal conditions, peak supply on the other hand relates to the actual volume of electricity available for consumption at any given time. Naturally, a comparison between supply and demand needs to spring out of how much electricity is actually provided and not how much can be theoretically produced. The actual supply of electricity is affected by several factors, such as the quality of the electricity grid or the supply-stability of energy input factors,[8] all of which contribute to the disparity between theoretical capacity and actual supply. Similarly, the demand for electricity will be indicated by *peak demand*, which measures the maximum volume of electricity being consumed at once over a given period of time. The disparity between demand and supply is called the *supply deficit* and will be the direct indicator for the ability of renewable energy technologies to meet demands directed towards it.

[8] The seasonal conditionality and dependence on external conditions that in turn can create considerable variation in the actual electricity output of renewable energy sources is another reason for the assumption that renewable energy will be down-prioritized in situations of high energy demand growth.

There are exceptions to this assumption however, and a secondary indicator will be included to represent the second independent variable, to control for situations where renewable energy technologies might be more mature. Drawing on the literature on niche-innovations, it is expected that the general application of renewable energy could be more widespread where it was first employed within protected niche-spheres. In India, there exists one such niche within which renewable energy could be uniquely positioned at answering to external requirements, and this is within the field of rural and decentralized electrification. Remote and otherwise hard-to-reach villages and areas in India have a particular problem in connecting to central electricity grids, which has been one of the main challenges in achieving full electrification of the country. One proposed solution to this challenge has been decentralized electricity generation, or so-called mini-grids, which generate electricity to a sub-section of the population, without being connected to the central grid. Renewable energy technologies, with their relatively low output as well as low environmental externalities are much better posed than fossil energy technologies in providing electricity to these decentralized mini-grids, and studies have shown that within rural electrification, decentralized renewable energy can be more cost-effective than fossil energy central grid-extension (Nouni et. al 2008). Since the main assumption of this variable is that renewable energy technologies lack the necessary maturity to be able to provide large amounts of electricity over a short period of time, increased maturity could mitigate this inability to some degree.

3.2.3 Political Facilitation

The third independent variable is related to the influence of policies and institutions on the spread of renewable energy and embodies all of the requirements and implications for successful spread discussed under the socio-institutional perspective in the last section. It too is represented by two operational indicators: *policy instruments*, and *political saliency of renewable energy*.

Policy instruments is a measure of whether or not specific policies aimed at facilitating the spread of renewable energy, such as tariffs or tax exempts, exist and can be observed in the cases. This indicator represents the institutional expression of the socio-institutional perspective, and the importance it ascribes strong incentives in facilitating renewable energy transitions. It is not enough that policies have simply been adopted however, and one must be able to observe the implementation and expression of these policies in the form of specific and explicit incentive instruments. It is plausible to expect that ambitious policies to support renewable energy have been adopted, without any specific policy instruments actually having come into being. Counting this as the presence of facilitation towards renewable energy spread would therefore be a poor indication of actual facilitation, and it is important to instead look at the actual incentives that exist and have been produced as the result of legislation. The indicator will be measured dichotomously, roughly as the presence or absence of observable policy instruments for the facilitation and support of renewable energy investments and spread.

The second indicator, political saliency of renewable energy issues, relates to the priority and attention given to renewable energy issues on the political arena, relative to other issues, by dominant political parties. This indicator will be measured at the state level, as it is the federal states in India that are given the responsibility to implement and follow through on legislation related to renewable energy. The logic behind this indicator is that one can expect the actual implementation and management of specific policy instruments to be more or less effective, depending on the importance ascribed to renewable energy issues by policy- and decision-makers. The saliency indicator is thus expected to have an indirect impact on the spread of renewable energy through its supplementary and conditioning influence on the effectiveness of policy instruments. The saliency of renewable energy issues will be measured by analyzing party manifestos and news sources, to assess to what degree renewable energy issues are given attention and are being prioritized by the dominant political parties on the state political arena. In this case, dominant political parties refer to the party or parties currently in office at any given year. In the assessment of saliency, specific and explicit promises will weight heavier than vague and general ones, which are often only thrown into manifestos without any actual substance or intention of being implemented.

3.3 Research Design

Because of the lack of general indicators for what explains variations in renewable energy transitions, answering the research question requires us to carefully map the mechanisms which influence the degree of transitional success in the energy system. One way to achieve this is to utilize the method of *process-tracing*, which in the words of George and Bennett (2005: 206) is a method that "attempts to identify the intervening causal process – the causal chain and causal mechanism – between an independent variable and the outcome of the dependent variable". For two reasons however, process-tracing will not make out the main research method for this report. First, the sheer amount of data and case knowledge required in order to conduct proper process-tracing would require extensive fieldwork and interviewing. This report on the other hand, is mainly focused on primary and secondary literature. Second, Blatter and Blume (2008: 331), argue that process-tracing is a fundamentally case oriented approach. This report however, is to a much larger degree theory oriented.

For analyses that are more theoretically oriented, *congruence analysis* is proposed as a more fitting alternative, in that it allows for more direct testing of theoretical implications on empirical data. Congruence analysis involves comparing theory-derived expectations for what one would anticipate to observe within a case given its scores on proposed explanatory factors, with actual empirical observations on the same case. This enables us to assess which of several proposed explanations best match what is actually observed, thereby contributing to strengthening or weakening the explanatory power of proposed explanations (George and

Bennet 2005: 182). Because implications for expected empirical observations were derived from the assumptions of two theoretical perspectives in the previous sections, congruence analysis seems fitting for the purpose of this study.

3.4 Case Choice Justification

The two cases that will make up the comparative case study in this report are the Indian federal states of Maharashtra and Tamil Nadu. Both states have about the same assessed potential for renewable energy development, but they display striking differences in actually achieving renewable energy spread. The similarity in potential and disparity in achievement between the two states is fruitful for a comparative analysis of what factors are important in explaining variation in renewable energy transitions. They were chosen after deliberation regarding the most fitting cases to be included in such a study, in terms of data availability, representing India in general, and suitability for comparison with each other. In terms of comparison suitability, these states qualify for a most similar systems design; first and foremost of course, because they both are federal states within the same country, which secures some key institutional, political, organizational and legal similarities. Additionally, to try and minimize background variation between the two cases and to isolate the effect of the proposed independent variables on the dependent variable, some extraneous factors that are plausible to influence renewable energy variation if they are seen to vary between cases are discussed. These extraneous factors are *socio-economic indicators*, *level of corruption*, and *fossil resource endowments*. Some considerations regarding the suitability of the two cases for inclusion in a most similar systems design will be made on the basis of their degree of similarity on these factors.

Variation in crucial indicators for the level of socio-economic development in a state can have a decisive effect on the prospects for climate change mitigation and renewable energy investments. Although the cases are chosen on the background of fairly similar levels of development, this aspect should nonetheless be controlled for, as poverty and inequality can be expected to severely inhibit the ability to implement successful renewable energy policies. Measures of human development (HDI), poverty rates (multidimensional poverty index and percentage beneath the poverty line) and wealth levels (GDP per capita) will be taken into account when considering the level of socio-economic development in the two states. Being the second-most and third-most populous states, as well as the biggest and third-biggest producers of electricity in India, Maharashtra and Tamil Nadu are considered heavyweights in Indian energy politics, whose actions and choices have impacts far beyond state borders. Furthermore, Maharashtra and Tamil Nadu are both leading states in terms of socioeconomic and human development, rivaled only by Gujarat on most economic and social indicators.

In 2011, Tamil Nadu had a Human Development Index of .736, which is the third best in India. Its GDP per capita was at 98550 rupees in 2012. Its multidimensional poverty index score for 2010 was .141 which is relatively low, and the share of Tamil Nadu's population that was living below the poverty line in 2011-12 was 17% (Shanmugam 2012). In 2011, Maharashtra had a .689 Human Development Index rating, which is 12th best in the country. Its GDP per capita was at 107670 rupees in 2012. Maharashtra has a score of .180 on the Multidimensional Poverty Index, which is moderately low, and 24.5% of its population lived beneath the poverty line in 2010 (Shanmugam 2012). By effect of this position, their comparability to smaller and poorer states in India might not be very good, but they can be argued to represent India well in general, as these are the richest and thus the most influential states in the country. Decisions made in these states can be expected to reflect and be reflected in India's general decisions regarding energy politics.

Corruption levels can negatively affect the efficiency of governments and institutions and thus also impede their ability to effectively regulate and implement extensive and grand policies. Corruption levels are assessed on the basis of reports by transparency international and Centre for Media Studies (2005, 2008). Although data-access is limited on corruption, these studies can give an indication of its general levels in the two states. Two independent studies have confirmed that Tamil Nadu is highly corrupt, and the received a "very high" corruption rating in 2008, while it was ranked the 8th most corrupt state in India in 2005. Maharashtra was rated as having "moderate" levels of corruption in 2008, and was ranked the 5th least corrupt state in India in 2005 (Centre for Media Studies 2005, 2008).

The presence of fossil energy sources within a state will most probably have a major effect on political decisions regarding what energy sources to be given priority in future policies. This indicator does not measure resources already tapped, but rather unexploited endowments. This is done to separate this indicator from the explanatory variables regarding fossil industry heaviness. Tamil Nadu has no fossil resource endowments and its coal firing power plants are reliant on expensive coal imports. Maharashtra on the other hand has one of the largest coal reserves in India, and also the largest electricity capacity generated by coal, but is still increasingly reliant on coal imports to run its coal power stations (Ministry of Statistics and Programme Implementation 2011).

While not considered detrimental to the prospects of utilizing a most similar systems-design, there are some crucial differences between the two states that are important to keep in mind during the empirical analysis. The most crucial of these differences is arguably the rich coal deposits in Maharashtra, which makes it natural to assume that they should be more inclined and have more incentive to push for a more prominent fossil energy industry. When discussing the impact of coal dependency on the spread of renewables, it will be important to keep in mind that a ready access to rich coal deposits could shift incentives towards choosing coal over renewables, and not because of coal dependency, but because of accessibility. The second crucial difference is that Tamil Nadu is considerably more corrupt than Maharashtra. While it does not lead to any specific expectations surrounding observed empirical patterns, it is important to keep this in mind when going through the empirical processes that bring about and lead up to important decisions within all of the variables. Aside from these two factors, no crucial differences are found between the states in terms of the control variables. While the two states are not very close on all of the socio-economic indicators, their differences are small enough that they are considered within the same category of relatively affluent and well-developed Indian states.

Another effect of the leading role these states play in both economy and energy is that data availability is significantly higher for these states than for most others. Starting from the mid-nineties, Maharashtra and Tamil Nadu have received much scholarly attention, leading to a self-reciprocating snowball effect where a large amount of research and literature is being produced regarding these states. The availability of secondary literature to help answer the research question and assess the explanatory power of the independent variable should therefore be good. Furthermore, considering the quality and availability of secondary literature, interviews will not be used as a data source at all. While method triangulation through elite interviews could potentially strengthen or at-least secure the quality of inferences and conclusions drawn in this report, it is deemed resource-intensive, and not necessarily beneficial to the final product considering the time it would take to organize and execute them. Given the comparative nature of the case study, the costs associated with carrying out interviews can be of an even greater magnitude, as interview subjects would be geographically dispersed.

3.5 Measuring the Variables

An important aspect of maintaining the construct validity of the operational indicators is the score it translates to on the variable it represents. While an array of different measures are used to ascribe values on the operational indicators, they will need to be decoded into a singular set of scores in order to enable comparison and assessment, both between the different variables and across cases. The scores for the cases on each of the variables are divided into four: high, fairly high, fairly low, and low. How the measures on each indicator will be translated into these four scores will be discussed in the next chapter, but the general method will be outlined here.

The quickest and easiest way to achieve this conversion would be to simply divide each of the score-ranges of the indicators into quartiles, and assign linear scores from high to low on the basis of this. This method however, runs the risk of arbitrary cut-off points. Indicator-scores in the vicinity of each other that in all accounts signify the same substance can be split into separate categories on the score of a variable, if they are located close to an arbitrary yet linear cut-off point. A solution can be to sort all frequencies on a particular indicator from one extreme to the other, and identify clusters of scores around which frequencies gather.

These frequency clusters can further be used as natural cut-off points. This provides a considerably better method of assigning cut-offs for two reasons. First, because one avoids the problems relating to arbitrary cut-off points, and second; because one can argue that the clustering of frequencies indicates substance in itself, and that such clusters at different levels indicate natural groups of high and low scores. The specific cut-off points for each indicator and how these will translate into scores on the variables will be detailed in section 4.1 and 4.2 in the next chapter.

3.5.1 Sources of Data

The main sources of data gathered and analyzed to answer the research question differ considerably between the three independent variables. While the data for the two independent variables representing the techno-innovational perspective and the dependent variable are calculated exclusively on the basis of primary data from official government sources, the third independent variable which represents the socio-institutional perspective is more qualitative, and its data is predominantly gathered from secondary sources, such as other studies or news articles. There are some exceptions to this, such as election and party manifestos which constitute the primary sources for the political saliency indicator. Although official government statistics are considered a valid and reliable source of data, some challenges have nevertheless presented themselves in gathering and comparing statistical data on components of the energy systems of the two states.

Originally, individual state data on wind power capacity presented by the SERCs of both states was used as the primary indicator of renewable energy capacity in the two states (Maharashtra Energy Development Agency 2010, Tamil Nadu Generation and Distribution Corporation Limited 2014). When comparing this data to the official government reports which were used to calculate total generation capacity and coal dependency for the states, these figures did not add up. Specifically, in several years, reported wind energy capacity additions by both states were higher than the reported total renewable energy capacity additions in the annual reports from the central government. The reason for this discrepancy in data is unknown, but since such a clear discrepancy is observed, it figures that it is best to deal with one source for all data. Therefore, the more coarse-grained renewable energy data from the official government sources have been used as the primary source for the states' renewable capabilities, in order to secure transferability and comparability between the two states, as well as between different sources of energy in the energy mix (Government of India 2003-2015).

3.6 Summary and Implications

This chapter has attempted to provide a theoretical framework for the analysis. It first synthesized two analytical perspectives for understanding spread of renewable energy – the techno-innovational and the socio-institutional perspectives. Three separate independent variables, each represented by two indicators were then derived. The two first variables – coal dependency and alignment challenge – represent the techno-innovational perspective, while the third independent variable – political facilitation – represents the socio-innovational perspective. The chapter also detailed the methodological delimitations of the report.

4 Results and Analysis

This chapter will present the results of the comparative case study of the Indian federal states of Maharashtra and Tamil Nadu, and discuss them in light of the expectations presented in chapter three. The objective of the chapter is to give greater clarity to what explains variations in transitions to renewable energy in India, in order to provide a basis for conclusions that responds to the research question to be developed in the next and final chapter. The discussion and analysis in this chapter will be structured around four distinct phases of variation in the proposed explanatory factors since the year 2003 until today, that can be identified for both states. These phases are determined partly through the historical mapping of the Indian wind energy sector in Shukla and Sawyer (2012: 86-94) as well as supplemented by my own up-to-date observations and assessments. It is proposed here that the preconditions for successful spread of renewable energy in the two states have taken the shape of two relatively distinct *waves* over the last twelve years, where *flow* periods of high renewable energy facilitation have been followed by periods of *ebb*, in which support mechanisms recede and weaken to some degree.

The chapter is comprised of seven sections. The first one expands upon the general presentation of renewable energy in Maharashtra and Tamil Nadu from chapter two, scoring the dependent variable for the two states in a comparative manner. Section two maps the three independent variables chronologically within the two cases, with an eye to variation in their scores across cases and over time. Sections three to six discusses the values for the independent variables in regards to their influence over the dependent one within each of the four phases. Different constellations of scores on the explanatory factors are compared, and how they may have influenced renewable energy developments in both states are discussed. The degree of congruence between expectations and actual results are taken as an indicator for the explanatory power of the independent variables, especially when backed up by clear links to observed processes. Moreover, for an independent variable to be supported, expectations for both states need to match well with actual observations. If the expected patterns match with observations in one state, but not with the other, this can indicate the presence of some confounding or underlying explanatory factor that is distorting the results. Lastly, section seven summarizes the findings in the previous four sections and discusses the influence of the explanatory factors on the development of renewable energy in the two states in a general sense over the entire period of analysis.

4.1 Developments in the Dependent Variable

The general picture that emerges when comparing the two states in terms of renewable energy developments is that Maharashtra appears as “the laggard”, while Tamil Nadu traditionally is considered a frontrunner. Although Maharashtra is often portrayed in a positive light in the media for having a higher share of renewables in its energy mix than the national average, the state arguably falls short of expectations given its immense potential (Pratap et al. 2013: 6). It has however, recouped some of its lost potential in the last few years (hence the term laggard), managing impressive capacity additions that has made Maharashtra the state with the second-highest renewable energy capacity in the country, only beaten by the state to which we now turn (Government of India 2015: 14-18).

Unlike Maharashtra, Tamil Nadu was up until recently way ahead of all other Indian states in terms of renewable energy capacity, but although a quarter of all renewable electricity generation capacity in the country still comes from Tamil Nadu, the state has seen somewhat of a fall from grace over the last few years, as it has been confronted with the harsh realities of increasing power deficits and economic decline (Government of India 2015: 23).[9] This has led to quite pervasive changes in the power situation in the state, calling into doubt its continued future as a frontrunner in Indian renewable energy politics. While on a downward trend as of now however, the situation could change in the near future, depending upon whether the state realizes its ambitious solar power development goals or not (Government of Tamil Nadu 2012: 2).

To best enable an assessment of the relationship between the independent and dependent variables, specific values will be ascribed to the dependent variable in both states. This will be done by calculating the share of renewable energy in total annual additions to power generation capacity in the states, from which a percentage-score ranging from zero to a hundred percent can be derived. Further, once the score for each year in percentage-points is calculated, the percentages are translated into low, fairly low, fairly high or high scores, depending on the percentage.

4.1.1 Over-time Comparison of Developments in the Two States

Comparing the trajectories of renewable energy capacity additions in the two states over the last two decades reveals an interesting picture of how renewable energy developments differ, yet relate between Maharashtra and Tamil Nadu. Whereas Maharashtra has seen its greatest capacity additions in the renewable energy sector in the last few years, Tamil Nadu had a generally high rate of development over the span of almost ten years, from 2004 until 2013. From 2012 and out however, additions within the renewable power sector have died down, flattening the development curve of the state. The overall trend curve of renewables capacity in Tamil Nadu thus takes on somewhat of an s-shape, with clear and consecutive periods of stability, takeoff, and cooldown being visible throughout the figure. What the states share however, is a largely similar shape and form of capacity additions within renewable energy over the course of the last decade. From figure 6 it is clear that spikes and drops have occurred at largely the same time in both states, the only difference being that Tamil Nadu have generally had a higher volume of capacity additions than Maharashtra.

[9] In 2011, Tamil Nadu stood for over one-third of all installed renewable energy capacity in India (Government of India 2012).

Figure 6: Total renewable electricity generation capacity, and annual renewable electricity capacity additions in Maharashtra and Tamil Nadu in MW, 2002-2014 (Government of India 2003-2015)

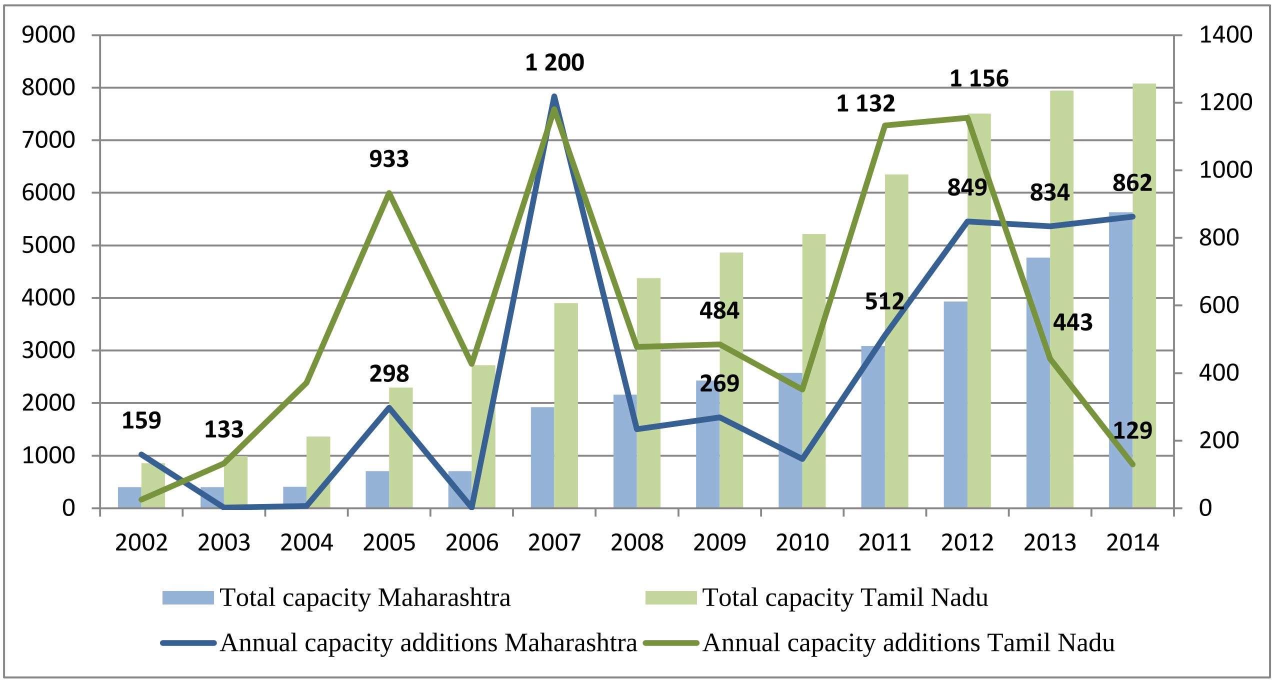
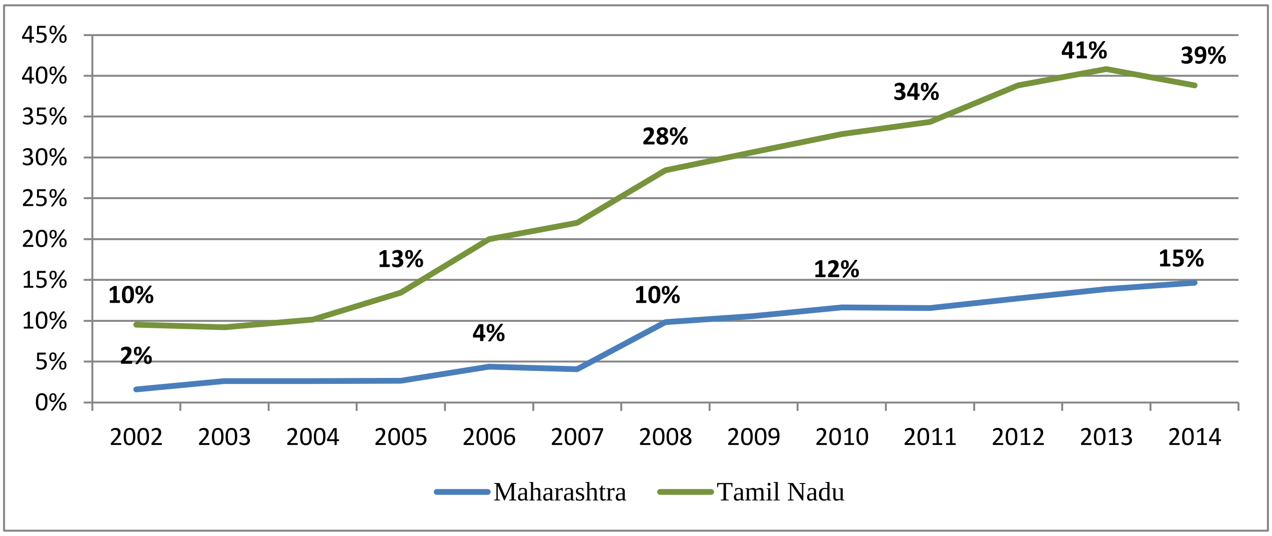


Figure 7: Share of renewables in total electricity generation capacity in Maharashtra and Tamil Nadu, 2002-2014 (Government of India 2003-2015)



The trend curve for Maharashtra seems to be somewhat similar to that of Tamil Nadu, yet it displays less stability and it peaks at a later point. Renewable energy developments in the state were slow and erratic up until 2005, after which it picked up considerably. Relatively small but steady capacity additions punctuated by some sharper spikes contributed to increasing the total installed capacity for renewable energy by a factor of eight between 2005 and 2014. In the same period, the share of renewables in the total energy mix in the state went up more than by a factor of five. While it is impossible to say anything certain regarding future trends in the state, Maharashtra might very well follow the same cooldown trend as Tamil Nadu, the only difference being a notable lag of a few years separating the developments in the two states. While Tamil Nadu reached a current peak in terms of renewable energy developments in 2011, Maharashtra does not seem to have peaked yet.

Figure 8: The share of renewables in annual additions of power generating capacity in Maharashtra, 2002-2014 (Government of India 2003-2015)

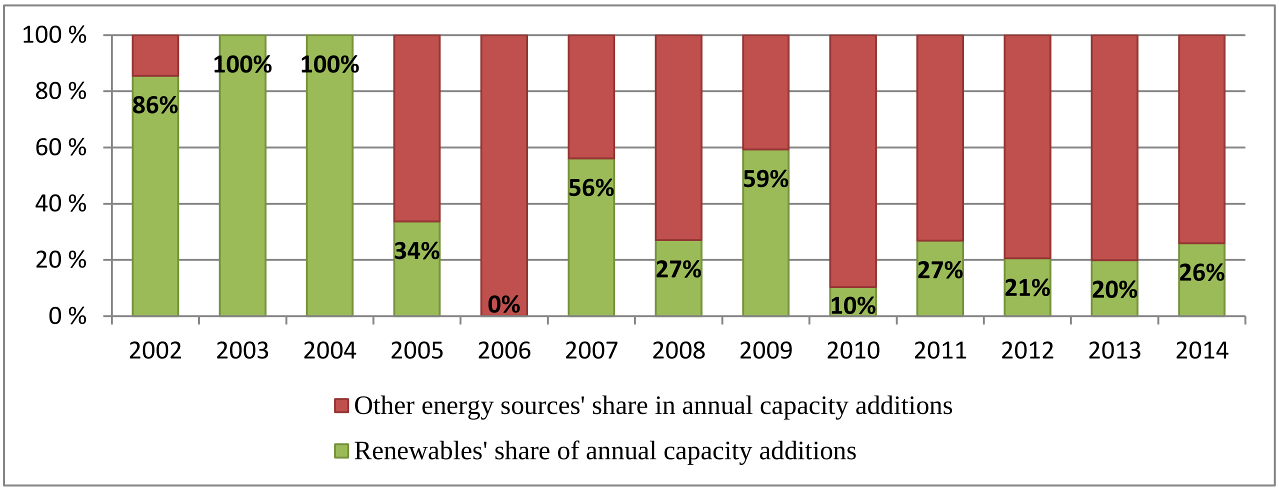
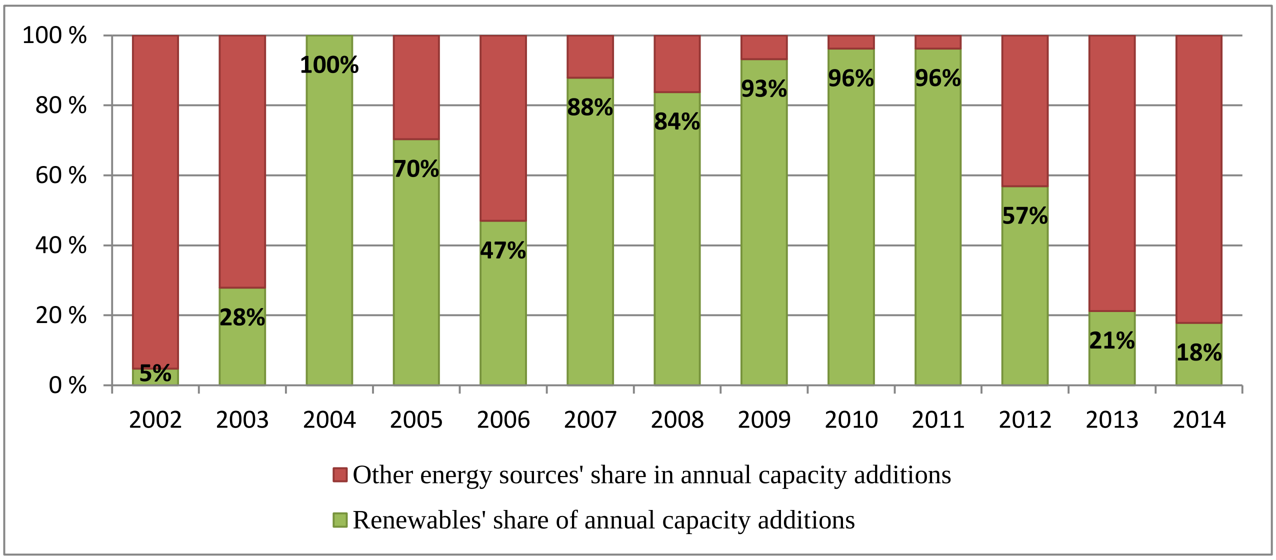


Figure 9: The share of renewables in annual additions of power generating capacity in Tamil Nadu, 2002-2014 (Government of India 2003-2015)



In order to enable determination of how the independent variables contribute to explaining the observed patterns on the dependent variable relative to each other, high or low values must be given to the development of renewable energy in both states over the course of the analyzed period. In addition, because this report aims to measure variation in the *transition* towards renewable energy in India, a relative measure of the development of renewable energy in comparison to the energy system as a whole is needed, in order to discern whether or not renewable energy is spreading or receding. Instead of deriving a combined measure based on both total annual capacity additions and the relative share of renewables in the total energy mix, a single measure that picks up both of these aspects can be constructed by calculating the relative share of renewable energy in total annual additions of power generation capacity. This indicator enables easy and intuitive observation of whether or not renewable energy is growing or shrinking relative to other energy sources in the energy mix. To further reduce the complexity of the dependent variable, the percentage scores for each of the states are divided into quartiles, subsequently signifying low, relatively low, relatively high, and high scores on the dependent variable. The indicator is illustrated in figures 8 and 9. As discussed in chapter three, to avoid validity concerns and arbitrary cut-off points, all frequencies on this indicator have been sorted from high to low, and cut-offs have been drawn between clusters of scores. Table 1 shows the cut-off points used to separate the four scores on the dependent variable, based on the frequency distribution shown in figures 8 and 9.

Table 1: The share of renewables in annual total capacity additions and the corresponding scores

Score	**Low**	**Fairly Low**	**Fairly High**	**High**
Share of total	**≤22%**	**23-44%**	**45-74%**	**≥75%**

This measure sacrifices linearity in favor of reliability. Whereas some scores now have a considerably greater range than others, it avoids arbitrary and artificial cut-off points between shares that are located very close to each other. While this measure acts as the main indicator for the dependent variable, some additional controls will be made to ensure that the indicator has substance and validity. The main concern with portraying renewable energy spread through this indicator is that it does not take into account the total amount of added generating capacity each year. Renewable energy could constitute 100% of added capacity in a year, yet if these additions only add up to a few megawatts, one can hardly speak of any spread of renewables having taken place. The indicator will therefore be supplemented by a lower threshold requirement of total capacity additions, in order to ensure that the score reflects the substance. This lower threshold is set at 100MW, to separate substantial from insubstantial capacity additions. If total renewable energy capacity additions fall below this threshold for a given year, a low score is automatically set on the dependent variable, because it becomes practically meaningless to talk of renewable energy spread when capacity additions are lower than this.

Table 2: Scores for Maharashtra and Tamil Nadu on the dependent variable, 2002-2014

	Maharashtra	**Tamil Nadu**
2002	High	Low
2003	*Low*	Fairly Low
2004	*Low*	High
2005	Fairly Low	Fairly High
2006	Low	Fairly High
2007	Fairly High	High
2008	Fairly Low	High
2009	Fairly High	High
2010	Low	High
2011	Fairly Low	High
2012	Low	Fairly High
2013	Low	Low
2014	Fairly Low	Low

Based on these two methods of scoring, table 2 shows the scores of both states on the dependent variable *renewable energy spread* from 2002 until 2014. Maharashtra displays significantly more variation on its scores than Tamil Nadu, and throughout, the latter state scores generally higher on the dependent variable than the former. For the sake of transparency, the years in which the lower threshold has come into effect and caused modification of the states' scores are shown in italics. In the two years it is activated, it modifies the scores from high to low, demonstrating the importance of including such a threshold.[10]

4.2 Developments in the Independent Variables – Four Distinct Phases

While section 4.1 provided an over-time description of the developments on the dependent variable for the two cases, this section will present how the two states score on each of the three independent variables *coal dependency*, *innovation challenge*, and *political facilitation of renewable energy*. Following the separate attribution of scores on the variables, some general patterns to their variation will be highlighted and used as a

[10] Total capacity additions in Maharashtra in 2002 and 2003 were consequently 2 and 6 megawatts.

basis for the identification of four distinct phases that will structure the rest of the analysis.

4.2.1 Coal Dependency

Coal dependency refers to how heavy the coal industry weighs down upon the energy system of the two states. A state with a high coal dependency will see more investments and money locked up into the coal industry, which creates rigidity and path dependency in the system. Additionally, coal dependent states tend to be characterized by a higher scale of installations and infrastructure. The larger and more centralized the coal industry is, the harder it becomes to replace it incrementally with renewable energy. Both of these aspects can contribute to effectively create barriers for the increased spread of all other types of energy in the energy system. Coal dependency is measured by two indicators, the share it occupies in the state's energy mix, and the scale of installations and facilitating infrastructure. To avoid confounding effects, the share indicator is lagged with one year. Scale is measured by the direct electrical output of coal power plants in the state, supplemented by an assessment of to what degree the electricity grid and other central infrastructure is constructed around these power plants.

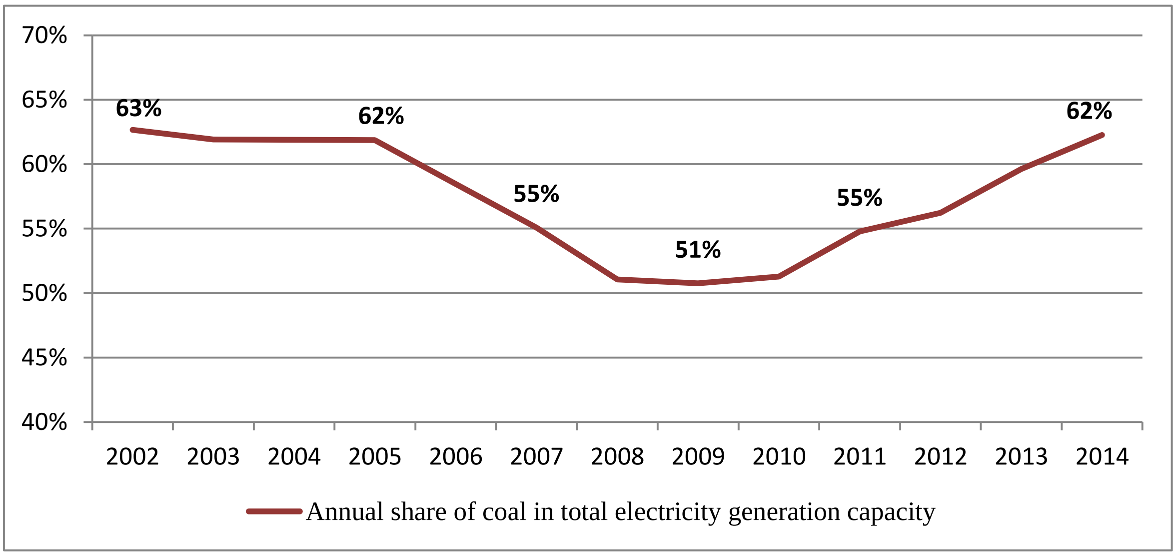
Table 3: The share and scale of coal and its corresponding scores

Score	**Low**	**High**
Share	**0-57%**	**58-100%**
Scale	**<1GW**	**>1GW**

In assigning high to low scores for the cases on this variable, the share of coal in the energy mix is weighted heavier than the scale. A high score on coal dependency indicates that both the share and scale of the coal sector is high in a state. A fairly high score indicates a high share of coal in the energy mix, but a generally low scale of coal installations and infrastructure. Conversely, a fairly low score indicates that the scale of the coal sector in the state is high, but that the share it holds is low. A low score indicates that both the share and scale of coal in the state is low. The cut-off for low and high scores on the share of coal in the energy mix and the scale of the coal sector is found through the same means as with the dependent variable, by plotting all the frequencies for both states in all years, and identifying groups of values whose clustering delimits natural scores. Table 3 shows the cut-off points used to give high and low scores for both indicators representing coal dependency.

Maharashtra has always been heavily dependent on coal in generating electricity, which is clearly illustrated through the share the resource has held in the state's installed electricity capacity throughout the last two decades. Since 2000, coal has consistently made up more than half of the total electricity generation capacity in the state, nearing two-thirds at the start and at the end of the analyzed period. One main reason for the persistent dominance of coal in Maharashtra's energy mix is the rich coal endowments in northern and eastern parts of the state, where also a majority of its coal power plants are located. The persistent high share of coal in Maharashtra's energy mix gives it a high score on this indicator half of the years during the analyzed period.

Figure 10: Annual share of coal in total electricity generation capacity in Maharashtra lagged with one year, 2002-2014 (Government of India 2003-2015)

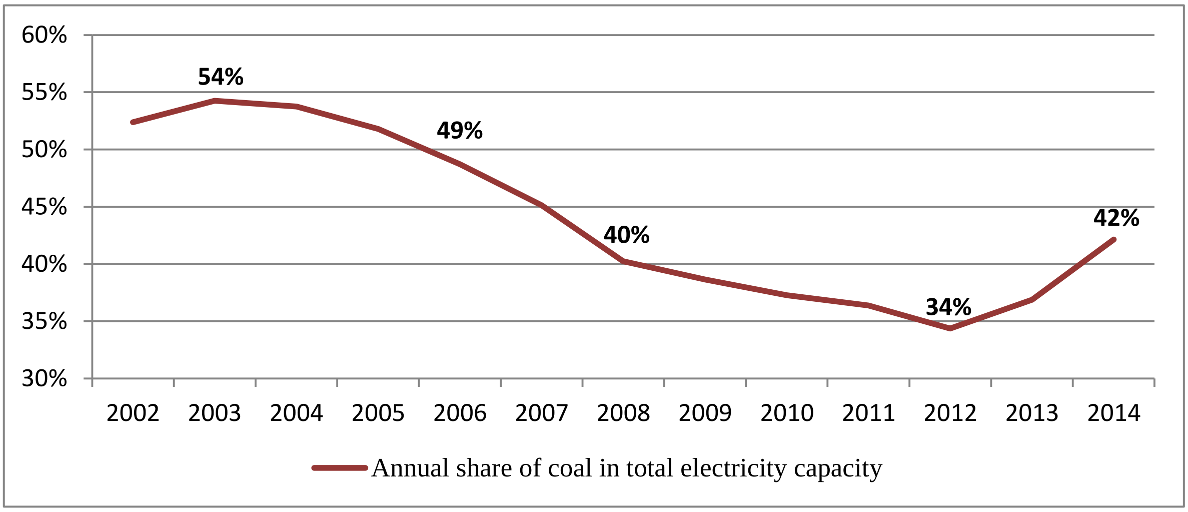


The scale of the fossil energy industry in Maharashtra has increased over the period of analysis, and its score on the indicator for scale went from low to high between 2010 and 2011. One can expect the scale of Maharashtra's coal sector to further increase in coming years. The Chandrapur Super Thermal Power Station for instance, with a generating capacity that will constitute well over 10% of the state's total electricity generation output once undergoing expansions are finished, is already the largest thermal power plant in India (Sourcewatch 2015d). A host of similar large-scale power plants exist in the state, with the consequence that close to half of the state's power comes from less than ten generating-sources (Global Energy Observatory 2015). The expansion of already existing power plants with new additional generating capabilities adds to the sheer scale of the power that is fed into the grid from singular sources. While the average generating capacity of coal-fired power plants were around 850MW in 2005, it has risen to nearly 1200MW in 2015, signifying an increased average output scale of Maharashtra's coal power plants by over 40% (Sourcewatch 2014a-f, Sourcewatch 2015a-n).

Furthermore, being the state in India with the most thermal power plants, Maharashtra has developed a large and effective supporting infrastructure of roads and railroads to facilitate and ensure good supply of coal to these plants (Maps of India 2010). The electricity grid in Maharashtra is furthermore in-large structured around the main sources of electricity generation in the state; the eastern coal power plants. Because, however, the main consumers of electricity are the cities located along the western shoreline, investments have been made into expensive high-voltage transmission lines between the largest eastern power plants and transmission hubs located closer to the coast (Maharashtra State Electricity Company 2015). These high-capacity and low transmission-loss lines are yet another indicator of the heavy weight the coal industry has in the state. A growing number of plants however, are now also being placed along the coast of the state, relying largely on imports to fuel their power generation.

Unlike Maharashtra, Tamil Nadu has seen a decreased dependency on coal over the period of analysis. However, from a low-point of 34% in 2012, the share of coal in Tamil Nadu's energy mix has increased rapidly over the last two years in an attempt to keep up with the rising energy demand of a population in the midst of rapid socioeconomic development, and coal now stands for over 42% of the total electricity generation capacity in the state (Government of India 2012, 2015). The share of coal in the energy mix of Tamil Nadu shows much greater variation than it does in Maharashtra, yet throughout the period of analysis, it also holds a considerably lower general share. Additionally, while both states see a drop in the share of coal which then again rises towards the end of the period, coal in Maharashtra has restored much more of its previous dominance than what is the case in Tamil Nadu.

Figure 11: Annual share of coal in total energy generation capacity in Tamil Nadu lagged with one year, 2002-2014 (Government of India 2003-2015)



The scale of the coal industry in Tamil Nadu has been decreasing over the analyzed period. From being relatively large-scale, the score for Tamil Nadu on the scale indicator went from high to low between 2011 and 2012. Although the state has several large-scale thermal power plants that make up a substantial share of the total generating capacity of fossil energy sources, the electricity mix of Tamil Nadu is characterized by a relatively high degree of diversification of sources, with few very large-scale electricity generation contributors (Global Energy Observatory 2015, Government of India 2015: 20). This could change in years to come however, considering the plans for substantial expansion of the coal industry (Sourcewatch 2013). Although not yet officially confirmed, the “Cheyyur Ultra Mega Power Project” for example, is a governmentally proposed thermal power plant in later stages of planning that, if constructed according to the original plans, would singularly increase the electricity generation capacity of Tamil Nadu with close to 20% (Coastal Tamil Nadu Power Limited 2012). In spite of these grand plans however, the general tendency in the state during the period of analysis has been an inclination towards smaller-scale electricity generation units and thus a more diverse, flexible and de-centralized electricity infrastructure. Unlike in Maharashtra, where the tendency has been that new power plants are of a generally higher output scale than already existing older ones, newly built coal-fired power plants in Tamil Nadu have generally been of a very small output scale, often with a generating capacity of less than 100MW. The one-third reduction in the average scale of coal-fired power plants from around 1130MW in 2004, to less than 750MW in 2014 illustrates this tendency. Table 4 shows the scores for the two states on the independent variable *coal dependency*, from 2002 to 2014.

Table 4: Scores for Maharashtra and Tamil Nadu on the coal dependency variable, 2002-2014

	Maharashtra	Tamil Nadu
2002	Fairly High	Fairly Low
2003	Fairly High	Fairly Low
2004	Fairly High	Fairly Low
2005	Fairly High	Fairly Low
2006	Fairly High	Fairly Low
2007	Low	Fairly Low
2008	Low	Fairly Low
2009	Low	Fairly Low
2010	Low	Fairly Low
2011	Fairly Low	Fairly Low
2012	Fairly Low	Low
2013	High	Low
2014	High	Low

4.2.2 Alignment Challenge

The alignment challenge variable relates to the requirement posed to renewable energy technologies of adequately supplying sufficient amounts of electricity to meet growing energy demand. Based on the claim that renewable energy lacks the maturity to be able to follow rapid demand growth and quickly reduce power deficits, it is expected that attempts at reducing power deficits will lead to a down-prioritization of renewable energy in relation to other energy sources, specifically coal. The main indicator for this variable is the power deficit in the state, which is taken to represent the severity of the challenges posed to renewable energy. The power deficit is a measure of how much greater the demand for energy is in a state in relation to the actual supply. Furthermore, to smoothen out the development curve, a rolling average of the deficit for the last three years is used rather than just the annual deficit.

An additional auxiliary component of this variable exists, which states that if renewable energy technologies have been given the opportunity to mature within a protected niche sphere, it may be better posed at meeting challenges it is faced with. In the Indian context, the main niche within which renewable energy technologies could have had the chance to mature is arguably rural electrification through decentralized renewable energy mini-grids. Since this indicator is supplementary to the power deficit indicator, it will not be used in assigning scores on the independent variable. Instead, it will be discussed in the assessment of the overarching patterns of variation in section 4.7. The rolling average power deficit will thus be the singular indicator for the challenges facing renewable energy technologies in the two states.

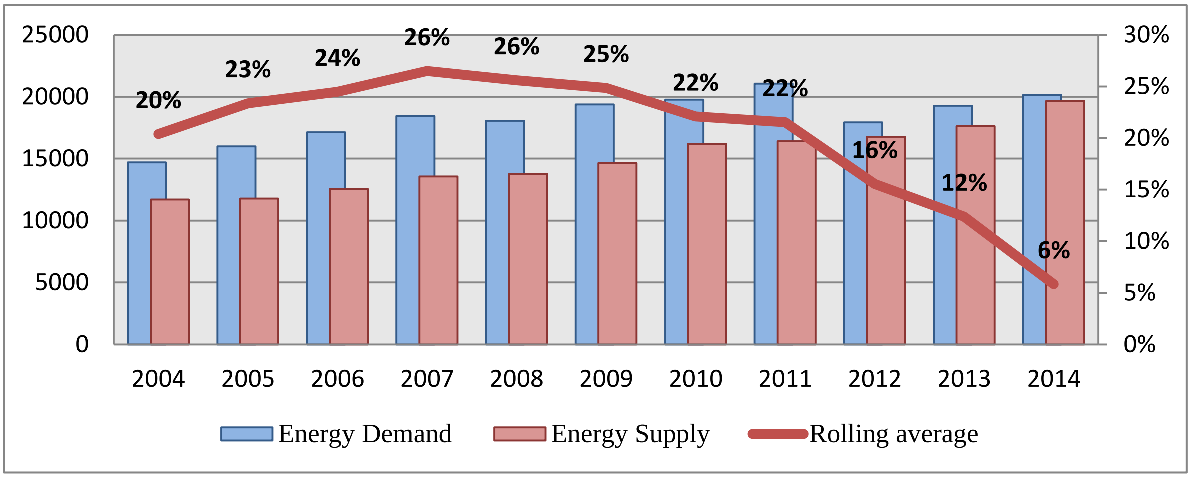
Utilizing the same method as with the other variables, cut-off points are determined based on the clustering of frequencies on the power deficit indicator. Table 5 shows the cut-off points used to assign scores from high to low. As with the dependent variable, the division of the categories sacrifices linearity for reliability, with the consequence that some scores have a much higher percentage-range than others. It is nonetheless argued that these categories contain high validity and intuitively reflect the severity of each power deficit segment.

Maharashtra has been plagued by generally high power deficits over the last decade, but has managed to almost turn it around over the last three years. Figure 12 shows the developments in peak demand and supply, as well as the rolling average deficit of energy supply in Maharashtra over the last ten years. As applies for India in general, Maharashtra has seen a great surge in electricity demand over the last ten years. The state noted a particularly steep demand increase between 2004 and 2011 – over six gigawatts – and while a sharp drop in total demand can be noted after 2011, this has done little to stymie its actual growth.

Table 5: Power deficit magnitudes and its corresponding scores

Score	**High**	**Fairly High**	**Fairly Low**	**Low**
Power deficit	**≥20%**	**19-12%**	**11-8%**	**≤7%**

Figure 12: Energy demand and supply in MW, and rolling average power deficit percentage in Maharashtra, 2004-2014 (Government of India 2005-2015)



While this rapid growth in electricity demand is a good indication of the success the state has had in terms of achieving socio-economic developments, it has also put strain on their ability supply sufficient amounts of electricity to its population. From 2004 and up until 2011, the deficit in energy supply in the state was without exception well over 20%, which in other words means that the population is consuming over 20% more energy than the state can actually deliver, leading to frequent blackouts and brownouts. In recent years, however, the state has managed to notably reduce their supply deficit, which can mainly be attributed to two factors: power-grid upgrades and infrastructure modernizations, and a sharp drop in electricity demand of nearly four gigawatts in 2012 (IDFC 2009: 12).[11] The reduced transmission and distribution losses that resulted from upgrades and modernization of the electricity infrastructure in the state has enabled Maharashtra to transfer more of its installed capacity to actual energy supply, making the impressive capacity additions achieved since 2010 count towards reducing a previously rampant power supply deficit. Between 2010 and 2015, peak supply increased by 2% more than demand, and if the trend continues, Maharashtra's power deficit could be turned into a surplus within the next few years.

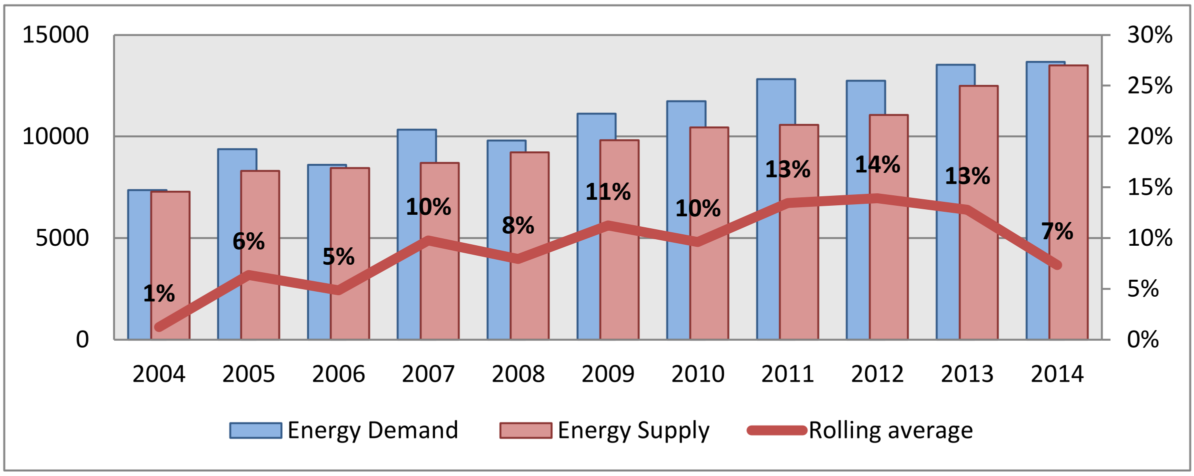
Maharashtra has frequently been characterized as having great potential for decentralized power generation through renewable energy mini-grids; yet, little has been done in terms of supplying electricity to rural areas through these means (Nouni et. al 2008, Deshmukh 2009). Instead, the preferred approach in Maharashtra and many other Indian states has been to try and ensure full electrification through grid-expansions, which can

[11] The most plausible explanation behind this drop seems to be the 40% electricity tariff hike proposed by the state government towards the end of 2011 (DNA 2011, Prasad 2012).

be inadequate in terms of power supply, as well as suboptimal in terms of cost-effectiveness (Deshmukh 2009: 27). Although Maharashtra is now largely electrified – with the exception of a few dozen villages too remote for central grid-access – power outages and brown-outs are more frequent in Maharashtra than it is in Tamil Nadu, with an effective supply-period of less than 10 hours a day in many of the more remote villages (The World Bank 2011, Central Electricity Authority 2015).

Like in Maharashtra, the power deficit in Tamil Nadu has been high throughout most of the analyzed period, yet not *as* high as in Maharashtra. It furthermore demonstrates much higher annual variations than deficits in Maharashtra, and developments in the state's deficit are somewhat more unclear. Despite the fluctuations however, one can none-theless delineate some patters in the development of Tamil Nadu's power deficit. These developments are shown in figure 13, which indicates that the ability of the state to provide sufficient amounts of electricity to its population has jumped up and down seemingly arbitrarily for a large part of the last ten years, ranging from a high of over 14% in 2012 to a low of just above 1% in 2004. Although the energy deficit in Tamil Nadu displays great variation between years, an upward trend can be observed between 2004 and 2012. The roller-coaster tendency dissipates after 2012 however, after which each following year sees a decrease in deficit from the year prior. The developments in electricity supply and demand in Tamil Nadu over the last ten years can thus be split into two separate periods of a highly different character.

Figure 13: Energy demand and supply in MW, and power deficit percentage in Tamil Nadu, 2004-2014 (Government of India 2005-2015)



The high variation in the state's deficit pre-2012 can in large be traced back to the great variation one observes in peak demand, and the inability of the state to follow up these demand-spikes with increased supply. While actual electricity supply increased fairly evenly from 2005 until 2011, peak demand saw somewhat of a biannual variation-pattern where high spikes were followed by clear drops. From 2011 and until 2015 on the other hand, electricity supply in Tamil Nadu increased by nearly four gigawatts, while demand only increased by around half of this, leading to the impressive deficit reduction observed in the figure. The key point to take out of the last decade's developments in electricity supply and demand in Tamil Nadu is thus that whereas the state saw a steady but slow increase in supply capabilities for the start of the period – leading to supply-deficit spikes in years where demand was high – it has managed to abate this uncertainty as of late by achieving a sharp increase in supply. However, as of yet, no substantial explanation for great variation in demand has been found, and it will be important to take this variation into consideration when discussing the constituting effects of energy supply deficit on decisions pertaining to renewable energy investments.

Tamil Nadu has had success with decentralized generation instead of grid-expansion, and as a result, Tamil Nadu was one of the first Indian states to ensure full electrification (Rural Electrification Corporation Limited 2005). Now, decentralized generation projects in Tamil Nadu are frequently used as examples for the successful implementation of such projects in India (Buragohain 2010: 90, Awasthi and Deepika 2013: 164-165). Studies and reports have further indicated that decentralized mini-grids have given more stability in supply than often frail extensions from the central grid (Nouni et. al 2008, Iyer et. al 2010: 186-187, The World Bank 2011, Kulkarni and Anil 2014: 388).

Table 6: Scores for Maharashtra and Tamil Nadu on the alignment challenge variable, 2004-2014

	Maharashtra	**Tamil Nadu**
2004	High	Low
2005	High	Low
2006	High	Low
2007	High	Fairly Low
2008	High	Fairly Low
2009	High	Fairly Low
2010	High	Fairly Low
2011	High	Fairly High
2012	Fairly High	Fairly High
2013	Fairly High	Fairly High
2014	Low	Low

Table 6 shows the scores of the two states on the independent variable *alignment challenge*. The available data for this variable only stretches back to 2004, but this is arguably of little importance, since the focus on – and thus the impact of – power deficits were not particularly prominent previous to 2004. The main premise of the alignment challenge variable – that a conscious decision is made to prioritize other energy sources over that of renewables in cases of high power deficits – necessitates political focus on deficits in order for them to have any effect on renewable energy spread. Lack of focus is thus argued to lead to lack of impact.

4.2.3 Political Facilitation of Renewable Energy

The political facilitation of renewable energy variable relates to the political focus towards renewable energy at the state level, as well as the general strength and momentum of policies aimed at supporting and facilitating renewable energy spread. The claim is that a higher level of political focus and facilitation will greatly help the spread of renewable energy in the states. This variable has two indicators: the political saliency of renewable energy at the state level, and the strength of policy instruments. The first indicator is related to the extent to which renewable energy receives focus and is ascribed importance by the dominant political parties in the two states. This is done through qualitative assessments of party manifestos and news sources. The second indicator measures whether policy instruments aimed at facilitating renewable energy exists, and if so; to what degree these support policies provide clear and direct incentives for renewable energy investments. The direct measure of the second indicator is thus whether support policies are initiated and adopted, and to what degree these policies produce actual instruments and incentives, such as tariffs, tax reliefs or obligations.

The weighting of these two indicators favor the latter one and it is claimed that high or low scores on the saliency indicator will work more to modify the efficiency of the policy instruments indicator. A high score on the political facilitation variable thus signifies that saliency and support for renewable energy is high. If good policy instruments are present, yet the political saliency of renewable energy on the state level is low, a fairly high score is given. If renewable energy has high political saliency, but support mechanisms are absent, a fairly low score is given. Lastly, if the state scores low on both indicators, a low score is given. These two indicators differ from the indicators for the two previous variables in that they rely more on qualitative assessment rather than just being calculated on the basis of data. As such, high or low scores are also ascribed more qualitatively. Nonetheless, it is aspired that a clear and transparent division between high and low scores on the two indicators should be achieved. The cut-off points between high and low scores for both indicators are therefore set at the absence or presence of both saliency of support policies and policy instruments. Because of the strict dichotomous presence-absence nature of both indicators, no table is needed to graphically display the cut-off points.

The political focus on the need for facilitation of renewable energy spread in Maharashtra has been limited at best. Before the State Assembly elections in 2014, environmental concerns were given low priority by both of the two political coalitions contesting for power in the state (Patil 2014). While political promises prior to the elections were criticized for their general vagueness, climate and environment were noted as particularly low on the agenda, with no major policy suggestions being fronted. The BJP, which went on to win the election by an unprecedented margin, made only a vague promise of introducing policies to encourage power generation using non-conventional energy sources, and furthermore explicitly stated that providing enough energy was their top priority (BJP 2014a: 6). Moreover, their “Vision for 2020”, pertaining to the long-term plans of the party does not in any way update or add to the clarity of the election promises, simply repeating the exact same phrasing regarding renewable energy used in the election manifesto (BJP 2014b). The INC on the other hand were no different, and in their 2014-2019 national party manifesto, the only mention of renewable energy sources is that solar and hydro energy will receive a “thrust” – hardly a specific promise (Indian National Congress 2014: 38). While no state manifesto for INC has been found online, news sources report a heavy focus on ad-hoc promises towards specific parts of the population, and no climate or renewable energy focus (Press Trust of India 2014, Shinde 2014, ZeeNews 2014).

The lack of clout in promises regarding renewable energy from any of the political parties prior to the 2014 state elections is highly illustrative for the focus on renewable energy for the dominant parties in Maharashtra for the entire period of analysis. The INC party manifesto for 2009 mentions that renewables will be one of many contributors to a great lift in power generating capacity, without ascribing any detailed role to the energy source (Indian National Congress 2009: 19). Furthermore, a comparative journalistic assessment of INC election manifestos between 2004 and 2014 makes no mention of renewable energy sources at all (India Tomorrow 2014). The BJP moreover has generally tended to give much more attention to the potential of nuclear energy, and not once in their 2004 vision document are renewables mentioned (BJP 2004). In their 2009 party manifesto, the role of wind and solar energy are mentioned in one sentence, yet without any specification of how much or when investments will aid its spread (BJP 2009). The score on the political saliency indicator is therefore low for Maharashtra throughout the entire period.

Although the explicit focus on renewables has been poor in Maharashtra over the entire period, promises do not necessarily dictate action, and actual policies could still have been enacted as instruments to help facilitate renewable energy spread, in spite of negligible attention prior to elections. The main authority responsible for securing development of renewable energy in Maharashtra has since the adoption of the Electricity Act 2003 been the Maharashtra Electricity Regulatory Commission (MERC), which sprung out of the requirement in the Electricity act that State Electricity Regulatory Commissions were to be formed in each state (SERCs). Prior to 2003, no coordinated or unitary state agency was tasked with ensuring the promotion of renewable energy. The Electricity Act of 2003 thus marks the first important policy instrument for facilitating renewable energy in the state (Deo 2008: 18). This also gives Maharashtra a fairly high score on the political facilitation variable.

The second significant national legislation that may have impacted the policy climate for renewable energy investments in the state is The National Tariff Policy of 2006, which functioned largely as an update or revision of the 2003 Electricity Act. The National Tariff Policy was adopted after many of the policy instruments promoted in the Electricity Act had lost effectiveness due to a lack of formal requirements and compliance mechanisms. Its main feature was the setting of a deadline for the SERCs to actually implement mechanisms and measures for supporting the spread of renewable energy. The result of this deadline was that Maharashtra had formulated its RPO goals already by the end of 2006, as the first state in the country (Schmid 2012: 319, and Krishna et al. 2015: 45). Due to political insecurities however, the RPOs were not formally implemented before 2009. In 2005 and 2006, Maharashtra scores low on the political facilitation indicator, but this picks up again by the start of 2007, where it yet again scores fairly high.

A generally high presence of policy instruments for facilitating renewable energy spread are noted following the 2009 State Assembly elections in Maharashtra, which reaffirmed the continuance of support mechanisms for renewables in the state. This presence lasts up until the end of 2012, where the RPO achievements of the states were assessed for the first time. After 2012, a notable lack of explicit and direct instruments are noted in the state, and while several policies aimed at securing continued compliance and focus on renewables in the state have been adopted, no actual instruments have been produced as a result of the policies. Maharashtra thus scores fairly high on the political facilitation variable up until 2012 and low in 2013 and 2014.

The two dominant political parties in Tamil Nadu, AIADMK and DMK have both traditionally focused on making Tamil Nadu a renewable energy frontrunner. Following years of increasing power deficits however, what really set the two political parties apart in the run up to the 2011 State Assembly elections was the issue of how to reduce these rampant deficits, and the future role of renewable energy in Tamil Nadu in light of this overarching challenge. Whereas the DMK emphasized the importance of a continued focus on renewable energy, the AIADMK stressed the reduction of the power deficit by any means possible, a tactic which according to observers helped them win election in the end (The D.M.K. Manifesto 2011: 13, Subramanian 2012). While explicit promises of over five gigawatts of electricity additions were given by AIADMK, the role of renewable energy in these additions or in the reduction of the state's power deficit was not mentioned at all (Panneerselvam 2011: 41-43, The Hindu 2011). Furthermore, in their 2014 national election manifesto, no mention of the environment, climate, or any form of renewable energy is mentioned at all, while the necessity of promoting industrial growth and development is mentioned several times (AIADMK 2014). While it is too early to speculate on the future political trajectory of the AIADMK, this may mark a shift in the party's focus away from renewables. The score for Tamil Nadu on the political saliency indicator is therefore high up until 2011, and low from 2012 and out.

Like in Maharashtra, the 2003 Electricity Act heralded the start of an overarching organization of renewable energy facilitation in the state through the Tamil Nadu Electricity Regulation Commission (TNERC) (Deo 2008). While wind energy developments in the state had been going on quite successfully for close to two decades already by the time this act was passed, the adoption of the Electricity Act marks a watershed in renewable energy policies by helping to ensure that a coordinated and organized effort could be made at promoting wind energy to private investors in the state (Bennecke 2011: 32). Tamil Nadu thus scores fairly low until 2003, when its score increases to high.

These heavy policy measures did not come without cost however, and TNERC accumulated a massive deficit between 2000 and 2005. Additionally, the rapid rate of investments and construction of renewable energy facilities put strain on the state's grid infrastructure, which there were given no incentives to invest in. This lead to difficulties in effectively distributing the supply of power that was produced, and both a popular and legislative backlash resulted (Krishna et al. 2015: 37). This forced a change of priority in TNERCs facilitation policies, and by 2006, additional incentives were set up for private infrastructure investments. 2007 further marked the end of Tamil Nadu's 10th Five-Year Plan, and the state subsequently modified and updated its support policies to meet new challenges (Krishna et al. 2015: 34). 2005 and 2006 mark low years for renewable energy policy instruments in Tamil Nadu, and the state scores fairly low in these two years. From 2007 however, the state regains its high score, which it retains until 2011.

Table 7: Scores for Maharashtra and Tamil Nadu on the political facilitation variable, 2002-2014

	Maharashtra	Tamil Nadu
2002	Low	Fairly Low
2003	Fairly High	High
2004	Fairly High	High
2005	Low	Fairly Low
2006	Low	Fairly Low
2007	Fairly High	High
2008	Fairly High	High
2009	Fairly High	High
2010	Fairly High	High
2011	Fairly High	High
2012	Fairly High	Low
2013	Low	Low
2014	Low	Low

Recent financial downturns coupled with high power deficits in the state however, have made it difficult for Tamil Nadu to continue and promote incentives for renewable energy spread, and since 2012, there has been a marked absence of support policies for renewable energy in the state (Kumar 2014, Siraj 2015). Since the evaluation of the states' RPO achievements in 2012, no specific renewable energy support policies have been adopted or implemented in Tamil Nadu, giving the state a low score on the political facilitation variable between 2012 and 2014. The state drops down to the lowest score since the political saliency of renewable energy also fades after the 2011 State Assembly elections. The annual scores for the two states on the *political facilitation* variable are detailed in table 7.

Table 8 summarizes and presents the scores for Maharashtra and Tamil Nadu on all three independent variables. Thick lines demonstrate the cut-off points for the different phases that are identified and will be detailed in the next sub-section.

Table 8: Scores for Maharashtra and Tamil Nadu on all of the independent variables, 2002-2014

	Maharashtra			**Tamil Nadu**		
	Coal dependence	**Alignment Challenge**	**Political facilitation**	**Coal dependence**	**Alignment Challenge**	**Political facilitation**
2002	Fairly High	High	Low	Fairly Low	Low	Fairly Low
2003	Fairly High	High	Fairly High	Fairly Low	Low	High
2004	Fairly High	High	Fairly High	Fairly Low	Low	High
2005	Fairly High	High	Low	Fairly Low	Fairly Low	Fairly Low
2006	Fairly High	High	Low	Fairly Low	Fairly Low	Fairly Low
2007	Low	High	Fairly High	Fairly Low	Fairly Low	High
2008	Low	High	Fairly High	Fairly Low	Fairly Low	High
2009	Low	High	Fairly High	Fairly Low	Fairly Low	High
2010	Low	High	Fairly High	Fairly Low	Fairly Low	High
2011	Fairly Low	High	Fairly High	Fairly Low	Fairly High	High
2012	Fairly Low	Fairly High	Fairly High	Low	Fairly High	Low
2013	High	Fairly High	Low	Low	Fairly High	Low
2014	High	Low	Low	Low	Low	Low

4.2.4 Four Main Phases of Variation in the Independent Variables

Some crucial shifts and points of variation can be identified over the period of analysis, roughly applying to both states. Since 2003, with the introduction of the Electricity Act, which was a major watershed in India's legislative approach towards renewable energy facilitation, four distinct phases can be outlined, that mark four separate periods of renewable energy legislation in the two states. Although data for pre-2003 developments exist to some extent, the quality and availability of information decreases considerably before this point in time, and therefore, the analysis will be limited to after 2003. The notion that wind energy developments in India have gone through separate phases is not new however, and it can be relevant to briefly reiterate an important scholarly contribution to this thinking before the phases employed here are specified.

In the IRENA report "30 Years of Policies for Wind Energy", the authors outline four main phases that characterize wind energy developments in India between 1981 and 2012 (Shukla and Sawyer 2012). These phases are in large based on major shifts in policy in relation to wind energy facilitation. The first one, termed "Technology demonstration and R&D", lasted from 1981 until 1990, and was characterized by the first careful infant steps of the wind energy industry in India, focusing largely on pioneer and demonstration projects, as the name implies. It was in this first phase that the foundation for the private initiative regarding wind energy investments that has come to dominate most developments within the technology was established (Shukla and Sawyer 2012: 82-84). The second phase, termed "Economic liberalization and institutionalism" ranged from 1991 until 2000, and marks a period of time in which the Indian economy generally opened up to market forces to a significant degree. This enabled the influx of private actors on to the energy and electricity arena, within all energy industries, from coal to wind (Shukla and Sawyer 2012: 84-85).

The third phase marks the start of the period of analysis in this report. Termed "Passing of the Electricity Act, provision of tariffs by the states", it stretches from 2000 until 2008, and marks a considerable increase in attention and political focus towards renewable energy in general and wind energy specifically in India. Together with this increased focus, incentives for renewable investments began to appear, such as tariffs and tax exemptions, in order to try and facilitate the increased spread of wind energy (Shukla and Sawyer 2012: 85-86). The fourth and last phase identified in the IRENA report is termed "New incentives and reinforcement of tariff scheme" and stretches from 2009 until 2012 – notably ending in the same year many other analyses of renewable energy in India end; right before a marked drop in initiative occurs in the two states examined here. The fourth phase is, as the name implies, characterized by further development and expansion of incentives initiated in the preceding phase. This period marks, among other things, the initiation of the RPOs, as well as the establishment of the State Electricity Regulatory

Commissions, tasked with carrying out and implementing the RPOs in each state (Shukla and Sawyer 2012: 86-87).

These four phases provide valuable insights to important political processes that have shaped wind energy developments in India for the last thirty-five years, and they largely confirm and coincide with the distinct periods uncovered through the empirical presentation throughout this section. This report expands upon this division of phases, and identifies four distinct phases of wind energy facilitation between 2003 and 2014. While these four phases largely coincide with the two phases identified in the IRENA report for this period, this report argues that a division into four distinct phases is representative of actual developments, as renewable energy facilitation policies in the two states have shown clear variation within each of the two phases in the IRENA report.

The first phase in this report is termed “establishment and consolidation of renewable energy support policies”, and stretches from 2003 to 2004 in both states. This marks a period where many new support policies for renewable energy were formed and initiated, and the investment climate for renewable energy was good. This period is followed by receding renewable energy facilitation in both states, stretching from 2005 to 2006 in both Maharashtra and Tamil Nadu. This phase is fittingly termed “political uncertainty and renewable energy backlash”, as this phase marks a time period of general uncertainty regarding the future investment climate for renewable energy, due to state elections and challenges relating to already implemented renewable energy policies. The third phase is labelled “reconfiguration and reinforcement of renewable energy facilitation”, starting in 2007 in both states and it stretches to 2012 in Maharashtra, and to 2011 in Tamil Nadu. This period saw a rejuvenated investment climate for renewable energy with new and improved facilitation policies. This phase is also followed by a period of ebb, termed “power deficit reductions take precedence”, where the dire state of power deficits in both Maharashtra and Tamil forced the state governments’ to take action to reduce the rampant deficits, necessarily taking focus away from facilitation of continued renewable energy growth. This period started in 2013 in Maharashtra and in 2012 in Tamil Nadu, and is characterized as still ongoing in both states. Table 9 summarizes the delimitation of the four phases in each of the two states.

Table 9: Delimitation of the four separate phases for each of the two states, 2003-2014

	First phase	Second phase	Third phase	Fourth phase
Maharashtra	2003-2004	2005-2006	2007-2012	2013-now
Tamil Nadu	2003-2004	2005-2006	2007-2011	2012-now

The analysis sections will assess the relative impact of each of three independent variables on renewable energy spread in the two states in comparison to each other over time. The discussion will be structured along the four separate phases identified above, wherein different constellations and combinations of values on the independent variables are observed, which is aimed at giving greater clarity to how they lead to different outcomes on the dependent variable. Holding the proposed explanatory factors up against each other throughout these phases where they all experience different variation can contribute to shed light on their relative explanatory strength, and additionally give a clearer image of how these factors' combined influence shapes the face of renewable energy in India. Following the sections on each of the four phases, they are summarized in section 4.7, and a general discussion of the relationship between the variables concludes this chapter.

4.3 Establishment and Consolidation of Renewables Support, 2003 and 2004

While the first phase starts off in 2003, all the variables are given scores that date back to 2002. This is to enable observation of variation prior to the start of the first phase, which can be valuable for framing the importance of the developments that kicked off this phase. In this way, one more point of variation can be observed – and an important one at that: the variation from pre-legislation to post-legislation in an industrial sector that was previously largely ad-hoc regulated. Although the two states were at different starting points prior to its passing, the Electricity Act of 2003 marked the establishment of a formal and explicit framework for how renewable energy facilitation was to be governed and implemented in both states. The passing of the Electricity Act thus constitutes the only common variation that is introduced to the states in this phase, and the expectation is that an increase in the spread of renewables should follow as the result of the passing of this act. We turn first, however, towards the two other proposed explanatory factors, in order to see whether they provide alternative explanations for the developments in the dependent variable in the first phase.

At the outset of this analysis, the two states share quite a high dependency towards coal, but differ in terms of the other two variables. Maharashtra had at this point already accumulated a substantial power supply deficit; while conversely, the deficit in Tamil Nadu was only marginal, and no concerns were raised in this period regarding a lack of power supply in the state. The deficit variable remains wholly static throughout the first phase for both states. Regarding coal, its high share in Maharashtra's energy mix remains largely fixed. The static nature of coal leads to no other specific expectations than that it maintains a general dampening impact on the effectiveness of efforts to increase the spread of renewable energy in the state. It further leads to the contention that no concrete efforts were being made at addressing the power deficits in the state, which can further indicate that attention was not being given to it politically. Its effect on the dependent variable is therefore also expected to be negligible.

Coal occupies a larger share of the energy mix in Tamil Nadu in 2003 than it does at any other point in the analyzed period. Despite its relatively high share in the total generation capacity however, Tamil Nadu has a fairly diverse energy mix at this point, and there are no indications of path dependencies creating barriers for other energy sources. Although the scale of coal installations in Tamil Nadu is high during this phase, the state had been facilitating the spread of wind energy since the start of the 1980s, and as a result, electricity infra-structure in the state is not structured to particularly facilitate coal. Moreover, following the passing of the Electricity Act in 2003, a notable downturn of the share of coal in total capacity in the state is clearly visible. 2004 further marks the first year in which renewables occupy a larger share of annual capacity additions than coal, which testaments to its decreasing importance in the state. The decreasing importance of coal in the state after 2003 corresponds with the increasing spread of renewables around the same period, but given its concurrence with an important policy watershed, investigation of the particular processes that lead to the increased developments within the dependent variable is needed.

This leads to the political facilitation variable. Before the passing of the 2003 Electricity Act, Tamil Nadu had an already favorable investment climate for renewable energy. Still, the passing of the act marked the establishment of a formal and explicit framework for how renewable energy facilitation was to be governed and implemented. This organized effort was exactly what the state needed at this point in time, because while Tamil Nadu previously had been very successful in securing private renewable energy investments by promoting it as a means for different industries to become self-sufficient and cost-effective, this rhetoric had started to lose its power around 2002, as the Bangladeshi manufacturing sector started to rival that of India.

With the passing of the Electricity Act however, TNERC was granted permission to set more favorable tariffs for investing in renewables, and the state managed to maintain the high level of private investments into the renewables sector (Krishna et al. 2015: 34-37). This can be seen to have had an observable effect on the spread of renewable energy in the state, and the share of renewables in total added capacity goes from five to one hundred percent between 2002 and 2004. Observed variation both in political facilitation as well as in coal dependency has led to the expected results on the dependent variable. Establishing how the two explanatory factors relate, and through this, deciding on their relative importance in comparison to the other thus becomes paramount, if definitive conclusions are to be drawn regarding their impact on the spread of renewable energy.

Two critical factors can help shed light on the competing claims of the independent variables; one regarding the manner of the process; and one regarding the timing of it. First, no direct link between the decrease in coal dependency and the increase in renewable energy spread can be found outside their concurrent occurrence in time and place. In terms of political facilitation on the other hand, there is a direct and clear link between the increased facilitation of renewable energy through favorable tariffs and the spread of renewable energy. Second, the increase in the value on the political facilitation indicator takes place before the decrease in the coal dependency indicator. In other words, the relative importance of coal in Tamil Nadu's energy sector only waned *after* the passing of the Electricity Act.

These two factors can be argued to give the political facilitation indicator both greater causal depth and higher causal priority than the coal dependency factor. It is entirely conceivable that the increase in renewable energy spread would have come about even without the drop in coal dependency, due to the direct nature of the changes brought about by the Electricity Act. Additionally, it is entirely conceivable that the drop in coal dependency was in fact caused, and thus came about, as a consequence of the passing of the Electricity Act, which in that case would make the link between coal and renewable energy entirely spurious in this instance. This paints a plausible and logical picture of coal energy being down-prioritized in favor of renewable energy in the wake of legislation specifically aimed at increasing the spread of renewables in the state.

In Maharashtra, no competing claims to the explanation of variations in the dependent variable are assessed, as only one of the independent variables show variation during the first phase. Unlike in Tamil Nadu, the facilitation of renewable energy in Maharashtra prior to 2003 was – while not completely absent – unstructured and poorly governed. The consolidation of energy politics that came with the passing of the Electricity Act in 2003 lead to the increase of tariffs for renewable energy investments by close to 50%, a clear increase in policy instruments from the year before (Krishna et al. 2015: 43). This can be seen to have had an observable effect on the dependent variable and while the share of renewable energy in annually added capacity in the state before 2003 was already high, it climbed to one hundred percent following the passing of the Electricity Act. These high shares however, have no substance, because they can be traced back to a near absence of capacity additions in other energy sectors. Looking at added renewable capacity in 2003 and 2004 confirms this lack of substance, as they total less than ten megawatts of added generation capacity. The consequence of this lack of substance is that Maharashtra's score on the dependent variable decreases after the passing of the Electricity Act in 2003.

So whereas compelling indications are found for the importance of political facilitation relative to other explanations in Tamil Nadu, the evidence is less forceful in Maharashtra, because power generation capacity was at a near stand-still in the state in the years following the passing of the Electricity Act. The low political saliency of renewable energy in the state during this phase may be a contributor to the lack of force behind the policy instruments initiated in the state during this period, and so may the generally high dependency of coal in the state. In Tamil Nadu on the other hand, where the saliency of renewables was high and coal dependency lower, the upswing in renewable energy spread noted during the phase can largely be traced to the emergence of facilitating policies and the setting of tariffs, which gave greater transparency to and reduced risk for private actors investing in renewables in the state. While investors previously had to rely on ad-hoc bilateral agreements vulnerable to sudden policy shifts, the Electricity Act reaffirmed common investment conditions, providing greater security and stability.

Overall, the first phase does not exclude the influence of any of the proposed explanatory factors, although the alignment challenge variable is largely absent. Both coal dependency and the political saliency of renewable energy may have contributed to modify the effectiveness of policy instruments for facilitating renewable energy spread, yet one cannot conclude on their relative importance or direct influence on the matter. A central characteristic of renewable energy investments observed in the whole of India may contribute to making the political facilitation variable more important than first expected. Throughout the entire period of analysis, investments and developments into renewable energy have come near exclusively from private actors in both states. Thus, securing a favorable investment climate is arguably more important than it would have been if the main stakeholders in renewable developments were the state or other non-private actors. The notion that renewable energy spread is highly dependent on a favorable investment climate due to the predominance of private stakeholders in its developments will be further tested in the next phase, which delineates a period of facilitation ebb. If political facilitation is as important as argued above, it should not only lead to greater renewable energy spread in years when it is high, but also to lower renewable energy spread in years when it is low.

4.4 Political Uncertainty and Renewable Energy Backlash, 2005 and 2006

The second phase marks a period of distinct recession in renewable energy facilitation policies that takes place in both states. While this ebb of support policies occurs in both states at around the same time, the actual mechanisms behind the recession are nonetheless quite different and separate. Maharashtra saw a recession of facilitation following corruption allegations and uncertainties regarding the future of political power in the state, which subsequently lead to concerns surrounding how new leadership would approach funding of renewable energy support. Attempts at restarting fading renewable energy investment incentives were made in Maharashtra in 2006 with the passing of the National Tariff Policy, but the actual implementation of incentives such as the RPOs were hindered by two major setbacks that may very well have hampered the general implementation of renewable energy capacity additions in the state.

The first setback was an issue with the state having to reimburse and pay off debts owed to both external and internal fossil energy contractors. This lowered the ability of the MERC to continue providing good tariffs to wind energy in the state, and the delay of several tariff payments to private investors soured the investment climate some (The Economic Times 2006, and Press Trust of India 2007). Second, an investigative report done by the NGO Centre for Science and Environment uncovered several instances of corruption in regards to the development of wind installations in Maharashtra, as well as drawing a main conclusion that wind installations in the state were largely ineffective, providing low generation output relative to investment costs. This may have contributed to negatively influence popular perception of wind power in Maharashtra, leading up to the next drawback.

Tamil Nadu on the other hand seemed to have gotten ahead of itself in terms of rapidly pushing for renewable energy spread, which lead to economic deficits and low transmission and distribution effectiveness, as detailed in section 4.2. The ebb of political incentives in both states is followed by a clear and noticeable drop in renewable energy spread in Tamil Nadu while renewable spread remains low in Maharashtra. In the phase's first year the share of renewables in annual added power capacity drops down over two-thirds in Maharashtra, but due to the lacking substance of capacity additions in the previous period, Maharashtra's score goes from low to fairly low in the first year of the second phase. Tamil Nadu on the other hand sees a drop in the share of renewables in total capacity additions of thirty percent. In 2006 furthermore, the share drops by another third in Tamil Nadu, while it disappears completely in Maharashtra.

Maharashtra's coal dependency remains quite high throughout the two-year period that marks this ebb phase, although its share in the total energy mix drops. The power deficit in the state grows in the state over the same period, in spite of large capacity additions within the energy sector, reaching a point where blackouts are so frequent that it becomes an outspoken problem in the state. Thus while only one independent variable strictly shows variation in Maharashtra for this period – political facilitation – the power deficits in the state, which had been high for some time already, starts receiving more political focus, and can thus be expected to also gain more influence over decisions being made regarding the energy system in the state. The continued high coal dependency in the state, coupled with a recession of policy instruments and the rising awareness of power deficits in the state all points in the direction of reduced renewable energy spread in the state.

Although expectations towards it are clear, observed variations on the dependent variable in Maharashtra are less so. While renewables occupy a low share of total annual capacity additions, considerable investments are still observed over the course of this phase, and they constitute a significantly higher amount of added capacity than the additions in the previous period. This could point in the direction that some other factor is likely to be influencing the variation in renewable energy spread for this period.

What may provide some answers to these patterns is an underlying factor linked to the alignment variable, which is growth in energy demand. While power deficits are chosen as the main indicator to represent the extent of challenges and requirements posed to energy technologies, growth in energy demand can be taken as an indicator of the same. This is because one of the main assumptions of the alignment challenge variable is that renewable energy sources are expected to be down-prioritized in situations where energy supply is forced to increase rapidly over a short period of time. This is due to the lacking technological maturity of renewable energy technologies, which further prevents it from being able to provide required amounts of power in the required amount of time. Energy demand – which when subtracted from energy supply provides the measure for power deficit – saw a monumental growth of over two gigawatts in the state from 2005 to 2007, which was followed by the same amount of growth in energy supply. While renewables constituted a significant part of this growth in supply, other energy sources made up even more, tempering the score on the dependent variable.

The contention that growth in energy demand may better explain the variation pattern in the state during this period is supported by two specific observations. First, it is supported when looking at the two years of this ebb phase, where one of the main reasons for the initial backlash was criticisms aimed towards the lacking efficiency of new wind power installations in the state, and the fact that these installations supplied only around 20% of their stated capacity. In 2005 and 2006 moreover, renewable energy contributed a record low to total capacity additions. Second, the main reason for the end of the ebb in 2007 was an efficiency breakthrough in the Maharashtra wind sector which will be detailed in the next section. This is arguably an indication of the increased maturity of renewable energy technologies, which should better the prospects of the technology to answer to requirements to some degree. Accordingly, 2007 and 2008 also show an increase in the share of renewable energy in total capacity additions. The apparent linkage between renewable energy developments and energy demand growth lends support to the alignment challenge variable.

As in the last phase, the picture in Tamil Nadu appears somewhat less complicated than that in Maharashtra. While a clear policy facilitation recession can be observed in the state in 2005 and 2006, not a lot of variation occurs in the two other explanatory variables, limiting the complexity of the empirical expectations. Coal dependency sees a steady decline over this period, which links up well with both preceding and following periods, indicating that nothing out of the ordinary takes place within this sector in this phase. The first signs of the increasing power deficits that were to plague the state well into the next decade show its first signs at the start of this period, yet through 2005 and 2006 it does not reach levels that warrant any widespread attention towards it. On the basis of the observations for these two independent variables, no particular expectations are formed, as the variation is less than considerable.

This leaves the political facilitation of renewable energy. Whereas the mere coinciding of variation does not necessarily mean that the reduction observed in the share of renewables in total capacity additions in 2005 and 2006 is directly caused by the reduction of political support; looking at the specific processes taking place in the state in this phase lends strong support to it. The facilitation recession noted in Tamil Nadu took on a dual characteristic that very effectively put a choke on the ability of the state to continue adding renewable capacity. First, the economic deficit of the TNERC made it difficult to maintain a high level of support and incentives towards private investors, necessitating a temporary reduction in tariffs. Because of the predominance of private investors in the renewable energy sector in India, such tariff reductions can be expected to have had a direct impact on observed investments. Second, the inability of the state to follow impressive capacity additions with grid expansions made it very difficult to secure efficient distribution and transmission of all the newly installed capacity. The reduced rate at which capacity was turned into actual electricity supply contributed to dampen initiative towards renewable energy, not only because of the direct consequences of low distribution efficiency, but also because a popular backlash arose, following perceptions that renewable energy was not able to deliver the electricity it promised.

A seemingly clear link has thus been established between variations in the political facilitation variable and variation on the dependent variable in Tamil Nadu, strengthening the case for this variable within this state. As with the first phase however, this second phase has not given any overwhelmingly conclusive support to any variable, mainly because of the variation complexity observed in Maharashtra. In this state, the clearest link between any of the independent variables and the dependent one is found in the rapid energy demand growth, whose process can be somewhat directly linked to developments in renewable energy, unlike the other variables. It will thus be crucial to see how power demand growth and increasing power deficits may have affected renewable energy spread in both states in the two remaining phases.

4.5 Reconfiguration and Reinforcement of Renewable Support, 2007 to 2011/12

As the name implies, the third phase marks a reinvigoration of renewable energy facilitation policies in both states. As in phase two, the reemergence of these policies take on quite different characteristics in the two states, which is natural considering the different challenges the states are faced with at this point. This phase sees the introduction of two proposed alternative explanations for the greater variation in observed patterns in Maharashtra, and the lack of effectiveness in political facilitation in the state.

In Maharashtra, the third phase consists of a two-step reinvigoration process of facilitation which is initiated in 2007 as the discussion in the section above alluded at. Prior to the 2009 State Assembly elections in the state, the various government institutions overseeing tariffs and other investment incentives for renewable energy were insecure whether their financing would be maintained following the election. This led to largely delayed policy implementations awaiting clarity on financing (Krishna et al. 2015: 48-49). In 2007 however, some previously delayed tariffs came into effect at the same time as the major wind energy corporation in the state made a technological breakthrough regarding the effectiveness of wind installations, which bettered the situation somewhat compared to the two previous years (Krishna et al. 2015: 47). This gives Maharashtra a fairly high score on the political facilitation variable for 2007 and 2008. Furthermore, the 2009 State Assembly elections acted to reaffirm the positive policy climate in the state following years of uncertainty regarding political will towards renewable energy. The concrete policy consequences of the election were the initiation of the implementation of Maharashtra's RPO goals which were adopted in 2006 and thus new and increased tariffs to facilitate increased renewable energy spread.

This phase of high renewable energy policy facilitation coincides with a clear drop in the coal dependency in the state, which lasts throughout the phase, only noting a small recovery towards the end of the period. It also marks the first time in nearly a decade that power deficits in the state go down instead of up, and even though they remain high for most of the third phase, their continuous reduction throughout the period gives the state a fairly high score on the alignment challenge variable instead of high for 2012. The stable reduction of the power deficit during the phase was achieved through large capacity additions in the state's energy sector, and although this phase marks the period of highest growth in renewable energy capacity in the state, even higher capacity additions in other energy sectors impinge on the role these renewable additions play in the total picture. While the state added over two gigawatts of renewable energy capacity between 2007 and 2012, the total added capacity in the energy mix was well over nine gigawatts in the same period, making the in isolation impressive renewable energy capacity additions lose some significance. The only years within this phase in which renewables stand out is in 2007 and 2009, where it constitutes over half of new capacity additions. In all remaining years of the phase, renewables continuously contribute to no more than a quarter of added capacity each year.

An increasing focus towards reducing high power deficits in Maharashtra may very well be the key to renewable energy's relatively minor role during this phase. Since 2003, the state's moderate but steady efforts in increasing the spread of renewables in the state had done little to stymie increasing power deficits, and although the efficiency breakthrough in 2007 lead to a peak in investments following its announcement, this did not have a lasting effect on capacity additions in the state. The most compelling explanation for the generally very high level of capacity additions in the state over this time period is the explicit aim of reducing the lack of power supply in the state, and keeping up with explosive growth in energy demand. In light of the discussion in phase two, it seems a logical implication of this that renewables are necessarily not given top priority under these conditions.

This is not to say that the positive policy climate for renewables during this period did not have any effect whatsoever. Had not ambitious facilitation policies been adopted and initiated during this phase, one may not have seen the high rate of total capacity additions within renewables, which although moderate in the relative sense, are quite impressive when viewed in isolation. Although they are dwarfed in comparison to the increases for coal, Maharashtra received quite a bit of praise for their renewable focus from 2010 to 2012, highlighting the fact that Maharashtra established itself as the second-leading state in terms of renewable energy capacity in the whole of India. A direct positive link can be drawn from the adoption of the RPOs and an increase in total renewable energy capacity additions in the state. Since this report assesses *spread* however, the score is nonetheless lower than what one would expect when viewing the political facilitation variable in isolation.

This highlights the importance of using the right measure for indicating the dependent variable. Had only total capacity additions been looked at, Maharashtra would have received a high score throughout this phase. In fact, a clear positive link can be found between total capacity additions and renewable facilitation policies, but this ignores the impact of the other explanatory variables, and the fact that this report aims to measure the *spread* of renewables, and not its total additions. Furthermore, when looking at the spread of renewables, it becomes clearer how political facilitation can have an effect on renewable energy developments in Maharashtra, but that its spread is limited by the impact of increasing energy demand and thus a generally rapid-growing energy sector.

What is further highlighted is the importance of not viewing the explanatory factors in isolation when assessing their impact on the spread of renewable energy. They are all a part of a complex and interconnected web of intertwining political goals and aims. While some issues will take precedence over others, such as the reduction of deficits over the spread of renewables, this does not mean that the latter is completely ignored. Observed variation in Maharashtra for this period further supports an expectation that has been gaining strength throughout the previous two phases, that while political facilitation of renewable energy greatly helps its spread, some issues will still trump it in importance if they are salient enough. One such issue is providing sufficient electricity to the population. When renewable energy appears unfit to achieve this goal by itself, other sources of energy such as coal will gain priority, in spite of the presence of strong facilitative policies for renewables. Developments in Maharashtra throughout the three phases discussed so far lend support to the claim that renewables will be down-prioritized in situations of high and growing power deficits.

Tamil Nadu yet again shows less complexity in variations than Maharashtra during this phase. The high tide in the state starts off with new tariffs and policies aimed at upgrading infrastructure and enabling it to bear the load of new capacity that had been installed over the previous years. Many of these tariffs were adopted already in 2006, but they did not come into effect before in early 2007. The formulation of a new five-year plan the same year further increased the policy lift towards appropriate areas of renewable energy in the state. Renewable energy recaptures a very high share of total capacity additions in the state and retains this share throughout the period. Moreover, the developments in renewable energy share closely follow the implementation of favorable policies for renewable energy, picking up speed right after the increase in infrastructure tariffs and the adoption of the eleventh five-year plan. The initiation of the RPO in Tamil Nadu gives renewables a further push, the energy sources constituting well over nine-tenths of all annual capacity additions in the state between 2009 and 2011. Prior to assessing the potential impact of the other two independent variables, it seems as though the case for political facilitation affecting renewables spread in Tamil Nadu remains very strong.

Coal dependency remains low throughout the third phase and the share of coal in the energy mix of Tamil Nadu decreases for every single year in the period. 2012 marks the lowest recorded share of coal in the state's energy mix, at 34%, and this is subsequently also the first year in the state in which renewable energy has a higher total generation capacity than coal. In hindsight however, some signs of the reinvigoration that is to characterize the coal sector in the next phase begins to show already at the end of the third phase in 2011, through planning and deliberation surrounding the building of new power plants and upgrading the capacity of already existing ones. As these plans had yet to come into effect during the third phase, they provide no serious barriers towards renewable energy. Power deficits in the state continue to grow throughout this period, and towards the end of the third phase, it reaches a level where serious attention starts being given to it. The state of the power deficit in Tamil Nadu and how it is to be reduced becomes a matter of much political debate in the period leading up to the 2011 State Assembly elections, and it is not until after this election that actual plans to mitigate the deficit are introduced, which subsequently marks the end of this phase and the start of the next.

Through the observable link between new tariffs and the introduction of the RPOs, and developments in the spread of renewable energy in Tamil Nadu, the political facilitation variable is yet again strengthened within this state. In order to try and make sense of why political facilitation seems so more potent in Tamil Nadu than in Maharashtra, a closer look should be taken at how the two states differ over the course of the last two phases. While it could be as simple as Maharashtra being characterized by considerably more variation in both coal dependency and political facilitation – which could explain why it is also harder to ascertain clear links between them and the dependent variable – there are two other possibilities which should be entertained.

First, it is argued above that rapid growth in power demand may explain why renewable energy spread fails to follow expected patterns in Maharashtra in any of the two last phases. If this is so, one would expect energy demand growth in Tamil Nadu to be lower over the same period, since the political facilitation variable is apparently more potent in this state. This is the case to some extent. Between 2005 and 2011, total energy demand growth in Maharashtra was one-third higher than it was in Tamil Nadu. Controlling however, for the total energy demand in the two states, Tamil Nadu has actually seen a higher growth rate in percentage than Maharashtra, but this does not change the fact that the latter state had to deal with over one gigawatt more of total energy demand growth than the former. This is a significant difference in total energy demand growth, which adds to the plausibility of the claim that high growth in energy demand has an influence on the spread of renewable energy.

Second, throughout the entire period of analysis, the political saliency of renewable energy issues has been higher in Tamil Nadu than in Maharashtra. It can be argued that this may have had an effect on the effectiveness of implementation of policies for renewable energy facilitation. While this is a harder claim to empirically test, the claim is plausible, as one would expect political parties with a stronger focus on renewable energy to place the spread of the resource higher on their priority list throughout the period of analysis, even in light of other challenges. One way in which this proposed explanation could be strengthened is if variation on the saliency indicator were to be observed. The next phase records just such variation in Tamil Nadu, but with the caveat that policy instruments also fade within the state. It will still be interesting to see how this variation could have influenced the process of renewable spread in the state, which has remained comparatively high throughout all of the previous phases.

4.6 Power Deficit Reductions Take Precedence, 2012/13 to now

The last phase identified in the developments of renewable energy facilitation policies in Maharashtra and Tamil Nadu is another period of ebb of support policies that largely came about as the result of the impingement of soaring power deficits onto the political stage in both states. The issue of high power deficits was highlighted earlier in Maharashtra than in Tamil Nadu, but efforts to mitigate it were initiated around the same time in both states. It can appear as though the developments in all previous phases – especially in Maharashtra – have lead up to this point, where years of not addressing a growing deficit problem have forced both states to take fairly drastic measures in order to sort the situation out. Findings within this phase further support the proposed detrimental influence of power deficits on the effect of political facilitation.

Although this phase is characterized as a recession phase for both states, the clearest backlash in political facilitation can be found in Tamil Nadu, where the 2011 State Assembly elections produced a government that explicitly stated that power deficit reductions were given larger priority than continued renewable energy spread. This lack of commitment towards continuing renewable energy facilitation has affected the compliance of the state towards the Renewable Purchase Obligations, and there are few plans or proposals from the state's side on how the RPOs should be fulfilled beyond 2012, even though the states are formally required to make and enact policies for its fulfillment until 2020 (Pratap et al. 2013). One notable exception to this trend is a recent increase in the solar RPO of 1.5% issued by TNERC in January 2015, which translates to around 2GW of solar generation capacity if it is to be fulfilled (Sushma 2015). As of yet however, only small steps towards this goal have been taken, so the end result is yet to be seen. The general lack of support mechanisms towards renewable energy in recent years stands as a stark contrast to the heavy rhetoric recently used by both the Tamil Nadu state and the national government, regarding the future role of solar power across India (Government of Tamil Nadu 2012, Business Standard 2014). This lack of commitment and initiative from 2012 and out corresponds closely with the election of the new AIADMK state government in October 2011.

In Maharashtra, policy supports do not specifically recede, but rather experience a stand-still, where no particular policies are noted throughout most of the period. Two exceptions to this can be noted. First, a cross-party initiative to accelerate and strengthen renewable energy developments in the state was formed in Maharashtra's State Assembly midway through 2014. The group was tasked with fronting and steering all Assembly policy discussions, in order to provide continuous focus and promotion towards renewable energy. This initiative is reportedly an attempt to bring more political attention to renewable energy, rather than it being left in the hands of bureaucrats dependent on the whim of politicians (Climate Parliament 2014). Whether this initiative is substantial or purely rhetorical remains to be seen, but no policy instruments have yet to be produced from the initiative. Second, as the first state in the country, Maharashtra announced severe fines and penalties for distributers failing to meet their RPO quotas before a March 2014 deadline (Shreya 2013). No data has been found however, on whether such penalties have actually been imposed on distributors failing to meet their obligations. Thus, in spite of these movements on the Maharashtrian political arena regarding renewable facilitation, no policy instruments have come about, and the state thus scores low on the political facilitation variable for this period.

Despite not occupying that much of a share to being with, renewable energy spread in Maharashtra notes a drop in this phase, down from just over one quarter of total capacity additions in 2011 to one fifth in 2013. The share goes back up to a quarter at the end of 2014 however. When looking at total capacity additions within renewable energy sources in isolation however, they appear relatively impressive, but like in the previous phase; although substantial, renewable additions in Maharashtra are drowned out by even higher additions within other sectors of the energy mix. It is thus clear that what causes the recession in the share of renewable energy in new capacity additions in the state is not a reduction in total renewable capacity – this is high throughout the period – but rather that the installed capacity of the energy mix as a whole grows more than the installed capacity in renewables.

The steady increase of the share of coal in Maharashtra's energy mix noted over the course of the last phase continues throughout this period as well, and by the end of 2014, the resource occupies just as high a share as it did at the start of the period of analysis in 2002. Coal dominance has thus reasserted itself in the state, arguably to an even stronger degree than before, considering the increase in scale noted after 2010. The new push for coal is closely related to the effort of Maharashtra towards dealing with its two decades-long power deficit once and for all. Coal represents the predominant share of the added power generation capacity between 2012 and 2014, totaling nearly ten gigawatts in this period, a figure that dwarfs the additions in all other energy sectors. Through coal, Maharashtra largely manages to diminish its deficit, cutting its 2014 shortage down to a quarter of what it was in 2011. The increasing coal dependency in the state in this phase is thus inextricably linked with the power deficit situation, and the alignment challenge variable yet again seems the best place to find plausible explanations for the observed variation in Maharashtra.

The political facilitation variable exhibits no more clarity in regards to its link with the dependent variable in Maharashtra in this phase than in the others, and total renewable energy capacity additions actually go up in spite of noted cooldown in support policies towards the resource. This supports the claim that the alignment challenge variable might have greater causal depth than the political facilitation variable in Maharashtra. This is because the former variable is able to provide plausible explanations for both the dropping share of renewables in total added capacity, as well as its increase in total volume. As the state aims to reduce its power deficit, it adds capacity within all sectors of the energy mix, but it prioritizes where it can get the most favorable cost-to-benefit ratio. Thus, one sees an increase in renewables, but a *greater* increase within other energy sources. This lends further support to the discussion in the previous section concerning that political facilitation towards renewable energy may not be as potent – or as high up on the priority list – in Maharashtra as in Tamil Nadu.

In addition to seeing the strongest political backlash, Tamil Nadu is also the state that records the most significant drop in the share of renewables in total capacity additions during the period, and between 2011 and 2012, the share drops from close to one hundred percent to just over half. The share further drops to less than one quarter of total capacity additions in 2013, and then finally to less than one-fifth in 2014. This sharp drop is substantial both in terms of relative capacity additions as well as total capacity additions. While the state added well over one gigawatt of renewable energy capacity in 2011, total additions totaled less than one hundred and fifty megawatts in 2014.

A much clearer link can be drawn between variation on the political facilitation indicator and all the other variables included in the analysis in Tamil Nadu than in Maharashtra. The stated goal of the AIADMK to reduce deficits which won them the election is followed by clear reductions in both the power deficit in the state – as promised – as well as the share of renewables in total capacity additions in the state. The variation observed in all other variables can arguably be traced back to the variation on the political facilitation variable in Tamil Nadu in this phase. The halving of power deficit in the state between 2012 and 2014 can clearly be linked to specific election promises, giving the political facilitation variable causal priority over that of the alignment challenge variable. Furthermore, coal acts as the principal facilitator for the rapid growth in generation capacity that occurs over the same time-period, and the four gigawatts of added capacity within coal between 2012 and 2014 increases its share in the total energy mix by close to a quarter. This push for coal is arguably linked with the state's explicit aim of deficit reductions, and the alignment challenge variable thus gains causal priority over the coal dependency variable. Lastly, the drop in renewable spread can be directly linked with a shifting policy focus in the state, both in terms of a clear absence of policy instruments in this period, as well as the explicit change of priority by political parties, reducing the saliency of renewable energy politics in Tamil Nadu.

As in all of the other phases, the indicator representing the political facilitation variable is strengthened in Tamil Nadu, while it is less so in Maharashtra, where the alignment challenge indicator appears to stand much stronger. The alignment challenge variable is also present to a large degree in Tamil Nadu, but here causal priority of the political facilitation variable could be established. The chronological and comparative assessment of the explanatory strength of the indicators has shed much light on how they relate to each other and how different combinations of their values lead to different outcomes in terms of renewable energy spread. It seems that high political saliency of renewable energy coupled with clear and explicit facilitative policy instruments are a potent combination for securing greater spread of renewable energy. A high dependency towards coal and a growing energy demand on the other hand show potency in the other direction. To further strengthen the assessment of the relationship between the different mechanisms, it can be helpful to also conduct a more overarching discussion. The next section summarizes the findings throughout the last four sections, and discusses how the variables relate to each other in a more grand and general sense.

4.7 Summary and General Assessment of the Proposed Explanatory Factors

The major developments in renewable energy in Maharashtra and Tamil Nadu since 2003, and the link between these developments and three proposed explanatory factors have now been presented and discussed. Through four distinct but closely interrelated phases, different variations in the values of the different variables have been put up against each other over time and across space, in the hopes of uncovering some patterns of interrelation between the independent variables and renewable energy spread in the two states.

4.7.1 Summary of Findings

In the first phase, political facilitation was shown to have a positive effect on renewable energy spread in both states, although more so in Tamil Nadu than in Maharashtra. By looking closer at the specific patterns within and between the variables, it is argued that political facilitation holds higher causal depth and priority over coal dependence when it comes to influencing renewable energy spread in Tamil Nadu. No definitive or direct linkages were found in Maharashtra, and it is concluded that the latter state shows a much greater complexity in its variation patterns. This is an aspect that is to persist throughout the entirety of the analyzed period.

Ebb of political facilitation policies towards renewable energy characterizes the second phase for both states. For different reasons, tariffs and other support policies designed to facilitate the increased role of renewables had to be reduced in both states, which has shown to have had a clear link with receding renewable energy spread in both states. As in the first phase, the link is clearer in Tamil Nadu than in Maharashtra, and it is argued under the discussion regarding this phase that the rapidly increasing power demand in the latter state may have affected the spread of renewable energy. In support of this argument, clear process evidence is found linking the alignment challenge variable to decreased spread in renewable energy.

Phase three sees a reestablishment of political facilitation for renewable energy in both states, starting in 2007. In Tamil Nadu two important policy adoptions coincide, which again can be shown to have had a clear and positive effect on the spread of renewables in the state, which pick up again after a two year low. In Maharashtra too, previous patterns can yet again be observed, and given the positive policy climate for renewables that is reestablished in 2009, developments in renewable energy show signs of picking up, but not in any singular or clear way that can be directly connected to the political facilitation policies. Looking beyond the indicators, a connection appears in that an increase in total capacity additions within renewables is observed, but these are not high enough to keep up with capacity additions in the rest of the energy sector. Rapid energy demand growth yet again emerges as a potential explanatory factor behind the observed developments, and within this phase, a clear link can be drawn between variation in power demand and deficits, and the spread of renewable energy in the state. Lower saliency of renewables issues and a generally higher level of power demand growth and deficits emerge as alternative explanations for the apparent lack of effect of the political facilitation variable in Maharashtra.

By the end of the third phase, the chronology of the two states diverge in terms of their location within the phases, and the last phase starts off one year earlier for Tamil Nadu than for Maharashtra. The last phase differs somewhat more between cases than what previous phases have done, where the political support towards renewable energy spread has been similar across states. In this phase, recession can only truly be observed in Tamil Nadu, while Maharashtra sees more of a cooldown of political initiative. In both relative and total terms, Tamil Nadu also sees a sharper drop in renewable energy spread than Maharashtra, with relative capacity additions down to a quarter of the previous phase, and total additions also dropping greatly. Maharashtra sees less of a relative drop in capacity addition share, because the share was already quite low, and total additions also stay relatively high, notably higher than in Tamil Nadu. By this time, the importance of energy demand growth and reduction of the power deficit becomes very clear in Tamil Nadu as well as in Maharashtra. Variations and linkages observed during this phase leads on to the next subsection which deals with an overarching assessment of the relative strength and explanatory power of the independent variables. Below, a concrete proposal for how the three explanatory variables interrelate and affect each other and the dependent variable is discussed, leading on to the last, concluding chapter of this report.

4.7.2 Overarching Assessment of the Explanatory Factors

The most important finding uncovered throughout the last four sections is arguably the strong footing of the political facilitation variable in Tamil Nadu, and the importance of the power deficit in both states. While most developments in terms of renewable energy spread can be linked to concrete political decisions in Tamil Nadu, the rapid growth of energy demand seems to hold the key to the same developments in Maharashtra. The dynamic observed between securing a sufficient supply of power and facilitating the spread of renewable energy can be likened to that of the relationship between high and low politics, where the achievement of the first holds primacy over the second. Ensuring that an energy system is functional and operational is the top priority of any government, and it will utilize the most effective measures available to fulfill this primary requirement. Also making sure that the same energy system is sustainable and does not negatively impact the environment is a subsidiary requirement and will be conditional to the fulfillment this first.

In the Indian context, one could argue that because energy deficits have constituted much more of a challenge in Maharashtra than in Tamil Nadu, political facilitation for renewable energy has had less of an impact on the spread of renewable energy in that state. Conversely, since Tamil Nadu has had lower deficits in general over the course of the analyzed period, they could allow more focus towards "low" political goals such as facilitating the spread of renewable energy in the state. Figure 6 shows that the developments of renewable energy capacity additions in the two states have taken on largely the same shape and form. Following the same up-and-down trends, the constituting difference in the spread of renewable energy between the two states is that Maharashtra in general has added less total capacity to its energy mix than Tamil Nadu has. Viewed in relation to the fact that variations in political facilitation have followed largely the same temporal patterns in both states, this aspect of similar form yet different volume supports the claim that the effectiveness of policy instruments is modified by background factors that to a larger degree are present in Maharashtra than in Tamil Nadu, which in this case relates to coal dependency, power demand growth and the political saliency of renewable energy. This is furthermore supported by the fact that when the differences between the two states in terms of these factors dissipate at the end of the analyzed period, Maharashtra overtakes Tamil Nadu both in terms of total renewable energy capacity additions as well as in the share these additions constitute of the grand total.

Coal dependency is by its very nature not expected to neither vary to a great deal or to lead to sudden and rapid fluctuations in the energy mix. Instead, the slow burn of coal dependency can be expected to permeate all decisions and choices pertaining to the energy system of a state, and the general level of dependence is thus expected to exert an overarching influence on all decisions in the state, depending on how heavy it weighs down on the energy system. This is the reason for its somewhat lacking and auxiliary presence throughout the last four sections. The difference in the heaviness of the coal sector in the two states is one of the possible explanations for the variation observed in the effectiveness of political facilitation between Maharashtra and Tamil Nadu. It can be argued that its strength affects both the viability of policies and the available means for the states in reducing power deficits. For instance, with its well-established coal infrastructure, Maharashtra has access to a dominant means for efficiently and rapidly pumping increased capacity into the grid. The sheer size of the coal sector in the state increases the relative disadvantage of renewables when rapid growth in energy demand must be met, and correspondingly one sees greater capacity additions into coal in Maharashtra than in Tamil Nadu.

The present superiority of coal in terms of being able to quickly increase its generation capacity by large amounts of volume does not seem to be lost on any of the two states, and indications seem to point in the direction of an increased coal dependency in both Maharashtra and Tamil Nadu. Maharashtra has for the last four years been making considerable investments into the coal sector and in establishing more effective and better coal-facilitating infrastructure, all of which points in the direction of the state having committed itself to a continued path along coal dominance. Since 2010, eleven new power plants have been built in the state, of which many already have plans for further capacity expansions. These new constructions have more than doubled the total number of coal power plants in the state, which as of now counts twenty. At the same time, seven new expansions of already existing power plants are also in varying stages of development and completion (Sourcewatch 2014a-f and 2015a-n). Another trend that further reinforces the continued use of coal in the state is the initiation of several new coal mining operations to supplement growing imports with local resources, in hopes of staving off some of its import dependence (Maps of India 2010, Gagdil 2012, Anparthi 2015 and Press Trust of India 2015). The contention that Maharashtra will become increasingly dependent on coal in years to come is in addition to the data presented here, also supported by prognoses in recent studies, highlighting the increased role that coal is expected to have in future energy generation in all of India (Dubash et al. 2015: 8 and Graczyk 2015: 28).

Although not as strongly as in Maharashtra, coal dependency developments seem to be going in the same direction in Tamil Nadu as well. Coal capacity additions of over four gigawatts between 2012 and 2014 have yet again put coal in front of renewables in terms of total installed generation capacity. As in Maharashtra and India in general, these rapid increases in coal capacity over the last few years marks the first time in several decades that real significant additions to the coal capacity in the state has been conducted. This includes both the building of new power plants, and expansions of already existing ones. Since 2010, seven new power plants have been built in the state and another five expansions of already existing plans are in varying stages of development and completion. The erection of the new power plants in the state over the last five years signifies a doubling of the total number of coal power plants in

Tamil Nadu, now tallying a total of fourteen finished and operating plants (Sourcewatch 2014g-m and 2015o-u). Furthermore, the trend of a growing coal dependency in the state can be expected to continue in years to come. This is clearly demonstrated through the ambitious plans for expansion of the coal industry in the state, with sixteen new generation units, both small- and large-scale in varying stages of development and construction (Sourcewatch 2013).

In spite of the increased push for coal in Tamil Nadu, its energy mix is nevertheless more diversified than that of Maharashtra, and throughout the analyzed period, coal has consistently occupied between 15 and 20% less of share in the energy mix in Tamil Nadu. Furthermore, regardless of periodic problems of maintaining a favorable investment climate in the state, Tamil Nadu has generally been characterized as maintaining clear and open state-market relationships, reducing private stakeholders' perceived risk of investing in renewable energy developments in the state (Bennecke 2011: 39), all of which counts towards Tamil Nadu having a more flexible energy mix than Maharashtra.

While a central assumption throughout this report has been that renewables will lose priority in favor of coal and other fossil resources in situations of high power deficits and rapid energy demand growth, this is not necessarily going to be the case in the future. Over the course of the last decades, renewable energy technologies have matured tremendously, and although it is observed that they presently come up short in meeting power supply requirements in India, some renewable energy technologies are beginning to near a stage where they can compete with fossil energy sources both in price and in volume of supply (Salvatore 2013: 9, 14, TERI 2013: 21). This may have a large impact on the future scope of understanding what causes variations in the spread of renewable energy, and one of the main barriers for its spread uncovered here may not be as relevant or potent in years to come.

5 Conclusion

This report has attempted to explain variations in the transition towards renewable energy in the electricity sector of two Indian states that share largely the same potential for renewable energy, but display widely different development patterns in terms of its spread. This was done by empirically assessing the explanatory power of two different theoretical perspectives on what facilitates or bars societal transitions through a comparative case study. The report finds that while none of the perspectives are able to provide an adequate or exhaustive explanation for the variation observed on their own; in combination they paint a clearer picture of why the spread of renewable energy differs between the two states.

The main conclusion and the answer to the research question is that political facilitation of renewable energy will greatly help its spread, as long as more salient and pressing political issues are not forcing attention away from it. The variation observed in renewable energy spread in Maharashtra and Tamil Nadu can largely be traced back to the more pressing energy demand situation in the former state, and the greater political saliency of and priority towards renewable energy in the latter. At the end of the analyzed period, when these two aspects become more similar across the analyzed states, the differences in renewable energy spread also dissipates between them.

In the four identified phases, empirical observations indicate that a high coal dependency generally lowers the spread of renewable energy as a whole. Lacking political saliency of renewable energy furthermore may have the same effect, dampening the overall effectiveness of policy instruments aimed at facilitating renewable energy. In terms of specific linkages found in one or more of the phases, higher power deficits and higher energy demand growth leads to pressure towards the potential dominance of renewables, and forces the states to lower its prioritization in favour of more bulk-efficient energy sources. Policy instruments are shown to be linked to renewables spread in all of the four phases, but its effectiveness seems to be largely contingent on the presence or absence of other more salient political issues that take precedence over it. The identification of separate phases of renewable energy facilitation in the two Indian states, and the further claim that theses phases take on a concrete wave characteristic, impacts the expectations for future renewable energy development transpiration both in the two states and in India for the coming years.

Given that both states are argued to be located in the midst of a period of ebb, the future trajectory of renewable energy spread in both states could pick up again soon. An apparent reinvigoration of renewables focus and the saliency it holds in state politics observed in recent months could be seen to lend support to this claim. On the other hand, both states show an increasing reliance towards coal that could be expect to continue, as prognoses predict skyrocketing energy demand in the whole of India.

This expectation is supported by recent trends in the coal sector of both states, as well as explicit statements regarding the central role of coal in the future (Graczyk 2015: 28). Predicting how the dynamic between these two factors will play out is naturally impossible at this time, but there are some developments that can be expected with fair certainty, which can help us form expectations for the future of India's energy mix.

One such development is a continued rapid population growth over the coming decades, which is expected to make India the world's most populous country before 2050. Coupled with equally rapid economic growth, it is given that India will experience explosive growth in demand for energy over the same period, a demand that must be met with massive additions to electricity generation capacity. Notwithstanding the growing maturity of renewable energy technologies touched upon in chapter four, predicting the continued centrality of coal in India's energy mix hardly seems controversial in light of these developments. Even though focus on and investments in renewable energy were to see a massive push in years to come, its relative prominence and importance will necessarily be moderated by the even greater push that will need to come within other sectors of the energy mix.

The results uncovered in this report could contribute to form a basis for further and more general studies of the topic of renewable energy transitions. The theoretical model and the empirical delimitation of the report should be of a sufficiently general nature to be used also for other cases, in order to build validity and generalizability of the results, and to further develop the understanding of renewable energy developments.

The report argues that the lack of focus on previous literary contributions to the field of transition theory is a significant weakness in many studies of the causes of variable renewable energy developments. Through the synthesis and testing of scholarly perspectives on renewable energy transitions, this report lends supported to this claim, by demonstrating that a broad and balanced view on the potential mechanisms that influence renewable energy developments is preferable over a more singular political or technological approach, in order to gain a good grasp and understanding of observed variation. Presupposing that political and economic incentives are the decisive factors that influence the level of success in achieving renewable energy spread seems plausible taken at face value, but this report shows that such an early conclusion does not uncover the entire picture. Further efforts for cumulative use of theoretical mechanisms of influences on transitional success could have led to more robust findings and valid empirical analyses.

While the main explanation that is proposed for the variation observed in this case study has a fundamentally political logic, in that it uses the concept of political prioritization to explain why some factors matter more in some instances than in others, these political prioritizations were necessitated by the emergence of structural and technical phenomena. Not supplementing the political perspective with a more structuralist one could therefore also have reduced the ability to make sense of the observed patterns. This is also the case the other way around. One cannot view technological developments as separate from political ones, and applying a catch-all label on these factors only contributes to cloud empirical research. More often than not, it seems that political decisions underlie and predate technological ones – not only conditioning them, but acting as crucial prerequisites for any development to take place at all (Kemp 2005: 18, de Boer 2015). Although the electricity system is structural and technical, it is situated within a fundamentally social structure, and ignoring the constitutive role of social influence on the system can thus reduce the scope of understanding variations within it. Political decisions would accordingly need a role in any theoretical framework, which reflects this central position it arguably holds in making sense of changes and developments within a fundamentally social structure.

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