WIND ENERGY IN FOSSIL FUEL-RICH JURISDICTIONS: FACTORS INFLUENCING LARGE-SCALE DEPLOYMENT IN TEXAS, SASKATCHEWAN, AND WESTERN AUSTRALIA

BY

GISELLE DE GRANDIS

315964

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Supervisor: Dr. M. Haverland

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ABSTRACT

In the last two decades wind power has emerged as a mainstream alternative to fossil fuel-based conventional electricity. Its adoption, however, has been uneven across affluent countries, and climate scientists warn we must hasten our transition to non-emitting energy systems to avert catastrophe. This thesis studies the real-world experiences of Texas, Saskatchewan, and Western Australia with wind energy from 1997 to 2012 to look for lessons about stimulating accelerated deployment and explain divergent outcomes. A comparative case study, the thesis assesses within and across cases five factors thought to influence wind energy deployment: federal production tax incentives, mandatory renewable energy quotas, electricity market type, planning model, and approach to grid infrastructure improvements. Our findings suggest that federal tax incentives have stimulated deployment in Texas and Saskatchewan, and competitive electricity markets along with proactive grid infrastructure improvements have bolstered deployment Texas and Western Australia. However, the ambitiousness of mandatory quotas and the simplicity of planning models were less important.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AWEA	American Wind Energy Association
CanWEA	Canadian Wind Energy Association
CO2	Carbon dioxide
CREZ	Competitive Renewable Energy Zone (TX)
DOE	Department of Energy (US)
EcoERP	EcoENERGY for Renewable Power Program (Can.)
EIA	Energy Information Administration (US)
ERCOT	Electric Reliability Council of Texas
FERC	Federal Energy Regulatory Commission (US)
FIT	Feed-in Tariff
GHGs	Greenhouse gases
GW	Gigawatt
IMO	Independent Market Operator (WA)
IPP	Independent Power Producer
ISO	Independent System Operator
kW	Kilowatt
kWh	Kilowatt-hour
MRET	Mandatory Renewable Energy Target (Aus.)
MW	Megawatt
MWEP	Mid West Energy Project (WA)
MWh	Megawatt-hour
NIMBY	‘Not in my backyard’
NRCan	Natural Resources Canada
PPA	Power Purchase Agreement
PPS	Planning, Permitting and Siting
PTC	Production Tax Credit (US)
PUCT	Public Utility Commission of Texas
RE	Renewable Energy
REC	Renewable Energy Certificate
RET	Renewable Energy Target (Aus.)
RPS	Renewables Portfolio Standard (US/Can.)
SB	Senate Bill (TX)
SK	Saskatchewan
SWIS	South-West Interconnected System (WA)
TX	Texas
WA	Western Australia
WEM	Wholesale Electricity Market (WA)
WPPI	Wind Power Production Incentive (Can.)
WTG	Wind Turbine Generator

1. WIND ENERGY IN THE AGE OF CLIMATE CHANGE

Energy is “far and away the most significant international resource system and political economic nexus” and presents critical challenges across many policy areas (Zimmerer 2011, p.705). As the world’s population grows and developing countries rapidly adopt the industrial processes that characterize the developed world, energy demand is intensifying. At the same time, over the last two decades the quadruple threats of climate change, impaired public health, energy insecurity, and rising fossil fuel prices have loomed ever larger. We have been forced to accept that the era of energy systems built on bountiful, inexpensive fossil fuels is ending.

1.1. THE ORIGINS OF A SUSTAINABLE ENERGY IMPERATIVE

With energy issues atop international, national, regional and local political agendas, an imperative to transition to sustainable energy systems has emerged, underpinning a heightening need for amplified and accelerated adoption (‘deployment’) of renewable energy technologies. Transitioning to renewable energy, however, has so far been a complex process with challenges extending from local to global that implicate the technical, environmental, economic, political, institutional and social spheres (Warren et al. 2012, p.2). Even among developed countries, which have the means to transition rapidly, some jurisdictions have led the transition to renewable energy while others, despite expressing support for renewable energy, have made only modest progress.

This thesis is a comparative case study of three similar subnational jurisdictions (two states and one province) of Anglo-American advanced industrial democratic countries that began using wind energy technology around the same time, about fifteen years ago, but followed different trajectories to arrive at divergent wind energy deployment outcomes in 2012. We examine this puzzle over the sample period of 1997 to 2012, in search of explanations. First, though, we will introduce the primary drivers behind a global imperative to transition to renewable energy.

1.1.1. CLIMATE CHANGE

There is a scientific consensus that anthropogenic climate change, caused by escalating greenhouse gas (GHG) emissions, is a global threat that must be addressed swiftly and decisively if we are to avert environmental disaster. If the rate and level of GHG emissions continue on their current trajectories, climate scientists predict irreversible catastrophe. Despite this urgency, countries have been unwilling to commit at the international level to binding targets for emissions reductions. Treaties like the Kyoto Protocol seeking hard emissions-reduction commitments from industrialized countries (the largest emitters on a per capita basis) have been undermined by the refusal of the US to sign on. In the Copenhagen Accord of 2009, industrialized countries agreed only to voluntary targets.

Meanwhile, lay people and experts alike can observe the consequences of unabated climate change as abnormal flooding and drought grow in frequency, ocean levels rise, ecosystems are destroyed, and extreme temperatures and weather patterns occur.

1.1.2. PUBLIC HEALTH

Conventional fossil fuel-based electricity generation – a major source of GHG emissions globally – not only has negative global effects, but also negative environmental and health impacts at local and regional levels, near power plants. The US Environmental Protection Agency acknowledges that conventional electricity generation is a major source of air pollution that releases harmful carbon dioxide, nitrogen oxides, carbon monoxide, sulfur oxides, ground level ozone, mercury and particulates as byproducts of the combustion process (EPA 2012).

1.1.3. ENERGY SECURITY

The oil shocks of the 1970s highlighted the vulnerability of countries relying on any one energy source and brought to the fore concerns over energy security and reliance on foreign oil. Diversification of energy supplies and energy independence suddenly became core energy policy goals and helped propel the development of large-scale nuclear generation capabilities in many places. While some countries have always been wary of nuclear generation (indeed, Denmark's world-leading wind energy industry took off amid nuclear opposition), a series of nuclear accidents like Three Mile Island in 1979, Chernobyl in 1986, and Fukushima in 2011 have underscored the need for safer energy alternatives to fossil fuel-based generation.

As the spotlight, particularly in the developed world, has turned to renewable energy in the past two decades, the safety of energy sources like wind, solar, geothermal, wave and tidal has not gone unnoticed. Furthermore, although several of these sources, including wind and solar, are classified as 'variable' or 'intermittent' generation technologies – they only generate when natural conditions are optimal – their supply cannot be constrained nor depleted and they are invulnerable to the kinds of disruptions that can afflict gas pipelines and coal trains. They are also domestically available and therefore free from national security externalities (i.e., hefty diplomatic and military expenditures) associated with reliance on foreign oil from unstable or hostile countries (Gillingham & Sweeney 2010).

1.1.4. THE CHANGING ECONOMICS OF FUEL

Natural gas is domestically produced in countries like the US, Canada and Australia and its share of electricity-generating capacity in these places has grown as gas production increased in recent years thanks to new extraction technologies. Gas-generated electricity emits about half the GHGs that coal-generation does and its domestic production should theoretically improve energy security. However, Byrne et al. (2007) find that the volatility of natural gas prices exposes the US electricity sector to a different risk, citing the 2005 spike in prices following hurricane damage to natural gas facilities in the Gulf of Mexico, which in turn drove up electricity costs. Byrne et al. advise that gas-heavy portfolios should hedge against price volatility by increasing renewable energy (RE) capacity to “decouple the cost of energy service from fuel price” (2007, p.4567).

In addition to the short- and medium-term risks associated with fuel price volatility, there is an even bleaker outlook for the longer-term. Fossil fuel supplies are finite and economic forecasters predict that even if a worst-case, ‘peak oil’ scenario does not come to pass, increasingly difficult extraction and processing methods for ‘non-conventional’ fossil fuels will contribute to higher prices. There is also the looming prospect of policies penalizing carbon emissions, which will further drive up the cost of fossil fuel-based generation. These economic realities will favour the cost-competitiveness of non-emitting, renewable energy technologies like wind, where operational costs are very low – ‘fuel’ is plentiful and free – and there are no carbon emissions to penalize.

Alongside the growing cost-competitiveness of renewable energy, there are business opportunities in developing renewable energy sectors. In places like Spain, Denmark, Germany and the US, bustling ‘green energy’ sectors have emerged, where RE industry investment has been booming and jobs created in R&D, equipment manufacturing, installation and generation. The public also appreciates the environmental and health benefits of safe and clean electricity generation.

1.2. WIND ENERGY TECHNOLOGY

We argue that the threats identified in the last section can be mitigated to a large extent by phasing out fossil fuel-based conventional technologies and switching to renewable energy technologies. In this section we will discuss the ways in which wind energy technology, in particular, has offered advantages over both conventional and other renewable technologies for some time.

Wind energy technology uses the rotational movements of wind turbines to generate electricity by converting kinetic energy from wind currents (‘wind energy’, measured in joules) into mechanical energy (‘wind power’, measured in watts).[1] The resulting electricity can be used on-site or locally (off-grid ‘distributed generation’), or it can be sent to a centralized electricity transmission grid, as is common with larger-scale wind projects that use multiple turbines (‘wind farms’). In the latter case, wind farms transmit their power over high-voltage transmission lines to transformer stations where voltage is reduced so that electricity can be locally distributed to consumers via low-voltage power lines.

Wind energy is sometimes derided by critics for being unreliable, due to the intermittent nature of wind itself. However, research shows that geographically disparate wind farms,

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[1] For simplicity, this thesis uses ‘energy’ and ‘power’ interchangeably, as is common practice.

which are likely to experience different wind regimes, can be interconnected through the transmission grid to reduce intermittency, improve overall reliability, and deliver steady generation to such an extent that wind power can provide baseload generation (Archer & Jacobson 2007, p.1701).

Unlike other non-hydro renewable energy technologies, wind is considered a mature technology (see Figure 1.1) as utility-scale wind turbines have been commercially available for decades.

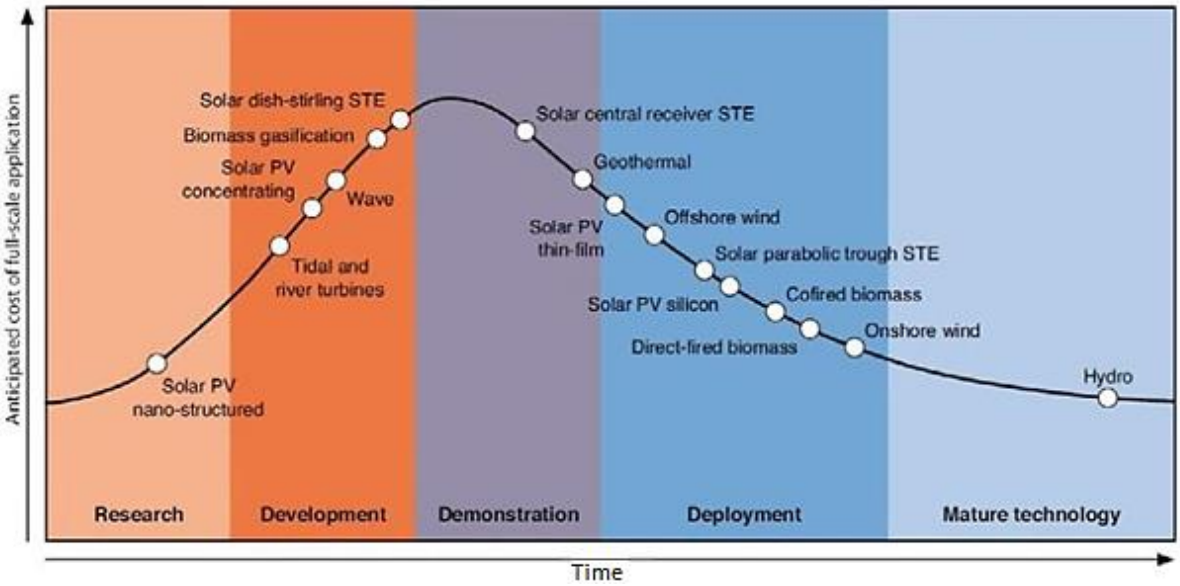

Figure 1.1. Grubb curve of renewable energy technologies. Source: ABARE Australian Energy Resource Assessment 2010.

As a mature commercial technology, wind energy has offered two main advantages over other renewable technologies for some time. First, wind energy has unparalleled cost-competitiveness among non-hydro renewable technologies due to progressive improvements in turbine efficiency combined with decreasing manufacturing costs. Wind-generated electricity costs less per kilowatt-hour (kWh) than the alternatives.

Second, wind energy offers economies of scale as the number and size of wind turbines per wind farm increase, making it suitable for large-scale deployment and the most viable large-scale non-hydro renewable alternative to coal- and gas-fired generation. Large-scale wind deployment has the potential to make a sizeable contribution to GHG emissions reductions because each megawatt-hour (MWh) of wind-generated electricity that displaces coal power avoids nearly a tonne of CO2 emissions (Macintosh 2002). Furthermore, the economies of scale benefit investors as investment costs decrease per kW as turbine capacity increases. Additionally, the reliability improvements and intermittency reductions that come from wind farm interconnection increases as more interconnected sites are added (Archer & Jacobson 2007, p.1701).

Cost-competitiveness and economies of scale have contributed to the growing number – and size – of wind farms in recent years. These advantages have helped make wind energy the fastest growing renewable energy source and among the fastest growing sources of power generation in the world (Slattery, Lantz & Johnson 2011, p.7930).

1.3. RESEARCH PURPOSE

1.3.1. THEORETICAL RELEVANCE

The literature on renewable energy deployment demonstrates a knowledge gap where oil- and gas-producing jurisdictions are concerned. Such jurisdictions present a unique and theoretically relevant research opportunity for a variety of reasons, not least because they often have exceptionally high levels of electricity consumption and among the highest per capita levels of GHG emissions in the world, due to the energy-intensive processes of fuel extraction.

Focusing on filling this knowledge gap, this thesis seeks explanations for variation in wind energy deployment, from 1997 to 2012, across three oil- and gas-producing subnational jurisdictions: the American state of Texas, the Australian state of Western Australia, and the Canadian province of Saskatchewan (see Figure 1.2). Texas, Western Australia, and Saskatchewan, along with the countries in which they are situated, share a number of important institutional, historical, political, cultural as well as economic similarities, as we will discuss in detail in chapter three. Over the last fifteen years, wind energy deployment in Texas has rapidly expanded – the so-called 'Texas wind rush' – making the state a wind energy world leader and attracting the attention of policymakers and academics. Meanwhile, wind energy deployment in lesser-known Saskatchewan and Western Australia has grown only modestly despite the similarities they share with Texas and the favourable public opinion of wind energy in all three places.

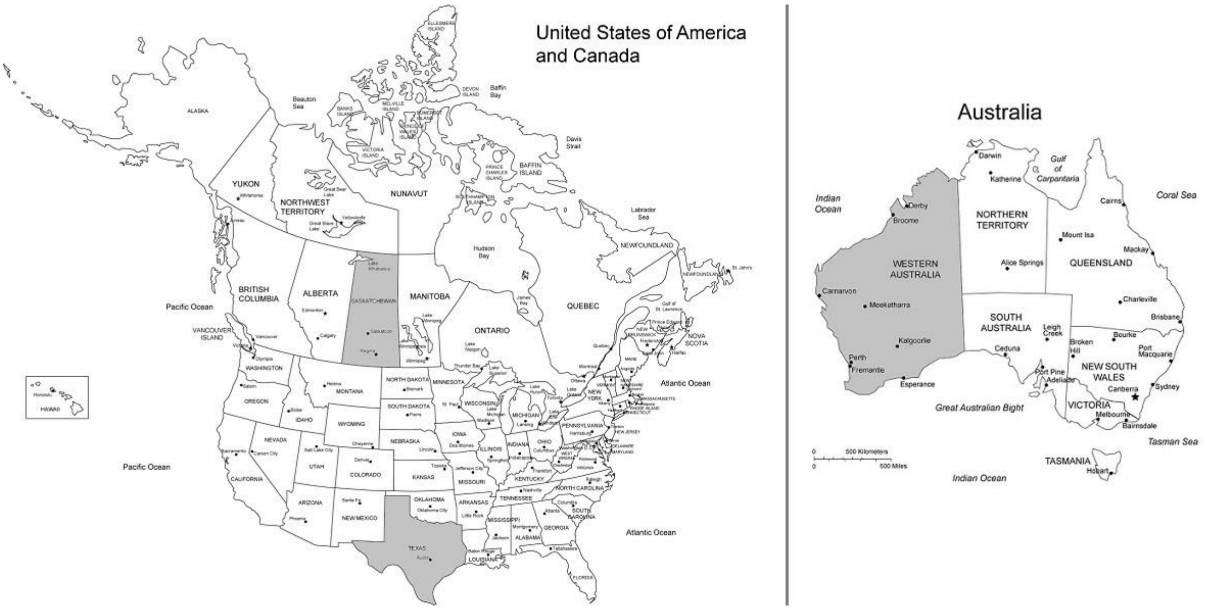

Figure 1.2. Map indicating Saskatchewan and Texas (L), Map indicating Western Australia (R). Source: Adapted from freeusandworldmaps.com.

1.3.2. RESEARCH QUESTION

Therefore, our central research question asks:

What factors can explain divergent wind energy deployment outcomes across these three similar jurisdictions?

1.3.3. SOCIAL RELEVANCE

At the beginning of the chapter, we discussed four drivers – climate change, public health, energy security, and forecasted fossil fuel prices – behind a mounting global imperative to abandon fossil fuel-based electricity generation and to transition to sustainable energy systems. Staving off these threats, and especially climate change, is of the utmost social relevance. A swift transition to renewable energy systems is needed to curb GHG emissions and avert a climate change crisis – to achieve this will require greater, accelerated deployment of renewable energy technologies.

We have also argued that for several decades wind energy technology has been best positioned among non-hydro renewable technologies for large-scale deployment. However, while there has been great interest in wind energy around the world in recent years, deployment has been uneven and there is still no consensus on how best to stimulate it.

This thesis aims to identify the causal mechanisms at work in Texas' rapid, large-scale wind energy deployment program so that lessons relevant to Saskatchewan and Western Australia, and perhaps even other jurisdictions, can be distilled. It also aims to identify the primary barriers to greater wind energy deployment in Saskatchewan and Western Australia.

1.4. SCOPE OF RESEARCH

RD&D (research, development and demonstration) precedes deployment in the aforementioned DOE technology development timeline and makes critical contributions to ever-improving turbines, however, this thesis will not be examining the impact of RD&D funding nor domestic manufacturing on wind deployment.

Although wind energy is well-suited to small- and medium-scale, decentralized, off-grid and distributed generation, this thesis relies on data about utility-scale wind systems that supply power to a jurisdiction’s primary transmission grid and will therefore focus on large-scale wind deployment. There are currently no offshore wind projects in our three jurisdictions so it follows that we will only be looking at onshore wind. The availability of data also shapes our focus on deployment as installed capacity (e.g. megawatts) rather than actual generation (e.g. megawatt-hours).

It is beyond the scope of this thesis to assess the allocative efficiency of financial incentives or other policy instruments, or to detail the far-reaching impacts of wind energy deployment on, for example, GHG emissions reductions, electricity prices, industry growth and employment, and air quality improvements.

1.5. OVERVIEW OF CHAPTERS

Following this introduction, chapter two reviews the scholarly literature, discussing theories about the general factors thought to influence wind energy deployment. Chapter three outlines our comparative case study research design and methodology, describing how the thesis pairs a ‘most similar cases’ case selection strategy with process-tracing analysis and elements of the congruence and comparative analytical methods. Chapter four draws on both the literature and our research design to formulate a theoretical framework in which we identify our five independent variables and corresponding hypotheses. Chapter five defines our variables conceptually and operationally. We then conduct three separate within-case analyses – chapter six for Texas, chapter seven for Western Australia, and chapter eight for Saskatchewan – in which we evaluate our independent variables and weigh our theory-derived predictions against empirical evidence. Chapter nine is a cross-case comparison and discussion of findings from the within-case analyses and draws conclusions about our hypotheses. Chapter ten concludes, identifying main findings and their broader implications, and making recommendations for further research.

2. LITERATURE REVIEW

2.1. DEFINING DEPLOYMENT IN THE LITERATURE

Of the two definitions of the verb (with object) 'deploy' offered by the Oxford English Dictionary, the second is salient to this research: "bring into effective action". The noun form, 'deployment', is often used in reference to technologies. The US Department of Energy (DOE), for example, uses 'deployment' to connote the final, operational, stage of its technology development timeline, ERD3, which stands for 'energy research, development, demonstration, and deployment' (Anadon et al. 2010).

The concept of renewable energy deployment is widely discussed in the literature, particularly within the last decade as interest in the subject has grown. This thesis will focus on deployment in the context of wind energy technology and take the term to connote the achievement of commissioning – the operational phase during which turbines are installed, functional and grid-connected.

In the literature, 'deployment' is used interchangeably with several other terms: 'adoption', 'uptake' (OECD 2011; de Babline, Urmee & Ally 2012), 'dissemination' (Neij & Åstrand 2006; Environment Canada 2006; Saidur et al. 2010; OECD 2011), 'development' (Menz & Vachon 2006; Lewis & Wiser 2007; Toke, Breukers & Wolsink 2008), 'diffusion' (Dinica 2010), 'implementation' (Wolsink 2012), 'utilization' (Doukas et al. 2006) or 'use' (Menz & Vachon 2006; Lewis & Wiser 2007). It is also implied where reference is made to its indicators such as 'penetration' and 'wind capacity'.

2.2. FACTORS INFLUENCING DEPLOYMENT

The literature identifies a multitude of factors known to influence wind energy deployment, however, some of these factors appear to be case-specific. Most researchers find that more than one factor impacts deployment in any given jurisdiction but the importance of individual factors can vary widely based on the context in which it operates.

What follows in this section is a compendium of factors known generally – that is, in more than one jurisdiction – to effect deployment. Several factors arise from political decision-making at the state/province and federal levels: adoption of policy instruments; electricity market type; planning, permitting & siting model; and grid infrastructure upgrading. Other factors found to influence deployment are geographic (wind resources), demographic (population) and social (community acceptance).

2.2.1. QUALITY OF WIND RESOURCES

It is widely conveyed in the literature that the consistent availability of suitable wind resources, unsurprisingly, is a technical requirement for wind energy. Evaluating the quality of wind resources is usually the first step for any wind developer because deployment cannot occur in low-wind areas.

However, several researchers note that the quality of wind resources in a jurisdiction is itself insufficient for explaining deployment outcomes (Toke et al. 2008; Ferguson-Martin & Hill 2011). We can also observe that there are excellent unharnessed wind resources all over the world, both onshore and offshore.

2.2.2. POPULATION SIZE

According to Bohn and Lant's (2009) multi-variable regression analysis of factors influencing variance in installed wind power capacity in 37 US states, population size has the strongest influence because it acts as "a surrogate for electricity demand and accessibility to electrical transmission" (p.94). Their results indicate that every million people bring 65.9 MW of installed capacity (p.94). However, we can also note that many populous jurisdictions around the world have no or low levels of wind energy deployment.

2.2.3. ADOPTION OF POLICY INSTRUMENTS

Over the last few decades, a variety of policy instruments have been implemented in different jurisdictions, and by different levels of government, with the objective of increasing renewable energy deployment. The instruments can also contribute to meeting other, interrelated environmental and energy policy objectives: diversifying electricity generation mixes, decreasing fossil fuel dependency, and lowering the cost of renewable energy relative to conventionally generated energy (Carley 2009).

The literature suggests that some policy instruments have been more effective than others at stimulating renewable energy deployment in real-world applications. However, this can be partially attributed to the specific context in which instruments are applied – the same instrument can perform differently in different conditions. These instruments can be implemented alone or as part of a policy mix, and there can be discrepancy between the expected and the observed effects of instruments applied in certain contexts, highlighting the role of non-policy factors in deployment outcomes (Batlle, Perez-Arriaga & Zambrano-Barragan 2011). Policy instrument selection can offer important clues for why wind energy deployment varies across countries.

2.2.3.1. DIRECT POLICY INSTRUMENTS: PRICE-BASED

Price-based policy instruments can be characterized as financial incentives intended to lower cost of market entry for new generators.

Renewable energy production tax incentives are offered at the national level in some countries, the best known of which is the US Production Tax Credit (PTC). It offers an annual tax credit based on a set price per kilowatt-hour of electricity generated, for the first ten years of a renewable project's operation. The Canadian version of this incentive was a tax rebate rather than a credit.

The *feed-in tariff (FIT)*, also called a standard offer contract, is a high-profile fixed-price policy instrument that has been the subject of much scholarship in the last decade. Wind energy giants Germany (since 1991) and Spain (more recently) have used FIT programs to propel their large wind energy deployment programs. This instrument has been adopted in countries around the world.

Although there is variation across programs, the FIT can be characterized by three common features: long-term purchase agreements for independent power producers, guaranteed grid access for the power they produce, and predetermined prices per kilowatt-hour (kWh) that usually reflect the cost of generation (Couture et al. 2010). These features are intended to give developers confidence they will see returns on their investments and insulate their earnings from fluctuations in fossil fuel prices.

Net-metering allows individual property owners to install small-scale wind generation systems (with a kW cap) at their residence or business and send any excess power to the grid in exchange for payment or utility credit. They do not usually offer incentives for participants to produce more than they consume, and their contribution to total installed capacity is minimal and often not included in capacity tallies of large-scale projects.

2.2.3.2. DIRECT POLICY INSTRUMENTS: QUANTITY-BASED

Quantity-based incentives use market mechanisms to create 'demand pull' for renewable energy. They can be characterized as demand-side instruments.

The most popular such instrument, the *mandatory renewable energy quota,* is a type of regulatory instrument that uses a 'market mandate' to create demand for renewable energy, thereby stimulating deployment. These quotas are known by different names: in US states this is called a renewable portfolio standard (RPS) and elsewhere at the national level, a renewables obligation, a renewable electricity standard or a renewable energy target. This regulatory instrument obligates electric utilities or retailers in a jurisdiction to include a minimum portion of renewable energy in their total electricity generation mix, by a specified date.

While the RPS serves the same broad objective everywhere it is applied – to bring renewable energy deployment up to a mandated minimum – the stipulations in terms of the percentage requirements or additional megawatts of capacity, penalties for noncompliance and types of qualifying technologies can vary greatly. In the absence of a coherent US federal standard, RPS programs with their own targets and deadlines have emerged in 37 US states (Texas Office of the Governor 2012). According to Rabe (2007), the RPS combines "regulation and reliance on market mechanisms … a hallmark of more recent innovations in U.S. environmental and energy policy" (p.10).

While much of the literature proclaims the effectiveness of the RPS at spurring RE deployment, Carley (2009) disputes the impact of RPS policies on deployment, using state-level data from 1998 to 2006 in a fixed-effects vector decomposition model to determine that adoption of RPS policies is not a major predictor of RE deployment.

Tradable certificate schemes are essentially RPS tracking systems that allow companies that do not generate their own RE to buy evidence of RE generation from those who do, with a certificate proving purchases and therefore compliance with the RPS. Such schemes are in place in several European countries, Australia and some US states. The success of these schemes at stimulating deployment hinges on enforcement and the market price of the certificates relative to the penalty price for noncompliance (Wiser, Hamrin & Wingate 2002).

2.2.3.3. OTHER FINANCIAL INSTRUMENTS

The financial incentives in the policy instruments toolkit also include various other subsidies such as *preferential-rate loans, grants,* and *investment incentives.* These are intended to mitigate what Menz and Vachon (2006) call the ‘time profile of costs’: while operating expenses are low, the high upfront capital costs of many RE projects can pose a key barrier to entry (p.1789).

2.2.3.4. INDIRECT POLICY INSTRUMENTS

Carbon taxes are intended to deter further use of polluting conventional electricity generation methods. They can be seen as Pigouvian taxes designed to internalize the cost of pollution, a major negative externality arising from fossil fuel combustion. Carbon pricing asks polluters to pay for their pollution, which indirectly promotes clean RETs and improves its cost-competitiveness.

Similar policy instruments with a positive indirect effect on deployment include *carbon emissions standards* and *carbon emissions trading scheme*s.

2.2.4. ELECTRICITY MARKET TYPE

There is a debate in the literature over the impact of electricity market type on RE deployment levels, particularly that of market restructuring, which has occurred in many parts of the developed world in last two decades. Restructuring has often entailed breaking up traditional state-owned electricity monopoly regimes into separate entities and introducing competitive wholesale and retail markets.

Arguing that wholesale and retail electricity market competition is crucial to boosting RET deployment, Joskow (2008) writes that if the US government is serious about reducing GHG emissions, it needs a national policy supporting electricity market reform in every state. Discussing Canadian provinces, Ferguson-Martin and Hill (2011) conclude that “liberalized electricity markets that encourage or permit private sector involvement appear more likely to accelerate wind energy deployment” (p.1651).

However, Heiman and Solomon (2004) find the opposite true, citing the barriers to RET deployment that accompany market restructuring: “price distortions, lack of storage capability, discriminatory transmission system access, and the end of linked utility rate hikes guaranteed to cover the additional expense of renewable generation” (p.94).

There is also an issue of ‘fit’ between market type and adopted policy instruments. The literature suggests that some policy instruments perform better in the context of specific types of market structures. For example, Wiser et al. (2002) write that the FIT is “more appropriate in a regulated setting where absolute competitive parity is not required” while the RPS is well-suited to both noncompetitive and liberalized electricity markets but requires a strong enforcement mechanism and “complex and sophisticated administration” not needed for a FIT program (p.11). Wiser et al. (2002) also recommend tendering schemes for restructured wholesale markets, especially combined with an RPS (p.11).

The RPS and tradable certificate schemes rely on market mechanisms, making these policy instruments seemingly more compatible with restructured electricity markets with competitive features. Lyon and Yin (2010) find that adoption of an RPS is also more likely in American states with restructured electricity markets.

Menz and Vachon (2006) look at US state-level policies and how they interact with restructured electricity markets, finding an RPS along with mandatory green power options effective at influencing deployment in this context.

2.2.5. PLANNING, PERMITTING AND SITING MODEL

Several scholars identify planning, permitting and siting (PPS) procedures as influencing wind deployment. Taking a historical institutionalist approach, Toke et al. (2008) identify planning systems as key institutions that influence deployment (p.1130).

Referring to these ‘institutions’ as ‘political models’ that encompass planning, permitting and siting activities for wind farms, Bohn and Lant (2009) find statistical evidence of their importance. Of three models ranked by level of simplicity, the ‘minimal’ model, the simplest with few regulatory requirements, was most beneficial to deployment and, according to Bohn and Lant (2009), helped Texas quickly attract investors. By contrast, the ‘standard’ model, the most complicated, had a less positive impact (p.94). Similarly, Ferguson-Martin and Hill (2011) find that “[u]nnecessarily complex regulatory approvals and siting processes can delay or even cancel a wind power project” (p.1651).

2.2.6. TRANSMISSION GRID INFRASTRUCTURE ADEQUACY

Intermittent or variable generation sources like wind can bring challenges to electrical grids built to accommodate incumbent technologies. When wind penetration levels become high, generators can encounter grid capacity constraints (‘congestion’), which usually need to be resolved with upgrading and network expansion.

Modern high-capacity transmission lines are best suited to transmitting electricity from intermittent generators, like wind farms, located far from load centres (Hogan 2008; Scorah, Sopinka & van Kooten 2012). Hogan finds that wind energy investment flourishes in places where transmission infrastructure has been modernized, but describes a persistent chicken-and-egg dilemma concerning which comes first (2008, p.1). Wind developers are hesitant to proceed with a project until they can be assured of transmission, and transmission providers are hesitant to build new or upgraded infrastructure without wind developers committing to project sites. Alagappan, Orans and Woo (2011) conclude that this dilemma has fostered two distinct approaches to transmission planning – a 'reactive' approach, where planning follows a wind developer's request for interconnection (grid hook-up), and an 'anticipatory' approach where planning and possibly construction precedes a wind developer's request (p.5102).

Without public funding, transmission upgrading entails a large investment from utilities that might be unsure if ratepayers are willing to pay extra for clean energy. The grid upgrades also need a critical mass of generators coming on-line to make the investment worthwhile.

Intermittent or variable energy sources like wind – which only generates electricity when weather conditions are suitable, and for which no large-scale battery storage solutions yet exist – benefit from sophisticated 'smart grid' control and dispatch methods to facilitate maximum grid integration. Furthermore, Moura and Almeida (2010) find that demand-side management (DSM) techniques can help grids accommodate and integrate large quantities of wind power.

2.2.7. SOCIAL ACCEPTANCE

Social conditions, such as public opinion of wind energy or attitudes towards environmental protection, can indirectly influence deployment via the political decision-making process, when policies are being created and instruments selected. Social conditions can also directly influence (indeed, make or break) deployment at a much later stage, when wind farm permitting and siting arise.

A number of scholars focus their research on ways in which social acceptance (or lack thereof) can impact deployment (Szarka 2006; Wüstenhagen, Wolsink & Bürer 2007). An important phenomenon has been observed repeatedly, particularly in small countries with high population density – protest groups blocking the permitting and/or siting of wind farms, where the group members support wind energy in the abstract but simply do not want wind farms sited near their communities. The media often refers to such people as 'NIMBYs' – 'not in my backyard'. While some scholars reject the usefulness of the NIMBY label (Devine-Wright 2005; Wolsink 2006), others find empirical evidence for NIMBYism, even if they use a different term. For example, Bell and Haggett (2005) write that a 'social gap' exists in places where public support is high for wind energy but low when a nearby wind farm is proposed.

NIMBYism, however, is not necessarily a permanent condition. Wüstenhagen et al. observe a U-curve in community acceptance over time, often starting high, dipping during a wind project's siting phase, and finally rising again when deployment is complete (2007, p.2685). Researchers studying social barriers to wind energy deployment heavily emphasize the importance of social context, collaborative approaches and meaningful community engagement in the success of wind farm siting (Aitken 2010). In terms of securing wind farm siting, deployment can hinge on public perceptions of (un)fairness in the community consultation process, finds Gross (2007).

It is worth noting that the minimal planning, permitting and siting model seemingly favoured by investors, which we discussed earlier, tends to minimize or bypass community consultation. Ferguson-Martin and Hill (2011) find that this could incite social opposition and impair deployment (p.1651) while Bohn and Lant (2009) find the opposite and endorse bypassing community consultation as a way of improving the likelihood of a project's successful siting (p.98).

In contrast to NIMBY-style community opposition, which can often be assuaged by community consultation processes and tends to weaken over time, deployment prospects are all but doomed where opposition "is based on the fundamental rejection of wind power as an acceptable energy source", write Toke et al. (2008, p.1136). This variety of stubborn resistance is commonly seen with landscape protection organizations, who object, on aesthetic and/or cultural heritage grounds, to any visible alterations of a natural landscape (Warren et al. 2005; Toke et al. 2008, p.1136). The presence of such organizations in England and Wales can partially explain lower levels of deployment in those countries (Toke et al. 2008, p.1137).

2.3. CONCLUSION

While the literature is rich in research identifying case-specific causal factors for wind deployment, in this literature review we have attempted to focus on those factors which are known, more generally, to influence deployment. Our study aims to explain why similar jurisdictions arrive at disparate levels of deployment, and at this point the factors we have identified could be potentially causal influences. However, not all factors will be present in our cases. So in the coming chapters we will discuss our research design and then elaborate on which factors are present in our cases and which ones we suspect are influencing deployment.

3. RESEARCH DESIGN AND METHODS

Frankfort-Nachmias and Nachmias (1992) describe research design as "[t]he program that guides the investigator in the process of collecting, analyzing, and interpreting observations. It is a logical model of proof that allows the researcher to draw inferences concerning causal relations among the variables under investigation" (p.78). Outlining our research design and case selection strategy is crucial to understanding the implications the literature review has on our theoretical framework. Hence, we will address this logical bridge first and then describe our methods – our plan for answering the central research question.

This thesis is a longitudinal comparative case study of 'most similar cases'. It analyses the three cases individually using 'explaining-outcomes process-tracing' analysis to examine temporal variations and the causal mechanisms that may be influencing wind energy deployment outcomes. Then we compare the three sets of findings in a cross-case analysis and discussion in order to more fully assess our hypotheses and draw conclusions.

3.1. COMPARATIVE CASE STUDY

Yin (2003) defines a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (p.13). A case study design allows researchers to examine a case in depth in order to look for insights about complex, real-world phenomena.

This thesis uses a comparative case study design to facilitate our explanatory, 'outcome-centric' research because we are seeking explanations for divergent outcomes in wind energy deployment in three cases. Using longitudinal data, we will look for evidence of cause and effect both over time and across space. Our cases are three subnational jurisdictions: the American state of Texas, the Canadian province of Saskatchewan, and the Australian state of Western Australia. The subnational jurisdiction is our unit of analysis or 'system of action', and we have set a temporal limit for the analyses to the period between 1997 and 2012, which allows us to study the emergence and expansion of large-scale wind energy deployment in these jurisdictions.

3.2. INTERNAL VALIDITY

Internal validity considers the extent to which we can infer that a causal relationship exists between an independent variable and a dependent variable. It queries whether our data reflect the observable implications of our theoretical framework.

When case studies are designed as quasi-experiments – that is, cases are deliberately selected for their characteristics in order to approximate the research controls used in randomized experimental methods – they can be appropriate for examining causes and effects in real-world contexts where ‘true’ experiments cannot be performed.

Faced as we are with multiple potentially causal relationships that could explain divergent deployment outcomes, we have had to decide which variables are the most relevant in our cases and strike a balance between using too few variables (which brings the risk of an overly narrow analysis that misses the main explanatory variables) or using too many variables (which can produce too many viable explanations). We have focused our study on the five strongest independent variables and added a third case to our original proposal (a two-case study) in an effort to bolster internal validity. We anticipate this arrangement will allow us to locate the main explanatory variables.

Although our cases are chosen intentionally, we try to mitigate the threat of spuriousness by testing factors established as being potentially causal in peer-reviewed publications. We try to reduce the risk of select bias by selecting for variation on the dependent variable, in addition to ‘most similar cases’ features.

Due to our use of multiple independent variables, the greatest challenge to internal validity is likely the threat of overdetermination, which occurs when the observed effect (deployment) can be simultaneously determined by multiple causes, any one of which alone may sufficiently account for the effect. However, we will attempt to mitigate this by tracking our variables annually, and monthly in certain instances, to look for nuanced changes in values.

3.3. CASE SELECTION

This thesis uses a ‘most similar cases’ case selection strategy, which derives from the “most similar systems design” described by Przeworski and Teune (1970). ‘Most similar systems’ allows for causal inference that hinges on comparing cases with characteristics that are as similar as possible. The concept is related to John Stuart Mill’s “method of difference” (1858), which advises using cases so similar they differ only on the dependent variable. Mill’s design is intended to simplify the identification of a single common independent variable that explains the presence or absence of the dependent variable, since irrelevant variables are kept constant. While we have selected our cases according to the logic of MSSD, Mill’s “method of difference” design is too restrictive for our research; our operationalization is complicated and we expect, based on the literature review, that more than one causal variable is influencing outcomes.

The logic of the ‘most similar cases’ method of case selection serves as the foundation for the social sciences subfield of area studies, which assumes that geographic clusters, such as the Scandinavian countries, are as similar as possible across multiple dimensions and therefore best-suited for outcome-oriented explanatory studies. Much of the scholarship on renewable energy deployment draws on the assumptions and techniques of area studies, comparing cases selected according to close geographic proximity, such as clusters of EU countries or of subnational jurisdictions of a country like the US.

However, somewhat counter-intuitively, the use of geographic proximity as the primary criterion for case selection can serve to underscore the institutional, political, cultural and economic differences between cases that can manifest in a jurisdiction's approaches to energy and environmental policy. For example, wind farm siting in Britain often incites deployment-halting protest from landscape protection groups motivated by a particular understanding of British cultural heritage, while such groups are not active in nearby Spain, because preservation of rural landscapes does not figure prominently in Spanish culture (Toke et al. 2008, p.1137). While this research has enriched our knowledge of the subject, the resulting list of factors found to influence renewable energy deployment is long, varied and sometimes difficult to generalize.

With this in mind, we have selected our three subnational jurisdictions in order to control for as many institutional, social, cultural, political and economic factors as possible, at both the national and subnational levels.

3.4. SAMPLE PERIOD

To trace the emergence and subsequent expansion of wind energy deployment, we have selected the time frame spanning 1997 to 2012 for analysis. The year 1997 was chosen because it offers a baseline scenario where existing wind deployment levels in our cases were minimal, and it is before significant changes occur in our independent variables, such as electricity market reform or the adoption of policy instruments. Focusing on this time frame allows us to measure the effect that changes in our IVs have on our DV.

3.5. DATA COLLECTION

The validity and reliability of findings from case study research is strengthened when information is gathered from multiple sources (Yin 2003, p.97). This thesis draws its theoretical framework from the scholarly literature on renewable energy deployment but relies primarily on a range of empirical sources for data against which to test the explanatory potential of competing theories.

For quantitative data, we use publications issued by a number of ministries and departments within national and subnational governments. We also use census data along with reports from electricity systems operators and utilities, electricity market operators and regulators, and industry organizations.

3.6. WITHIN-CASE ANALYSIS

Recognizing the limitations of relying on published sources of information, for the three within-case analyses we will use a variant of process tracing, the method described by George and Bennett (2005) as “an operational procedure for attempting to identify and verify the observable within-case implications of causal mechanisms” (p.137-8). George and Bennett (2005) describe a variant where “the investigator constructs a general explanation rather than a detailed tracing of a causal process” (p.211), where every step of the causal chain need not be identified and theoretically predicted. Beach and Pedersen (2013) call this variant “explaining-outcome process-tracing” and note its suitability where researchers are attempting to compile “a minimally sufficient explanation of a particular outcome” (p.18). This approach allows for “the pragmatic use of mechanismic explanations to account for the important aspects of the case” (p.11).

The validity of explaining-outcome process-tracing is enhanced by its pairing with a ‘most similar systems’ design, which should enable us to establish causality.

3.7. CROSS-CASE ANALYSIS

After conducting three separate within-case analyses, we compare their findings in a cross-case analysis, looking for additional insight about the causal mechanisms at work. We take note of covariation where present but do not view its absence as necessarily disconfirming evidence. We draw on the logic of congruence analysis in these situations to assess the extent to which the data reflect the theory’s implications. Haverland (2010) writes of congruence analysis that “[a]n explanation is valid if the implications of a proposed theory fit the data and the implications of rival theories do not fit the data” (p.71).

3.8. CONSTANTS

In order to provide a semi-controlled scenario that helps rule out alternative explanations for divergent outcomes, we draw on Sartori’s (1991) assertion that “comparing is controlling” by selecting highly comparable ‘most similar cases’ – the subnational jurisdictions of TX, SK, and WA. These jurisdictions offer this research a number of salient constants.

3.8.1. THE US, CANADA AND AUSTRALIA: NATIONAL SIMILARITIES

Before we discuss similarities between our three cases, we should note that the countries to which these jurisdictions belong – the United States (US), Canada and Australia – share a number of institutional, political, economic, social, and linguistic traits that stem from their shared *historical origins as British colonies* in the New World.

According to the varieties of capitalism framework presented by Hall and Soskice (2001), our three countries, like many other Anglo-Saxon countries, are *Liberal Market Economies*. This means we should expect a degree of similarity in their institutional structures. We should also expect a similar level of affluence as all three countries are considered highly developed Western nations.

Another similarity is that the US, Canada and Australia have highly decentralized *federalist systems of governance*. Federalist systems see decision-making powers divided between federal, state/provincial and municipal governments, as established in their constitutions.

In *Patterns of Democracy*, Lijphart (1999), too, points out similar institutional and political decision-making conditions in the US, Canada, and Australia. His research identifies them as a cluster of countries featuring majoritarianism on the executives-parties dimension of democracy as well as strong federal institutions and decentralization on the federal-unitary dimension.

Despite being parties to the 1992 UN Framework Convention on Climate Change (UNFCCC), the US, Canada and Australia continue to rank among the *largest emitters of carbon dioxide* (CO2) in the world, according to the IEA (2012). On a per capita basis, these countries find themselves consistently in the top five for CO2 emissions, which makes them particularly prone to international scrutiny and pressure for climate change action. This pressure notwithstanding, the US, Canada and Australia have been loath to making binding international commitments, agreeing only to *modest and/or non-binding GHG emissions reduction targets*. In the non-binding Copenhagen Accord of 2009, the US agreed to reduce GHG emissions to 17% below 2005 levels, and Canada intentionally aligned itself with the US by adopting the same target. While Australia and Canada were both signatories of the Kyoto Protocol, Canada withdrew in 2011 after a change in government. Australia's GHG emissions reduction target, set at Cancun, is binding but a modest 5% from 2000 levels by 2020, with an additional 10-20% reduction contingent on participation from other developed countries.

3.8.2. TEXAS, SASKATCHEWAN AND WESTERN AUSTRALIA: SUBNATIONAL SIMILARITIES

Having described the national contexts in which our subnational jurisdictions are embedded, we will look at the ways in which Texas, Saskatchewan and Western Australia are similar and identify the 'constants' they provide this research.

Of particular salience to this thesis, responsibility for natural resources, a category frequently including energy and electricity, falls primarily to the state/province, thus demonstrating an important way in which the subnational jurisdiction is an appropriate unit of analysis or ‘system of action’ for this study. There is also a division of power between the federal and subnational governments over the environment. An interesting shared feature is that while the federal governments have the authority to conclude international treaties like the Kyoto Protocol, requiring GHG reductions, the reductions cannot be achieved nor can the targets be enforced without the cooperation of the states/provinces.

While failure to cooperate at the international level critically prevents a coordinated approach, in some countries a trend of ‘bottom-up’ action on climate change has been observed (Rabe 2004). In countries with federalist systems, like the US, Canada and Australia, subnational jurisdictions (territorial units like states and provinces) are largely responsible for their own energy and natural resources policies. In what some scholars are calling acts of ‘environmental federalism’, some states and provinces have taken it upon themselves to adopt binding renewable energy targets for their electricity sectors (Lutsey & Sperling 2008). A large portion of all GHG emissions are produced by electricity generation – specifically, conventional generation technologies that use fossil fuel combustion. So where these targets have been well designed and enforced, renewable energy has made impressive penetration into electricity generating mixes, sometimes bringing thousands of new megawatts of installed renewable capacity onto grids as coal-fired power plants are retired. However, not all states and provinces have adopted such targets and not all targets are well designed, offering opportunities for policy learning and innovative policymaking.

The nature of their economies, based as they are on natural resources, is a key similarity between TX, SK and WA, and this yields other shared characteristics. *Fossil fuel extraction and export are primary economic activities* in our three cases. The profitability of petroleum, natural gas and coal-related activities has resulted in income levels that are above national averages as well as recent population growth triggered by job creation in the resource sector.

That the economies of TX, SK and WA are based on oil and gas sector activities translates directly into *elevated electricity use* in these jurisdictions, which consume electricity at well above their countries’ per capita national averages. Because electricity production by conventional methods is a major source of GHG emissions, and because clean energy technologies still only make up less than 12% of total electricity generating capacity in our cases, our three jurisdictions are not only the largest GHG emitters per capita in their respective countries, but among the largest emitters in the world. In short, our cases are the *top emitters in top emitting countries*.

TX, SK and WA are uniquely poised for criticism as major polluters consuming large amounts of dirty, fossil fuel-based electricity in order to extract still more fossil fuels for export. Effectively their economies are built on perpetuating the world’s problematic reliance on fossil fuels. We might therefore expect that international pressures placed on the US, Canada and Australia to cut emissions and wean off fossil fuels would produce state/province-level pressures to accelerate the rate of RET deployment in our subnational jurisdictions. For this reason, we will treat our cases as sharing a compelling driver – external pressure to reduce GHG emissions – for wind energy deployment.

However, top-down pressures to reduce GHG emissions for the sake of climate protection notwithstanding, the economies of TX, SK and WA are firmly based on fossil fuels and will likely remain that way for decades to come. Environmental protection is sometimes crudely framed as being at complete odds with economic growth – a zero-sum game. However, this zero-sum logic is brought into starkest relief in our cases because the livelihood of TX, SK and WA residents depends on the continued exploitation of fossil fuels. We would therefore expect residents to oppose the adoption of state/province-level indirect policy instruments designed to stifle demand for fossil fuels, such as carbon taxes or cap-and-trade schemes. We might also expect residents to be less concerned about climate change than other populations. Such attitudes would likely be taken into consideration by political decision-makers who hold the ability to implement policy instruments and structural reforms. A majority of political representatives in TX, WA, and SK are affiliated with right-of-centre parties. This is a long-standing feature in TX and WA, but a newer one in SK.

Geographically, TX, SK and WA share common features that are highly relevant to this research. First of all, they are situated in locations offering an excellent quality of wind resources, meaning there are abundant natural opportunities for wind power generation and optimum turbine performance, in terms of capacity factor. Second, in terms of physical terrain, all three have vast expanses of uninhabited or sparsely populated land outside urban areas, where wind farms tend to be built. This ample space for wind farm siting should theoretically improve the likelihood of social acceptance in our three cases, providing another important constant for our research, by mitigating the risk of social opposition from the NIMBYs and landscape protection groups (Richards, Noble & Belcher 2012, p.695).

3.9. EXTERNAL VALIDITY

Findings from case study research are sometimes perceived to offer poor generalizability. Yin refutes this, however, writing that:

> *the method of generalization is 'analytic generalization,' in which a previously developed theory is used as a template with which to compare the empirical results of the case study. If two or more cases are shown to support the same theory, replication may be claimed (Yin 2003, p.32-3).*

By analyzing three cases, this thesis draws on the logic of replication in an attempt to strengthen external validity. While we do not expect our findings to be able to support widely generalizable claims, we hope this research has applicability to other similar jurisdictions.

3.10. CONCLUSION

We have selected ‘most similar cases’ to control for as many variables as possible. To leverage our research design, we will be using ‘explaining-outcomes’ process-tracing for the within-case analyses and the comparative and congruence methods for the cross-case analysis.

4. THEORETICAL FRAMEWORK

In this outcome-centric thesis, we take an explanatory theoretical approach to our analysis of divergent wind deployment outcomes in Texas, Saskatchewan, and Western Australia. In the literature review we identified a variety of factors that researchers have found to influence wind energy deployment generally. Then, in the research design and methodology chapter we outlined our comparative case study design, case selection and data collection strategies, and analytical approaches to within-case and cross-case analyses.

We expect that wind energy deployment is influenced by multiple factors. Increasing the rate and scale of wind energy deployment offers to satisfy objectives set by energy policy, climate change policy, environmental policy, industrial policy, national security policy and public health policy, so multi-causality seems likely. This thesis endeavors to tease apart potential causal factors and ultimately identify the main causal variables.

4.1. CONTROLLING FOR TWO CAUSAL VARIABLES AND RULING OUT A THIRD

In the previous chapter, we took stock of the ways in which our 'most similar cases' case selection strategy provides multiple constants. Importantly, it allows us to control for two potentially causal factors identified in the literature as influencing deployment: wind resources and social acceptance.

4.1.1. WIND RESOURCES

TX, SK and WA have similarly excellent wind resources in large parts of their terrain. This means there is a practically inexhaustible supply of suitably strong and reliable wind that can be harnessed. More importantly, however, The equal technical potential, and likely similar performance in terms of capacity factors, for wind deployment in our cases, afforded by high quality wind resources, means this variable is held constant and cannot account for divergent deployment outcomes.

4.1.2. SOCIAL ACCEPTANCE

Toke et al. (2008) note that wind projects proposed in small, densely populated countries like England and the Netherlands are more prone to deployment-preventing social opposition. They write, "the more densely populated a region is, the more spatial claims will exist and the more conflicting land uses may emerge" (p.1133).

Our cases all boast vast swathes of uninhabited or sparsely populated rural areas far away from communities, making them ideal in this respect for wind farm siting (Richards, Noble & Belcher 2012, p.695). On this basis we are assuming that the ample space for wind farm siting in our cases drastically reduces the chances of NIMBY ('not in my backyard') action.

Furthermore, we assume the rural residents of our jurisdictions are likely to be familiar with the often visually unappealing industrial landscapes created by extensive oil, gas and mining activities. This attribute greatly reduces the chances that landscape protection groups are active there. We are therefore assuming that social acceptance is all but ensured by the vast, sparsely populated terrain of our three jurisdictions, and can be treated as another important constant.

4.1.3. POPULATION SIZE

We were able to rule out the two previous potential variables because they were similar (constant) across our three cases. However, we will now rule out another potential variable identified in the literature because it does not accommodate a demographic dissimilarity between our cases: population size.

The quantitative research identifying population size (a surrogate for electricity demand) as an important causal variable – the primary influence on wind deployment in 37 US states, in fact – measures its effect on deployment in absolute terms, in total installed capacity (Bohn & Lant 2009). They find total installed capacity is related to population size, which is predictable because larger populations consume more resources.

As this thesis will be comparing three subnational jurisdictions with different population sizes, we will use two other, more representative indicators, in addition to total installed capacity, to measure wind energy deployment: total installed capacity per 100 people, and wind penetration of total generation capacity (wind’s share of the mix). These two indicators can account for population size variations, making them valuable to our analyses. Indeed, it is with these two indicators that we can determine that tiny Denmark is actually a wind energy world leader with “just” over 4,100 MW of total installed capacity in 2012. Therefore, as a potential causal variable in this research, we find population size weak in explanatory power for our purposes and will exclude it from consideration.

4.2. FIVE COMPETING CAUSAL EXPLANATIONS

By ruling out population size as an important causal factor, and by holding constant the wind resources and social acceptance factors, we are able to narrow the scope of our investigation to the five causal factors – our independent variables – we think offer the strongest explanatory potential (see Figure 4.1).

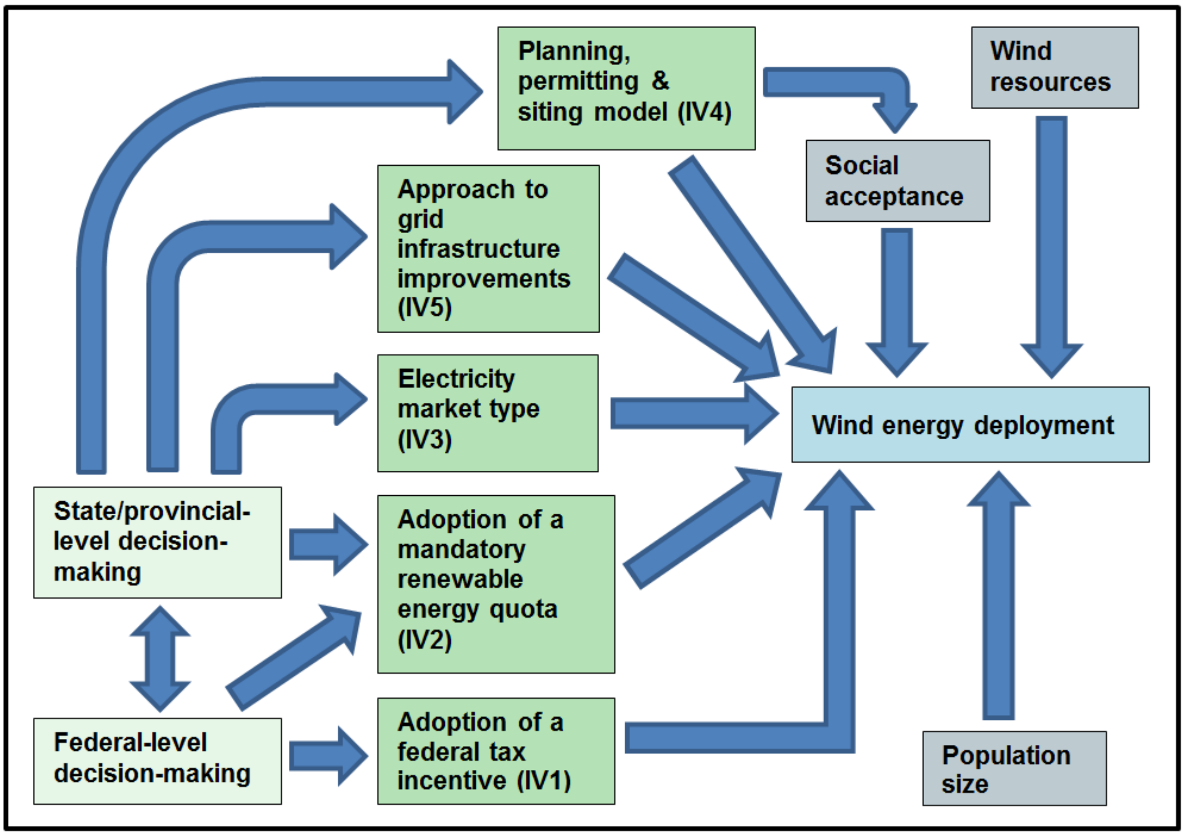

Figure 4.1. Five factors we expect to influence wind deployment in our cases.

Next we develop our hypotheses. Johnson, Reynolds and Mycoff (2008) define a hypothesis as a theoretically-derived testable statement of causal relationship between two variables that "represents the proposed explanation for some phenomenon and that indicates how an independent variable is thought to affect, influence, or alter a dependent variable" (p.70).

4.2.1. IMPROVING THE FINANCIAL VIABILITY OF WIND ENERGY

A federal wind energy production tax incentive, like the US production tax credit (PTC), is a policy instrument designed to increase wind deployment. It encourages deployment by lowering two major barriers to entry for would-be RE producers: high upfront capital requirements and low cost-competitiveness of wind-generated electricity relative to conventional generation. Essentially the instrument works by improving the financial viability of wind projects for developers, which is the most important consideration for private sector actors.

When offering such financial incentives, governments will often explain that they are only supporting RETs until they are commercially competitive with conventional generation. This principle is a cornerstone of industrial policy. However, renewable energy faces a particularly unlevel playing field, making federal tax incentives crucial in the short-term but not a real solution to structural disadvantages in the market in the longer term.

Renewable energy technologies are at a disadvantage in the marketplace for two main reasons. First, fossil fuel-based conventional generation is often the least expensive generation type in part due to market failures that have not internalized the marginal social costs of air and atmospheric pollution, its major negative externality. Without carbon taxes and/or carbon emissions trading, users do not bear the full costs of conventional generation, making it underpriced and overprovided, while non-emitting electricity is overpriced and underprovided.

Second, renewable energy technologies need financial supports from governments because of many governments' own massive long-term subsidies to the nuclear and fossil fuels sectors, which further distort economic costs (Wiser, Bolinger & Barbose 2007, p.13). Compared to these subsidies, the financial supports available to wind energy is a pittance. In 2011, the European Commission reports that in 2004 the European fossil fuels industry received €21 billion while renewable energy technologies received €5.3 billion (in Szarka 2012, p.237). These subsidies, combined with the marginal social cost of pollution going unpaid, make conventional generating technologies artificially inexpensive.

In the face of these considerable competitive challenges, supportive government policies and financial incentives are needed to push for greater renewable energy deployment. Toke et al. (2008) find that financial incentives vary in effectiveness across countries at stimulating deployment, but conclude such incentives are indispensable policy instruments, calling them a "sine qua non for large-scale deployment" (p.1137). Furthermore, the PTC's positive influence on wind deployment in the US is highlighted in the literature, so we expect the PTC and its lower-value Canadian equivalent to exert causal influence on wind deployment in Texas and Saskatchewan, respectively. Therefore, we arrive at our first hypothesis:

H1: Jurisdictions with a high-value federal wind energy production tax incentive will have increased levels of wind energy deployment

4.2.2. USING POLICY TO DRIVE DEMAND FOR RENEWABLE ENERGY

While the federal tax incentive boosts deployment by improving the cost-competitiveness of wind energy, the mandatory renewable energy quota boosts deployment by increasing market demand for renewable energy. This regulatory instrument takes the form of a government mandate obligating electric utilities and retailers to purchase a minimum percentage of their power from renewable generation sources, usually by a specific date, or face a penalty.

Because the quota means a minimum amount of RE will be deployed, this instrument allows governments a way to compensate for the market failures that underprovide renewable energy. At the federal level in Australia, this mandatory quota is known as a Renewable

Energy Target (RET), while in North America it is known as a Renewable Portfolio Standard (RPS).

Our cases allow us to compare the effect of mandatory quotas in Texas and in Western Australia, at different 'levels of ambition' for quota goals.

H2: Jurisdictions with a highly ambitious mandatory quota goal will have increased levels of wind deployment

4.2.3. LIBERALIZING ELECTRICITY MARKETS TO INCREASE OPPORTUNITIES FOR INDEPENDENT POWER PRODUCERS

Wiser et al. (2007) note that in the US approximately 90% of wind power capacity is owned by independent power producers (IPPs). Ferguson-Martin and Hill (2011) also find this true in the Canadian context. It would therefore seem that market conditions that attract private investors – prospective IPPs – would benefit wind deployment.

Based on the findings in the literature, we expect that competitive wholesale electricity markets provide more opportunities for private developers to take up wind generation and participate in the market than noncompetitive electricity regimes are. In competitive markets, private investors can become IPPs who sell wind-generated electricity to the grid. Electricity regimes closed to competition, like those dominated by the traditional vertically integrated state-owned utility, do not offer many business opportunities for prospective IPPs seeking to start wind projects and we expect this to be linked to lower levels of wind deployment.

The literature also suggests that the RPS regulatory instrument is more effective at promoting wind deployment when implemented in the context of competitive markets.

H3: Jurisdictions with a high level of competition present in their electricity market will have increased levels of wind deployment

4.2.4. MINIMIZING REGULATIONS TO ACCELERATE DEPLOYMENT AND ATTRACT DEVELOPERS

In terms of regulatory requirements for planning, permitting and siting, Ferguson-Martin and Hill (2011) find that "[s]treamlined and less stringent processes can reduce project risk and are preferred by developers" (p.1651). Therefore, we expect that jurisdictions using a 'minimal' model for planning, permitting and siting (PPS), according to Bohn and Lant's (2009) three model scale (depicted in Figure 4.2), will have simplified procedures that are few in number, which should attract potential developers and thereby enhance wind deployment levels (2009). This works by improving the financial viability of projects by reducing lead times and by minimizing the need to hire external consultants to manage regulatory procedures.

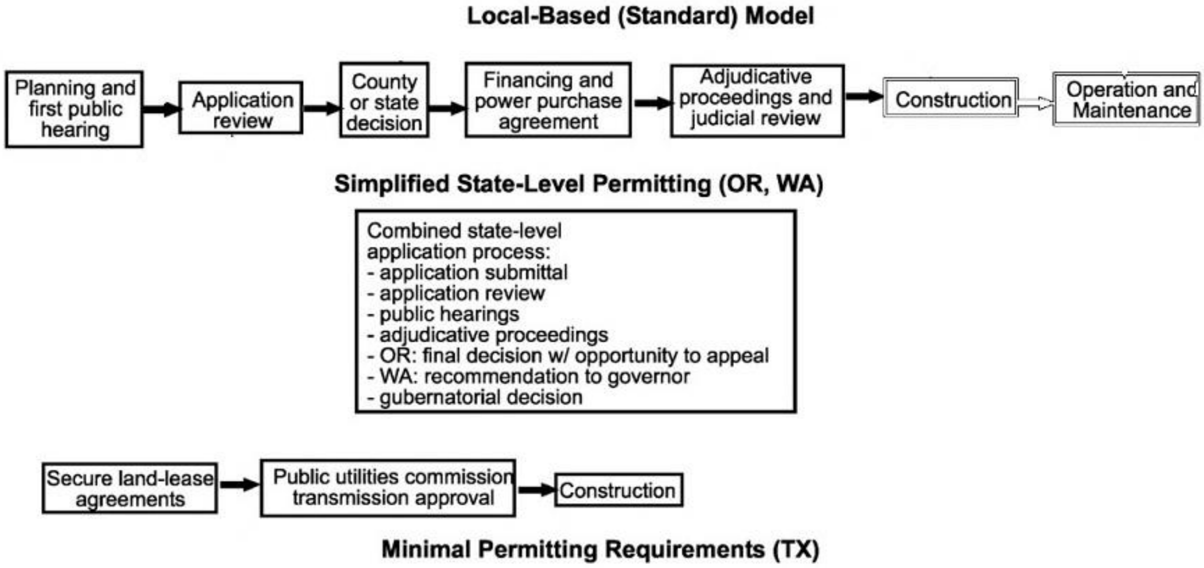

Figure 4.2. Three planning models (adapted from Bohn & Lant 2009, p.93)

Conversely, we expect that jurisdictions using the most complicated 'standard' model to deter prospective developers with mandatory extra steps like environmental assessments and feasibility studies, stakeholder consultations, and approval from multiple levels of government.

H4: Jurisdictions using a simplified planning, permitting and siting model will have increased levels of wind deployment

4.2.5. IMPROVING TRANSMISSION GRID INFRASTRUCTURE TO ACCOMMODATE WIND POWER

Alagappan et al. (2011) describe two approaches to transmission grid infrastructure improvements (i.e., transmission upgrading and network expansion): a 'reactive' approach where "transmission planning and construction occurs after a renewable developer's request for transmission interconnection and service", and an 'anticipatory' approach where transmission planning sometimes construction precedes a wind developer's request (p.5102).

We expect that a jurisdiction's use of an 'anticipatory' approach to transmission improvements boosts deployment by improving the grid's physical ability to effectively integrate wind energy (e.g. with new high capacity transmission lines), thereby reducing the potential for problems stemming from transmission insufficiency like congestion and wind generation curtailment.

H5: Jurisdictions using an anticipatory approach to grid infrastructure improvements will have increased levels of wind deployment

4.3. CONCLUSION

In this chapter we generated a theoretical framework by critically reviewing the potential causal factors suggested by the literature and speculating on the importance of specific factors in our cases. We then elaborated on the theoretical underpinnings of our competing causal explanations – our hypotheses. In the coming chapters, we will test our five hypotheses by analyzing the extent to which the empirical data reflect the observable implications of our theoretical framework.

5. CONCEPTUALIZATION AND OPERATIONALIZATION

In the previous two chapters we brought the theories and findings of the literature into the context of our three cases. We identified constant variables and a variable with weak explanatory power before going on to identify the five potentially causal factors we expect offer the most explanatory power, our independent variables (IVs). In this chapter we will give conceptual and operational definitions for our dependent variable (DV) and five IVs, laying the foundation for the empirical observations we will be making in the case studies to come. To conclude, we discuss measurement reliability and validity, and summarize our variables in tabular form.

5.1. DEPENDENT VARIABLE: DEPLOYMENT

CONCEPTUAL DEFINITION

A dependent variable is the presumed effect of one or more causes. It is the variable we seek to causally explain. This thesis treats wind energy deployment outcomes as its DV.

As we discussed in the literature review, of two definitions of the verb (with object) 'deploy' offered by the Oxford English Dictionary, the second is salient to this research: "bring into effective action". The noun form, 'deployment', is often used in reference to technologies. We are conceptually defining the term to connote the achievement of commissioning – the operational phase during which turbines are installed, functional and grid-connected.

In the literature review we mentioned that deployment is used interchangeably with terms like 'adoption', 'uptake', 'dissemination', 'development', 'diffusion', 'implementation', and 'utilization'. These terms are treated by researchers as theoretically and operationally identical to deployment.

OPERATIONAL DEFINITION

We are operationalizing deployment outcomes with four main quantitative indicators in order to paint as full a picture as possible of changes in DV values over the sample period.

First, we should cover the term 'installed capacity'. Also known as nameplate capacity, it is the maximum electric output a (group of) turbine(s) can produce according to the manufacturer, and it is measured in megawatts (MW).

INDICATOR 1: *Total installed capacity* is the cumulative amount of installed wind capacity in absolute terms and measured in MW.

INDICATOR 2: *Annual capacity additions* are the amount of new wind capacity installed each year, measured in MW.

INDICATOR 3: *Total installed capacity per 100 people* divides the first indicator values across a population, producing values measured in kilowatts (kW) per capita. This is a relative measure that allows us to compare deployment across jurisdictions with different population sizes.

INDICATOR 4: *Wind penetration of total generation capacity* is the share of wind capacity within a jurisdiction's larger electricity generation mix or portfolio, measured by percentage. This is also a relative measure, and it indicates the amount of wind capacity versus capacity from coal, natural gas, hydroelectricity, nuclear, etc.

In a few circumstances, a change in IV value occurs too close to the end of the sample period for us to observe any possible effects on deployment as measured by the DV indicators specified above. Here we take into consideration indicators of potential deployment, such as wind project proposals, and indicators of future deployment, such as wind projects under construction or at an advanced planning stage.

5.2. INDEPENDENT VARIABLE ONE (IV1): FEDERAL WIND ENERGY PRODUCTION TAX INCENTIVE

CONCEPTUAL DEFINITION

A federal wind energy production tax incentive is a type of policy instrument that can be theoretically defined as a financial incentive available to new wind projects upon their commissioning and calculated on the basis of kilowatt-hours (kWh) of electricity produced.

OPERATIONAL DEFINITION

We are operationalizing IV1 as real values on a scale of 0-2 cents per kWh of wind-generated electricity production that corresponds to ordinal values reflecting level of incentive value, where 0 = no incentive/low value (e.g. 0-cents/kWh), 1 = medium (e.g. 1-cent/kWh), 2 = high (e.g. 2-cents/kWh).

5.3. INDEPENDENT VARIABLE TWO (IV2): MANDATORY RENEWABLE ENERGY QUOTA

CONCEPTUAL DEFINITION

A mandatory renewable energy quota can be theoretically defined as a regulatory instrument in the form of a government mandate that obligates electric utilities and retailers to purchase a minimum percentage of their generation mix from renewable sources.

OPERATIONAL DEFINITION

We are operationalizing IV2 as ordinal values reflecting the ambitiousness of the mandatory quota goal (scale of 0 to 3), where 0 = no/voluntary quota, 1 = low (quota <12% RE capacity by end-year), 2 = medium (quota 12% - 24%), 3 = high (quota >24%) (adapted from Carley 2009, p.3074).

5.4. INDEPENDENT VARIABLE THREE (IV3): ELECTRICITY MARKET TYPE

CONCEPTUAL DEFINITION

A liberalized electricity market can be theoretically defined as a restructured electricity market featuring competition.

OPERATIONAL DEFINITION

We are operationalizing IV3 as ordinal values reflecting the level of competition present in the electricity market (scale of 0 to 3), where 0 = no competition, 1 = low (some wholesale competition), 2 = medium (wholesale competition), 3 = high (wholesale and retail competition).

5.5. INDEPENDENT VARIABLE FOUR (IV4): PLANNING, PERMITTING AND SITING MODEL

CONCEPTUAL DEFINITION

On a three-model scale created by Bohn and Lant (2009), the 'minimal' planning, permitting and siting (PPS) model can be theoretically defined as the simplest procedures for proposed wind projects, allowing them to commence construction without many intervening steps.

OPERATIONAL DEFINITION

We are operationalizing IV4 as ordinal values reflecting the PPS model's level of simplicity (scale of 0 to 2), where 0 = low ('standard' model), 1 = medium ('streamlined'), 2 = high ('minimal') (terminology adapted from Bohn & Lant 2009).

5.6. INDEPENDENT VARIABLE FIVE (IV5): GRID INFRASTRUCTURE

CONCEPTUAL DEFINITIONAL

Alagappan et al. (2011) define an 'anticipatory' approach (versus a 'reactive' approach) to grid improvements as transmission planning and sometimes construction that precede a developer's interconnection request.

OPERATIONAL DEFINITION

We are operationalizing IV5 as binary ordinal values reflecting the jurisdiction's approach to grid improvements, where 0 = 'reactive', 1 = 'anticipatory' (terminology adapted from Alagappan et al. 2011).

5.7. MEASUREMENT RELIABILITY

Measurement procedures that yield the same results on repeated trials are considered to be reliable. As discussed in our data collection section, most of our data comes from publications issued by operators of electricity systems and markets, governments, industry groups, think tanks and international organizations, as well as from the literature. Therefore, most of our indicator values can be empirically determined, improving reliability.

In a few instances we consult online news sources, which are less reliable, about proposed wind projects or wind projects under construction, and about recent political events.

5.8. MEASUREMENT VALIDITY

All of our indicators derive from the scholarly literature and have been subject to peer review. Therefore, they can be thought to produce accurate results.

TABLE 1. SUMMARY OF VARIABLES AND INDICATORS

	Variable	Indicator
DV	Deployment	1. Total installed wind capacity (MW) 2. Annual wind capacity additions (MW) 3. Total Installed wind capacity per 100 people (kW) 4. Wind penetration of total generation capacity (%)
	Potential deployment	Wind project proposals
	Future deployment	Wind projects under construction, at an advanced planning stage or financially committed to
IV1	Federal wind energy production tax incentive	Value of incentive (scale of 0- to 2-cents/kWh) 0 = no incentive/low value (e.g. 0-cents/kWh) 1 = medium (e.g. 1-cent/kWh) 2 = high (e.g. 2-cents/kWh)
IV2	Mandatory renewable energy quota	Ambitiousness of mandatory quota goal (scale of 0 to 3) 0 = no/voluntary quota 1 = low (quota <12% RE capacity by end-year) 2 = medium (quota 12% - 24%) 3 = high (quota >24% RE)
IV3	Electricity market type	Level of competition present (scale of 0 to 3) 0 = no competition 1 = low (partial wholesale competition) 2 = medium (wholesale competition) 3 = high (wholesale and retail competition)
IV4	Planning, permitting & siting model	Level of simplicity (scale of 0 to 2) 0 = low (‘standard’ model) 1 = medium (‘streamlined’) 2 = high (‘minimal’)
IV5	Grid infrastructure	Approach to grid improvements (scale of 0 or 1) 0 = ‘reactive’ 1 = ‘anticipatory’

6. CASE ANALYSIS: TEXAS

This within-case analysis takes a longitudinal approach to examining wind energy deployment outcomes and their possible causes in Texas over the sample period of 1997 to 2012. The chapter comprises two parts. The first part evaluates Texas' wind energy deployment outcomes across several DV indicators. The second part is organized by hypothesis and uses an explaining-outcome process-tracing analysis to identify causal mechanisms that can help explain how an IV may be influencing the DV. We also assess time series graphs, looking for covariation or, in its absence, drawing on the logic of congruence analysis to determine the extent to which the data reflect a theory's implications.

6.1. BACKGROUND

Texas has several sparsely-populated regions with excellent wind resources, particularly the Texas Panhandle in the state's northwest, the mountainous Trans-Pecos area in the west, and along the Gulf Coast in the south east (see Figure 6.1).

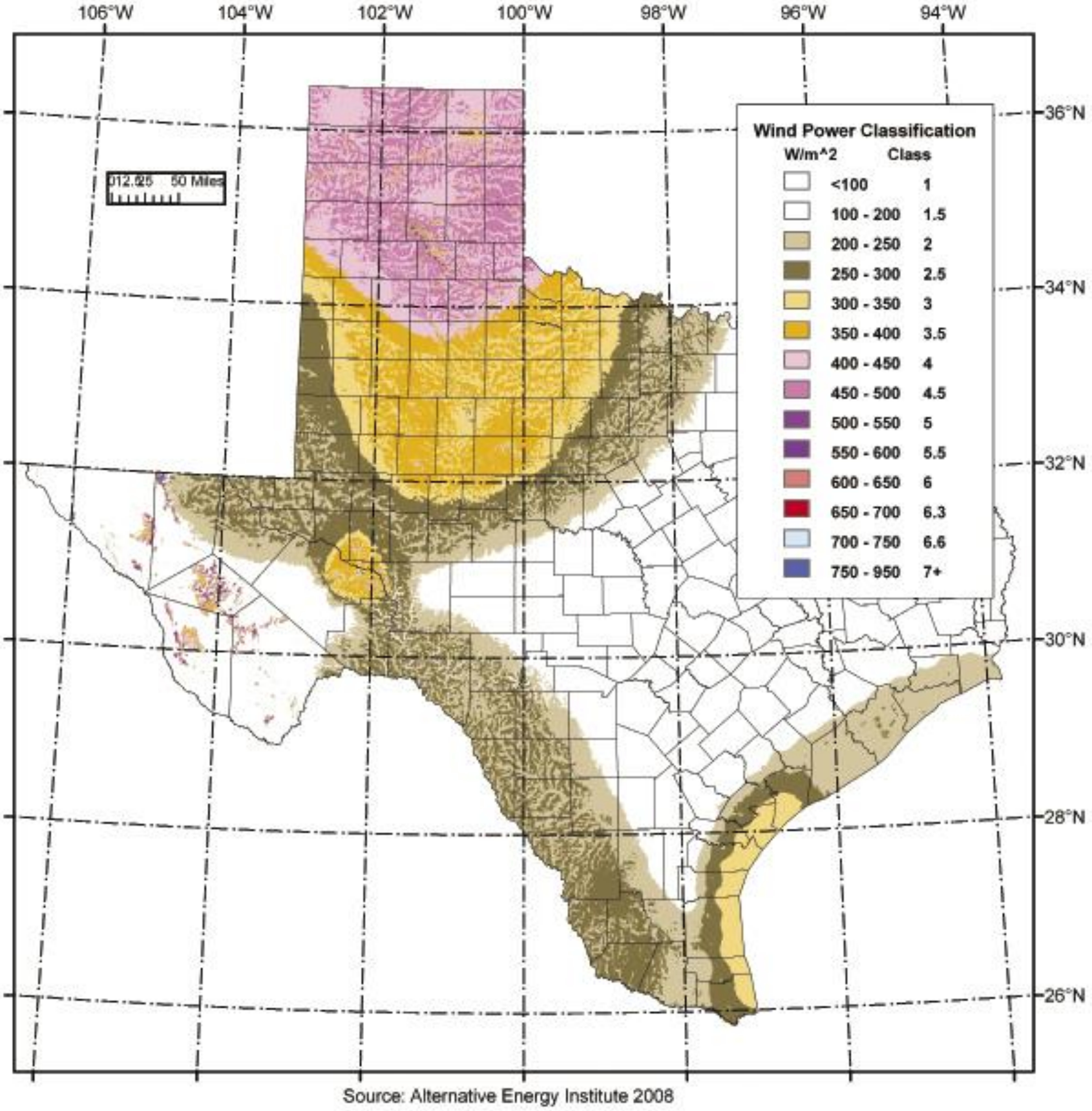

Figure 6.1. Texas wind map. Source: Alternative Energy Institute 2008 in SECO 2008.

While some of the data in this chapter comes from the US Energy Information Administration (EIA), a portion of data comes from Texas' Electric Reliability Council of Texas (ERCOT) electricity market, which serves about 85% of the population, approximately 22 million Texans, including the urban centres of Dallas/Ft. Worth, Austin, San Antonio and Houston. Its grid connects 75% of the state's territory, with over 550 generators, via 65,000 kilometres of transmission lines (ERCOT website 2012). Some information also comes from Public Utility Commission of Texas (PUCT).

6.2. DEPLOYMENT OUTCOMES

This section examines the 'Texas wind rush' – the period from 1999 through present that sees wind energy deployment levels escalate dramatically in the state. Several mega wind farms were commissioned during the sample period, including the 735-MW Horse Hollow

Wind Energy Center, which has 421 turbines, spans two counties, and, at commissioning in 2005, was the largest wind farm in the world.

The following graph, Figure 6.2, shows three of our deployment indicators: Total installed wind capacity (in MW), annual capacity additions (MW), and total installed wind capacity per capita (kW per 100 people). These indicators are based on federal data and include the whole state.

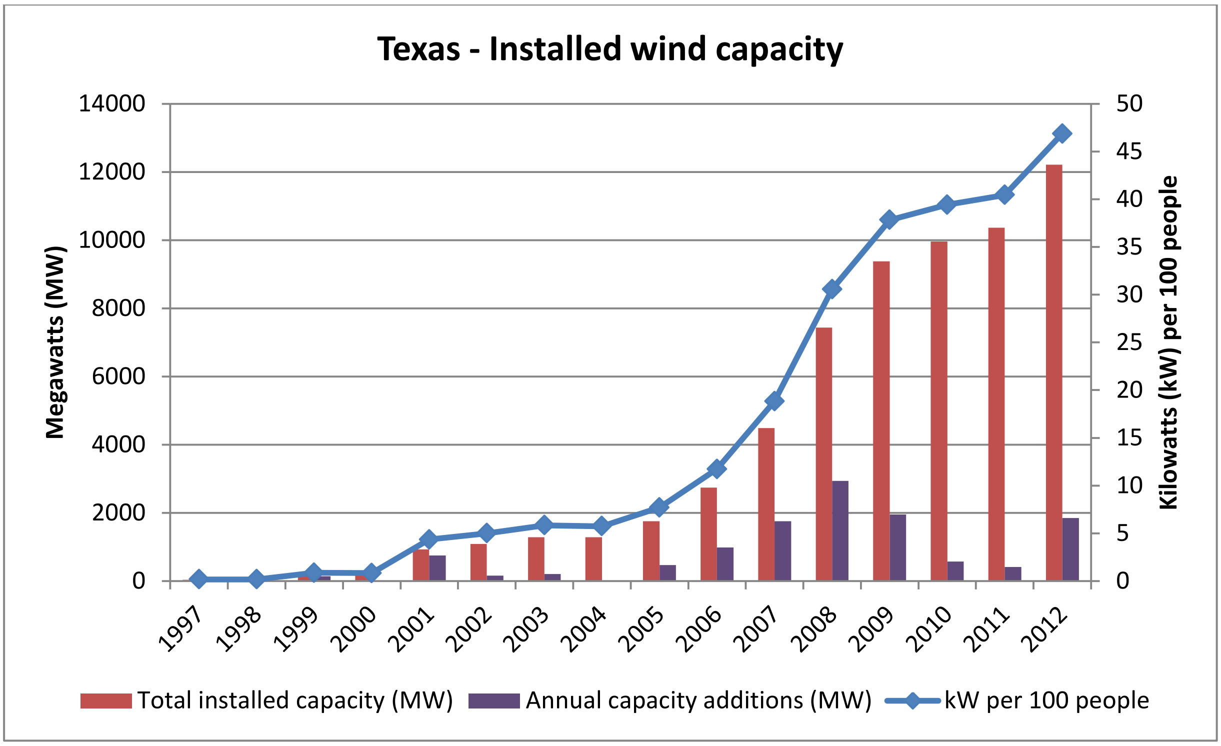

Figure 6.2. Texas: Installed wind capacity, 1997-2012. Sources: Data from EIA 2012, October; U.S. DOE 2013b; Texas DSHS 2012.

Figure 6.2 shows that total installed wind capacity has grown tremendously since large-scale wind deployment began in Texas in 1999, and its sharpest growth came from 2005 to 2009. Then, reflecting the drop-off in annual capacity additions, total capacity growth moderated between 2009 and 2011, before leaping up in 2012 to an impressive 12,212 MW. Total capacity per 100 people reveals that deployment has been outpacing population growth, most clearly from 2009 onward. This indicator ended 2012 at 46.86kW per 100 people.

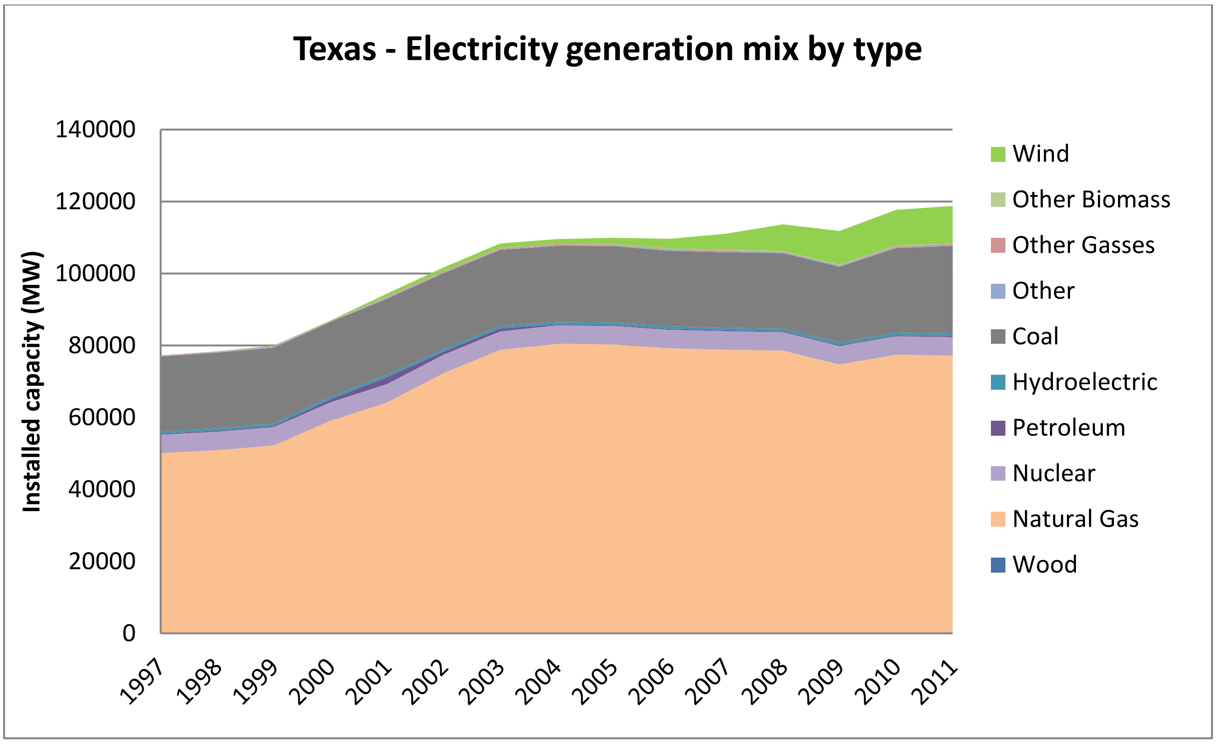

Figure 6.3. Texas: Installed generation capacity by type. Source: Data from EIA 2012, October.

Figure 6.3 shows wind penetration of Texas' total electricity generation capacity mix grew in the latter half of the sample period. Since 2008 wind has made up the third largest share of the mix, surpassing nuclear.

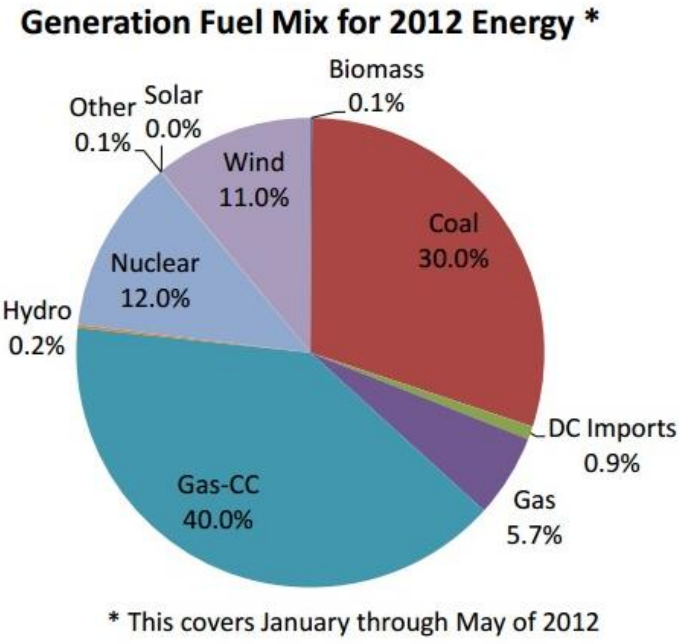

Figure 6.4. Generation capacity by type in ERCOT. Source: ERCOT 2012.

Figure 6.4 shows that wind made up 11% of ERCOT's total electricity generation capacity in 2012.

6.3. TESTING HYPOTHESES

This section is organized by hypothesis and we combine different analytical approaches to attempt to identify and validate cause-effect links between the IVs and DV.

6.3.1. H1: JURISDICTIONS WITH A HIGH-VALUE FEDERAL WIND ENERGY PRODUCTION TAX INCENTIVE WILL HAVE INCREASED LEVELS OF WIND ENERGY DEPLOYMENT

In 1992, Republican President George H.W. Bush's final year in office, he signed the Energy Policy Act (EPAct) into law, creating a federal tax credit for renewable electricity production (the Production Tax Credit or PTC) designed to stimulate wind energy deployment by improving the financial viability of wind projects for developers.

The incentive was set at 1.5 cents[2] per kilowatt-hour (kWh) of wind-generated electricity in 1992 dollars and payable over the first ten years of a project's operations. Its value is indexed to inflation and therefore the PTC's real value has not changed over time. In 2012, the PTC stood at 2.2 cents/kWh for wind projects installed that year. We operationalized *IV1 – federal wind energy production tax incentive* to be measured on a scale of 0-2 cents per kWh of wind-generated electricity production and corresponding to incentive value (no/low, medium, high), and the PTC is therefore considered a high-value incentive.

For the first several years, the tax credit had a muted effect on wind energy deployment nationally (EIA 2012, November). However, by 1999, the year when the PTC was initially set to expire, it was beginning to have a noticeable effect. In combination with supportive renewable energy policies in a handful of states, the PTC had spurred over 500 MW of new installed wind capacity (EIA 2012, November).

However, the PTC has been allowed to expire several times – in 1999, 2001, 2003 and 2012 – before subsequent extensions were passed (later in 1999, and in 2002, 2004 and 2013), when Congress retroactively extended the PTC sometime after it had lapsed. Between 2004 and 2012, Congress did not let the PTC expire and this period included a three-year extension built in to Democratic President Obama's 2009 stimulus bill.

The instability of the PTC has caused pronounced 'boom-bust cycles' that serve as dramatic evidence of the PTC's strong causal influence on deployment.

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[2] Prices in this chapter are in USD

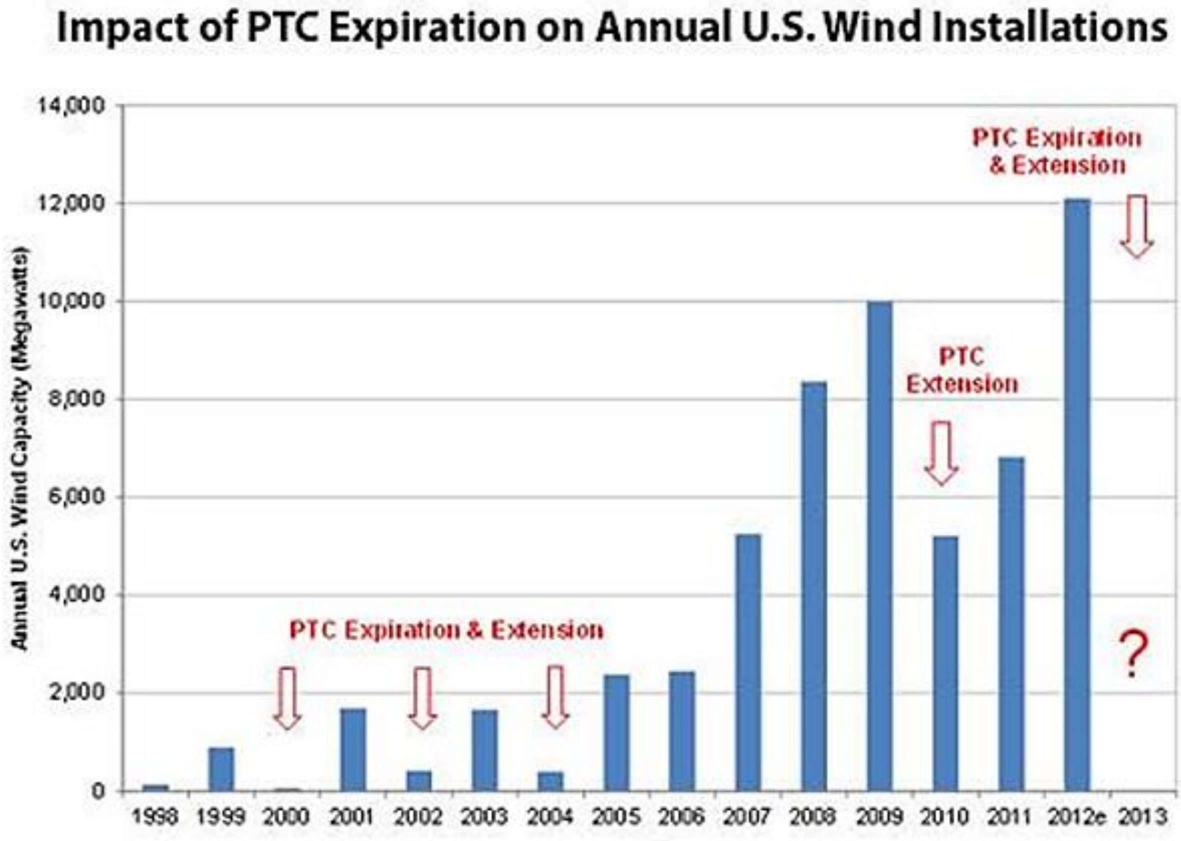


Figure 6.5. Impact of PTC Expiration on Annual US Wind Installations. Source: UCS 2013.

In particular, Figure 6.5 shows that, nationally, developers have repeatedly scrambled to complete wind projects in the months leading up to the PTC's scheduled expiration, to ensure their eligibility for the tax credit. The following year would then see levels of new installed capacity fall dramatically as developers waited to see if the PTC would be renewed before resuming projects. Wiser et al. (2007) explain that "uncertainty in the near-term future availability of the PTC may undermine rational industry planning, project development, and manufacturing investments" (p.5).

During the long period of legislative stability for the PTC from 2004 and 2012, the US wind industry posted steep annual growth until new capacity additions slowed in 2010.The EIA (2012, November) attributes the slow-down to an "echo effect" of the global financial crisis and recession of 2008 and 2009. Also, the nature of the incentive, as a tax credit, became problematic as many investors lacked "sufficient tax appetite, or tax-situation ability to take advantage of the credits" (EIA 2012, November).

In Texas, capacity additions during the sample period (Figure 6.6) largely mirror national trends. A negligible amount of new capacity added (0.08 MW) was added in 2000 and no new capacity was added in 2004, as investors responded to PTC lapses by suspending or cancelling projects.

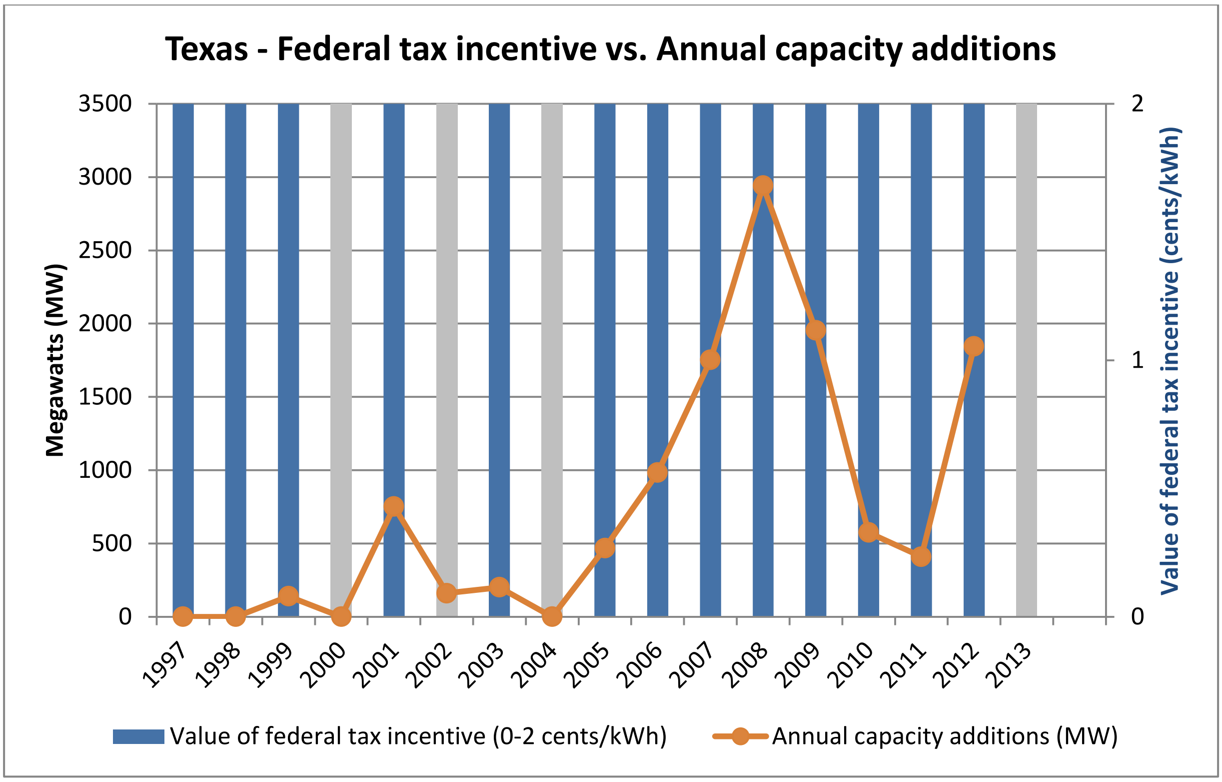


Figure 6.6. Impact of federal tax incentive (PTC) on deployment, showing lapse years in gray. Source: Data from EIA 2012, October.

As Figure 6.6 shows, the real value of the PTC did not change during the sample period (in 2012 dollars, the PTC held steady at 2.2 cents/kWh) but its availability did, causing a stark trend of deployment levels growing sharply in the years preceding the tax credit's expiration and then plummeting in the lapse years.

If our theory is correct, we would expect the availability of a high-value federal wind energy production tax incentive like the PTC to produce high levels of wind deployment. The PTC would stimulate deployment by enhancing the cost-competitiveness and financial viability of wind projects. However, if we were to see no or low levels of deployment in years when the PTC was available, this would indicate our theory is incorrect.

Our findings indicate the PTC has exerted a significant causal influence on wind energy deployment in Texas, with its high value incentive causing high levels of new deployment in those years where the tax credit was available. Each of the boom-bust cycles demonstrated by the annual wind capacity additions indicator can be thought of as the result of a natural test of the PTC's effectiveness, conducted multiple times as legislative status changed. The boom-bust cycles, therefore, cannot be a coincidence.

The dip in annual capacity additions seen in Figure 6.6 from 2009 to 2011 may be linked to the global financial crisis and 'credit crunch', as well as a lack of 'tax appetite', as the EIA (2012, November) suggested was the case at the national level. This shows that although the PTC's availability repeatedly exerts a clear influence on changes in DV values, it is not the only factor influencing wind deployment levels.

Therefore, we can confirm this hypothesis, but not to the exclusion of the others.

6.3.2. H2: JURISDICTIONS WITH A HIGHLY AMBITIOUS MANDATORY RENEWABLE ENERGY QUOTA GOAL WILL HAVE INCREASED LEVELS OF WIND DEPLOYMENT

In 1999, Texas adopted a mandatory renewable energy quota – a renewable portfolio standard (RPS). It was among the first US states to adopt one and it did so by strategically linking RPS adoption to electricity market restructuring; the same legislation, Senate Bill 7 (SB 7), introduced both.

A type of 'market mandate' (i.e., a quota that stimulates market demand), RPS goals are set in terms of installed capacity. PUCT, however, measures compliance by electricity output in megawatt-hours (MWh). The RPS requires electricity retailers, cooperatives and municipal utilities to collectively generate an additional amount of renewable energy or to purchase a sufficient number of renewable energy certificates (RECs, each equal to one MWh) to prove compliance. Failure to comply results in a penalty of $50 per MWh of shortfall. Retailers are assigned a portion of the mandate according to their pro rata share of sales (US DOE 2013a). Renewable energy generators benefit from a secondary revenue stream by selling RECs in addition to electricity.

The Public Utility Regulatory Act of 2005 specifies the following statewide quota goals, in total installed renewable energy capacity:

2,280 MEGAWATTS BY JANUARY 1, 2007,
3,272 MEGAWATTS BY JANUARY 1, 2009,
4,264 MEGAWATTS BY JANUARY 1, 2011,
5,256 MEGAWATTS BY JANUARY 1, 2013,
5,880 MEGAWATTS BY JANUARY 1, 2015,
10,000 MEGAWATTS BY JANUARY 1, 2025
(PUBLIC UTILITY REGULATORY ACT OF 2005, P.182).

The Texas Comptroller of Public Accounts interprets these quota goals:

> *The 2015 goal represents about 4 to 5 percent of the state's projected electric annual generation production, and roughly 8 percent of ERCOT's currently installed generation capacity of 72,416 MW … The 2025 goal of 10,000 megawatts would represent 14 percent of ERCOT's currently installed generation capacity. Assuming the SB 20 goal is met by wind generation, the 10,000 MW would represent about 11 percent of ERCOT's estimated 89,883 MW peak summer demand in 2025 (2008).*

All of Texas' RPS quota goals amount to less than 12% RE in the total electricity generation mix by the compliance year, corresponding to quota goals of low-ambition, according to our operationalization of *IV2 – mandatory renewable energy quota.*

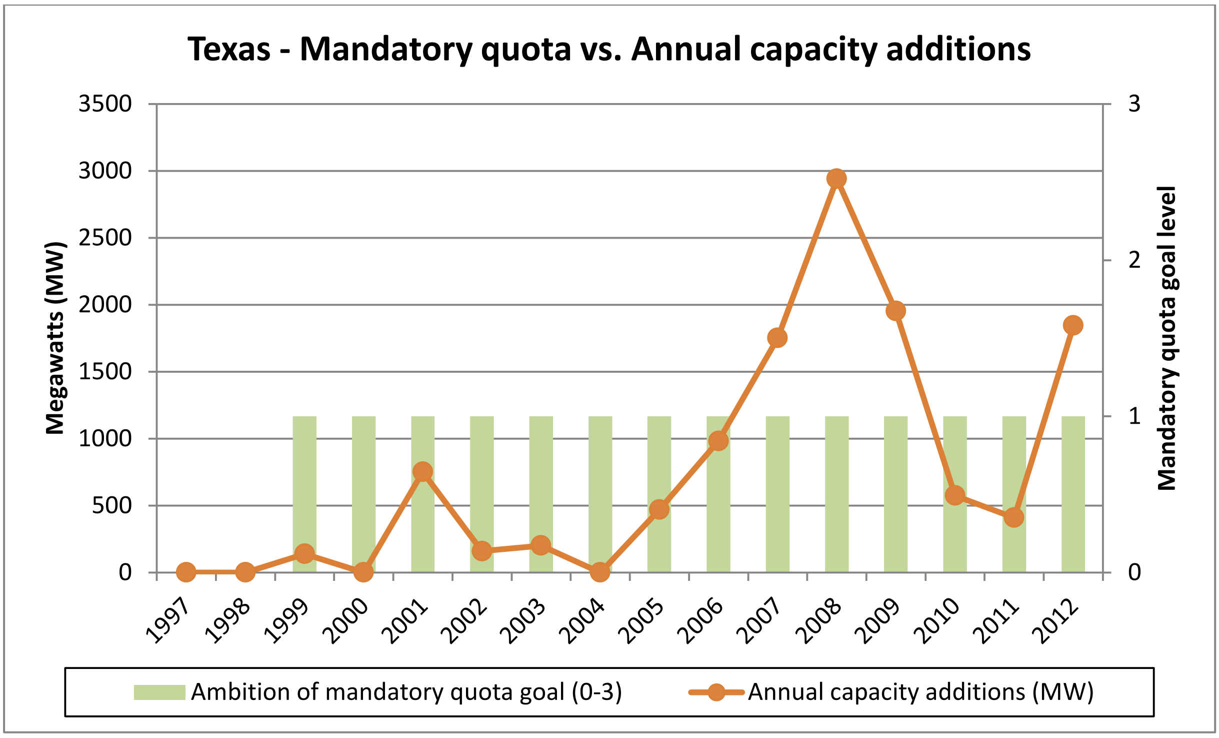


Figure 6.7. TX: Impact of mandatory quota on annual capacity additions. Sources: Data from Texas Comptroller of Public Accounts 2008; EIA 2012, October.

Figure 6.7 suggests that while the first uptick in annual capacity additions, in 1999, coincides with the adoption of a low-ambition RPS, IV2 cannot explain changes in this deployment indicator over time.

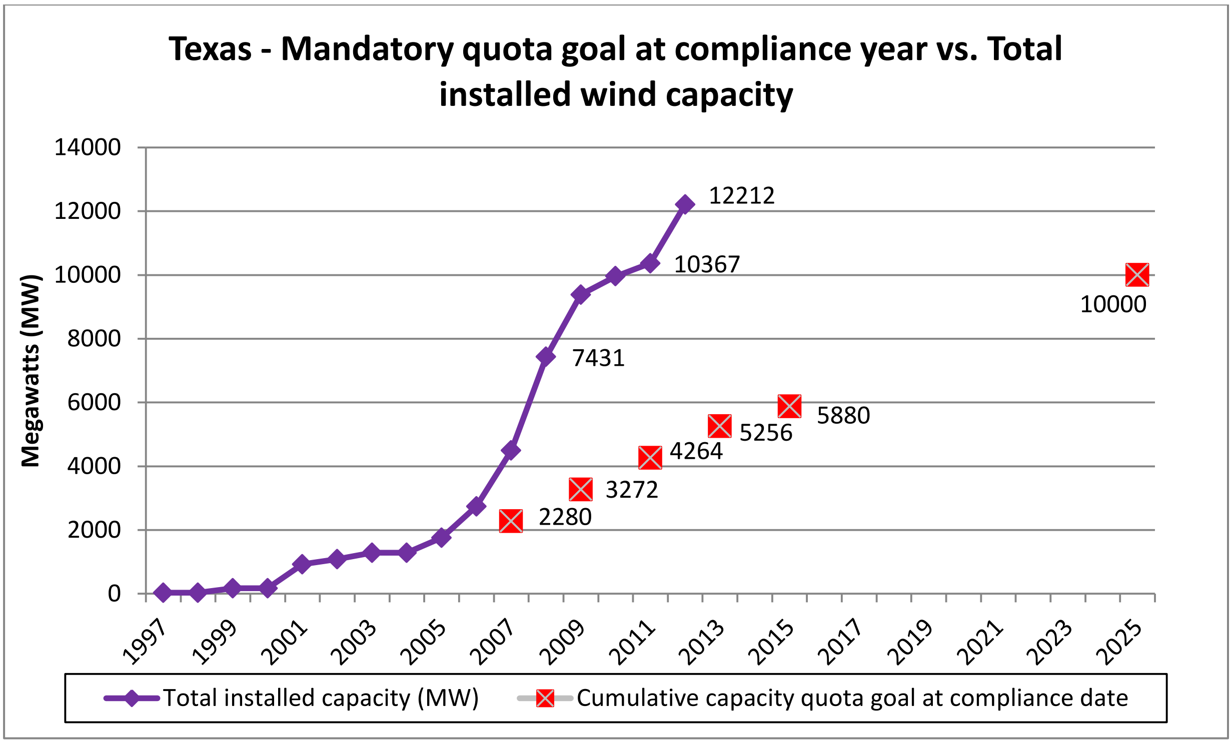


Figure 6.8. TX: Mandatory quota goals in MW of total installed capacity at compliance year vs. total installed capacity. Sources: Data from Texas Comptroller of Public Accounts 2008; EIA 2012, October.

Figure 6.8 is another way of illustrating the low-ambition nature of the RPS goals. When the total installed capacity goals (shown in red in the compliance years) were set in 2005, their trajectory appears to have been planned as an extension of the growth in RE capacity to date. In reality, however, total installed wind capacity took off after 2005, far outpacing and exceeding all existing RPS goals, including the 2025 goal of 10,000 MW.

If our theory that a highly ambitious renewable energy quota goal promotes high levels of wind deployment is correct, we would expect to see deployment levels commensurate with the ambitiousness of the quota goal because the latter determines market demand for renewable energy.

There is strong evidence our theory is incorrect. First, Texas' RPS goals have never been set higher than a low-ambition level, so our theory predicts such a goal would only minimally stimulate market demand for renewable energy and would therefore produce low levels of deployment. Second, the fact that Texas has quickly exceeded all of its quota goals repeatedly tells us IV2 is not driving deployment and therefore cannot explain the Texas 'wind rush'.

6.3.3. H3: JURISDICTIONS WITH A HIGH LEVEL OF COMPETITION PRESENT IN THEIR ELECTRICITY MARKET WILL HAVE INCREASED LEVELS OF WIND DEPLOYMENT

The Federal Energy Regulatory Commission (FERC) began pushing states to restructure and liberalize their electricity markets starting with the PURPA Act of 1978, which ordered utilities to buy electricity from non-utility generators at their 'avoided cost'. Then, the EPAct of 1992 (which also created the PTC, IV1) authorized the FERC to order that transmission systems be opened for non-utilities to access, which enabled renewable energy generators to participate.

Historically Texas has had a strong pro-business character. By the time the FERC ordered states to introduce competitive wholesale electricity markets in 1996, Texas had already done so: In 1995, the Texas Legislature deregulated electricity generation and authorized the Electric Reliability Council of Texas (ERCOT) to oversee wholesale competition and fair grid use by becoming a non-profit and the first Independent System Operator (ISO) in the US.

In 1999, SB 7 deregulated the retail electricity market, creating a competitive retail electricity market starting in 2002. (SB 7 also enacted the RPS, IV2.) The bill also granted Transmission Service Providers (TSPs) the ability to offer transmission services to other utilities in the ERCOT.

ERCOT prides itself on being “the top market in the US and Canada” because many industry groups and policymakers consider its restructuring a success (Distributed Energy Financial Group). ERCOT’s wholesale market has more than “1,100 active entities that generate, move, buy, sell or use wholesale electricity”, and FERC Chairman Wellinghoff said “Texas has the most robust retail competition anywhere in the country” in 2011 (ERCOT 2013, March).

Restructuring has introduced wholesale (in 1995) and retail (in 1999) markets in Texas with high levels of competition. One result is that most of the state’s generators are IPPs, who own the vast majority of generation capacity. This is true of wind generation: EIA (2012, October) data show that from 1997 to 2011 more than 99% of the state’s total installed wind capacity has been IPP-owned, and that 94 of the state’s 96 wind generators were IPPs in 2011.

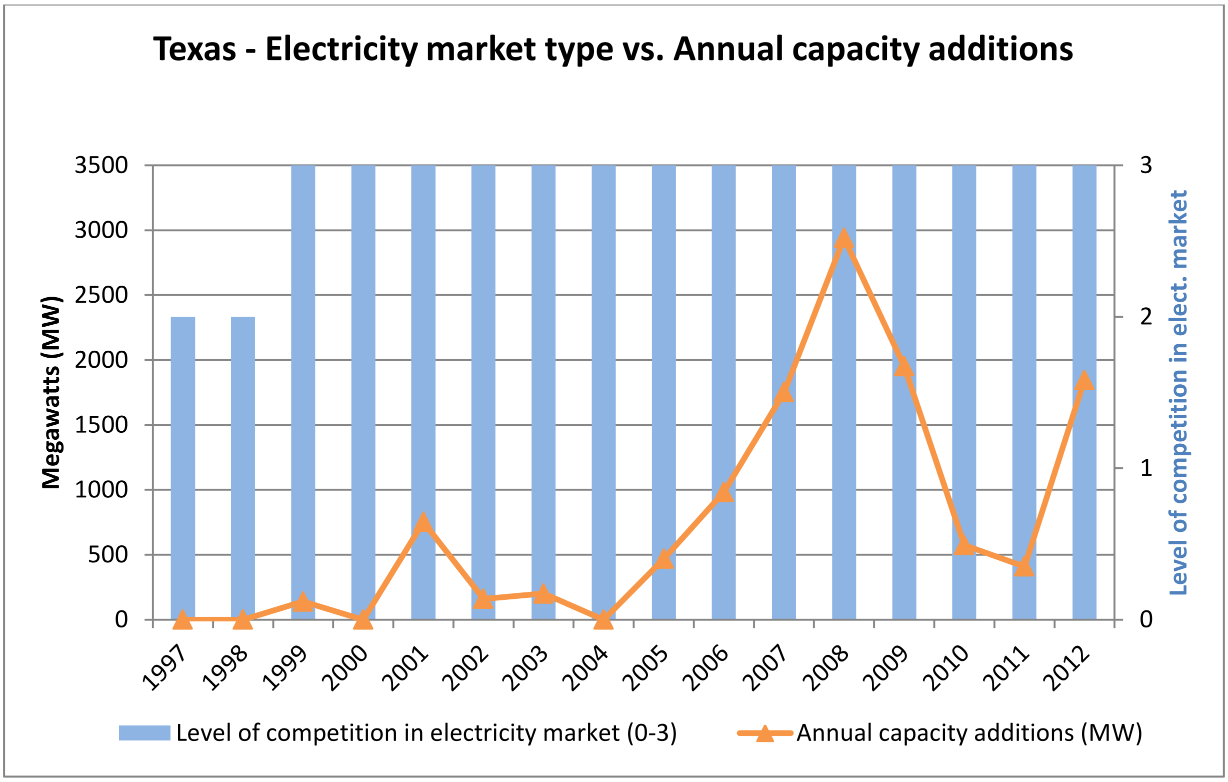


Figure 6.9. TX: Impact of electricity market type on deployment. Source: Data from EIA 2012, October.

Figure 6.9 shows that although a competitive wholesale market was already in place, annual wind capacity additions did not experience an uptick until 1999, when retail competition was enacted. However, a simultaneity problem makes it unclear if the 1999 uptick was due to this factor or to the adoption of the RPS and/or the availability of the PTC also that year. Furthermore, the annual capacity additions indicator suggests other factors are likely influencing deployment as well.

We are assessing *IV3 – electricity market liberalization* by the level of competition present in the electricity market, on a scale of 0-3. From 1995 to 1999, Texas had wholesale market competition, which corresponds to a medium level of competition. Then from 1999 to 2012 Texas had both retail and wholesale market competition, corresponding to high level of competition. If our theory that highly competitive electricity markets promote high levels of wind deployment is correct, we would expect Texas' progression from medium to high levels of competition to produce medium and then high levels of deployment, by opening up greater opportunities for prospective wind IPPs to start generating and enter the market. However, if we were to observe low levels of deployment in these conditions, it would indicate that our theory is incorrect.

Indeed, EIA (2012, October) statistics indicate that almost all wind capacity in Texas is owned by IPPs. Without competitive market conditions, it seems unlikely that this many IPPs would have received purchasing power agreements (PPAs) to sell their wind power to vertically integrated, state-owned utilities.

Our findings indicate that IV3 is likely a necessary but not sufficient condition for wind deployment and can tentatively confirm H3.

6.3.4. H4: JURISDICTIONS USING A SIMPLIFIED PLANNING, PERMITTING AND SITING MODEL WILL HAVE INCREASED LEVELS OF WIND DEPLOYMENT

Texas has no official planning guidelines for wind projects and administrative oversight is strictly at the local level (Bohn 2007; Window on State Government 2008). Siting of proposed wind projects in Texas is "unregulated by any level of government" and the most that can be done to discourage siting is a "county board can choose not to give a tax abatement if there is public opposition" (FWS 2007). Prospective developers need only negotiate a lease with the landowner. Furthermore, developers may voluntarily ask Texas Parks and Wildlife Department to review their project plans (FWS 2007).

We are assessing *IV4 – planning, permitting and siting model* according to a scale created by Bohn and Lant (2009), which ranks planning, permitting and siting (PPS) models by their simplicity level. Texas uses the simplest type – the 'minimal' model, which requires the fewest regulatory steps. Our literature review indicated that wind developers prefer to do business in jurisdictions with minimal amounts of regulatory red tape, where few steps are required to take a project from concept to construction to completion.

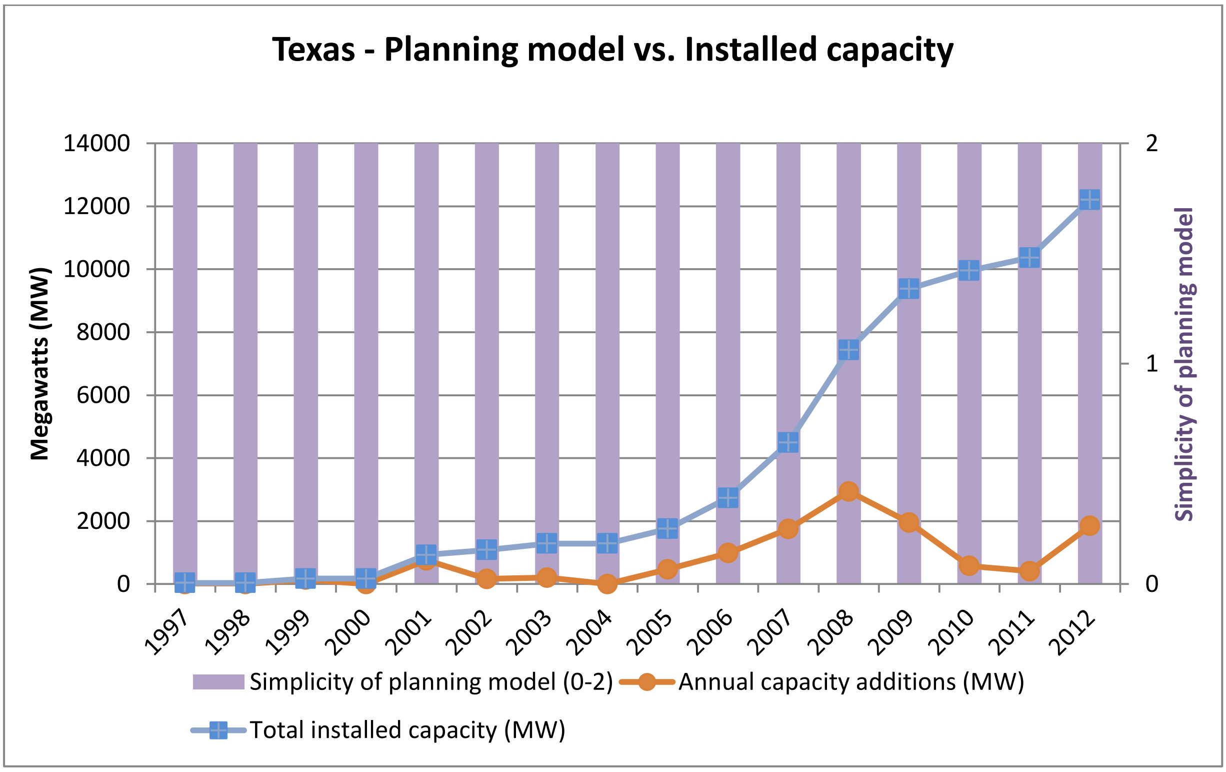


Figure 6.10. TX: Impact of planning model on deployment. Source: Data from EIA 2012, October.

If our theory that use of a highly simplified ('minimal') planning, permitting and siting model promotes high levels of wind deployment is correct, we would expect Texas' use of this model to entice prospective wind IPPs, leading to high levels of wind deployment. However, if we were to see low levels of deployment despite the state's use of the 'minimal' model, it would indicate our theory is incorrect.

In Figure 6.10, the invariance of IV4 values while our DV indicator values change suggests that other factors are influencing deployment. However, overall, our results are congruent with our theory: use of a 'minimal' model in Texas appears to have provided attractive business conditions for wind developers, who flocked to the state.

We can tentatively confirm H4.

6.3.5. H5: JURISDICTIONS USING AN ANTICIPATORY APPROACH TO GRID INFRASTRUCTURE IMPROVEMENTS WILL HAVE INCREASED LEVELS OF WIND DEPLOYMENT

In 1999, wind farms began springing up near the West Texas city of McCamey and by 2001 the area had 755 MW of installed wind capacity (Diffen 2009, p.16). Transmission congestion problems quickly became apparent and, in 2000, ERCOT started curtailing wind generation to avoid overloading the system. Significant expansion of transmission capacity was needed and ERCOT could not keep up. Its 2004 annual report states that it would take until 2006 to bring all 755 MW of generating capacity in West Texas, installed by 2001, on-line. Meanwhile, electricity demand from urban load centres was growing and more wind farms were in planning and construction stages in windy areas around the state.

In those years, ERCOT took a 'reactive' approach to infrastructure improvements (such as expansion and upgrading) to accommodate renewable energy. Alagappan et al. write that a 'reactive' approach means "transmission planning and construction occurs after a renewable developer's request for transmission interconnection and service" (Woo et al. 2006 in Alagappan et al. 2011, p.5101-2).

In 2005, however, Texas broke with its exclusively reactive approach and shifted to an innovative 'anticipatory' approach to better tackle the growing transmission capacity needs of wind developments in West Texas. Its piecemeal, reactive approach was failing to alleviate congestion. It was also failing to address the ongoing chicken-and-egg dilemma, which we described in the literature review, plaguing transmission planning in general: wind developers are hesitant to site a project until they can be assured of transmission, and transmission providers are hesitant to build transmission until developers have committed to sites (Alagappan et al. 2011, p.5101). 'Anticipatory' transmission planning refers to planning and sometimes construction that precedes a wind developer's "actual request for interconnection and service" (Alagappan et al. 2011, p.5102).

Use of an anticipatory approach to grid infrastructure improvements began when the Texas state legislature enacted SB 20 in 2005, which authorized PUCT to identify Competitive

Renewable Energy Zones (CREZs) around the state – geographic areas with excellent wind resources and potential for wind project development. Initially twenty-five CREZs were identified, each capable of generating 4,000 MW of wind energy, and wind developers were then asked to vote for their preferred CREZ locations and demonstrate financial commitments to develop these locations (PUCT 2012).

In 2008, PUCT announced five final CREZ selections (see Figure 6.11) where significant, publicly funded, transmission infrastructure would be built to transmit an expected total of 18,500 MW of wind power to urban demand centres, at a cost of $4.93 billion (PUCT 2012). Costs have since increased to close to $7 billion (Weiss et al. 2013, p.23). Kwok and Greathouse (2011) estimate that the CREZ project could potentially allow a doubling of wind penetration (which was 11% in ERCOT in 2012), integrating up to a 21% share of the electricity generating mix (p.34).

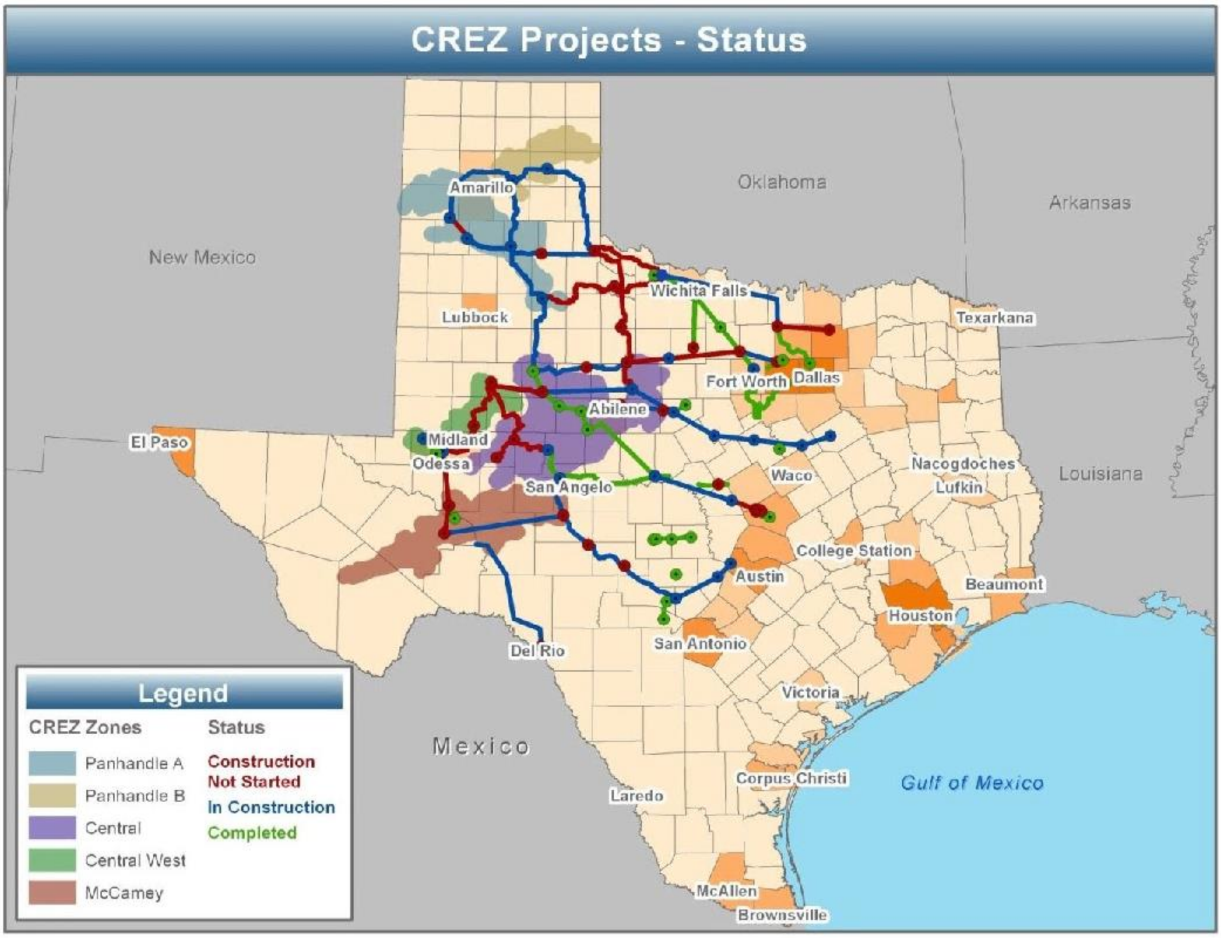


Figure 6.11. CREZ projects - status. Source: PUCT 2012, October.

Effectively, in exchange for renewable energy developers demonstrating financial commitments within the CREZs, the state takes on the upfront risk of building new transmission infrastructure to connect remote projects to end-users. This approach is intended to prevent future situations where wind farms are constructed but insufficient transmission capacity results in congestion and generation curtailment. It is also intended to provide adequate transmission for future wind projects, attracting new developers by reducing chicken-and-egg transmission planning uncertainty.

With the CREZ project embodying the anticipatory approach, PUCT boldly undertook a groundbreaking, expensive, long-term plan for the electricity grid, to ensure it is able to integrate large amounts of wind-generated electricity well into the future. Daniel (2009-10) calls the project “a powerful statement to potential developers that the state is serious about remaining a leader in wind energy generation” (p.179).

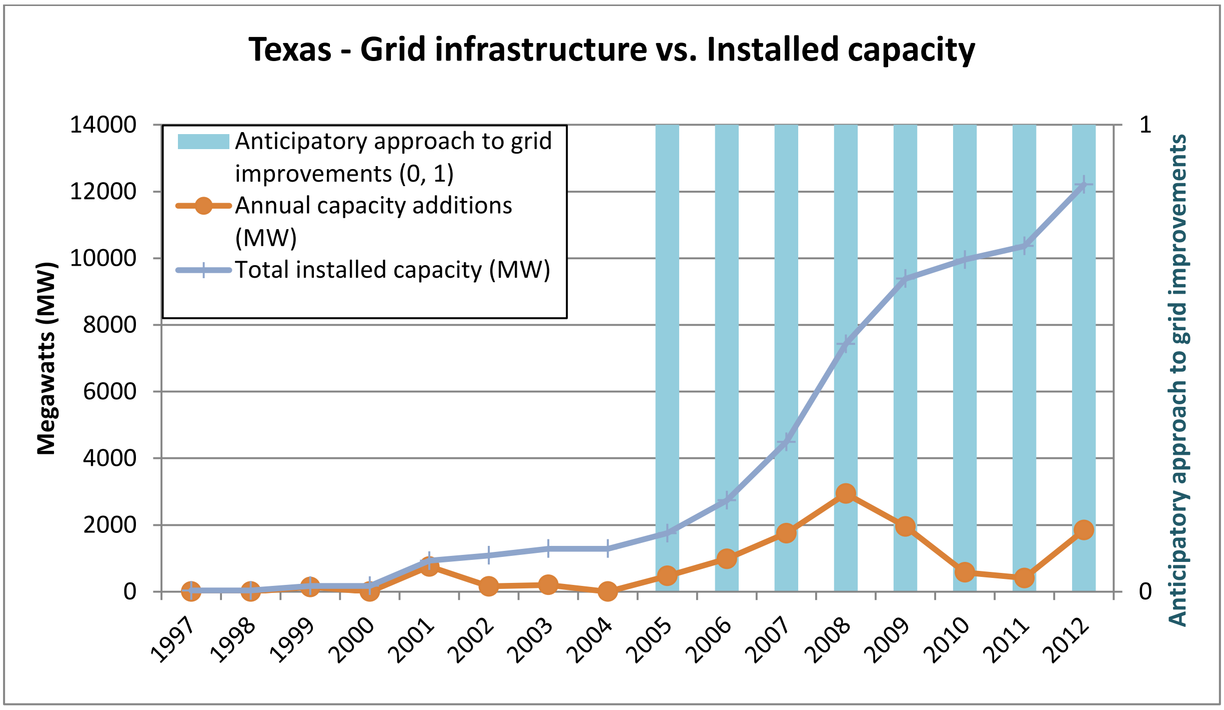


Figure 6.12. TX: Impact of reactive vs. anticipatory approach to grid infrastructure on deployment. Source: Data from EIA 2012, October.

Figure 6.12 shows *IV5 – grid infrastructure* in Texas initially at zero values, from 1997 to 2005, due to the state’s exclusive use of a reactive approach to grid improvements. Then, following the CREZ project’s authorization in 2005, IV5 values rise to one to mark Texas’ use of an anticipatory approach. We are treating the 2005 authorization as the earliest possible starting point for observing effects the CREZ project may have on wind deployment, based on the assumption that the market and its actors will recognize such a major infrastructure investment as an economic stimulus and as an investor confidence-boosting signal from Texas of its present and future commitment to its growing wind energy industry.

Our theory that jurisdictions taking an anticipatory approach to grid improvements have elevated levels of deployment predicts the CREZ project has positively influenced wind deployment levels in Texas. While values on our DV indicators in Figure 6.12 look broadly consistent with our theory, attribution of observed effects to the CREZ project is difficult.

Furthermore, we recognize our sample period is too short for us to observe the full range effects, considering CREZ construction began in late 2010 and will be completed in late 2013, and that wind projects typically take one to three years to complete. We will therefore consider alternative sources of evidence that indicate future deployment.

The first piece of evidence supporting the CREZ project's positive effects on future deployment comes from Robinson (2012). While PUCT announced the five CREZ regions in 2008, it waited until October 2010 to publish the locations of the proposed new lines and substations (Smitherman 2010, cited in Robinson 2012).

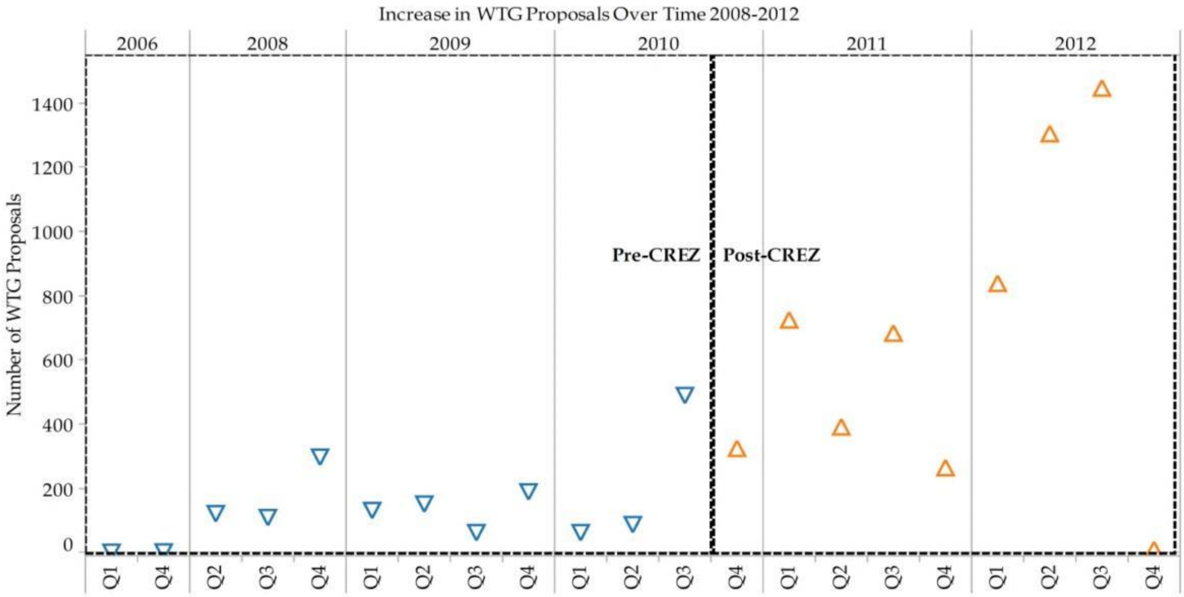
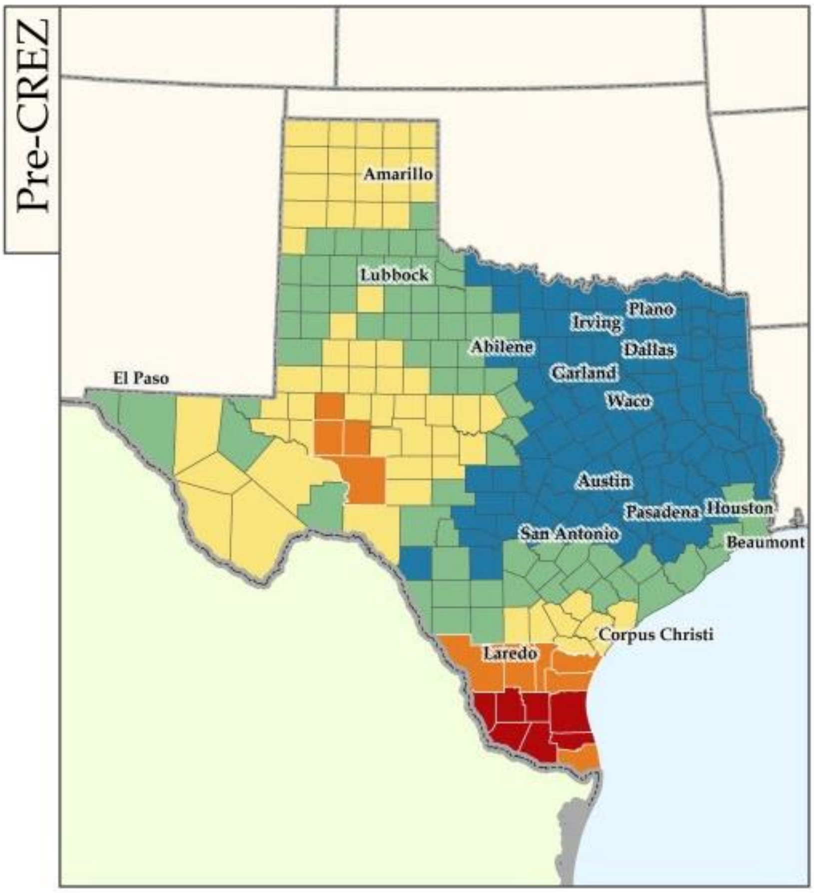


Figure 6.13. Increase in number of Texas wind turbine generator siting proposals received by the FAA, 2008 to 2012. Source: Robinson 2012, p.2.

In Figure 6.13, Robinson evaluates Federal Aviation Administration (FAA) data, finding that the October 2010 publication of the new CREZ transmission lines and substations locations resulted in a significant increase in the number of wind turbine generator (WTG) proposals from Texas-based wind projects (2012, p.18). There appears to be a causal relationship between the CREZ project and indicators for future deployment.

The second and third pieces of evidence take a close look at deployment-precursor effects in the two CREZs located in the Texas Panhandle (Panhandle A and Panhandle B), the northernmost part of the state, which was wind-rich but transmission-poor before the CREZ project.



The Competitive Renewable Energy Zones transmission project has increased the number of statistically signicifcant ($p < 0.01$) counties with regional neighbor weighted clustering from 0 before to 41 after, as measured by the Getis-Ord Gi* statistic. Null values included to increase regional neighbor influence. Includes WTGs > 1 MW.
Sources: PUCT, FAA, Geocommunity, Texas Data Center, USGS
Datum: NAD83 Texas Centric Mapping System, Lambert (meters).
Created by: Scott A. Robinson, University of Texas at Austin, Energy and Earth Reseources

Figure 6.14. Pre-CREZ (FAA data from 2008 to October 1, 2010) number and spatial distribution of wind turbine generator (WTG) proposals. Legend with Figure 6.15. Source: Robinson 2012, p.10.

Robinson (2012) uses GIS cluster analysis to show numbers and spatial distribution of WTG siting proposals for the state. In Figure 6.14, he finds that relatively few WTGs were proposed for the Panhandle between 2008 and October 1, 2010 (“pre-CREZ”), despite the area’s excellent wind resource.

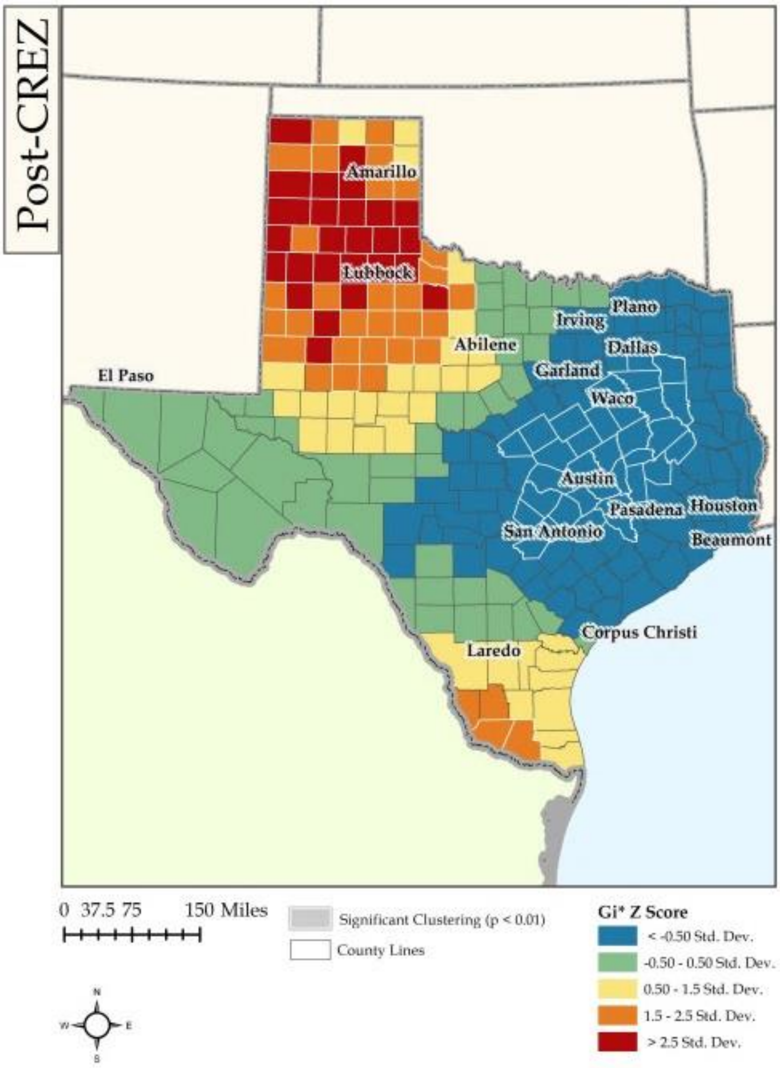


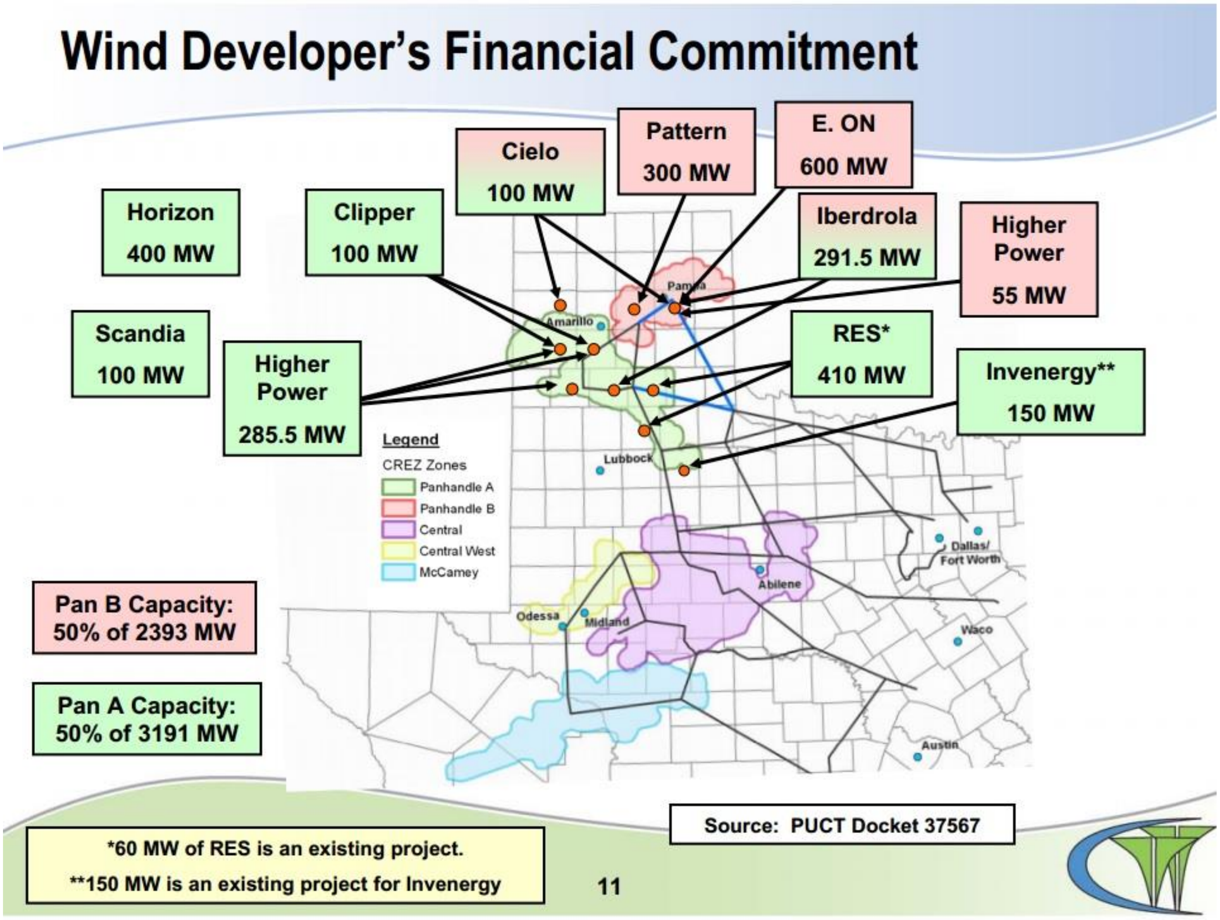
Figure 6.15. Post-CREZ (FAA data from October 1, 2010 to 2012) effect on number and spatial distribution of wind turbine generator (WTG) proposals. Source: Robinson 2012, p.10.

In Figure 6.15, compared to Figure 6.14, Robinson (2012) shows that WTGs proposed between October 1, 2010 and 2012 ("post-CREZ") are more numerous and are spatially distributed differently, with dense clusters concentrated in the Panhandle. This seems to confirm the theory that inadequate transmission infrastructure had constrained wind deployment pre-CREZ.

The third piece of evidence concerns 'financial commitments' from wind developers in the Panhandle CREZs. Earlier we noted that PUCT asked wind developers to demonstrate financial commitments to proposed CREZ locations to help PUCT determine which to designate as CREZs. After the 2008 announcement of the five final CREZ areas, PUCT increased its financial commitment requirements from wind developers before it decided which transmission lines to authorize. PUCT's test was as follows: "If the sum of the capacity represented by completed projects, projects under construction, signed interconnection agreements and collateral is at least 50% of the designated capacity for a CREZ, the financial commitment requirement will be deemed to be met for that CREZ" (PUCT 2009, p.3).

The Panhandle CREZs, with their dearth of siting proposals (see Figure 6.14) and dearth of existing wind projects (see yellow box in Figure 6.16), faced a challenge not encountered by the other CREZs in demonstrating financial commitment to PUCT (the CREZs in West Texas were already host to many wind farms). So PUCT, in an October 8, 2009 order, says it expects the Panhandle CREZs to fail its test. However, upon reviewing a follow-up order from July 30, 2010, we learn that in the intervening months Panhandle A and Panhandle B both managed to rally developers and demonstrate sufficient financial commitment, critically allowing the intended transmission lines to be authorized.

A slide (Figure 6.16) from the Cross Texas Transmission company shows the ten Panhandle A and B developers who emerged between October 2009 and April 21, 2010, when they submitted a petition to PUCT showing their project proposals, and posted collateral of about $26m (CTT 2010, p.10).



Wind Developer's Financial Commitment

Horizon 400 MW

Clipper 100 MW

Cielo 100 MW

Pattern 300 MW

E. ON 600 MW

Iberdrola 291.5 MW

Higher Power 55 MW

Scandia 100 MW

Higher Power 285.5 MW

RES* 410 MW

Invenergy** 150 MW

Pan B Capacity: 50% of 2393 MW

Pan A Capacity: 50% of 3191 MW

Source: PUCT Docket 37567

*60 MW of RES is an existing project.
**150 MW is an existing project for Invenergy

Figure 6.16. Panhandle developers demonstrating financial commitments by April 21, 2010. Source: Cross Texas Transmission 2010, May, p.11.

It is clear that while few existing or even proposed projects were found in the Panhandle pre-CREZ, the desire to secure major publicly funded grid infrastructure from CREZ directly motivated wind developers to make significant financial commitments strongly indicative of future deployment. This is strong support for our theory.

IV5, therefore, appears to have several pro-deployment effects, consistent with our theory. Evidence from our DV indicators (pre- and post-2005 CREZ authorization), Robinson's analysis of siting proposals for wind turbine generators in Texas (pre- and post-October 1, 2010, when CREZ line locations were published), and the quickly-strengthening level of financial commitment from Panhandle wind developers between October 2009 and April 2010 in response to PUCT criteria, allows us to confirm H5.

6.4. CONCLUSION

This within-case analysis sought explanations for the Texas 'wind rush' in general and changes in DV indicator values more specifically. We assessed our five IVs by comparing empirical results to the theory-derived expectations we outlined in the theoretical framework, and attempted to locate causal mechanisms that could explain changes in the DV.

Tentatively, we found:

TABLE 2. SUMMARY OF FINDINGS FROM TEXAS

Independent variable	Assessment of findings	Preliminary conclusion
IV 1: Federal wind energy production tax incentive	Consistent with expectations, IV1 exerted a clear causal effect on deployment	Confirm
IV 2: Mandatory renewable energy quota	Against expectations, the ambitiousness of a quota goal did not determine market demand and therefore deployment levels	Disconfirm
IV 3: Electricity market type	Consistent with expectations, competitive wholesale and retail markets create opportunities for wind IPPs, who, in turn, cause deployment	Confirm
IV 4: Planning, permitting & siting model	Consistent with expectations, use of a 'minimal' model seems to have attracted developers, although evidence of cause and effect is weak	Confirm
IV 5: Grid infrastructure	Consistent with expectations, the CREZ project's 'anticipatory' approach had a clear causal effect on indicators of future deployment	Confirm

We anticipate greater insights will be available in the cross-case analysis. As with complex real-world phenomena, our IVs cannot collectively explain all the changes in the DV, for example the dip in annual capacity additions after 2008.

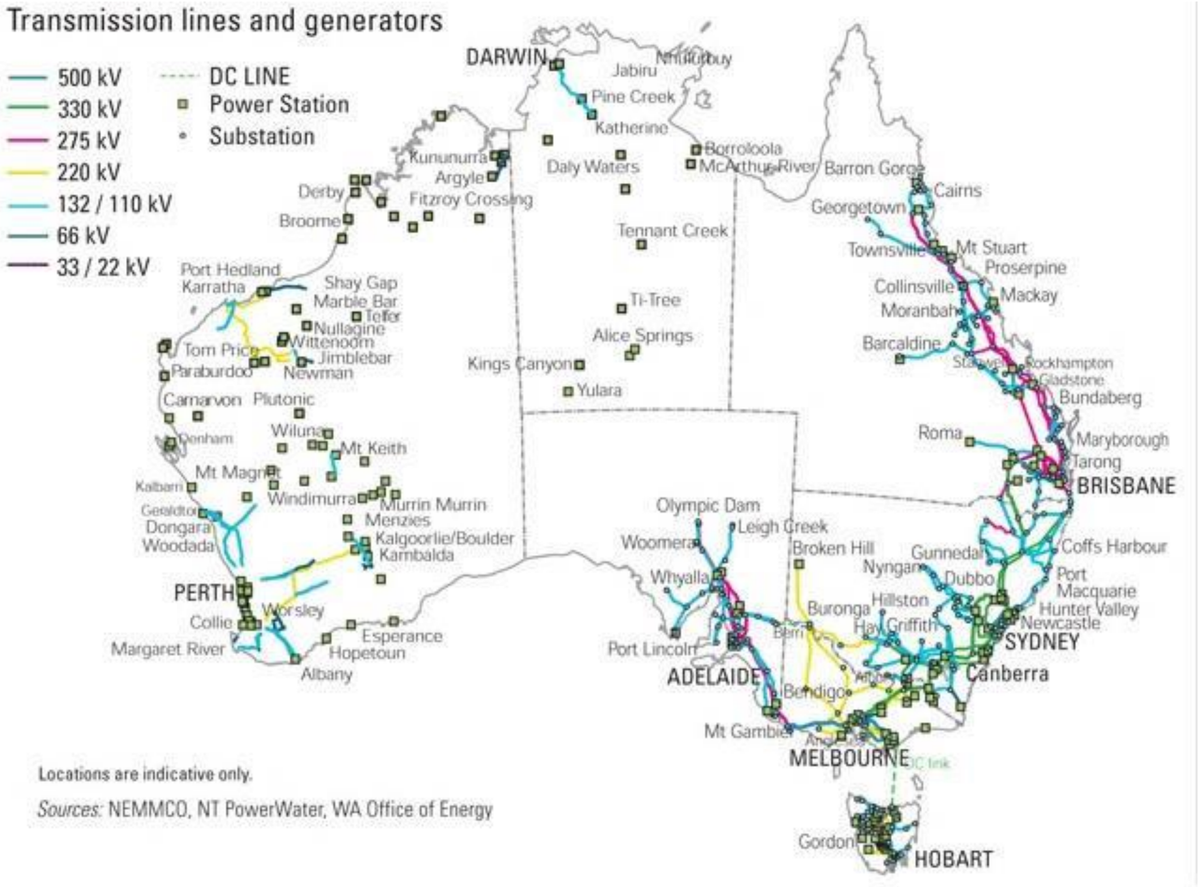
Furthermore, some of the IVs change values in the same year, posing a simultaneity problem that makes it hard to disentangle the distinct contributions of each IV when looking for covariation. The same 1999 legislation that introduced further electricity market liberalization (IV3) also enacted the RPS (IV2). In 2005, the PTC (IV1) entered a period of stability at the same time the CREZ project was announced (IV5) and the RPS goals were extended (IV2).

7. CASE ANALYSIS: WESTERN AUSTRALIA

In this within-case analysis we examine the factors that may be influencing wind energy deployment outcomes in Western Australia over the last fifteen years. In the first part of the chapter, we evaluate deployment outcomes. Next, we assess our five hypotheses by combining an 'outcome-explaining process tracing' analysis with the logic of both congruence analysis and comparative analysis. We are interested in how well our empirical observations match with theoretically-derived expectations, and how well they do not match with rival explanations.

7.1. BACKGROUND

Of the three geographically dispersed grids comprising the electricity market in Western Australia, the South West interconnected System (SWIS) is by far the largest, supplying most of the state's population, who live in the south-west region near Perth (see Figure 7.1). Our study uses data from both the federal government and the SWIS electricity market, to which most commercial wind farms in Western Australia are connected.



Locations are indicative only.

Sources: NEMMCO, NT PowerWater, WA Office of Energy

Figure 7.1. Map of transmission lines and generators in Australia. SWIS grid shown extending from Perth region. Source: WA Office of Energy n.d.

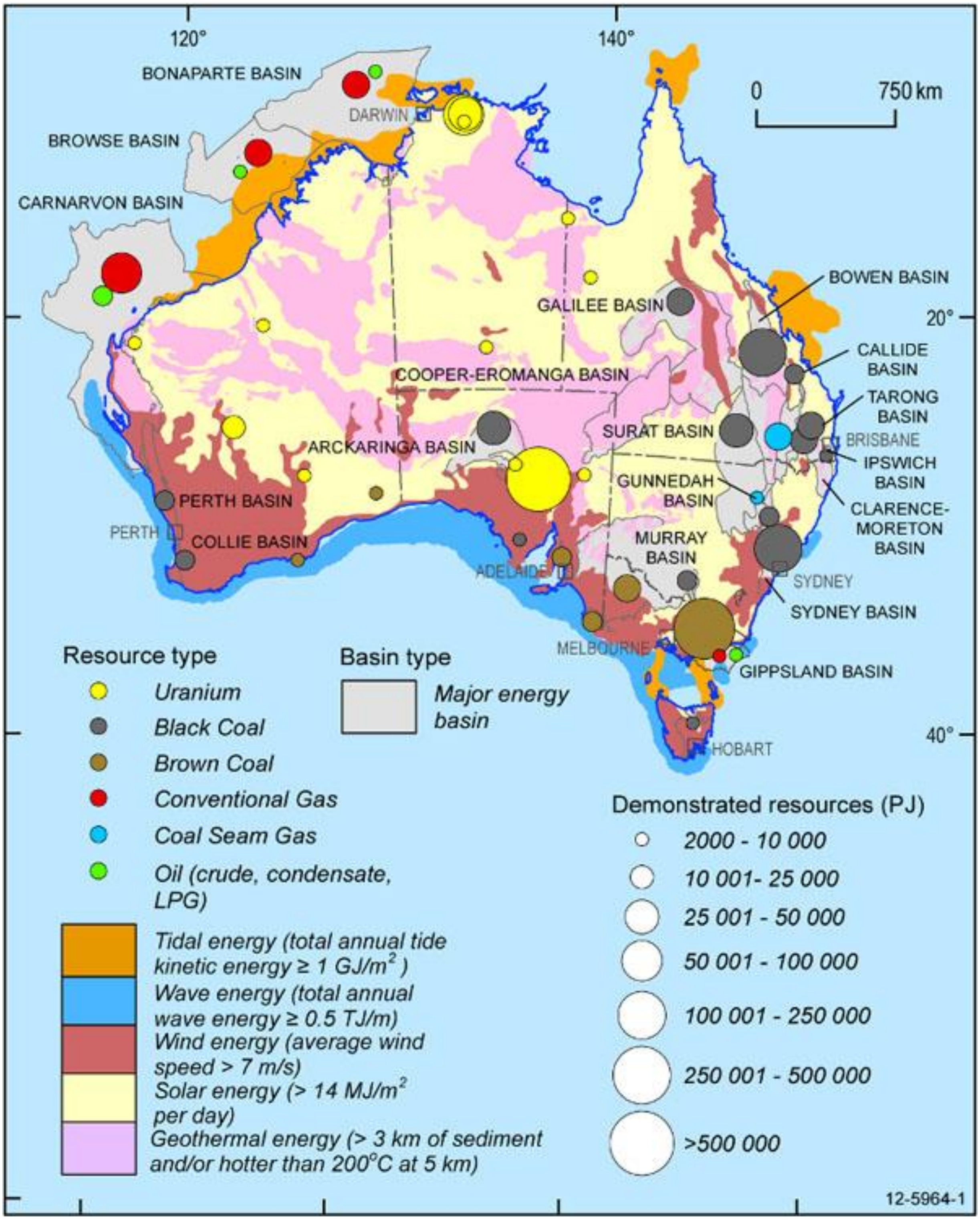


Figure 7.2. Australian resources map. Source: Australian Government Department of Resources, Energy and Tourism 2012.

As Figure 7.2 shows, the southwestern coastal areas of Western Australia have among the best wind resources in the country.

7.2. DEPLOYMENT OUTCOMES

Despite the state's great potential for high levels of wind energy deployment, Western Australia had uneven growth in wind deployment during the sample period.

The following graph, Figure 7.3, shows three of our four deployment indicators: Total installed wind capacity (in MW)[3], annual capacity additions (MW), and total installed wind capacity per capita (kW per 100 people). These indicators are based on federal data and include the whole state.

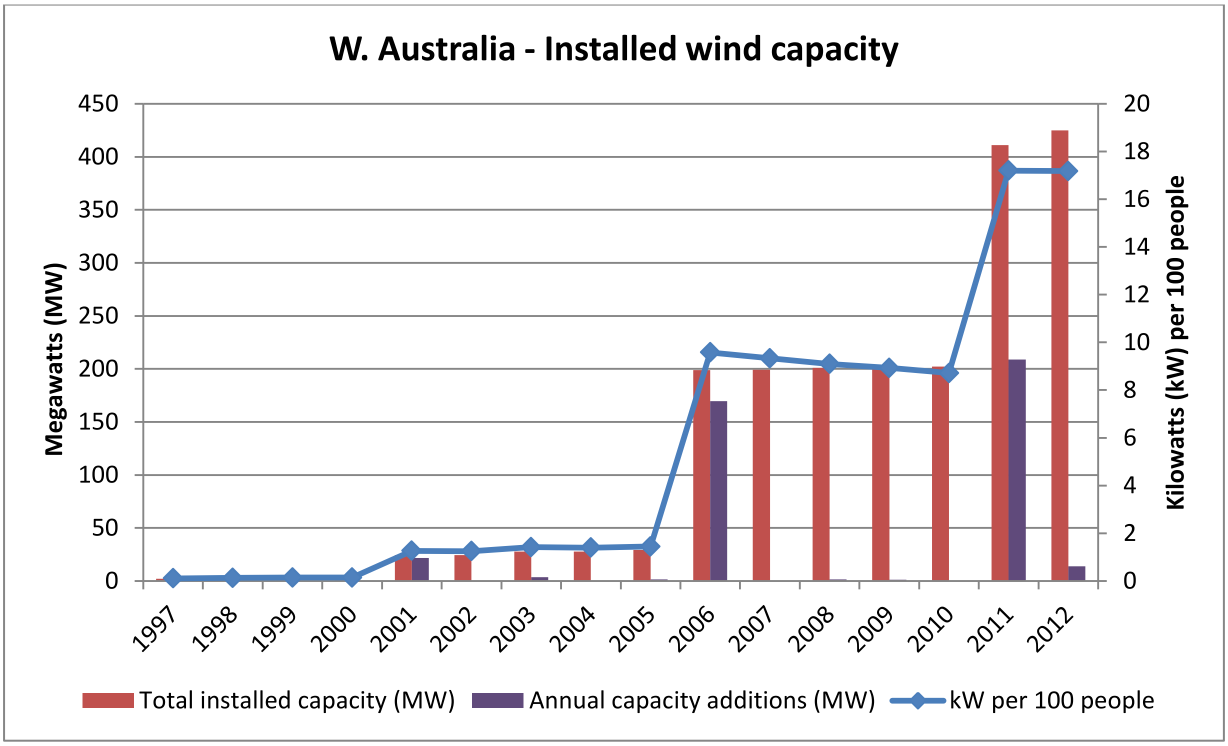


Figure 7.3. WA: Installed wind capacity. Source: Data from WA Office of Energy 2010; Clarke 2013; Australian Bureau of Statistics 2013.

Figure 7.3 shows that installed wind capacity in Western Australia grew in spurts both in absolute terms and across population, over the sample period. The annual capacity additions indicator reflects the fact that the majority of the state's wind capacity is installed in three IPP-owned wind farms: Walkaway (2006, 90 MW), Emu Downs (2006, 80 MW) and Collgar (2011, 206 MW). At the end of 2012, the state had 424.79 MW of total installed wind capacity. Changes in the third indicator, kilowatts of wind energy per 100 people,

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[3] Data includes only projects >1 MW but reflects that one 1 MW project was installed in three parts (0.33 MW added each time in 1998, 1999, 2007).

roughly mirror those of total installed capacity, starting at 0.11 kW/100 people in 1997 and growing to 17.18 kW/100 people in 2012.

The next two graphs look at our fourth DV indicator, wind penetration of electricity generation mix.

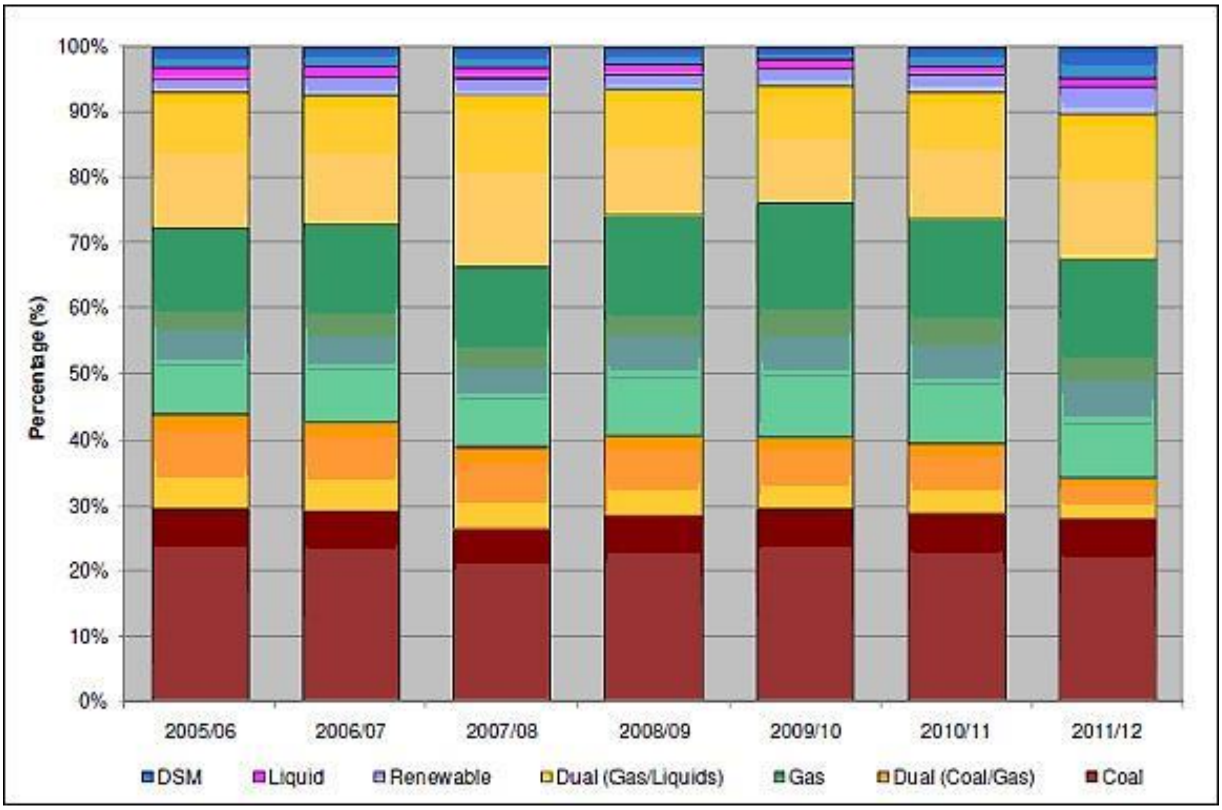

Figure 7.4. SWIS: Installed generation capacity by fuel type. Source: IMO website n.d.

Figure 7.4 displays the share of renewables penetration in the electricity generation mix for the SWIS from FY2005/06 to FY2011/12, where wind comprised almost 80% of the renewables share in 2011 (Clarke, 2013). A significant increase in that segment in FY2011/12 is caused by the completion of the large Collgar Wind Farm in late 2011, which singlehandedly near-doubled the penetration of renewables in the SWIS, taking it from 5% to 9% (Collgar 2013).

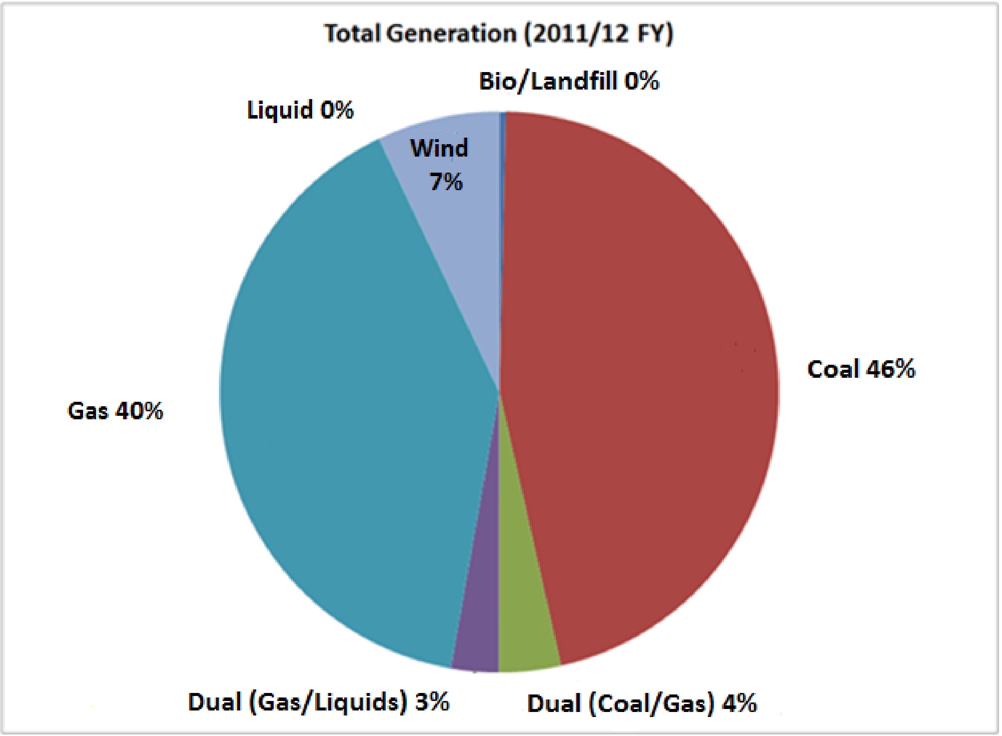

Figure 7.5. SWIS: Total generation 2011/12 FY. Source: Adapted from IMO 2013.

Figure 7.5 shows that wind had a 7% penetration among total installed generating capacity on the SWIS in FY2011/12.

7.3. TESTING HYPOTHESES

This section is organized by hypothesis and we combine different analytical approaches to look for insights into the cause-effect links between the IVs and DV.

7.3.1. H1: JURISDICTIONS WITH A HIGH-VALUE FEDERAL WIND ENERGY PRODUCTION TAX INCENTIVE WILL HAVE INCREASED LEVELS OF WIND ENERGY DEPLOYMENT

Australia did not enact or have in place a federal wind energy production tax incentive during the sample period. We operationalized *IV1 – federal wind energy production tax incentive* to be measured on a scale of 0-2 cents per kWh of wind-generated electricity production and corresponding to incentive value (no/low, medium, high). On IV1, Western Australia earns a zero (no incentive) for the entire sample period.

This is because, as the Clean Energy Australia (2011) report makes explicit, the only two supports the federal government is implementing to promote deployment of commercial wind, solar and geothermal energy technologies are the expanded RET (to be discussed in the next section), which came into effect in 2009, and the new carbon tax (p.3). The latter came into effect on July 1, 2012 – too late in the sample period to produce observable effects on wind deployment.

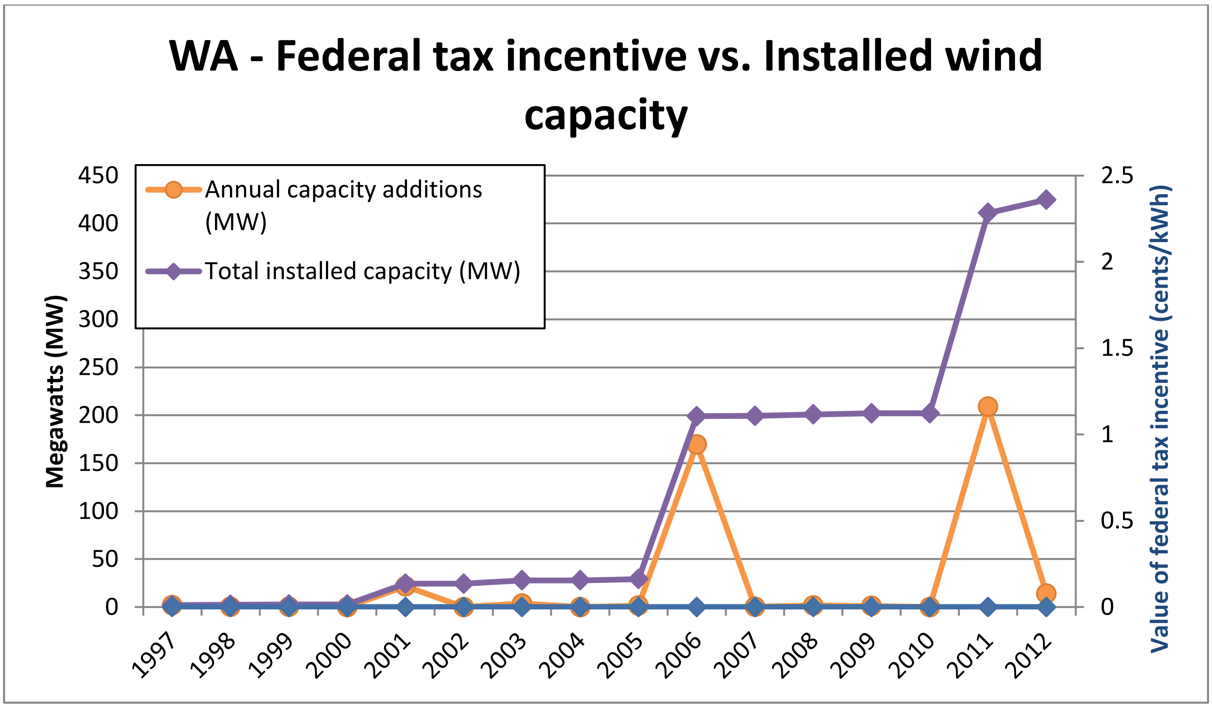

Figure 7.6. WA: Impact of federal tax incentive on deployment. Sources: Data from WA Office of Energy 2010; Clarke 2013.

If our theory that a high-value federal wind energy production tax incentive promotes high levels of wind deployment is correct, we would expect the sustained absence of any such incentive in Western Australia to deny additional financial motivation to prospective wind IPPs, resulting in no or low levels of wind deployment. However, if we were to observe medium or high levels of deployment despite the absence of such an incentive, it would indicate that our theory is incorrect.

In Figure 7.6, we can see that on the dependent variable that Western Australia had low overall levels of wind deployment during the sample period, which featured many years with only very small amounts of additional wind capacity installed. This is consistent with our theory. However, we can see a few years where large wind projects were installed even without the presence of a federal tax incentive, showing us that such an incentive is not necessary for deployment. Furthermore, the invariance of IV1 signals that other factors are influencing the elevated instances of deployment. We are unable to draw conclusions about H1 at this point in the analysis.

7.3.2. H2: JURISDICTIONS WITH A HIGHLY AMBITIOUS MANDATORY RENEWABLE ENERGY QUOTA GOAL WILL HAVE INCREASED LEVELS OF WIND DEPLOYMENT

In 1997, Liberal Prime Minister John Howard announced the impending adoption of a mandatory quota: the Mandatory Renewable Energy Target (MRET), which came into effect in 2001. Like the RPS, the MRET imposed a mandatory quota (initially 2% by 2010, with interim targets increasing each year) for the proportion of renewable energy that electricity retailers, or industrial customers purchasing directly from the electricity wholesale market, must purchase annually. The MRET was backed by the world's first tradable renewable energy certificate (REC) scheme, used to demonstrate MRET compliance, whereby eligible RE generators earn a certificate for each MWh they produce, which they can sell to liable parties like retailers (Aparicio et al. 2012). Failure to comply results in a financial penalty based on the amount of shortfall, at a rate of $65 per MWh. The scheme is administered by the Clean Energy Regulator, a federal agency.

In combination with the MRET, the REC scheme is credited with expanding wind energy deployment in Australia because in addition to having guaranteed minimum demand for their electricity in the wholesale markets (assured by the MRET), RE generators can earn supplemental income by selling RECs to liable parties (Macgill 2010, p.3184). In 2009, the MRET was superseded by the expanded RET, which raises the amount of RE required to 20% by 2020. It also breaks the REC scheme into large-scale and small-scale RET schemes.

In a 2012 report to the Clean Energy Council, consulting firm SKM quantified the direct, positive impact the MRET and RET have had since 2001 on increasing renewable energy deployment nationwide.

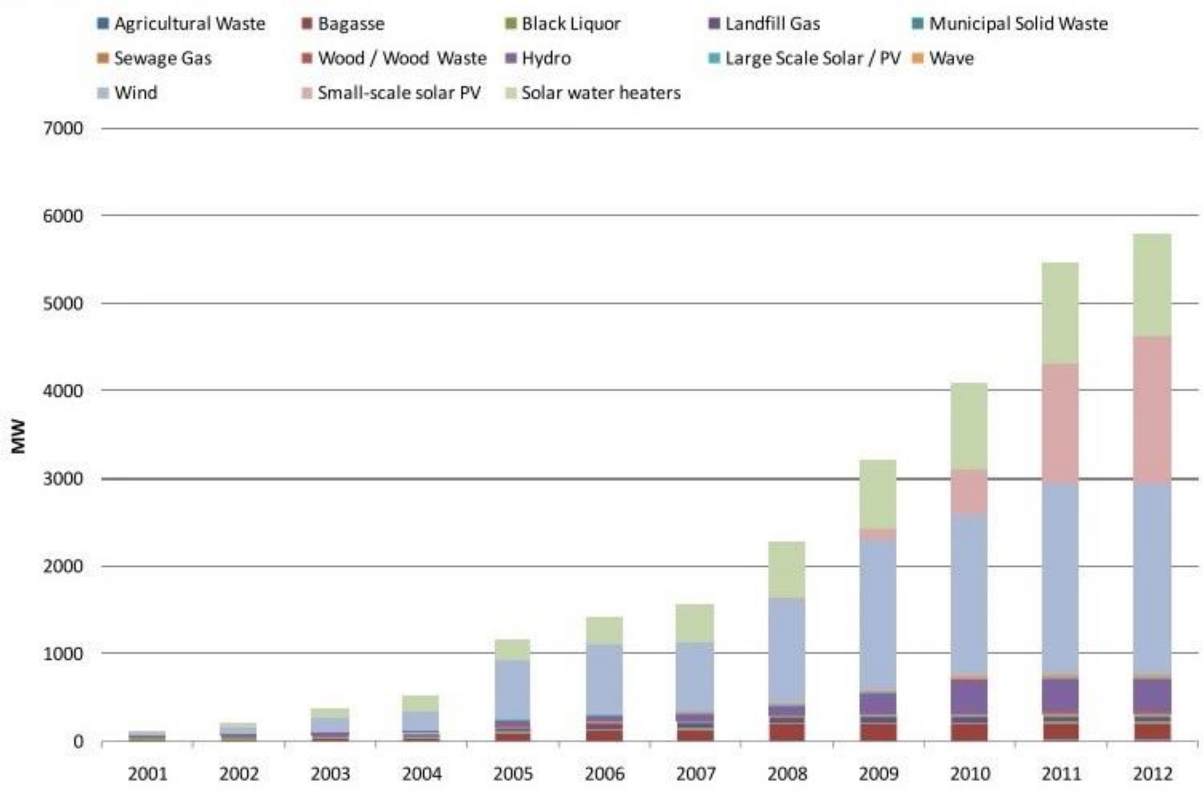

Figure 7.7. Total installed renewable capacity by type in Australia. Source: SKM 2012, p.2.

Figure 7.7 shows that 38% of total installed renewable energy capacity in Australia has been wind energy. SKM also found that the average size of turbines and wind farms had gone up, along with capacity factors (a turbine performance measure).

We are assessing *IV2 – mandatory renewable energy quota* on a scale based on the ambition level of the goal for the quota program's terminal year. In 2001, the MRET came into effect, set at a goal of 2% RE by 2010. Our scale treats this as a goal of low-ambition (less than 12% RE by terminal year). Then, in 2009, Australia adopted the expanded RET set at a goal of 20% RE by 2020. Our scale treats this as a goal of medium-ambition (12% - 24% RE by end year).

The expanded RET requires the state of Western Australia "to annually produce (or acquire) 4,750 GWh of renewable energy by 2020. To meet this target, almost 1,100MW (at 50% capacity factor, 1,350MW at 40% capacity factor) of installed wind generating plant is required by 2020" (Western Power 2010a, p.17).

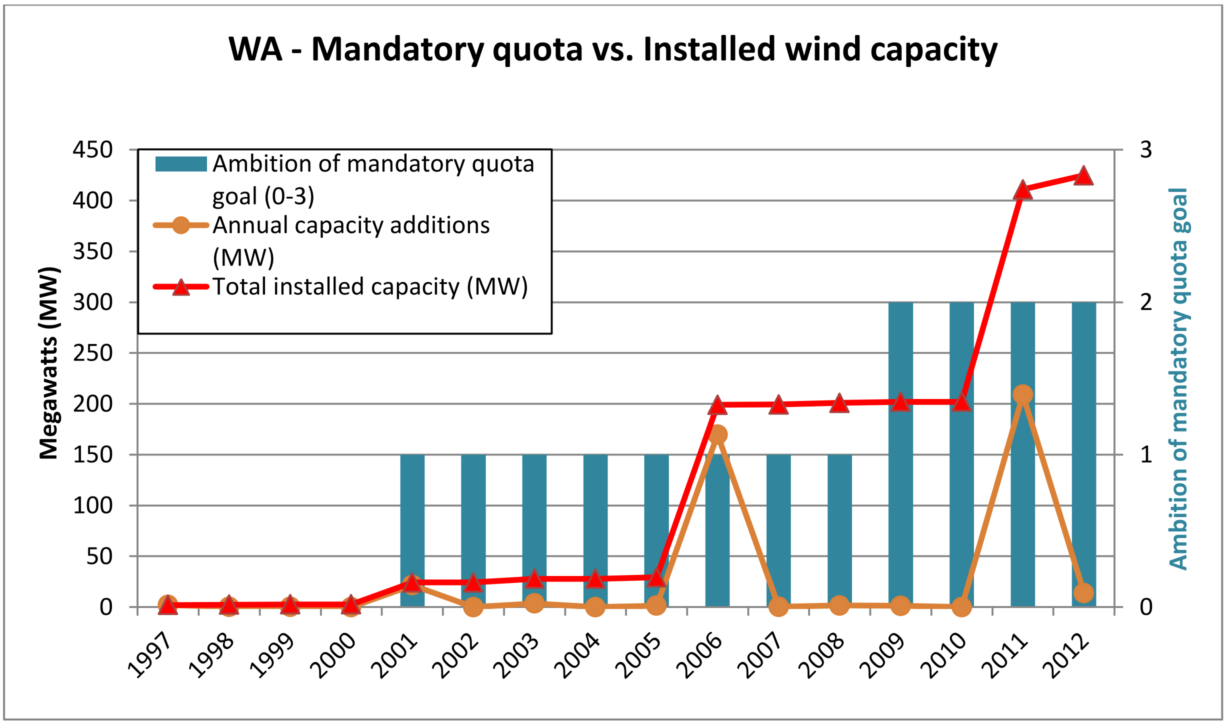

Figure 7.8. WA: Impact of mandatory quota on deployment. Sources: Data from WA Office of Energy 2010; Clarke 2013.

Figure 7.8 shows the introduction of the federal MRET in 2001 (first announced in 1997) coincides with the first noteworthy instance of wind deployment in Western Australia. The second instance of deployment, in 2006 – five years into the MRET – is significantly larger than the first, due to the commissioning of the Walkaway (90 MW) and Emu Downs (80 MW) wind farms that year. Then, the third and by far largest instance of deployment – the giant 206 MW Collgar Wind Farm – occurs in 2011, two years after the MRET is superseded in 2009 by the more ambitious expanded RET.

If our theory that a highly ambitious renewable energy quota goal promotes high levels of wind deployment is correct, we would expect deployment levels to rise following the adoption of a quota and again following the raising of the quota goal. This would reflect the increased market demand for wind energy that the quota is designed to create. However, if we were to see high levels of deployment before any quota is adopted, or see low levels of deployment following a rise in quota goal, this would indicate our theory is incorrect.

Weakly consistent with our theory, our results indicate that the vast majority of Western Australia's wind energy deployment occurred following the adoption of a mandatory quota in 2001. Only 2.66 MW of wind energy in Western Australia predate the introduction of a quota, meaning the other 422 MW were deployed while the MRET or RET was in effect. The single largest instance of deployment comes two years after the raising of the quota goal, possibly in response to it, although we were unable to determine this. This suggests that while a mandatory quota is not necessary for wind deployment, it may have a positive influence, as predicted. This is also in line with SKM's national findings. However, we cannot rule out the possibility that other factors may also be shaping deployment outcomes.

We can weakly confirm H2.

7.3.3. H3: JURISDICTIONS WITH A HIGH LEVEL OF COMPETITION PRESENT IN THEIR ELECTRICITY MARKET WILL HAVE INCREASED LEVELS OF WIND DEPLOYMENT

In 1998, five states in southern and eastern Australia embraced restructuring and formed an interconnected wholesale National Electricity Market (NEM), with Tasmania later joining. The SWIS area, however, is so distant from the NEM – nearly 1,500 kilometres apart – it had no choice but to continue to operate in isolation for the foreseeable future. One consequence of this isolation is that Western Australia's electricity market was dominated for nearly a decade longer than the other states' markets by a single state-owned utility – the vertically integrated monopoly Western Power Corporation. Although an 'open access regime' was implemented in 1997, among other minor reforms, supposedly giving IPPs access to the grid, in practice IPPs felt discriminated against as the regime still favoured Western Power (Weiter 2004, p.82).

In 2001, an Electricity Reform Task Force recommended 79 reforms, which Cabinet later approved, in the direction of market liberalization, in order to separate Western Power's functions – generating, transmitting, distributing and retailing – and to create a competitive wholesale market under an independent regulator. After passing key legislation in 2004, the bulk of reforms occurred in 2006, starting with the disaggregation of Western Power into four separate state-owned entities: generator Verve Energy, transmission and distribution network operator Western Power, retailer Synergy, and regional (outside the SWIS) supplier Horizon Power (AER 2007, p.207).

Also in 2006, the new Wholesale Electricity Market (WEM) started operations in the SWIS with an aim "to facilitate greater competition and private investment and allow generators and wholesale purchasers of electricity (such as retailers) greater flexibility" (IMO n.d.). Additionally, an Independent Market Operator (IMO) was created to administer and operate the WEM, and an independent state regulator, the Economic Regulation Authority (ERA), was set up to monitor the WEM and enforce the Electricity Networks Access Code (Au. BREE 2012, p.31). The ERA's role is to "maintain a competitive, efficient and fair commercial environment (ERA n.d.).

Since the WEM started in 2006, introducing competition to the wholesale market, a growing number of independent power producers (IPPs) have emerged. As intended by policymakers involved in restructuring, generation capacity owned by state-owned generator Verve has been shrinking modestly but steadily as IPP generating capacity has grown (see Figure 7.9). In 2006, Verve had 75% of total generation capacity (all types) in the SWIS, but this fell to a 59% share of generation in late 2012 (AER 2007; IMO 2013).

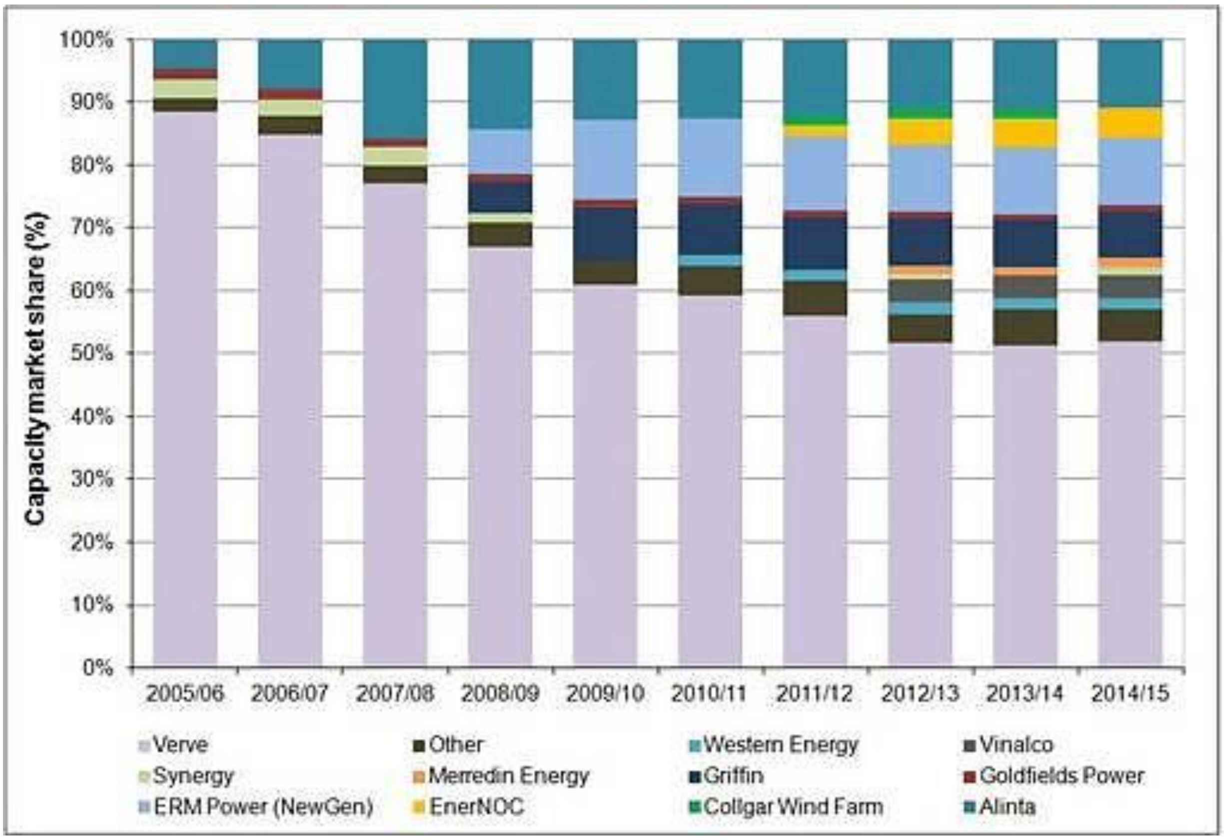

Figure 7.9. SWIS capacity market share by owner – all generation types. Source: IMO n.d.

In terms of total wind capacity, Verve is a small player owning just 12% (43.6 MW, in 11 small wind farms) in 2011 (Clean Energy Council 2011, p.12). The other 88% (367.4 MW) of total installed wind capacity in 2011 was IPP-owned but installed in the state's three largest wind farms – the two built in 2006 and the huge Collgar Wind Farm in 2011 (WA Public Utilities Office, Renewable Energy Handbook, 2010; Clarke, 2013).

Although the restructured market has been operating since 2006, there is evidence of 'growing pains' through the end of the sample period. In 2011, Western Power asked the IMO to reduce the reliability-rate ('capacity credit') payments made to wind IPPs to penalize them for their variable output. In 2012, the IMO agreed and scaled back wind farms' capacity credit rating drastically, from 40% to 26% for every MWh of generating capacity a wind farm could theoretically provide. Western Power along with gas- and coal-fired plant owners are reported to have pushed the IMO for an even bigger cut (Mercer 2012). The rate reduction means existing wind farms stand to lose millions of dollars and prospective wind investors could be deterred by the unstable investment climate and the fact that planned projects may be rendered unviable. Another complaint is that IPPs are saddled with grid-connection costs.

With regard to our hypothesis, and according to the scale by which we are assessing *IV3 – electricity market type*, Western Australia had no competition from 1997 to 2005, the years prior to market liberalization. After the WEM began operating in 2006, through 2012, Western Australia had a low level of competition present in the SWIS electricity market.

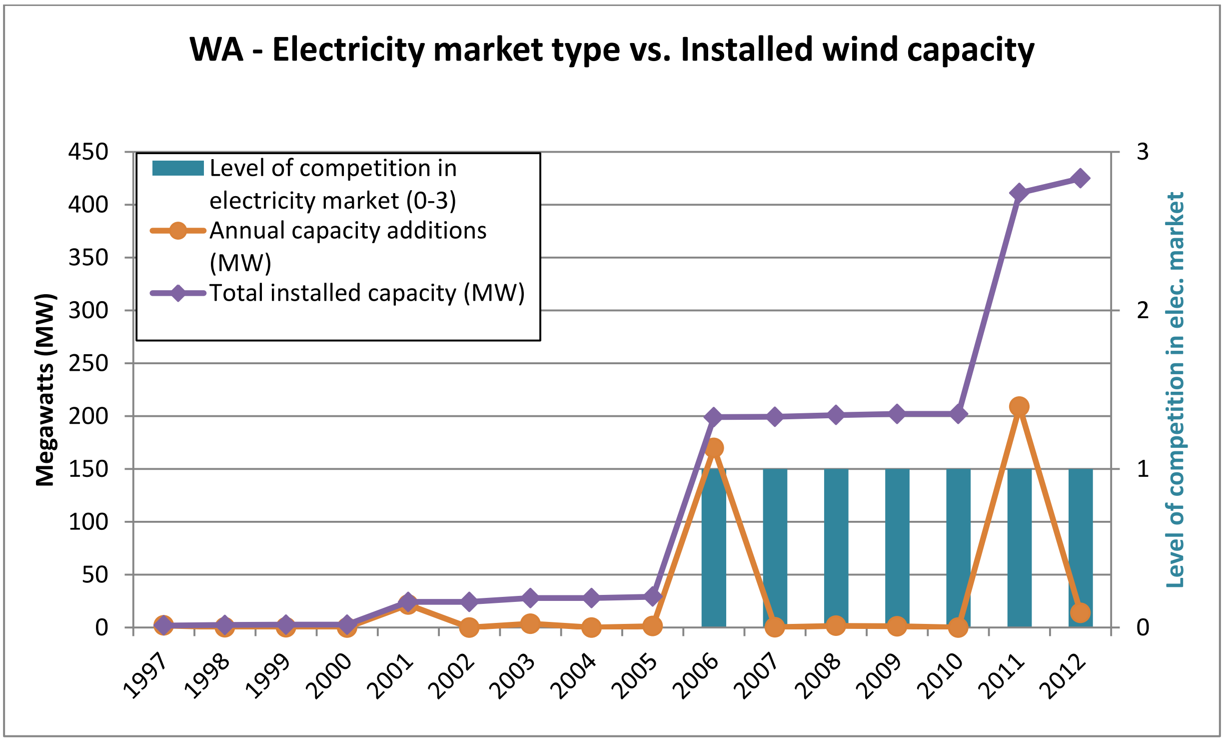

Figure 7.10. WA: Impact of electricity market liberalization on deployment. Sources: Data from WA Office of Energy 2010; Clarke 2013.

Figure 7.10 shows that the introduction of electricity market competition in 2006 occurs in the same year where Western Australia sees the first of two instances of very large-scale deployment.

If our theory that highly liberalized electricity markets promote high levels of wind deployment is correct, we would expect deployment levels to rise upon the introduction of wholesale market competition. After restructuring, prospective wind IPPs would recognize more favourable market conditions and thus business opportunities, and they would start generating electricity and selling it on the wholesale market. However, if we were to see high levels of deployment before market competition is introduced, or see low levels of deployment following the introduction of competition, this would indicate our theory is incorrect.

Our results indicate that the vast majority of Western Australia's wind energy deployment occurred following the introduction of market competition when the Wholesale Electricity Market began operating in 2006, which is consistent with our theory. Indeed, the first large-scale instance of deployment came in 2006, when two large IPP-owned wind farms were commissioned. Because the forthcoming creation of the WEM was announced in 2004, it is possible these two IPP-owned wind farms timed construction of their projects to have commissioning occur once the WEM was active. The giant Collgar wind farm was also built while the WEM was active.

However, a smaller instance of deployment occurred in 2001, before the market was liberalized. This suggests that a competitive electricity market is not necessary for wind deployment. Also, we cannot rule out the possibility that other factors may also be shaping deployment outcomes.

We can tentatively confirm H3.

7.3.4. H4: JURISDICTIONS USING A HIGHLY SIMPLIFIED PLANNING, PERMITTING AND SITING MODEL WILL HAVE INCREASED LEVELS OF WIND DEPLOYMENT

The Western Australian Planning Commission's most recent guidelines for wind farm development, which were issued in 2004, indicate that WA uses a relatively complicated model for its planning, permitting and siting (PPS) of commercial-scale wind farms. This corresponds to a classification system we adopted from Bohn and Lant (2009) that ranks PPS models by their simplicity level. The 'standard' PPS model is the least simple model due to the large number of steps it entails, implying a longer process to move from the early planning stages to the construction stage. In our theoretical framework we reproduced Bohn and Lant's (2009) diagram showing the steps typical of a 'standard' PPS model, and Western Australia's wind project guidelines reflect this model twice over since proposed wind farms are subject to approval from both the state government and local governments, and are subject to regional and local planning strategies (Western Australian Planning Commission 2004, p.3).

Furthermore, the Planning Bulletin guidelines ask that project applications include a technical assessment, separate impact assessments for landscape/visual impact, noise impact, environmental impact, amenity impacts, construction impacts, and an environmental management plan (2004, p.5). The guidelines also require:

> *consultation with the relevant local government, EPA, DoE, WAPC, Department for Planning and Infrastructure, Department of Conservation and Land Management, Civil Aviation Safety Authority, Air Services Australia, Commonwealth Department of Defence, electricity network provider, Department of Land Information, Department for Industry and Resources and Main Roads WA (Western Australian Planning Commission, 2004, p.6).*

The PPS procedures have not been, as one might expect, simplified after the expanded RET came into effect in 2009, to clear away unnecessary red tape and accelerate wind deployment to meet the 20% by 2020 target.

Energy industry group ESAA has the following to say about Western Australia's planning procedures in 2009:

> *Streamlining and simplifying the regulatory requirements for new power plants would reduce costs and encourage new entry, thereby promoting competition. One possible approach is a 'one-stop shop' interface between new entrants and the bureaucracies involved in administering the regulations (Western Australian Energy Market Study, p.29).*

Staff working for the now-defunct Office of Energy also seemed to be aware of a need to simplify its PPS procedures. In the Energy2031 report, they suggest the WA government assist with "securing planning pre-approvals for locations where significant renewable energy resources have been identified, streamlining approvals processes and simplifying licensing obligations for smaller generation facilities" (2011, p.34). However, this reform would only apply to distributed generation and local energy projects, which would not be supplying the SWIS.

If our theory that use of a highly simplified ('minimal') planning, permitting and siting model promotes high levels of wind deployment is correct, we would expect WA's use of the least simplified ('standard') model to deter prospective wind IPPs with time-consuming and potentially costly administrative procedures, leading to no or low levels of wind deployment. However, if we were to see medium or high levels of deployment despite the state's use of a 'standard' model, it would indicate our theory is incorrect.

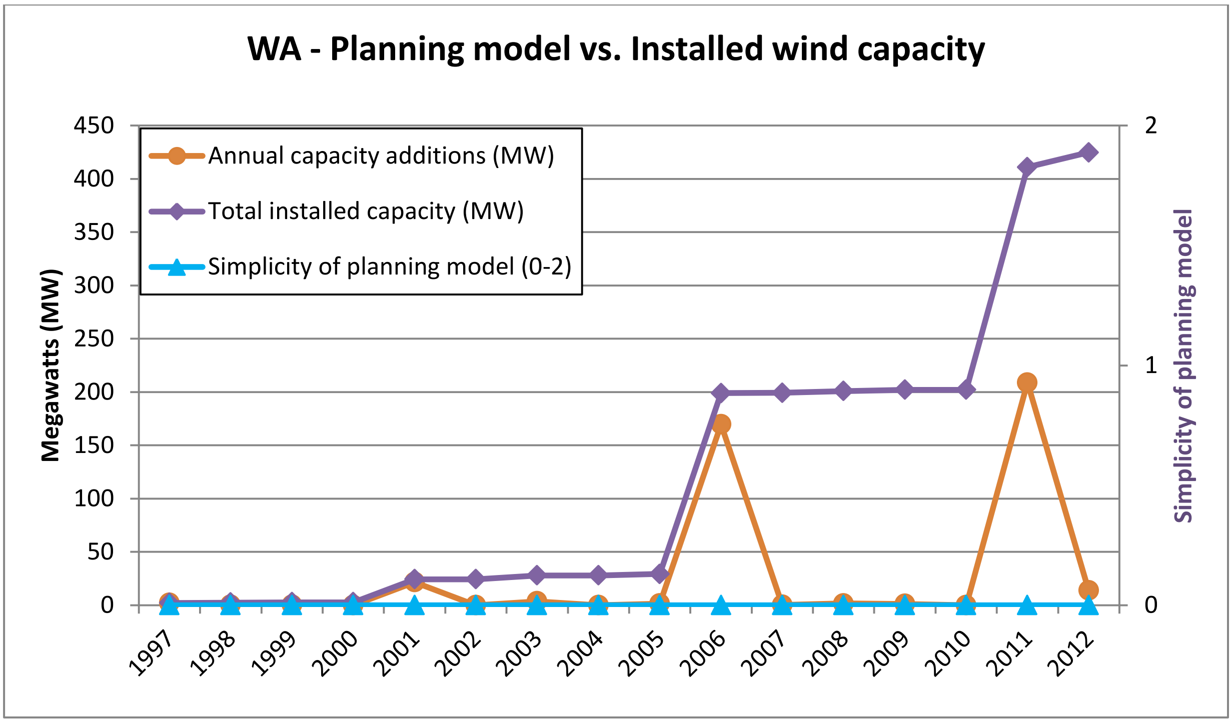

Figure 7.11. WA: Impact of planning model on deployment. Sources: Data from WA Office of Energy 2010; Clarke 2013; WA Planning Commission 2004.

Figure 7.11 shows WA had low overall levels of wind deployment during the sample period, which is consistent with our theory. However, we can see that a few instances of deployment occurred even without the use of simplified PPS procedures in 2001, 2006 and 2011, showing us that use of the 'minimal' PPS model is not necessary for deployment and that use of the 'standard' model does not prevent prospective IPPs from deploying. Furthermore, the invariance of IV4 suggests that other factors are influencing deployment in the years with elevated levels.

Perhaps the most convincing evidence is that Western Power reports a backlog of proposed wind projects seeking transmission approval, which signals a high level of interest from prospective IPPs – despite use of the 'standard' model. Western Power says it "has enquiries from proponents seeking to develop over 1,300 MW of wind generation projects" in one portion of the grid (Western Power 2010b, p.16). This indicates our theory, which predicts that use of the 'standard' model deters developers, may be incorrect.

We can tentatively disconfirm H4.

7.3.5. H5: JURISDICTIONS USING AN ANTICIPATORY APPROACH TO GRID INFRASTRUCTURE IMPROVEMENTS WILL HAVE INCREASED LEVELS OF WIND DEPLOYMENT

While WA Government reports have mentioned 'diversification of energy supply' among its goals for many years, the state did not invest in grid infrastructure improvements (i.e., expansion or upgrading) to accommodate growth of non-incumbent technologies like wind until late in the study period. From 1997 to 2006, WA's approach to grid improvements was exclusively ‘reactive’, meaning that transmission work followed developer’s requests for interconnection (Woo et al. 2006 in Alagappan et al. 2011, p.5101-2). As a consequence, the Energy2031: Strategic Energy Initiative report finds that “significant network augmentation” is needed if the SWIS is “to achieve large-scale [renewable energy] supply into the grid” (WA Office of Energy 2011, p.24).

A key area of concern on the SWIS grid is the Mid West region, an economically important region along the coast near Perth, where intensifying iron ore mining and processing, other industrial activities, a nearby port development, and the Geraldton urban area, are contributing to high electricity load growth. Furthermore, the Mid West region has some of the state’s best wind resources, which wind developers are hoping to exploit; Western Power says it has received numerous proposals for potential wind projects in the area (Western Power 2010a, p.2). Transmission constraints in the Mid West, however, are considerable. In 2010, ROAM Consulting finds that “no new generation capacity can be accepted in the Mid-West region until the transmission network capacity is upgraded or costly reactive power sources are provided” (p.5).

In response to this need for expanded transmission network capacity in the Mid West, in 2007, Western Australia shifts to an ‘anticipatory’ approach to grid improvements when it announces it has granted preliminary approval to Western Power to undertake a major network augmentation project – the Mid West Energy Project (MWEP). An ‘anticipatory’ approach is when transmission planning and sometimes construction precede a wind developer’s “actual request for interconnection and service” (Alagappan et al. 2011, p.5102).

The MWEP will see Western Power initially build a 200km double circuit 330kV transmission network (Stage 1) with a possible future extension to 400km if Stage 2 proceeds (see Figure 7.12) (Western Power 2010b, p.18). Construction on MWEP Stage 1 (Southern Section) of the MWEP began in 2012 and is expected to finish in 2014, at a cost of $450M (WA Mid West Development Commission 2012, p.14). Stage 2 (Northern Section) was in the planning stage in late 2012 and is expected to cost $160-$280M depending on the route selected. It would extend MWEP transmission north to Geraldton, with construction starting in 2015 and concluding in 2017 (WA Mid West Development Commission 2012, p.15).

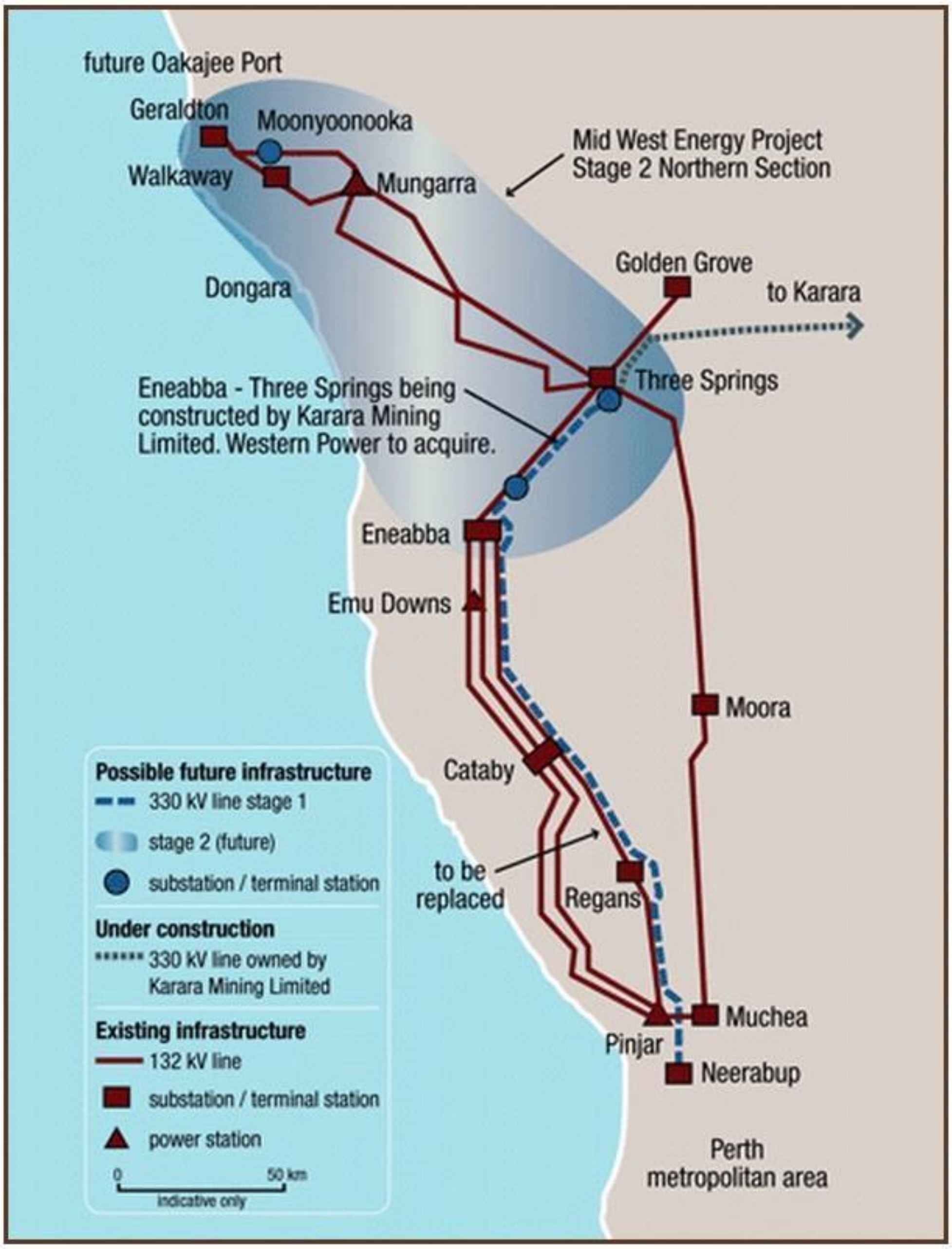

Figure 7.12. Map of Mid West Energy Project. Source: Western Power website n.d.

While seeking approval for its proposed MWEP transmission route in 2010, Western Power writes that “the ability to develop windfarms along the Mid West coastal region is constrained by the weak nature of the existing network north of Pinjar. Augmentation of the Mid West transmission network would create significantly enhanced opportunities for large scale wind projects to access the transmission network, along the route length” (Western Power 2010a, p.14). A study by ACIL Tasman also finds that “a stronger transmission network in the Mid West region would [promote] greater participation by wind generators in the electricity market” (Western Power 2010b, p.15). The MWEP plans include multiple connection points along the route to facilitate wind farm grid interconnection (Western Power 2010b, p.18).

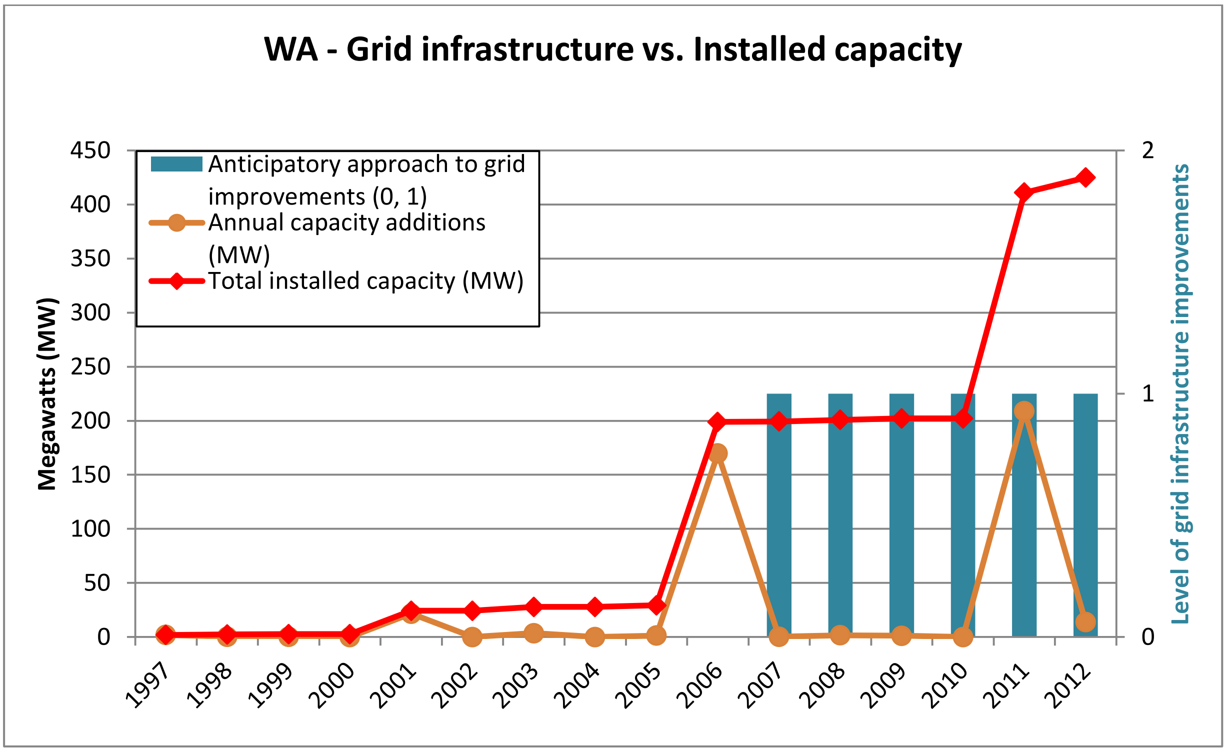

Figure 7.13. WA: Impact of reactive vs. anticipatory approach to grid infrastructure on deployment. Sources: Data from WA Office of Energy 2010; Clarke 2013.

Figure 7.13 shows *IV5 – grid infrastructure* initially at zero values, from 1997 to 2007, when a reactive approach to grid infrastructure improvements was used. Then, following the MWEP's authorization in 2007, IV5 values rise to one to show WA's shift to an anticipatory approach. We are treating 2007 as the earliest possible starting point for observing any potential effects the MWEP project may have on wind deployment, based on the assumption that announcements of major infrastructure investments send positive signals to the market and to prospective wind developers about the state's present and future commitment to wind energy. Our theory that jurisdictions taking an anticipatory approach to grid improvements have elevated levels of deployment predicts the MWEP has positively influenced deployment levels in WA.

We are looking for evidence the MWEP's authorization in 2007 triggered increased deployment, which would suggest that our theory is correct and that jurisdictions taking an anticipatory approach to grid improvements indeed see higher levels of deployment.

Figure 7.13 shows some results that at first appear inconsistent with our theory: major instances of deployment, in 2001 and 2006, precede the switch to an anticipatory approach. They were not deterred by a reactive approach. However, the transmission constraints warranting an anticipatory approach to infrastructure improvements did not emerge until after the two large wind farms commissioned in 2006 came on-line. Only then did transmission congestion seem to become an issue.

Our DV indicator values seem consistent with Western Power's claims that wind project growth in the Mid West portion of the SWIS is inhibited by transmission constraints until the MWEP transmission augmentation occurs: no significant amounts of new wind capacity were installed anywhere on the SWIS after 2006, except for the giant Collgar wind farm, which is located inland, not near the Mid West, and is connected with a different segment of the SWIS that may be less burdened. Moreover, that WA reached this technical impasse is consistent with our theory that exclusive use of a 'reactive' approach to grid improvements depresses wind deployment levels.

Our assumptions about the causal mechanism that makes an anticipatory approach effective may be flawed, however. Figure 7.13 shows that no significant deployment occurs between 2007 and 2011, which is a long enough span of time post-MWEP announcement for new wind projects to go from concept to completion. This may imply that the announcement alone of a major infrastructure project is insufficient to stimulate wind deployment in situations where potential deployment may be blocked by a technical obstacle.

Because physical infrastructure improvements may be necessary before new deployment can occur, and MWEP construction only began in 2013, we are unlikely to see any effects of changes in IV5 on our DV values during the sample period. However, as with the CREZ project in Texas, we can look for indicators of future deployment that allow us more insight.

The first piece of evidence is the "numerous plans for wind farms in the region" that Western Power has in hand by 2010 (Western Power 2010a, p.1). However, a lack of transparency with such proposals prevents us from determining if the proposals were filed before or after the 2007 regulatory approval of the MWEP, to test the validity of the suspected mechanism at work with IV5.

Additional pieces of evidence concern three very large proposed wind farms and they are more illustrative of the MWEP's seemingly positive impact on future deployment. In 2012, Verve filed documents with the WA Environment Protection Authority about its forthcoming 250 MW Warradarge wind farm. Recharge News reports that a key segment of the MWEP needs to be complete before Warradarge can be constructed: "Given state government approval and the completion of a 330kV transmission line from Eneabba to Three Springs, the project would start in 2014, with construction taking place in three phases through to 2020" (Wagg 2012). Western Power indicates that Verve chose the site to take advantage of post-MWEP upgraded transmission, as it needs a 330kV spur line to the SWIS. Furthermore, the planned Walkaway 2 and 3 wind farms, which are IPP-owned and located on the Mid West segment near Geraldton, have received planning approval for up to 400 MW of capacity (Au. BREE 2012).

Warradarge and Walkaway 2 and 3 wind farms represent 650 MW of new wind capacity that has been approved for installation on the Mid West segment of the SWIS. Both projects suggest that the MWEP upgrades and expansion influenced their selection of sites, which is an indication to us of future deployment caused by use of an anticipatory approach to grid improvements. This is consistent with our theory. However, a reactive approach does not seem to impede wind deployment up to the point at which transmission constraints are felt.

We were not able to observe deployment in our DV variables in response to the MWEP project during the sample period possible because the grid improvements may need to be complete for deployment to occur and MWEP construction only started in 2013, despite its authorization in 2007.

Use of the anticipatory approach does appear to cause future deployment so we can tentatively confirm H5.

7.4. CONCLUSION

In this within-case analysis we assessed our five IVs, compared empirical results to the expectations we outlined in the theoretical framework, and attempted to locate causal mechanisms that could explain changes in the DV.

Tentatively, we found:

TABLE 3. SUMMARY OF FINDINGS FROM WESTERN AUSTRALIA

Independent variable	Assessment of findings	Preliminary conclusion
IV 1: Federal wind energy production tax incentive	Weakly consistent with expectations, absence of federal tax incentive may have hindered deployment but insufficient evidence	Inconclusive
IV 2: Mandatory renewable energy quota	Consistent with expectations, IV2 may have sparked the 2001 wind project and, following the goal's raising in 2009, the giant Collgar project of 2011	Weak confirm
IV 3: Electricity market type	Consistent with expectations, the start of the competitive wholesale market seems to have boosted IPP participation and therefore wind deployment	Confirm
IV 4: Planning, permitting & siting model	Against expectations, use of the 'standard' model did not deter prospective developers	Disconfirm
IV 5: Grid infrastructure	Consistent with expectations, a 'reactive' approach seems to have hindered deployment while the MWEP's 'anticipatory' approach seems to have influenced future deployment in the Mid West	Confirm

8. CASE ANALYSIS: SASKATCHEWAN

Again using a longitudinal approach, this within-case analysis examines the historical processes shaping wind energy deployment outcomes in Saskatchewan over the last fifteen years, in search of explanations. After looking at outcomes across the DV indicators we use an explaining-outcome process-tracing analysis to identify causal mechanisms that can help explain how an IV may be influencing the DV. We follow that by assessing time series graphs, looking for covariation as well as drawing on the logic of congruence analysis to determine the extent to which the data reflect the theory's implications.

Our data mostly comes from the federal agency Statistics Canada as well as from the provincial electric utility, SaskPower.

8.1. BACKGROUND

Saskatchewan has excellent wind resources in the southwest of the province, where three of the province's five commercial wind farms are located (see Table 8 in Appendix III for the full list). The southern part of the province is also the most densely populated area, as reflected by the spatial distribution of generators on the SaskPower electricity system map (Figure 8.1).

Figure 8.1. SaskPower system map. Source: SaskPower annual report 2012.

8.2. DEPLOYMENT OUTCOMES

Figure 8.2 shows data for three of our deployment indicators: Total installed wind capacity (in MW), annual capacity additions (MW), and total capacity per capita (kW per 100 people). It depicts the project sizes and temporal distribution of Saskatchewan's five operational commercial-scale wind farms, showing that deployment occurred in just four unevenly spaced years of our fifteen-year sample period: 2001, 2003, 2006, and 2011.

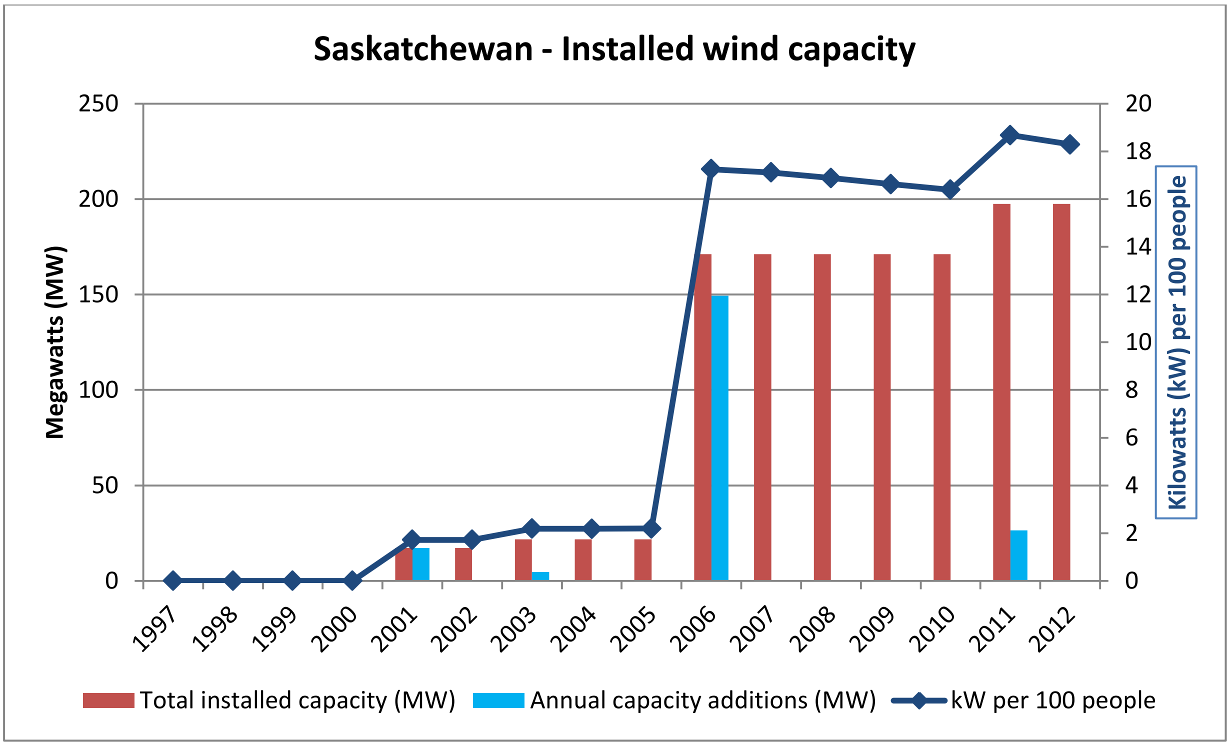

Figure 8.2. SK: Installed wind capacity. Source: Data from CanWEA 2013; Statistics Canada CANSIM database, Table 051-0001.

Most remarkably, total installed wind capacity shot up eight-fold in 2006, with the completion of the 149.4-MW Centennial Wind Power Facility, which also saw kW per 100 people, our third DV indicator, leap from 2.19 to 17.25. Then no new capacity was added until 2011, when a medium-sized project entered operation. At the end of 2012, total installed capacity was 197.58 MW. The third indicator, total capacity per capita, shows that deployment outpaced population growth from 2006 onward. This indicator ended 2012 at 18.30kW per 100 people.

The next two graphs show our fourth deployment indicator, wind penetration, first in megawatts (Figure 8.3) and second as a percentage, in the context of SK's electricity generation mix (Figure 8.4), from 1998 to 2012.

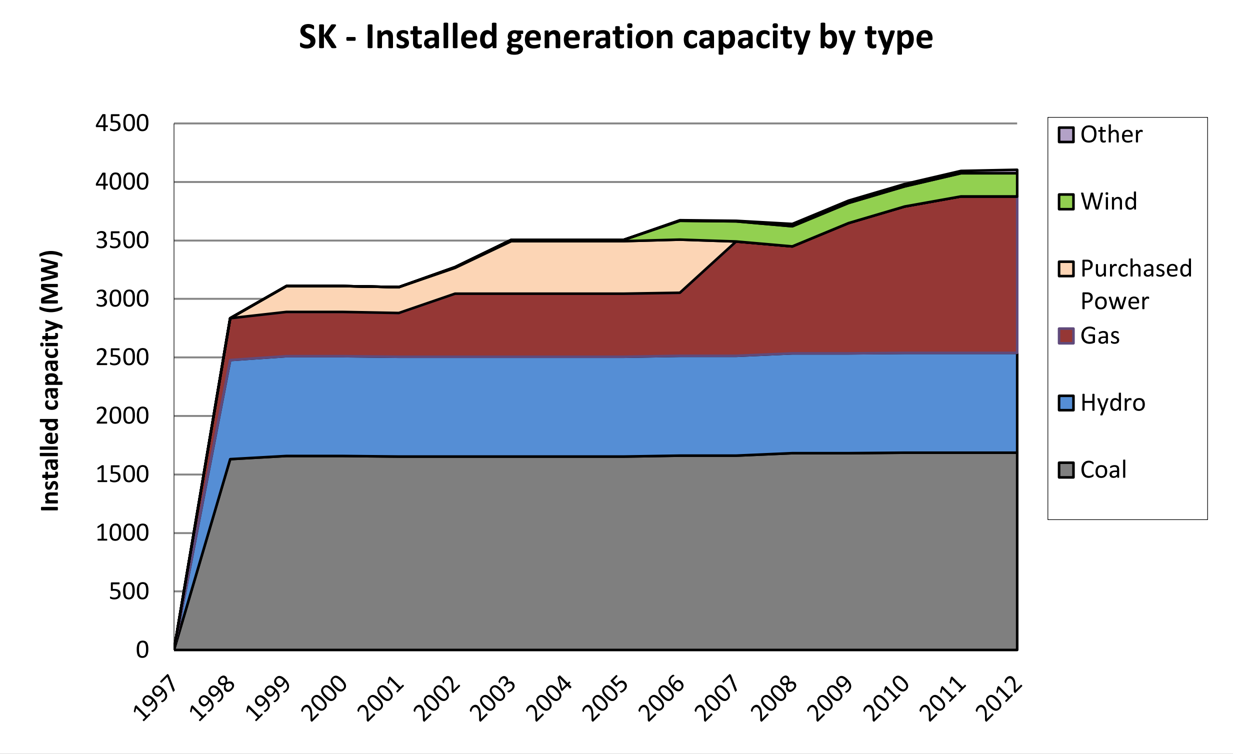

Figure 8.3. SK: Installed generation capacity by type (net MW). Source: Data from SaskPower annual reports 2002-2012.

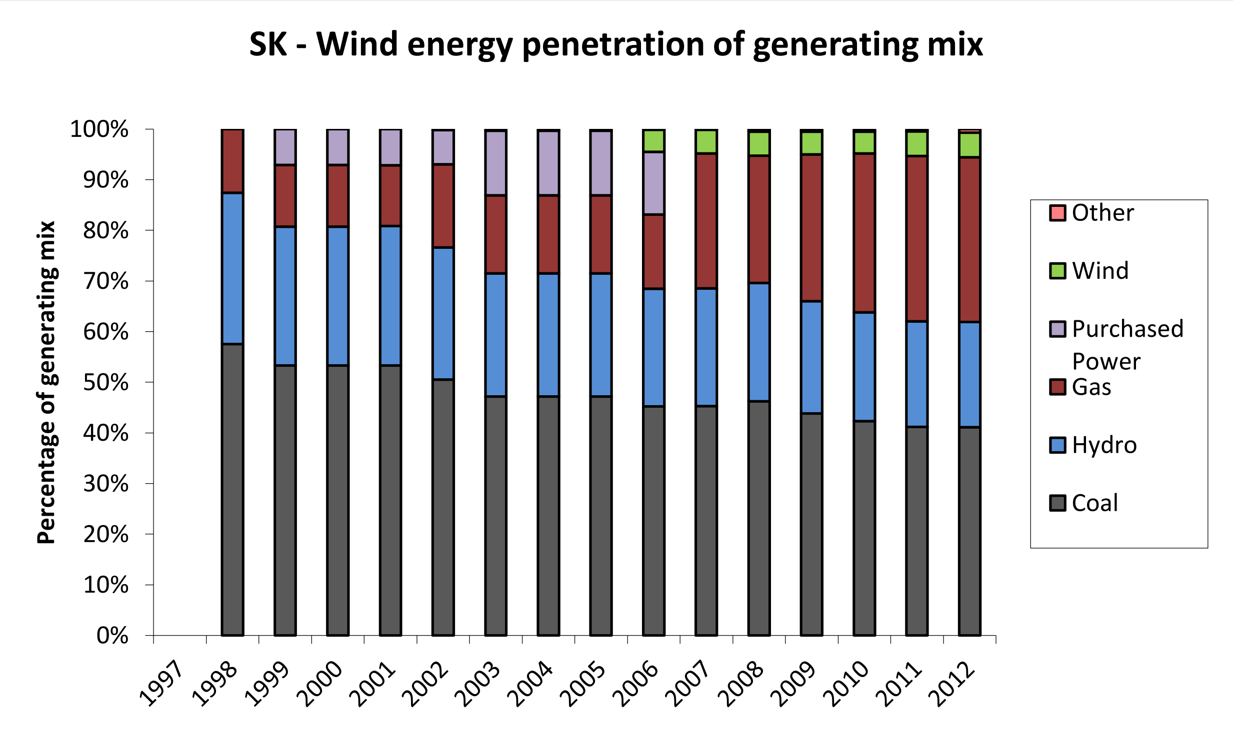

Figure 8.4. SK: Wind energy penetration of generating mix. Source: Data from SaskPower annual reports 2002-2012.

Figures 8.3 and 8.4 show that wind penetration visibly entered the electricity generating mix in 2006, with the completion of the large Centennial project. Wind's share of the mix jumped from 0.3%[4] in 2005 to 4.4% in 2006. At the end of 2012, wind made up 4.8% of the mix.

8.3. TESTING HYPOTHESES

This section is organized by hypothesis and we combine different analytical approaches to attempt to identify and validate cause-effect links between the IVs and DV.

8.3.1. H1: JURISDICTIONS WITH A HIGH-VALUE FEDERAL WIND ENERGY PRODUCTION TAX INCENTIVE WILL HAVE INCREASED LEVELS OF WIND ENERGY DEPLOYMENT

On April 1, 2002, Liberal Prime Minister Paul Martin introduced a wind energy production tax rebate available for the first ten years of a wind project's operations: the Wind Power Production Incentive (WPPI), administered by Natural Resources Canada (NRCan). Making the incentive available to private and public utilities, IPPs, cooperatives and businesses, the fifteen-year, $260 million program was designed to support the installation of 1,000 MW of new wind power.

After a federal election in 2006 brought a change of government, Conservative Prime Minister Stephen Harper allowed the WPPI to expire, as planned, on March 31, 2007. At the time of its termination, the WPPI program supported 22 wind projects, which added 924 megawatts of installed capacity (nearly reaching the government's 1,000-MW goal), and their ten-year contracts remained active. From April 1, 2007, the Harper government replaced the WPPI with a similar long-term incentive that offered 1-cent per kilowatt-hour (kWh) in nominal values over ten years to wind and non-wind renewable projects, under a new name: the ecoENERGY for Renewable Power Program (ecoERP). NRCan reports that by April 1, 2009 the ecoERP program had 3,100 megawatts of projects commissioned or under construction. NRCan estimates that the ecoERP program will allocate approximately 80% of the $1.46 billion (total funding through March 31, 2021) to wind projects. However, SaskPower annual reports show that annual federal transfers to the province for wind energy production dropped from $6 million in 2007 to $5 million in 2008, 2009 and 2010.

The ecoERP program stopped accepting new applications in March 31, 2011 despite internal program evaluations highlighting the positive impact ecoERP had on wind deployment (indeed many interviewees who received the tax rebate stated they would not have gone ahead with their developments without it), and despite a General Electric (GE) Financial Services study that found that an extension of the ecoERP program would net the

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[4] This figure is unreliable but probably off by <0.2% because we are using SaskPower data that grouped wind energy into its "Purchased Power" generation type until 2006, masking the small contributions made by wind capacity installed in 2001 and 2003.

government more in revenue than it outlaid (CanWEA 2011). It is thought that the Harper government cancelled the program for ideological reasons – to appear to be demonstrating fiscal restraint (Business Week 2011).

The federal government's audit found that 104 projects were receiving funding under the ecoERP program, representing investments of about 4,500 megawatts of RE capacity and almost $1.4 billion over 14 years, as of March 31, 2011 (NRCan 2012).

The Canadian Wind Energy Association (CanWEA), an industry group, decried the cancellation of the ecoERP program, saying it had provided "an important part of the developers' return on investment while reducing the price that utilities and their customers pay for the energy" (2011). In the absence of a federal production incentive, CanWEA and environmental think tank the Pembina Institute both note that Canada's ability to attract renewable energy investors is greatly reduced, particularly in light of the US federal government's generous wind energy production tax credit.

We operationalized *IV1 – federal wind energy production tax incentive* to be measured on a scale of 0-2 cents per kWh of wind-generated electricity production and corresponding to incentive value (no/low, medium, high). The ten-year per-kWh WPPI incentive was available to developers of new wind projects from April 1, 2002 to March 31, 2007 before being replaced (for purposes of political rebranding) by the nearly identical ecoERP incentive, which was offered from April 1, 2007 to March 31, 2011.

To calculate the incentive values of the WPPI and ecoERP tax rebates in real terms (in 2012 dollars), we adjusted the nominal values, which varied over the years, for inflation (see Table 9 in Appendix III) using the Bank of Canada's inflation calculator. The tax rebate incentive values are generally around 1-cent/kWh and correspond to a medium level of incentive value for the years they were available.

To accurately analyze IV1, we also had to adjust our installed capacity indicators to take into account the Canadian federal government's use of a fiscal calendar that runs from April 1 through March 31 of the following calendar year. New wind projects looking to secure the WPPI and ecoERP incentives needed to file applications on or before March 31 in order to qualify for that fiscal year's tax rebate value. To make the adjustments, we used CanWEA data to determine the month and year of each wind project's commissioning and then assigned it to the appropriate fiscal year and corresponding incentive value. This is an important consideration because some years were slightly more lucrative than others.

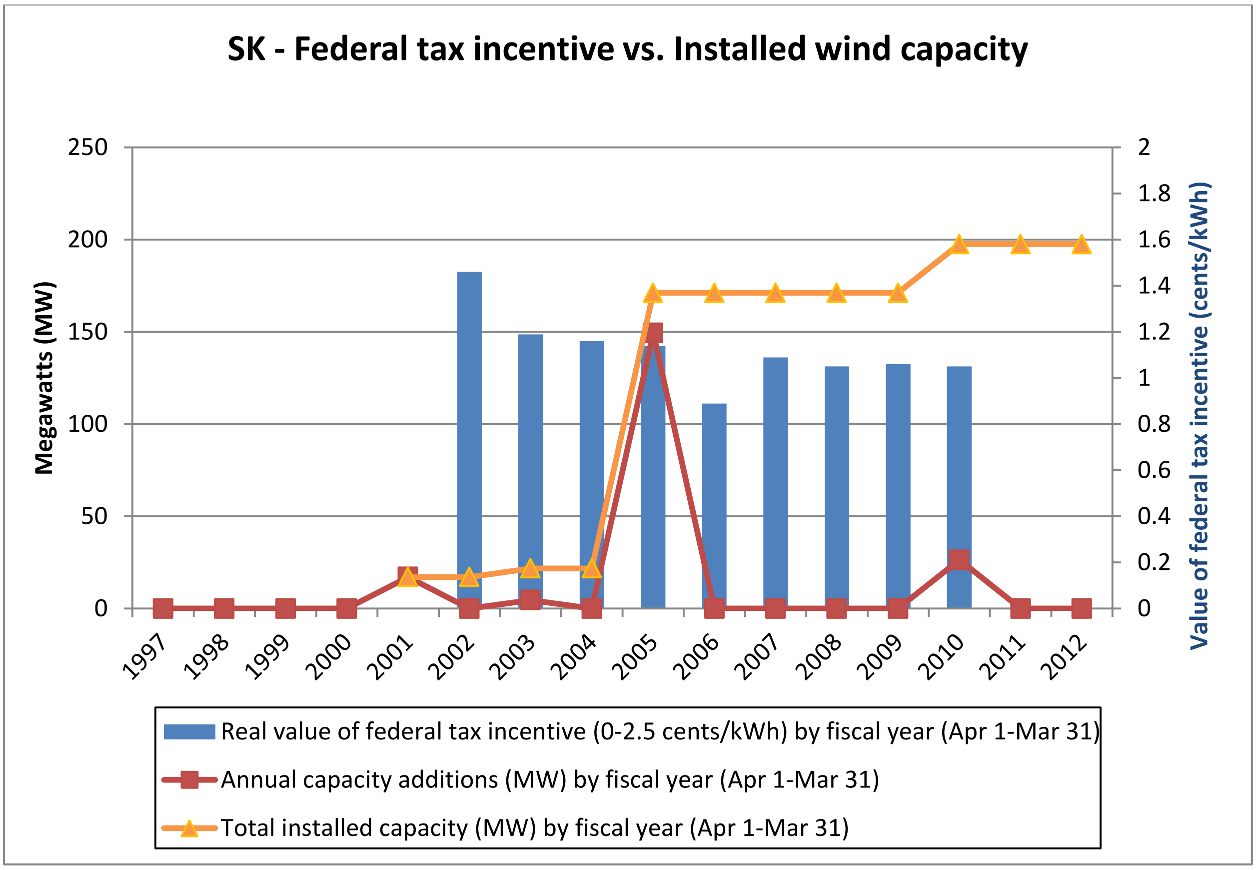

Figure 8.5. SK: Impact of federal tax incentive on deployment, organized by fiscal year. Sources: Data from CanWEA 2013; Own calculations based on data from OECD/IEA (2008).

In Figure 8.5 we can observe a trend markedly similar to the one we saw in Texas where, in the months leading up to the scheduled expiration of the PTC, developers rushed to complete projects to ensure their eligibility for the incentive. Likewise in Saskatchewan, the large 149.4-MW Centennial Wind Power Facility was completed in March 2006 – just in time to qualify for the FY2005 incentive of 1.14-cents/kWh before it was scheduled to drop to 0.89-cents/kWh as of April 1, 2006. In another instance of this trend, the 26.4 MW Red Lily Wind Project was completed in February 2011, around a month before FY2010 ended and the ecoERP program itself was terminated, according to schedule.

If our theory that a high-value federal wind energy production tax incentive promotes high levels of wind deployment is correct, we would expect the medium-value WPPI and ecoERP incentives to motivate wind project developers by improving the cost-competitiveness of wind projects to produce a medium-level of deployment in years when the incentives were available, and particularly in years when the incentive value was scheduled to drop in the following year. However, if we were to see no or low levels of deployment in years when IV1 was available or more lucrative than in the following year, this would indicate our theory is incorrect.

Our results clearly indicate that Saskatchewan's largest instances of deployment, in 2006 (FY2005) and 2011 (FY2010), occur in years when IV1 was both available and scheduled to drop in value the following year, providing strong evidence in support of our theory. The fact that those projects were commissioned just weeks before IV1 availability/value was scheduled to change is indicative of the incentives' influence on wind project development and timing.

Saskatchewan's first instance of deployment, in 2001, however, predates the WPPI incentive, suggesting that a tax incentive is not necessary for deployment. We can directly – but not exclusively – attribute changes in annual capacity additions to changes in IV1, thus confirming H1. However, we cannot rule out the possibility that other factors may also be shaping deployment outcomes.

8.3.2. H2: JURISDICTIONS WITH A HIGHLY AMBITIOUS MANDATORY RENEWABLE ENERGY QUOTA GOAL WILL HAVE INCREASED LEVELS OF WIND DEPLOYMENT

Saskatchewan did not have an *IV2 – mandatory renewable energy quota* during the sample period. Neither did it have a well-publicized voluntary target.

Only two obscure references were found to Saskatchewan's having a presumably voluntary renewable energy target. First, in an inventory of renewable energy targets set by Canadian provinces, the National Energy Board of Canada lists Saskatchewan as having had, around 2008, a target of 300 MW of wind capacity by 2011 (NEB 2013). Our deployment data indicates that SK was nowhere near meeting this target.

Second, in a presentation at a June 2012 international conference on renewable energy policy, Stumborg (2012) describes Saskatchewan as having a target of "100% new generation net zero GHG emissions" (p.8). However, with no hard target, no specified deadline, and no compliance mechanism, we deem that Saskatchewan had no mandatory quota during the sample period.

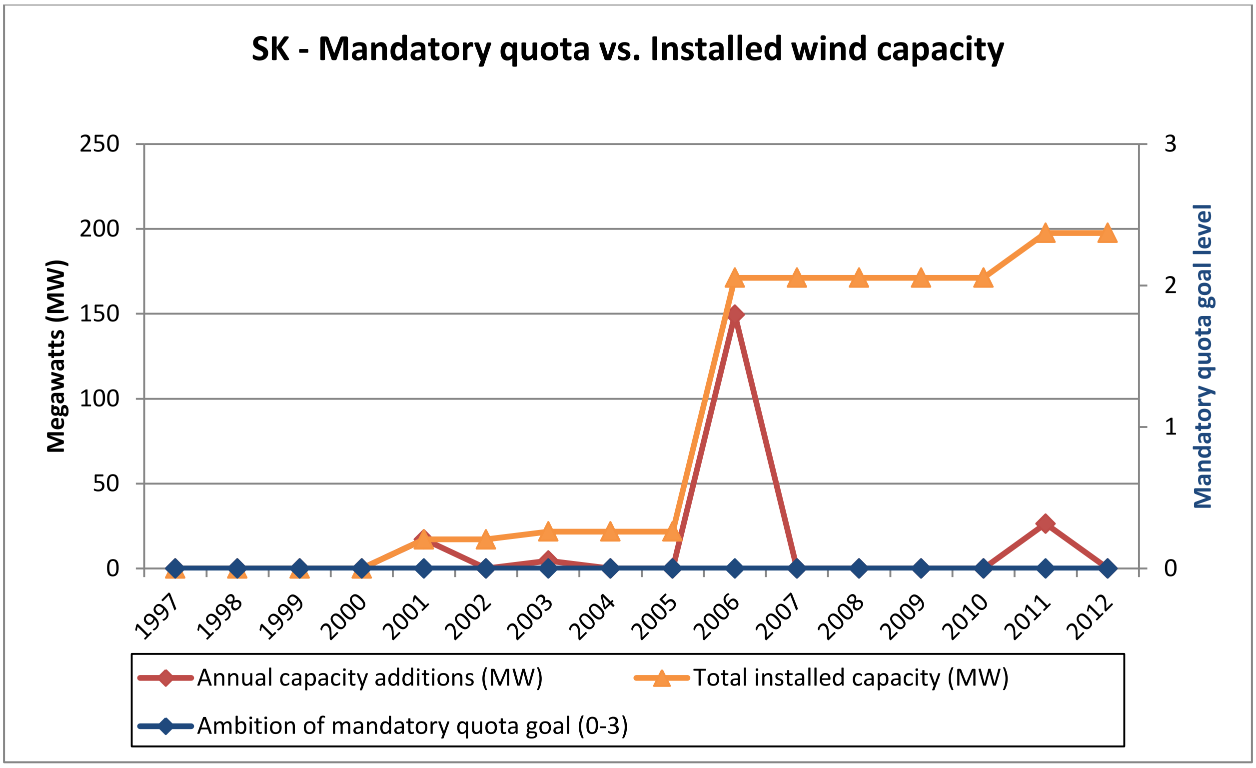

Figure 8.6. SK: Impact of mandatory quota on deployment. Source: Data from CanWEA 2013.

In Figure 8.6 we can observe that IV2 held invariant at zero throughout the sample period.

If our theory that a highly ambitious mandatory renewable energy quota goal promotes high levels of wind deployment is correct, we would expect the sustained absence of such a quota in Saskatchewan to create no or little additional market demand for wind energy, resulting in no or low levels of wind deployment. However, if we were to observe medium or high levels of deployment despite the absence of a mandatory quota, it would indicate that our theory is incorrect.

Looking at Figure 8.6, Saskatchewan had low overall levels of wind deployment during the sample period, including no deployment whatsoever in 11 of the 15 years, which is consistent with our theory. However, we can see that a few instances of deployment occurred even without the presence of a mandatory quota, showing us that IV2 is not necessary for deployment. Furthermore, the invariance of IV2 signals that other factors are influencing deployment.

We are unable to draw any conclusions about H2 at this point in the analysis.

8.3.3. H3: JURISDICTIONS WITH A HIGH LEVEL OF COMPETITION PRESENT IN THEIR ELECTRICITY MARKET WILL HAVE INCREASED LEVELS OF WIND DEPLOYMENT

As in most Canadian provinces, a single vertically integrated electric utility, owned by the province as a crown corporation, has persisted in Saskatchewan. Since 1929, SaskPower has had exclusive control of electricity generation, transmission and distribution across the province[5], making it a monopoly regime – the opposite of a competitive market. Although accountable to the Government of Saskatchewan, SaskPower is self-regulating and its board of directors steers investment decisions.

The constitutional division of powers in Canada that assigns responsibility for natural resources (including energy and electricity) to the provinces has produced highly independent, self-regulating provincial electricity regimes. Limited federal oversight, which is provided by the National Energy Board only where cross-border electricity or gas transactions are concerned, combined with the historically local nature of electricity generation and consumption, has allowed electric utilities in the form of provincial crown monopolies to flourish nationwide (Saunders 2004, p.3).

While the member states of the European Union have been formally required to open their markets until full competition is reached (under 2003/54/EC), and in the US, the FERC has been urging states to deregulate and open up their electricity markets since the 1970s, in Canada no coordinated national approach to restructuring provincial electricity regimes has been taken (Saunders 2004, p.3). Saskatchewan, therefore, has not faced pressure from the federal government to liberalize.

SaskPower, nevertheless, commissioned a study in 2003 to examine the possibility of transforming its electricity regime into a market by introducing competition. The study concludes that it would be too costly and difficult to restructure (Rushton, p.ii). The report points out that the primary expected benefit of retail competition is lower electricity prices, which SK already has due to its generation mix being heavily reliant on cheap, domestically sourced coal. Identifying barriers to market liberalization, Rushton writes that a lack of "political commitment [in Saskatchewan] to competition strong enough that it is perceived as irreversible" is a significant hurdle, "[g]iven Saskatchewan's history of substantial political involvement in the economy" (Rushton, 2003, p.19). He also explains that SK would need to open itself to wholesale competition from outside jurisdictions in order to create a truly competitive market.

In general, there seems little appetite for market liberalization for three main reasons. First, there is no federal pressure for provinces like SK to restructure their electricity markets. Second, existing Saskatchewan power generators enjoy guaranteed rates (courtesy of standard 20- or 25-year power purchasing agreements – PPAs) under the closed system and would only stand to lose if the market opened to wholesale competition. And third, although they perceive wind energy favourably (Richards, Noble & Belcher 2012, p.695), it appears SaskPower consumers are content with the low electricity prices they pay thanks to cheap, coal-based generation. Joskow argues that regulated electricity monopolies, like SaskPower, are not being held accountable for their high GHG emissions levels, allowing

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[5] Except in the Saskatoon urban area, for which SaskPower generates and transmits electricity but does not distribute, and the Swift Current area.

them to charge consumers artificially low prices, re-enforcing the continued heavy use of fossil fuel-based generation (2008). This appears to be the case in SK, where annual reports express SaskPower's ongoing strategic commitment to coal ("the low-cost foundation" of its system) despite the federal government's introducing more stringent carbon emissions standards (SaskPower 2012, p.7). In response to the new emissions standards, rather than focus investments on renewable energy installation, SaskPower and the province have invested in research towards the development of 'clean coal' technology. SaskPower's Boundary Dam Integrated Carbon Capture and Storage Demonstration Project is a $1.24-billion project they hope will eventually be able to reduce post-combustion CO2 emissions at that coal-fired power plant by up to 90%. The CO2 "will be primarily used in enhanced oil recovery (EOR) or placed in safe permanent storage in a deep saline formation" (SaskPower 2012, p.36).

Pointing out that private firms deployed most of Canada's installed wind capacity, Ferguson-Martin and Hill (2011) conclude that "liberalized electricity markets that encourage or permit private sector involvement appear more likely to accelerate wind energy deployment" (p.1651). This is true of the two provinces with the highest levels of wind deployment in Canada, Alberta and Ontario, which have liberalized and partially-liberalized electricity markets, respectively. Saskatchewan, however, is stifling wind IPPs' possible contributions. While the 2011 annual report includes the goal of "[e]ncouraging Independent Power Producer (IPP) development of renewables, including wind and biomass", SaskPower's record of extending PPAs to IPPs is weak: as of 2012, it had just two PPAs in place with wind developers (2011 report, p.20). As the penetration indicator for deployment shows, 'Purchased Power', generated by IPPs under long-term PPAs, made up only a small fraction of generation capacity.

By virtue of its status as a state-owned monopoly, SaskPower has no obligation to buy power from private developers but it solicits proposals from prospective IPPs through infrequent lottery and standard offer programs. Generally these programs call for expressions of interest from prospective IPPs and then the proponents that make the shortlist complete formal requests for proposals (RFPs), fund feasibility and transmission studies, and begin the planning, permitting and siting procedures. During the sample period, these programs attracted hundreds of proposals from prospective IPPs – indicating the high level of interest among private sector actors. The second and final phase of the Environmentally Preferred Power (EPP) program in 2005 drew expressions of interest from wind projects representing 436 MW of potential capacity (Gov. of SK 2005), one year after the first phase of the program selected only three project proposals, representing about 13 MW.

In 2010 and 2011, SaskPower conducted a Green Options (GO) Partners Program Lottery with the aim of contracting with small- and medium-sized (100 kW to 10 MW) alternative technology power producers. Choosing from 282 applications, the 2011 lottery selected three wind projects, totalling 24.8 MW of capacity (SaskPower website, GO Partners Program Lottery Selections 2011, n.d.). The lottery was then suspended for review in 2012.

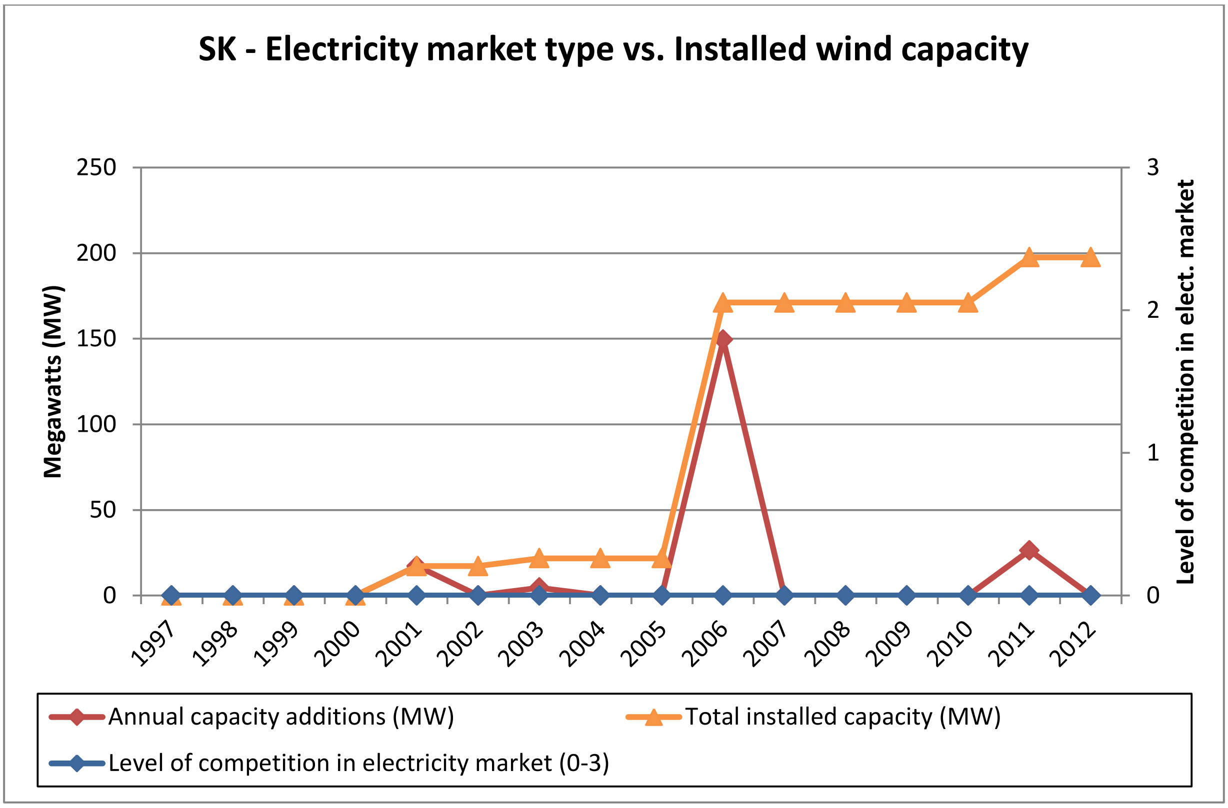

Figure 8.7. SK: Impact of electricity market type on deployment. Source: Data from CanWEA 2013.

Figure 8.7 reflects the fact that Saskatchewan had no wholesale or retail competition present during the sample period. The *IV3 – electricity market type* held invariant at zero because SK's vertically integrated, crown-owned electricity regime, SaskPower, remained unreformed.

If our theory that highly liberalized electricity markets promote high levels of wind deployment is correct, we would expect the sustained absence of competition in Saskatchewan's electricity regime to create no or few opportunities for prospective wind IPPs, resulting in no or low levels of wind deployment. However, if we were to observe medium or high levels of deployment despite the absence of electricity market competition, it would indicate that our theory is incorrect.

Our findings support our theory and Ferguson-Martin and Hill's claim that state-owned monopoly regimes "have less incentive, interest or capability to develop wind energy", although at first glance one finding appears to defy this claim (2011, p.1651). The single largest instance of wind deployment in SK, the 149.4-MW SaskPower-owned Centennial project, seems to suggest that a competitive market and greater wind IPP participation is not necessary for deployment. However, a wider view suggests that the Centennial project is not indicative of ongoing interest from SaskPower in pursuing more wind projects. In fact, the evidence shows that SaskPower has deployed no further wind projects, suggesting Centennial may have been planned as a kind of ‘green power’ showpiece rather than as a foundation for a growing wind energy portfolio.

While competition is not necessary for deployment, and SaskPower demonstrated it is capable of deploying wind projects, the medium-low overall levels of deployment support our theory that opportunities for IPPs determine deployment levels, and these opportunities flow from competitive electricity market conditions. By virtue of its monopoly regime, SK has just two wind IPP generators whose total installed capacity (19% of the province’s total, in 2012) is dwarfed by SaskPower-owned wind capacity (81%).

We can confirm H3.

8.3.4. H4: JURISDICTIONS USING A HIGHLY SIMPLIFIED PLANNING, PERMITTING AND SITING MODEL WILL HAVE INCREASED LEVELS OF WIND DEPLOYMENT

At the time of writing, SaskPower did not have guidelines for commercial-scale wind projects available. We will refer to media reports and government press releases to try to trace what steps were involved in the PPS procedures for Saskatchewan’s most recently built wind project, Red Lily, and future project, Chaplin. We will compare these to Figure 8.8, for an idea of the usual sequence of steps and the amount of time they take to move a wind project from concept to completion in Canada.

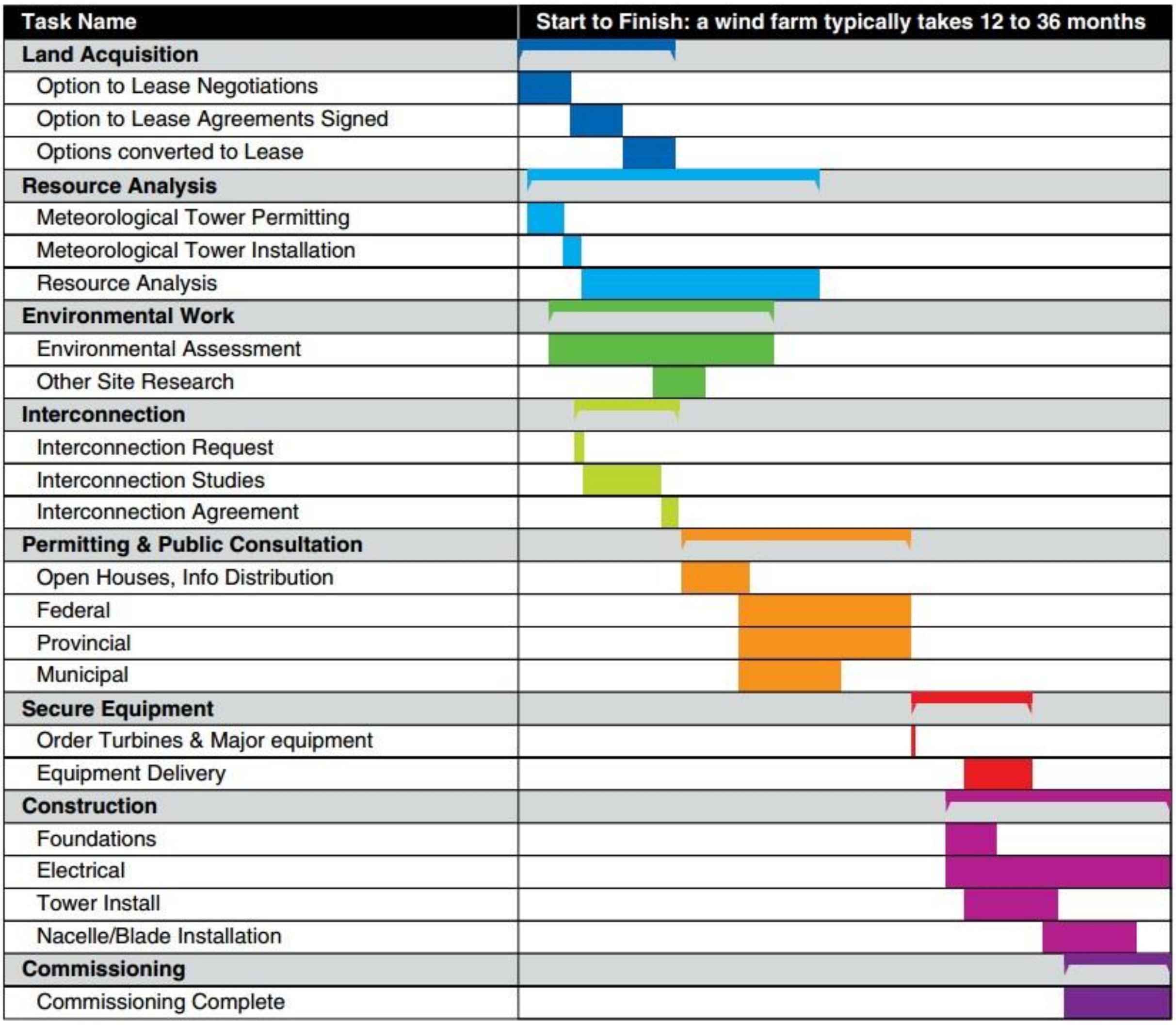

Figure 8.8. Typical sequence and duration of steps for commissioning a wind project in Canada. Source: CanWEA 2006.

Figure 8.8 shows that the typical concept-to-commissioning process in Canada takes up to three years. The Canadian Standards Association gives some context to the "Permitting" tasks, stating:

> *the Canadian regulatory environment is demanding and may be perceived as being complicated. Wind-energy developers are subject to dozens of approval processes involving various federal (national), provincial (state), and municipal (local) authorities. This may be further complicated by the makeup and ownership of the Canadian electrical transmission and distribution systems, which range from locally owned private businesses to fully integrated government-owned systems, with a wide range of regulatory roles and connection requirements. (2008, p.1)*

Indeed, we found that wind farms in Saskatchewan must obtain approvals from federal, provincial and local authorities. Environmental assessments, feasibility and interconnection studies, and a range of stakeholder consultations are also required of developers.

Consistent with this depiction, our research turned up evidence of a lengthy PPS process that ensnared Saskatchewan’s most recent project for several years. The 26.4 MW Red Lily Wind Project entered the planning process in 2004, was selected by SaskPower for a PPA in 2006 (SaskPower 2008, p.13), and finally got approval from the nearby rural municipalities in 2010 (Briere 2010). Actual construction took fewer than ten months and Red Lily was completed in February 2011, more than six years after planning started.

As with many construction projects, the longer the process takes from start to finish, the more it can cost the developers. The cancelled Benchlands wind project, selected by SaskPower as part of its EPP procurement lottery in 2004, signed a 20-year PPA for SaskPower in March 2006 but withdrew from the agreement in June. The developer explained: “We bid into this project at a fixed price back in 2004, and with the (construction) activity in Western Canada -- labour, materials, steel, concrete, everything has gone up -- it's just not viable at this point” (The Leader-Post (Regina) 2006).

At the time of writing, SaskPower was researching transmission options to connect the forthcoming Chaplin project to the grid. Its factsheet about the interconnection specifies a full three-year project timeline in order to build an 8-11 km transmission line across almost entirely uninhabited and uncultivated land, in order to meet a number of regulatory and environmental requirements at three levels of government, and to hold a series of consultations with stakeholders. When compared to the “Interconnection” task category on the CanWEA wind project sequence of steps (Figure 8.8), we can see how abnormally lengthy SaskPower’s regulatory, planning and consultation processes for interconnection are.

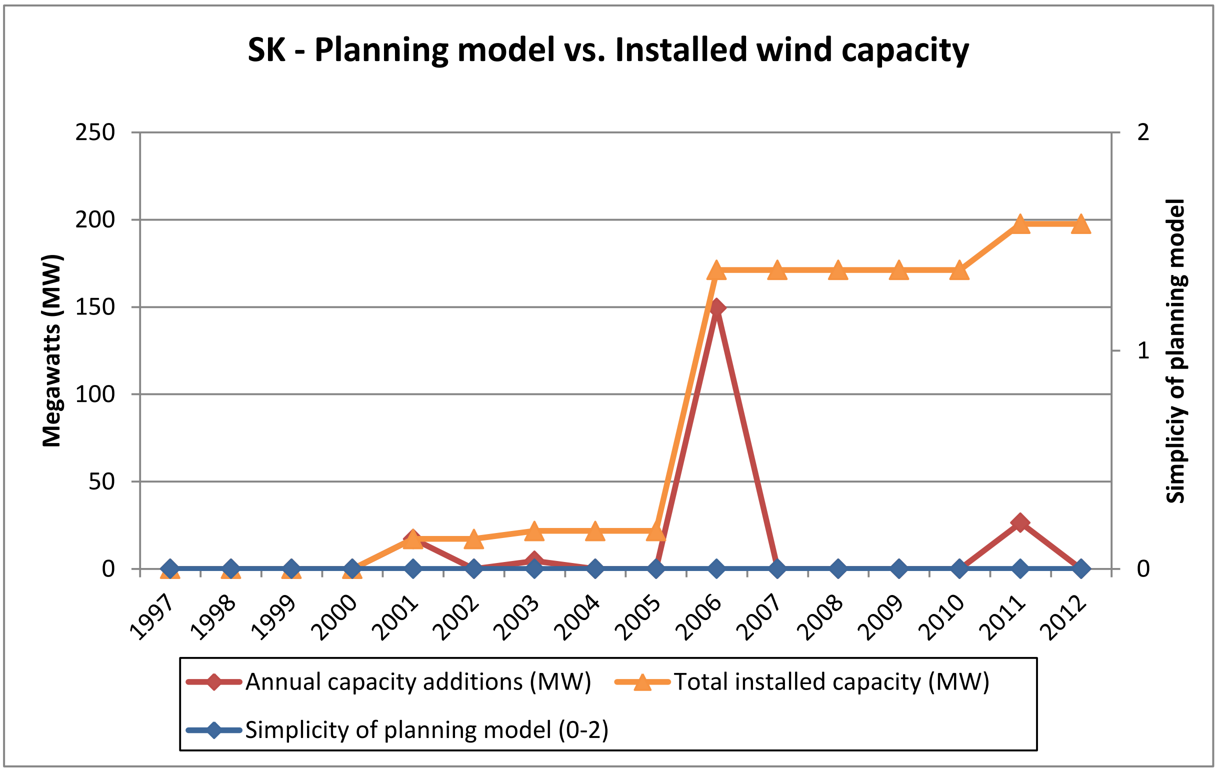

Figure 8.9. SK: Impact of planning model on deployment. Source: Data from CanWEA 2013; SaskPower annual reports 2002-2012; SaskPower website.

Figure 8.9 shows *IV4 – planning, permitting and siting model* invariant at zero throughout the sample period because we found no evidence that Saskatchewan simplified its PPS process. We are assessing IV4 according to a three model scale created by Bohn and Lant (2009), which ranks PPS models by their simplicity level. Saskatchewan's procedures fit the least simple, 'standard' model but its PPS procedures are more complicated than those depicted in Figure 4.2. Furthermore, to even reach these PPS procedures, the developer must first be selected by SaskPower in an infrequent procurement program.

If our theory that use of a highly simplified ('minimal') planning, permitting and siting model promotes high levels of wind deployment is correct, we would expect Saskatchewan's use of the least simplified ('standard') model to deter prospective wind IPPs with time-consuming and potentially costly administrative procedures, leading to no or low levels of wind deployment. However, if we were to see medium or high levels of deployment despite the province's use of a 'standard' model, it would indicate our theory is incorrect.

Our findings are consistent with our expectations that use of a complicated strain of the 'standard' model in SK is in fact delaying and hindering project deployment. The province's most recent wind project took six years to reach commissioning, which is indicative of unfavourable business conditions. However, counter to our theory, we also discovered high levels of interest from prospective wind IPPs in SK despite its use of cumbersome PPS procedures. As we described in H3, SaskPower's procurement programs have been flooded with interest from hundreds of prospective IPPs who, evidently, are not deterred like we had predicted by regulatory hurdles. This is strong evidence our theory is incorrect and implies that SK's many years featuring little or no new installed capacity are not for a lack of interest from wind developers. Rather, the real barrier to deployment seems to stem from SK's noncompetitive electricity regime and the extremely limited opportunities for wind IPPs. The hundreds of applications to SaskPower's programs indicate that prospective developers are willing to take on the time-consuming and costly regulatory steps for a chance to secure a 20- or 25-year PPA.

SK also shows us that zero-values on IV4 do not prevent deployment and use of a simplified PPS model is not necessary. Other influences must be at work.

We can disconfirm H4.

8.3.5. H5: JURISDICTIONS USING AN ANTICIPATORY APPROACH TO GRID INFRASTRUCTURE IMPROVEMENTS WILL HAVE INCREASED LEVELS OF WIND DEPLOYMENT

During the sample period, SaskPower's approach to grid infrastructure improvements was exclusively 'reactive', to use a term from Alagappan et al. (2011), meaning that SaskPower authorized and constructed transmission lines to interconnect wind projects only after wind developers requested service. We found no evidence that SK used an 'anticipatory' approach, which would have SaskPower planning and possibly constructing transmission in advance of a wind developer's "actual request for interconnection and service" (Alagappan et al. 2011, p.5102). A major infrastructure augmentation or upgrading program is an example of improvements based on an 'anticipatory' approach.

SaskPower frequently references its "aging infrastructure" in its annual reports, along with mentions of the province's vast territory and dispersed population. In the 2002 report, SaskPower says its approach to "aging infrastructure" is to "minimize these investments" by adhering to "a program of planned maintenance" (p.23), which suggests a 'reactive' approach to grid infrastructure improvements.

In the 2008 annual report, SaskPower indicates it would like to add more wind energy to its portfolio but it is already "experiencing grid operating challenges due to wind's inherent variability" with an installed wind capacity of 172 MW at that point (p.13). In response, that year SaskPower launched a Wind Power Integration and Development Unit to study the effects of wind power on the provincial grid. A team of experts was also asked to conduct a SK Wind Data Study, looking at "the benefits and feasibility of building future wind facilities in geographically diverse locations" (2008, p.12-3). The results of this study were to inform a Wind Power Deployment Strategy in 2009 that would "address the timing, ownership and procurement process for new wind power projects" (2008, p.12-3).

We could not find evidence that the wind data study was ever carried out, and it seems the drafting of the wind power deployment strategy has been delayed for unknown reasons, with negative consequences for prospective wind developers. On January 9, 2013, WMCZ law firm states that:

> *[Wind projects have] been delayed…while developers wait for SaskPower to complete their long-anticipated wind power deployment strategy. This strategy should address the timing, ownership and procurement process for new wind power projects…Once SaskPower completes their wind power deployment strategy, it is anticipated that development will proceed quickly.*

Since announcing its ambitious wind energy strategic goals in 2008, SaskPower seems to have lost interest in carrying them out. Wind energy may no longer be a priority on the province's energy agenda.

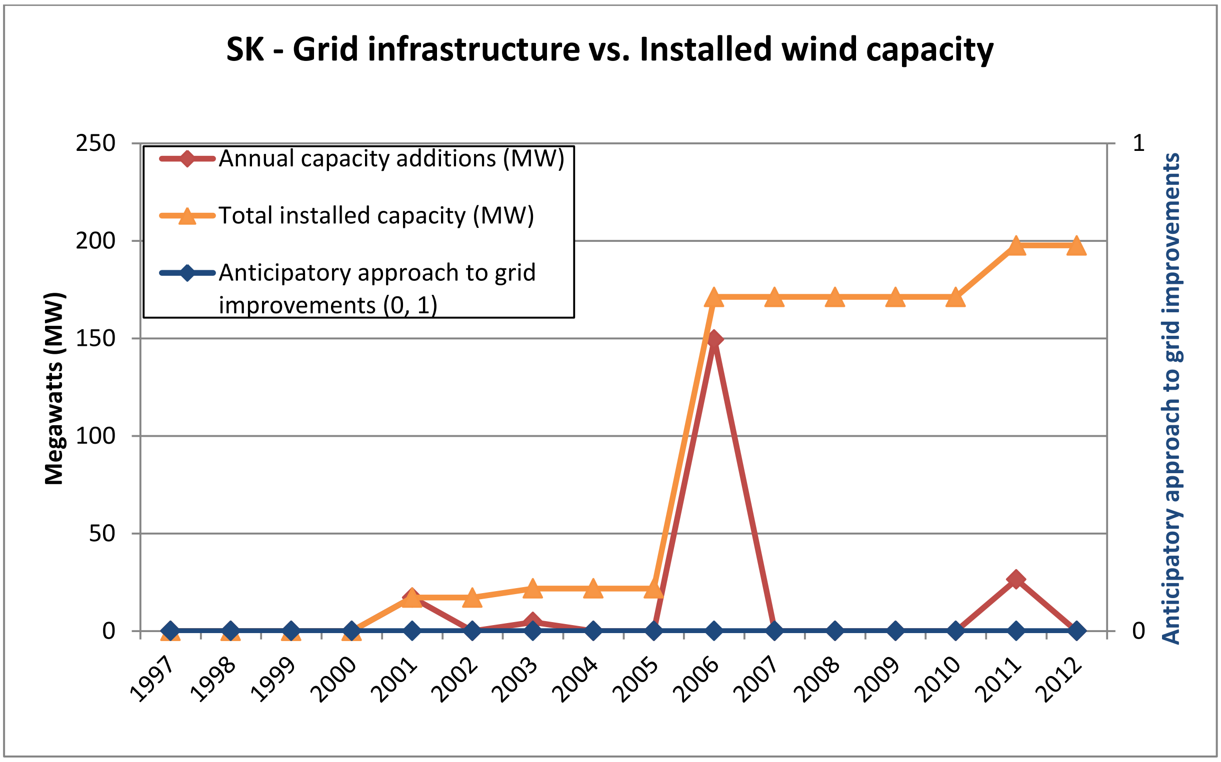

Figure 8.10. SK: Impact of transmission planning approach on deployment. Source: Data from CanWEA 2013; SaskPower annual reports 2002-2012.

Figure 8.10 shows *IV5 – grid infrastructure* invariant at zero to reflect SaskPower's exclusive use of a reactive approach to grid improvements.

If our theory that anticipatory improvements to grid infrastructure promotes high levels of wind deployment is correct, we would expect the years with no anticipatory improvements to coincide with no or low levels of deployment. However, if we were to observe no or low levels of deployment in years where a medium level of improvements were made, it would indicate that our theory is incorrect.

Findings from SK are mixed. SK has complained of wind energy causing transmission difficulties on its aging grid since 2008, and did not make or announce any major anticipatory improvements during the sample period, seemingly explaining all the years of no new deployment. However, without infrastructure improvements, it is unclear how Red Lily was able to come on-line. Furthermore, international research indicates that older grids built to accommodate fossil fuel-generated electricity, such as SaskPower's, should not have any trouble integration wind energy up to 10% of installed capacity; only once penetration levels climb above 20% are system and operational changes likely needed (Australian Energy Resource Assessment 2010, p.253). With wind penetration at approximately 5% in SK in 2012, we suspect SaskPower may be overstating the technical challenge that its grid infrastructure poses.

Furthermore, indicators of future deployment reveal that SK has a 177-MW wind farm (the Chaplin project) at an advanced planning stage and scheduled for commissioning in 2016, again suggesting that infrastructure may not be the constraint SaskPower made it out to be and underscoring the lack of information about the condition of the grid and its true ability to integrate more wind power without requiring a major upgrading or augmentation project. Perhaps the disappearance of the wind data study and the deployment strategy announced in 2008 is related to this.

We are not able to draw conclusions about H5.

8.4. CONCLUSION

In this within-case analysis we looked for explanations for Saskatchewan's deployment outcomes among our IVs. Weighing empirical evidence against the predictions we outlined in the theoretical framework, we attempted to locate causal mechanisms that could explain how IVs may influence the DV.

Tentatively, we found:

TABLE 4. SUMMARY OF FINDINGS FROM SASKATCHEWAN

Independent variable	Assessment of findings	Preliminary conclusion
IV 1: Federal wind energy production tax incentive	Consistent with expectations, IV1 exerted a clear causal influence	Confirm
IV 2: Mandatory renewable energy quota	Weakly consistent with expectations, absence of a quota may have hindered deployment but insufficient evidence	Inconclusive
IV 3: Electricity	Consistent with expectations, the absence of market	Confirm

market type	competition seems to have stifled wind IPP participation; seems to be key barrier to deployment	
IV 4: Planning, permitting & siting model	Against expectations, use of the ‘standard’ model did not deter prospective developers, although it did delay wind projects	Disconfirm
IV 5: Grid infrastructure	Consistent with expectations, a ‘reactive’ approach may have hindered deployment but insufficient evidence	Inconclusive

As with Texas and Western Australia, we anticipate greater insights will be available in the cross-case analysis and discussion.

9. CROSS-CASE ANALYSIS AND DISCUSSION

This thesis asks why Texas, Western Australia and Saskatchewan, as 'most similar cases', take different wind energy deployment trajectories between 1997 and 2012, and arrive at divergent outcomes. Ultimately we are looking for lessons from our cases about the factors that can facilitate or impede deployment of mature renewable energy technologies, with an eye to the growing global imperative to transition from fossil fuels to sustainable energy systems.

Our research design offers constants that allowed us to rule out some potentially causal factors identified in the literature. Our three cases also offer opportunities to "compare the effect of each independent variable on the dependent variables…by "controlling for" or holding constant one of the independent variables so that the effect of the other may be observed" (Johnson, Reynolds & Mycoff 2008, p.66), as we shall explore.

After first comparing deployment outcomes across our DV indicators, this chapter is then organized by hypothesis. Each hypothesis features a cross-case analysis in which we compare findings from the three within-case analyses, and a discussion in which we look for broader insights about our theories.

9.1. CROSS-CASE ANALYSIS – DV: DEPLOYMENT

Texas is a much more populous jurisdiction than the other two are, with 26.06 million people versus 2.47 million in WA and 1.08 million in SK, so it comes as little surprise that Texas had a substantially higher level of wind deployment in absolute terms, on the DV indicators for total installed capacity (Figure 9.1) and annual capacity additions (Figure 9.3). Figure 9.2 looks at total installed capacity for just WA and SK. Our third and fourth indicators – total installed capacity per 100 people (Figure 9.4) and penetration of generation capacity (Figure 9.5) – are relative measures and offer our cross-case analysis a better understanding of DV outcomes than the first two indicators do.

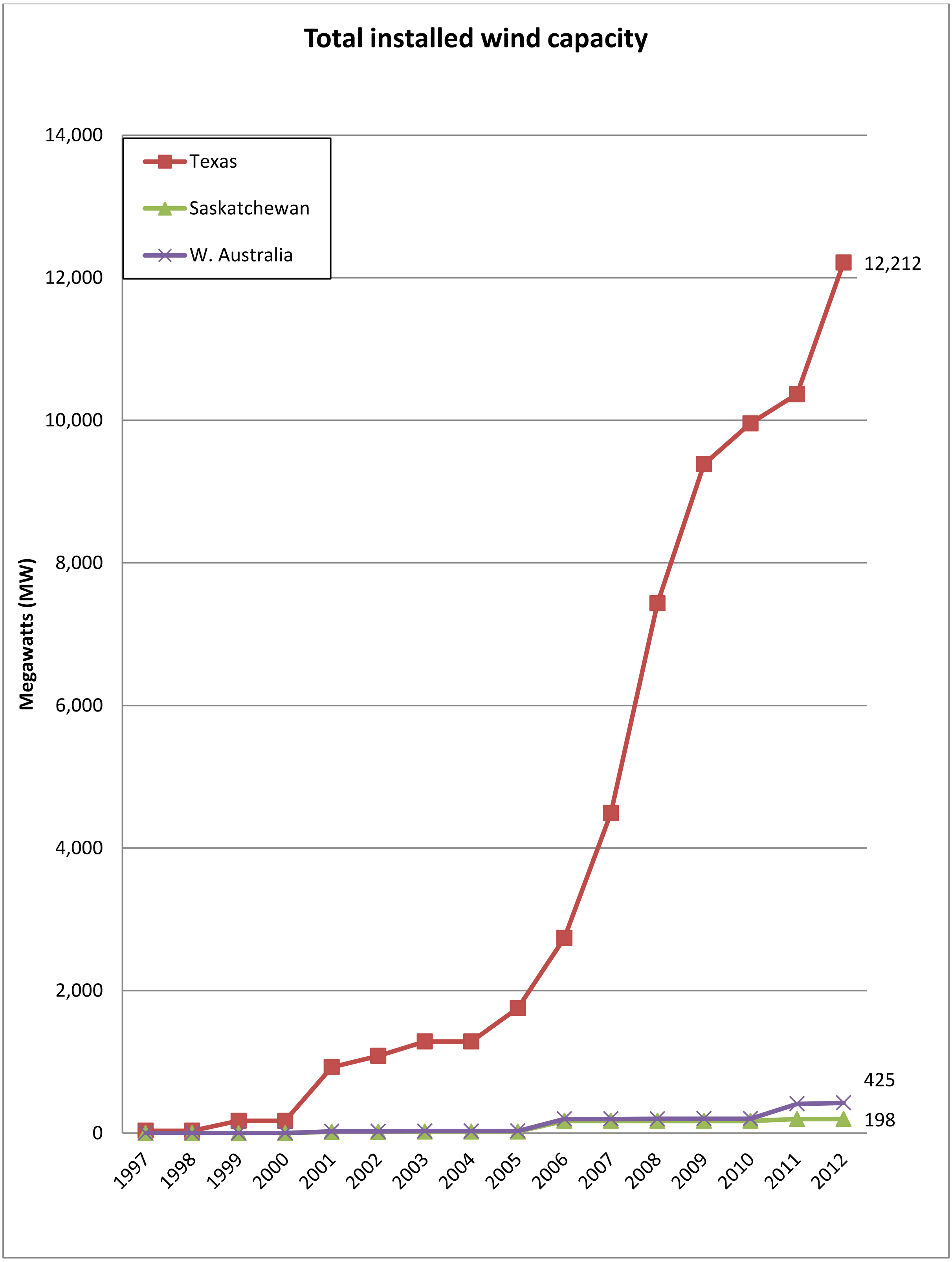

Figure 9.1. Comparison of total installed wind capacity

Figure 9.1 shows TX had 12,212 MW of total installed wind capacity to WA's 425 MW and SK's 198 MW at the end of the sample period but the most notable aspect is TX's steep slope, indicating that large amounts of wind capacity was installed rapidly, over just a few years.

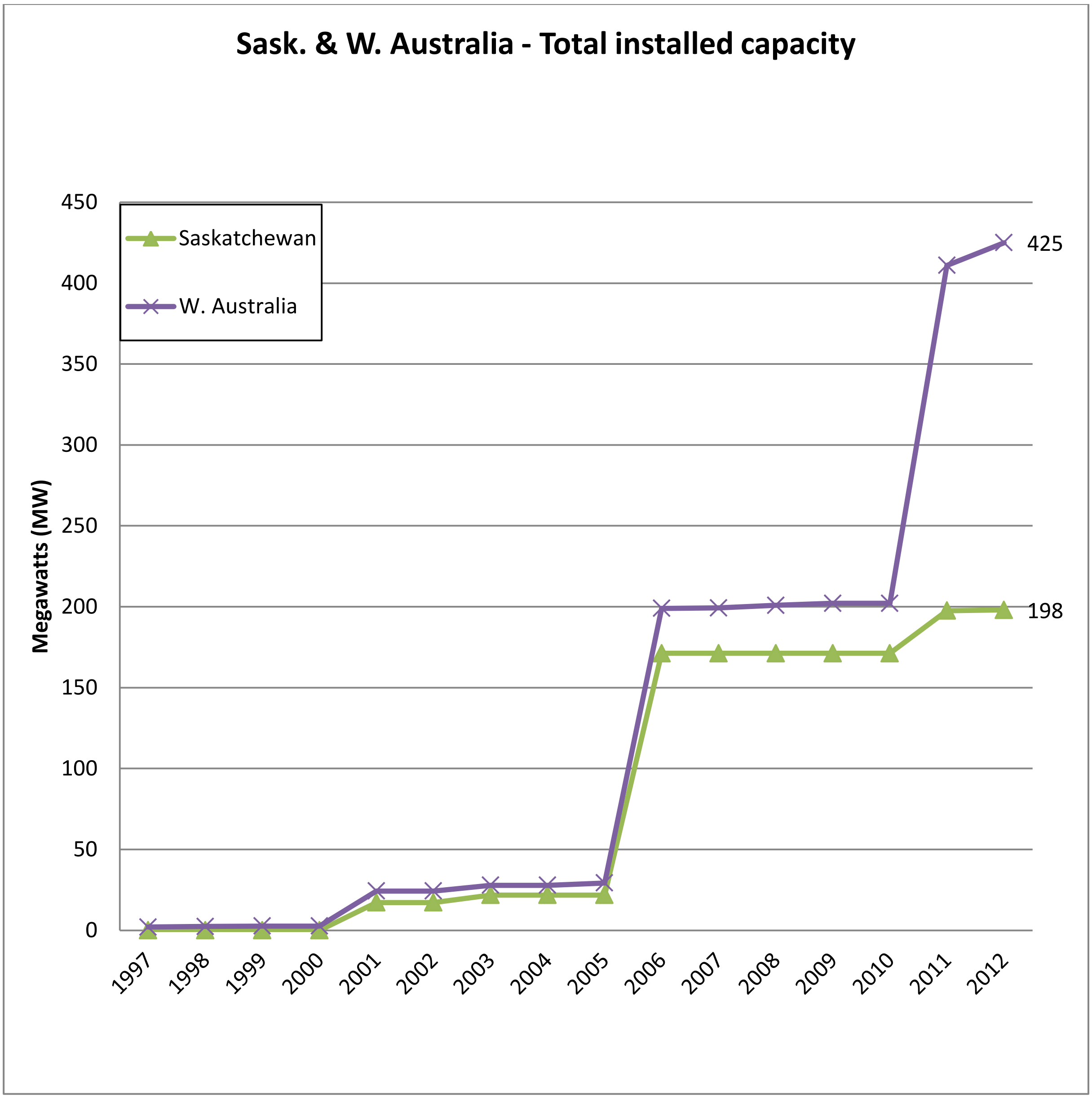

Figure 9.2. Total installed wind capacity in SK and WA.

Figure 9.2 shows that total installed capacity in SK and WA follows a remarkably similar trajectory from 1997 to 2010 – even deploying large projects in the same year. In the within-case analyses we find plausible, unrelated explanations for these 2006 instances of deployment (the 149.4-MW Centennial project in SK, and the 90-MW Walkaway and 80-MW Emu Downs projects in WA) so this shared deployment trajectory appears to be coincidental. While SK and WA both deployed projects in 2011, WA's was the 206-MW Collgar wind farm, which caused its indicator values to leap well ahead of SK's, which had the 26.4-MW Red Lily project commissioned that year.

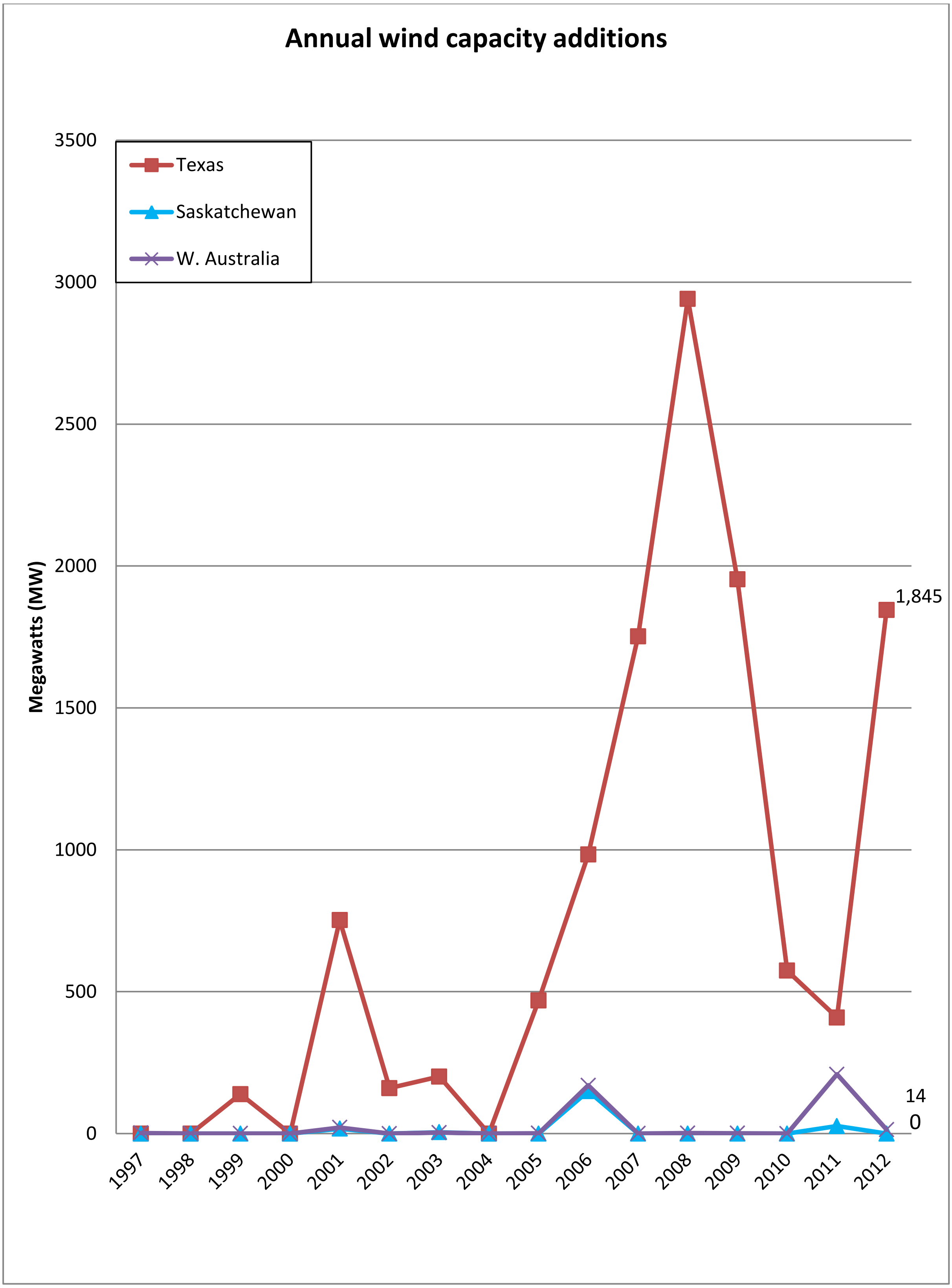

Figure 9.3. Comparison of annual wind capacity additions.

Figure 9.3 shows that on our second DV indicator, annual capacity additions, TX's end values are again significantly above WA's and SK's. What is most notable is TX's pronounced ups and down, particularly in the years leading up to, and following, 2008.

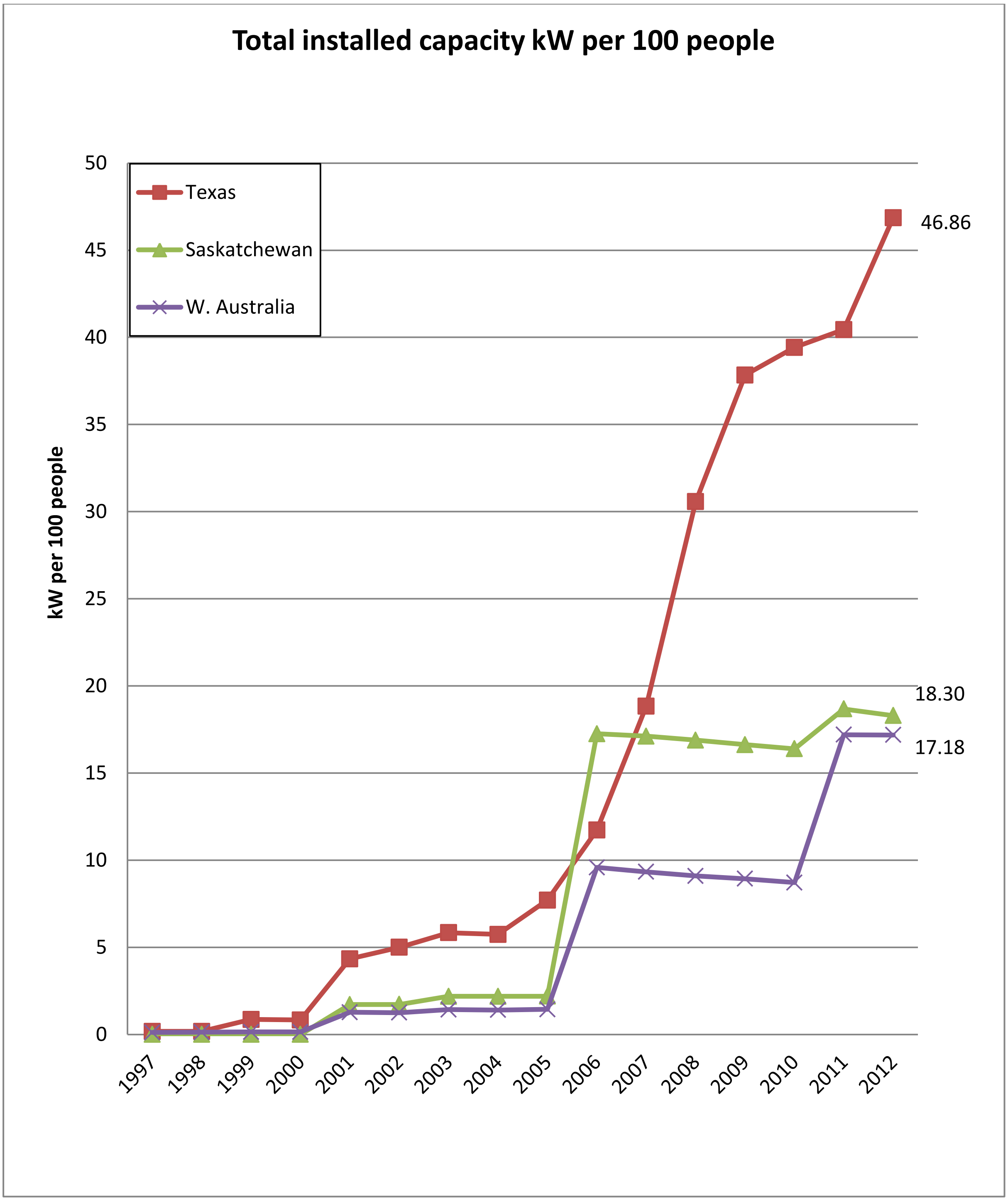

Figure 9.4. Comparison of total installed wind capacity per 100 people.

Figure 9.4 shows results for our third DV indicator, total installed capacity in kilowatts per 100 people. Unlike the first two indicators, takes different population sizes into account and are more appropriate for a cross-case analysis. Even on a relative measure, Texas ends with nearly three times the values of the others. Saskatchewan slightly outperforms Western Australia from 2000 to 2005 but then, remarkably, SK jumps well ahead of both WA and TX in 2006, after its Centennial wind farm is commissioned: SK had 17.25 kW to Texas' 11.72 kW and WA's 9.58 kW per 100 people. By 2007 TX is back in the lead, though.

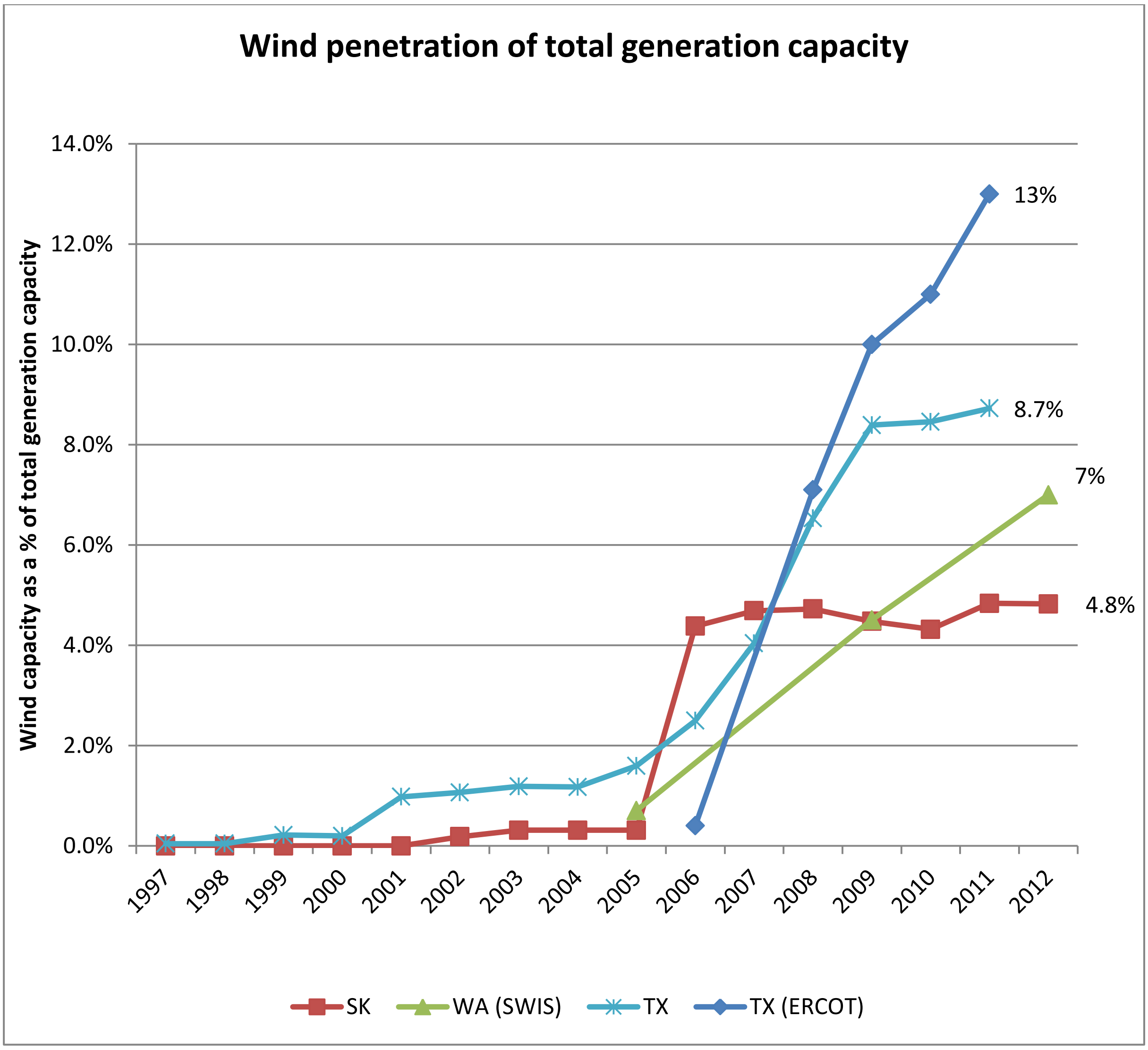

Figure 9.5. Comparison of wind penetration of total generation capacity. Source: Data from ERCOT 2006, 2008, 2010, 2012 (November).

Figure 9.5 shows our fourth DV indicator, wind penetration of generation capacity, our second relative measure. The ERCOT grid, which serves about 85% of Texans, has the highest level of wind penetration with wind capacity making up 13% of its total generation capacity in 2012. Notably, just six year earlier, ERCOT was in last place on this indicator, with wind making up a 0.4% share of total generation capacity, while wind made up 4.4% of total generation capacity in SK.

9.2. DRAWING CONCLUSIONS ABOUT HYPOTHESES

This section is organized by hypothesis. For each, we conduct a cross-case analysis of IV results followed by a discussion, where we draw conclusions. We also offer some additional insights.

9.2.1. VALUE OF FEDERAL WIND ENERGY PRODUCTION TAX INCENTIVE

CROSS-CASE ANALYSIS – IV1: FEDERAL WIND ENERGY PRODUCTION TAX INCENTIVE

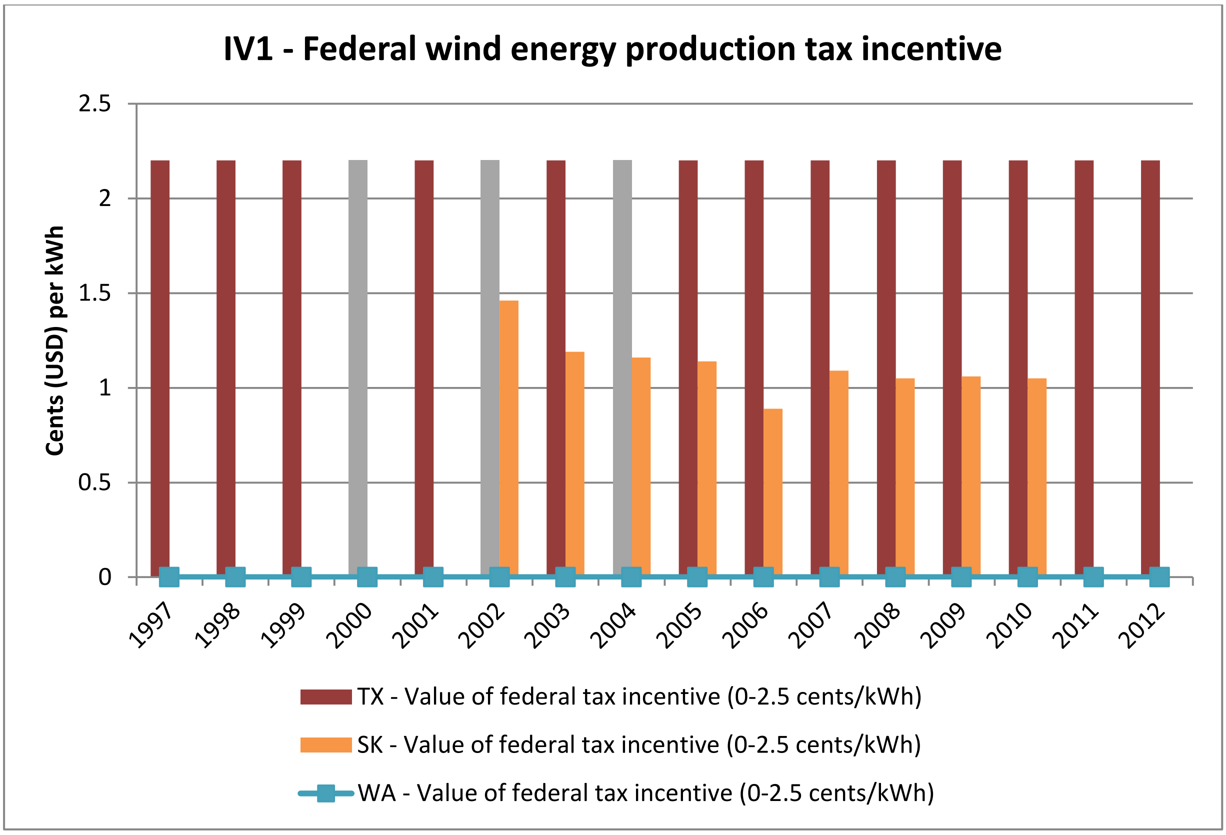

Figure 9.6. Comparison of IV1 values.

IV1 values for our three cases are given in Figure 9.6. It shows that the federal tax incentive in Texas, the US Production Tax Credit (PTC), shown in red, held an unchanging inflation-indexed value over time, worth 2.2 cents/kWh in 2012 dollars. This corresponds to a high-value incentive on our scale. However, the legislation backing the PTC was allowed to lapse in 2000, 2002, and 2004, with those years marked in gray.

For Saskatchewan, real values for the comparable federal tax incentives are shown in orange, and organized temporally to reflect the Canadian government's fiscal calendar. The Wind Power Production Incentive (WPPI) was in place from April 1, 2002, to March 31, 2007, and offered slightly different values ranging from 1.46 cents/kWh in FY2002 to 0.89 cents/kWh in FY2006. These variations were scheduled at the start of the program. The WPPI was succeeded by a nearly identical incentive called the ecoENERGY for Renewable Power Program (ecoERP). While the nominal value of the ecoERP remained constant at 1 cent/kWh from FY2007 to FY2010, we have adjusted for inflation (to 2012 dollars) for this analysis, to ensure comparability with the inflation-indexed US PTC. Furthermore, Bank of Canada exchange rates show that the Canadian and US dollars were roughly at parity for much of 2012 so no conversion is necessary for our purposes. Figure 9.4 shows that the real values of the Canadian incentives were approximately half the real value of the US incentive. On our scale, the WPPI and ecoERP rate as medium-value incentives.

Western Australia had access to no comparable federal wind energy production tax incentive so its values on IV1 remain invariant at zero.

DISCUSSION – H1: JURISDICTIONS WITH A HIGH-VALUE FEDERAL WIND ENERGY PRODUCTION TAX INCENTIVE WILL HAVE INCREASED LEVELS OF WIND ENERGY DEPLOYMENT

Texas and Saskatchewan both show that a *federal wind energy production tax incentive (IV1)* has a clear causal effect on deployment, consistent with our theory that such incentives stimulate deployment by boosting renewable energy's cost-competitiveness with cheaper fossil fuel-generated electricity, 'leveling the playing field' to some extent, thereby improving the financial viability of wind projects for developers. They can also help soften high upfront capital costs of wind projects.

In Texas, we repeatedly observed that in the months leading up to the scheduled expiration date of the PTC, developers hurried to complete projects to ensure their eligibility for the incentive, accelerating wind deployment, demonstrating the strong motivational power of the PTC. Then, in years where PTC legislation was allowed to lapse, even for just a few weeks, annual capacity additions plummeted for the year as wind developers put projects on hold in response to its legislative uncertainty.

Similarly, in SK we observed in Figure 8.5 that the province's largest wind farm, the 149.4-MW Centennial Wind Power Facility, was completed in March 2006 – just in time to qualify for the WPPI FY2005 incentive of 1.14-cents/kWh before it was scheduled to drop to 0.89-cents/kWh as of April 1, 2006. Then we saw another instance of this trend when the 26.4 MW Red Lily Wind Project was completed in February 2011, only a month before FY2010 ended and the ecoERP program was terminated. The evidence shows that developers timed their projects to deploy in years when the incentives were available, and particularly in years when the incentive value was scheduled to drop (as in SK) or legislative validity was set to expire in the following year (as in TX).

Texas' more lucrative incentive, reflected in its higher values for IV1 – nearly double those of SK – provides a convincing explanation for TX's much higher DV values in absolute (total installed capacity, annual capacity additions) and relative terms (total capacity per 100 people, penetration of total generation capacity).

Referring back to the literature, while we found a federal tax incentive to have a strong causal influence on deployment, we did not find it to be a "sine qua non for large-scale deployment", per Toke et al. (2008, p.1137) because WA managed to deploy a number of large wind projects, and has several more in advanced planning stages, without any such federal incentive.

On the basis of evidence from TX and SK, we can confirm H1.

9.2.2. AMBITIOUSNESS OF MANDATORY RENEWABLE ENERGY QUOTA GOAL

CROSS-CASE ANALYSIS – IV2: MANDATORY RENEWABLE ENERGY QUOTA

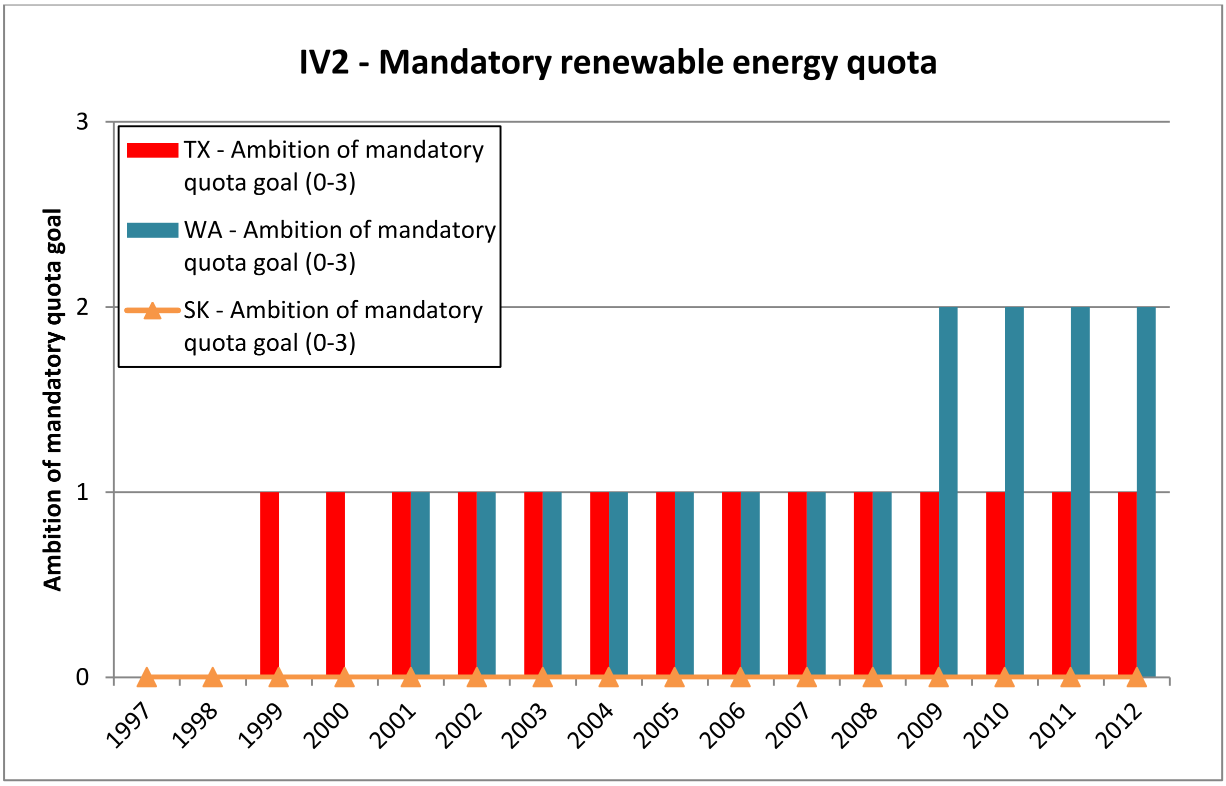

Figure 9.7. Comparison of IV2 values.

In Figure 9.7, we can observe that Texas adopts its Renewable Portfolio Standard (RPS) two years before Australia adopts its federal Mandatory Renewable Energy Target (MRET). Both of these regulatory instruments have low-ambition quota goals (<12% RE in the electricity generating mix in the compliance year). Although Texas raises its RPS goal in 2005, the future targets are still in the low-ambition range. Australia, however, adopts its expanded Renewable Energy Target (RET) in 2009, leading to WA's IV2 values surpassing those for SK and TX, by setting a goal of medium-ambition (12% - 24% RE by end year). Meanwhile, Saskatchewan had no such mandatory quota so its values on IV2 remain invariant at zero.

DISCUSSION – H2: JURISDICTIONS WITH A HIGHLY AMBITIOUS MANDATORY QUOTA GOAL WILL HAVE INCREASED LEVELS OF WIND DEPLOYMENT

Contrary to our expectations, and indicating our theory is incorrect, a more ambitious goal for a *mandatory renewable energy quota (IV2)* does not appear to cause more deployment than a less ambitious goal. Texas' RPS goals have never been set higher than a low-ambition level, so we would expect to see low levels of deployment; a low-ambition goal should only minimally stimulate market demand for renewable energy, according to our theory. DV indicators, however, show that Texas greatly outperforms Western Australia on deployment, despite Western Australia's RET goal being more ambitious than Texas' RPS from 2009 onward. Also, Texas has quickly met and exceeded its RPS goals several times, including meeting the 2025 goal fifteen years early, which cannot be explained by the ambitiousness of an RPS goal. The theory clearly fails in Texas.

Western Australia, in spite of its medium-ambition RET goal, produces deployment outcomes low enough to rival Saskatchewan's – a province that had no mandatory quota – with medium-low overall performance on most DV indicators in both cases. Although it looked plausible in the WA within-case analysis that the MRET and RET may have positively influenced the few instances of large-scale deployment there, when compared with SK's deployment outcomes and its zero-values on IV2, it suggests our theory is indeed incorrect. However, there may be a time lag between federal quota goal-setting and state-level industry behaviour in Western Australia, which we cannot rule out.

Because the theory fails in Texas, we can disconfirm H2.

Referring back to the literature now, we ask: why do scholars (and policymakers) insist that the RPS is responsible for the Texas 'wind rush' and suggest it should be adopted in other jurisdictions? The literature offers two main answers and each critically hinges on the pairing of a mandatory quota with another one of our independent variables.

First, Langniss and Wiser (2003) find that an RPS is most effective *in combination with a federal tax incentive (IV1)* like the PTC, identifying a causal mechanism whereby the PTC increases wind deployment by lowering the cost of complying with the RPS (p.533). We can characterize this as a stick-and-carrot approach, where the mandatory quota (IV2) is the stick and the federal tax incentive (IV1) is the carrot. Texas, with its high-value tax incentive and a low-ambition quota goal during the sample period, had a big carrot and a small stick, and the pairing seemed to be effective, per Langniss and Wiser's claim (2003).

The US DOE hints at another possible causal mechanism by calling jurisdictions with an RPS "an environment for stable [renewable energy] growth" (2008). It is possible that a stable mandatory quota – even a low-ambition one – may helpfully counterbalance an unstable federal tax incentive.

Our findings from WA and SK provide us with additional insights. DV indicator values for total installed wind capacity kW per 100 people (Figure 9.3) would seem to suggest that the adoption of a mandatory quota alone (a 'stick' approach), as in WA, or the adoption of a federal tax incentive alone (a 'carrot' approach), as in SK, are not even half as effective as the combined stick-and-carrot approach used in Texas. Indeed, Carley (2011) writes that these two instruments "can be combined to produce a potentially greater effect on renewable energy markets than if either worked in isolation" (p.281). While we have not yet ruled out other factors that may be influencing deployment, our evidence thus far is consistent with Carley’s (2011) observation, and supports Langniss and Wiser’s (2003) theory.

We also know of another example of a ‘carrot’-alone approach failing to spark wind deployment. EIA (2012, November) data suggest that the PTC, when introduced in 1992, caused little wind deployment until around 1999, when states like Texas with renewable energy targets began to take advantage of the incentive and wind deployment started accelerating. Of course this could also be caused by higher prices for wind turbines back then.

The second reason why the RPS is still in favour with scholars and policymakers, despite failing H2 in our study, comes from Hurlbut, who plainly states that an RPS goal can be successful without being ambitious *in the context of a competitive electricity market (IV3)* (2008, p.129). He writes:

> *As counterintuitive as it may seem at first glance, the ideal RPS goal is modest rather than ambitious … A state's renewable energy achievement is actually the sum of its RPS requirement, its voluntary demand for green power, and speculative development by competitors seeking to stay ahead of the market. An over-ambitious RPS will squeeze the voluntary green-power market, thereby undermining what should be the policy end game: economically sustainable renewable energy deployment (2008, p.157).*

However, the calibration of these conditions may be important: WA had medium-low overall deployment levels despite having a low level of electricity market competition introduced in 2006 and its low-ambition quota goal raised to a medium-ambition one in 2009.

9.2.3. AMOUNT OF COMPETITION IN THE ELECTRICITY MARKET

CROSS-CASE ANALYSIS – IV3: ELECTRICITY MARKET TYPE

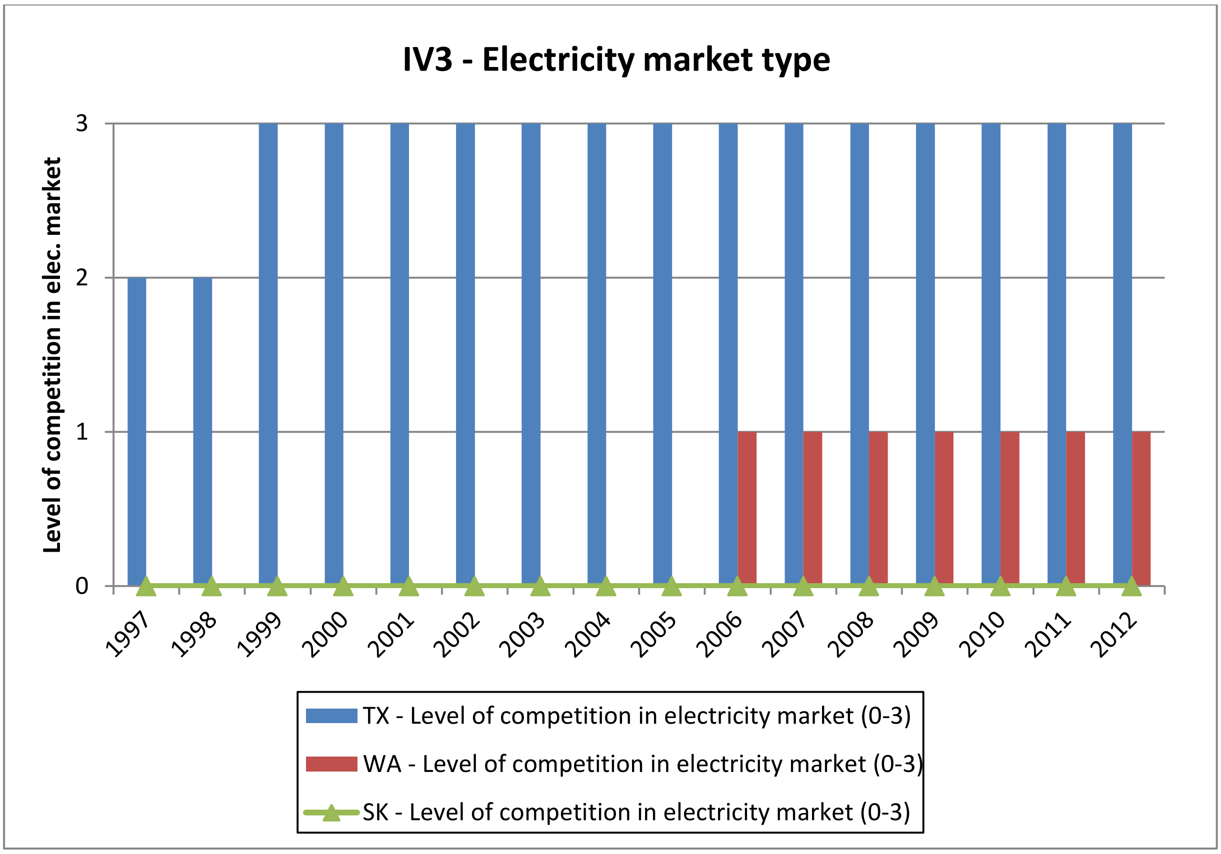

Figure 9.8. Comparison of IV3 values.

Figure 9.8 shows the evolution of the ERCOT market in Texas and the SWIS market in Western Australia, and the unchanging nature of the SaskPower monopoly regime in Saskatchewan. Texas introduced wholesale competition in 1995 and added retail competition in 1999, pushing its market-competition levels from medium to high that year. Western Australia disaggregated its electricity monopoly regime Western Power and established a wholesale electricity market in 2006, moving competition levels from none to low. Meanwhile, SaskPower maintained its noncompetitive regime.

DISCUSSION – H3: JURISDICTIONS WITH A HIGH LEVEL OF COMPETITION PRESENT IN THEIR ELECTRICITY MARKET WILL HAVE INCREASED LEVELS OF WIND DEPLOYMENT

Findings from TX, WA and SK for *electricity market type (IV3)* support our theory that the level of competition in an electricity market determines the number of opportunities for private sector actors to start generating and selling wind power as IPPs, and IPP participation increases deployment.

Among our cases, Texas has the highest levels of electricity market competition and EIA (2012, October) data show that from 1997 to 2011 more than 99% of the state's total installed wind capacity has been IPP-owned. IPPs have benefited from the market liberalization reforms of 1995 and 1999. Referring back to the literature, this is consistent with findings from the literature that IPP ownership of wind projects accounts for nearly all the wind capacity installed in Canada and the US (Wiser et al. 2007; Ferguson-Martin & Hill 2011). It is also consistent with Fischlein et al.'s (2010) finding that wind energy in Texas has benefited from “a profit driven system where anyone expecting a favorable return on investment will propose and build generation facilities” (p.4437).

At the other end of the spectrum, Saskatchewan suggests that a noncompetitive electricity regime may cause both medium-low overall levels of deployment and low levels of IPP ownership of wind capacity. While the province’s first commercial-scale wind farm was built in 2001 by an IPP, the 2001 and 2003 phases of the small Cypress wind farm plus the completion of the enormous Centennial wind farm in 2006, all owned by the SaskPower monopoly regime, shifted the majority of wind capacity ownership to the crown corporation. At the end of 2012, just 19% of installed wind capacity was IPP-owned in Saskatchewan.

In WA, since the wholesale market began and Western Power was disaggregated in 2006, state-owned generator Verve has been shrinking modestly (it still owned 59% of all capacity in 2012) but steadily as IPP-owned capacity increases. This is especially true of wind capacity, where 88% of total installed wind capacity was owned by IPPs by 2011. The high percentage of wind capacity owned by IPPs, along with the market reforms that allowed this, should theoretically lead to higher levels of deployment than what we see from the sample period. We suspect that both the low level of market liberalization (only wholesale competition was established, and IPPs are competing against Verve) and the relative newness of these reforms offer a partial explanation. Our WA case analysis also revealed evidence the wholesale market was experiencing ‘growing pains’ through 2012. The wholesale market reforms WA introduced in 2006 were introduced in Texas in 1995, so maturation effects may not yet have been felt.

Moreover, of all our theories, in Western Australia electricity market liberalization is the factor best able to explain the timing of the state’s then-largest wind farms in 2006 (see Figure 9.3). Because the creation of the wholesale market was announced in 2004, it is logical that the Emu Downs and Walkaway IPP-owned wind farms that deployed in 2006 timed commissioning to occur once the WEM – the venue for their power sales – was active.

Findings from SK’s noncompetitive electricity regime also seem to support our theory. There are just two wind IPPs under long-term contracts (PPAs) to sell their electricity to SaskPower, owning 19% of the province’s total installed wind capacity, despite their infrequent lottery and standard offers programs eliciting expressions of interest from hundreds of prospective IPPs. This suggests that interest from private sector actors is strong but their opportunities to participate SK are limited. In 2006, with the commissioning of its 149.4-MW Centennial wind project, SaskPower demonstrated it was capable of developing wind energy. While this may suggest that a competitive market and greater wind IPP participation is not necessary for deployment, a wider view of the sample period shows that the Centennial project is not indicative of ongoing interest from SaskPower in pursuing more wind projects – it has deployed no further wind projects.

The findings from the three within-case analyses and the cross-case analysis are broadly consistent with our expectations and we can confirm H3.

ADDITIONAL INSIGHTS ABOUT ELECTRICITY MARKET LIBERALIZATION

The Saskatchewan case analysis brought to light two separate findings that, when connected and when compared to TX and WA, may have significant implications for IV3 values during the sample period and possibly into the future. First, a 2003 report commissioned by SaskPower looking into the possibility of restructuring – which recommended against it – found that SaskPower would need to open itself to wholesale competition from generators located *outside* the province in order to create conditions for a sustainable competitive market (Rushton 2003). Without this, the small number of Saskatchewan-based generators would be able to gouge consumers and deregulation would fail. Rushton presents this as a rationale rejecting market liberalization and supporting the status quo. The second finding comes from SaskPower's 2012 annual report, which describes Saskatchewan's grid interconnections with Alberta, Manitoba and North Dakota and how they facilitate import and export of electricity "to meet higher internal demand or take advantage of export market opportunities" (2012 annual report, p.18).

By comparing SK, and its three interjurisdictional grid interconnections, to the isolated ('islanded') ERCOT grid in TX and SWIS grid in WA, we can locate a powerful rationale for the province to maintain the SaskPower monopoly regime and to reject a competitive wholesale market: the threat of out-of-province competition from wholesale generators. In a competitive electricity market, SK-based generators could be forced to adjust their prices downwards to attract buyers and could face uncertainty not currently present in a closed regime. In Texas' highly liberalized ERCOT market and in Western Australia's partially liberalized SWIS market, however, the threat of competition and downwards pressure on prices from wholesale generators located out-of-state is non-existent.

Our findings support a positive causal relationship between competitive electricity markets and wind deployment level, but we now appreciate that market liberalization may hold less appeal and therefore may be less likely to occur in SK than in places like TX and WA. This may pose an entrenched barrier for wind IPP participation in SK.

9.2.4. SIMPLICITY OF PLANNING, PERMITTING AND SITING MODEL

CROSS-CASE ANALYSIS – IV4: PLANNING, PERMITTING & SITING MODEL

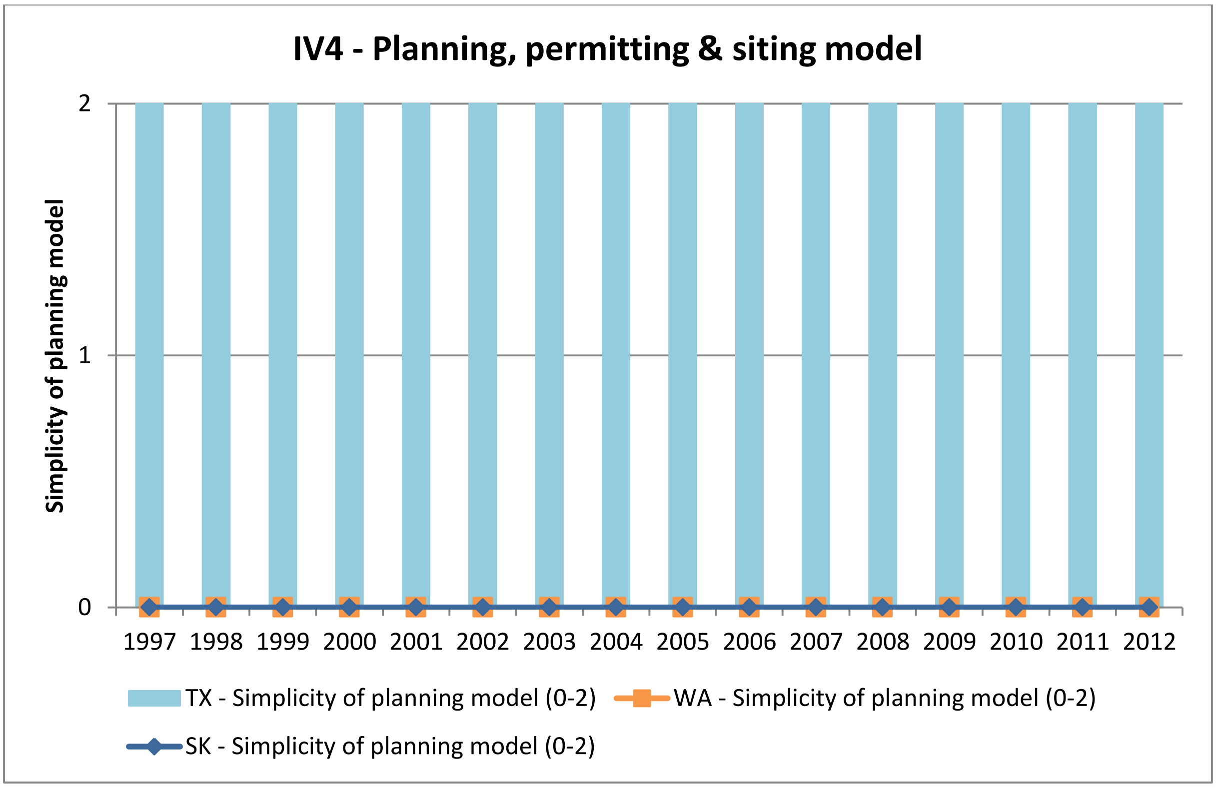

Figure 9.9. Comparison of IV4 values.

Figure 9.9 shows that none of our jurisdictions changes its planning, permitting and siting (PPS) model during the sample period. Texas maintains use of the most simplified ‘minimal’ model, which requires the fewest number of administrative procedures for prospective wind developers. Meanwhile Western Australia and Saskatchewan maintain use of the least simplified ‘standard’ model, which requires numerous regulatory procedures from developers, so their IV4 values remain invariant at zero.

Texas is deemed to use a ‘minimal’ model because it has no guidelines for wind farm siting and proposed projects are not subject to regulation at any level of government (FWS 2007).

WA is found to use a ‘standard’ model because proposed wind projects there are subject to approval at local and state levels and must adhere to regional and local planning strategies as well as the official wind farm planning guidelines. The guidelines specify the multiple impact assessments and wide range of consultations with stakeholders and multiple federal government agencies that prospective developers must undertake.

Like Western Australia, Saskatchewan also uses a ‘standard’ PPS model according to Bohn and Lant’s (2009) scale. If their scale were expanded, though, SK’s PPS procedures would correspond with an even more complicated model. Its regulatory requirements are numerous and time-consuming. Approvals are needed from all three levels of government, and environmental assessments, interconnection and feasibility studies, and stakeholder consultations are required of developers.

DISCUSSION – H4: JURISDICTIONS USING A SIMPLIFIED PLANNING, PERMITTING AND SITING MODEL WILL HAVE INCREASED LEVELS OF WIND DEPLOYMENT

Our process-tracing analysis offers evidence congruent with our theory-derived expectations in Texas, where the state's use of the 'minimal' *planning, permitting and siting model (IV4)* appears, as predicted, to have provided attractive business conditions for wind developers, who installed large amounts of new wind capacity. However, we were unable to directly attribute deployment growth in TX to this factor.

At first glance, the medium-low overall levels of deployment in WA and SK look consistent with our theory, and SK's process-tracing analysis confirms that use of complicated regulatory procedures has in fact delayed and hindered project deployment, as predicted. However, we discovered high levels of interest in new project development from prospective wind developers in SK and WA despite use of cumbersome PPS procedures in these places. The hundreds of applications to SaskPower's procurement lottery program and the many wind project proposals lodged with Western Power show that prospective developers are not deterred as we had predicted by time-consuming regulatory steps. This is evidence that our theory is incorrect and implies that PPS model is not a primary barrier to deployment in SK and WA. Furthermore, evidence from Texas could not support the theory.

We can disconfirm H4.

9.2.5. ANTICIPATORY APPROACH TO GRID INFRASTRUCTURE IMPROVEMENTS

CROSS-CASE ANALYSIS – IV5: GRID INFRASTRUCTURE

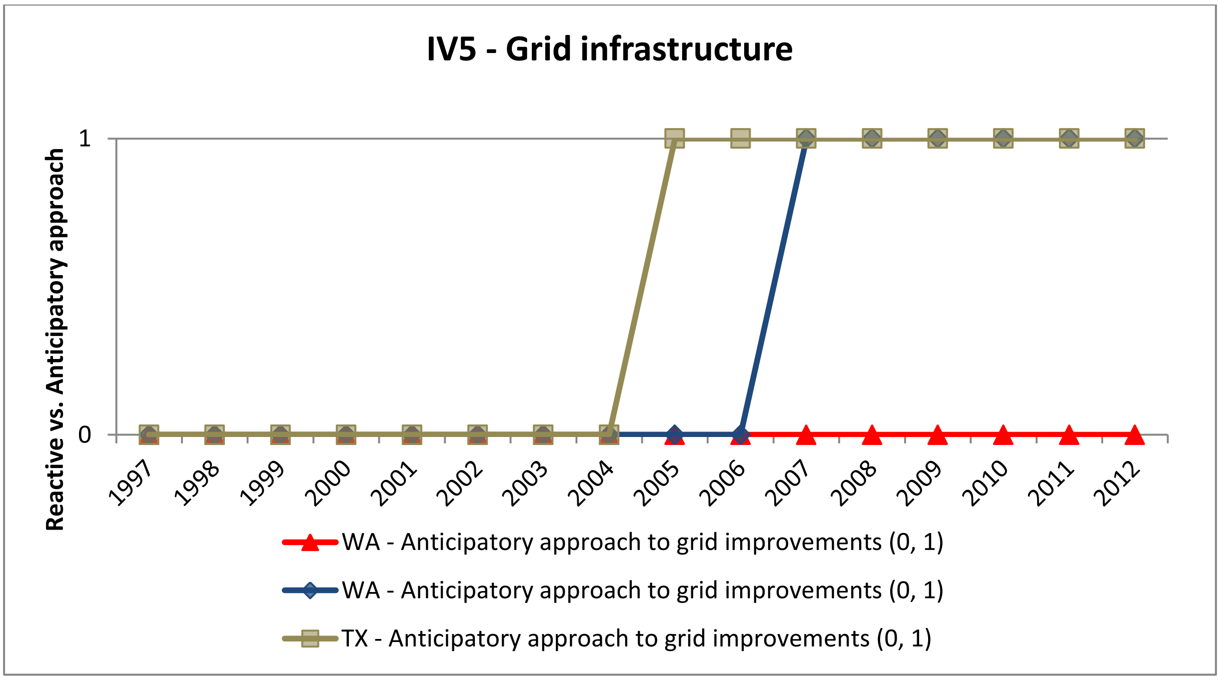

Figure 9.10. Comparison of IV5 values.

Figure 9.10 shows that all three jurisdictions used a reactive approach to transmission planning and grid infrastructure improvements at the start of the sample period. In 2005, Texas shifts to an anticipatory approach with the announcement of its ground-breaking CREZ (Competitive Renewable Energy Zone) transmission extension project, which began construction in 2010. In 2007, Western Australia also shifts to an anticipatory approach, announcing its transmission upgrade and extension Mid-West Energy Project (MWEP), which began construction in 2013.

DISCUSSION – H5: JURISDICTIONS USING AN ANTICIPATORY APPROACH TO GRID INFRASTRUCTURE IMPROVEMENTS WILL HAVE INCREASED LEVELS OF WIND DEPLOYMENT

Changes to values for *grid infrastructure (IV5)* in TX and WA came towards the end of our sample period so we have had to consider indicators of future deployment in order to assess H5. Findings from Texas strongly support our theory that a jurisdiction's use of an 'anticipatory' approach to grid infrastructure improvements (e.g. the network expansion and transmission upgrading embodied by the CREZ project) bolsters indicators of both potential and future wind deployment. Findings from Western Australia, with regard to its MWEP regional transmission build-out, seem to corroborate this.

After years of using a 'reactive' approach exclusively, both jurisdictions encountered transmission congestion due to inadequate transmission capacity that impeded further wind deployment, prompting the shift to an 'anticipatory' approach. Then, after their 'anticipatory' major network augmentation projects were announced and line routes were under study, we could see specific future wind projects emerging in response to the forthcoming grid improvements, suggesting the CREZ and MWEP projects had a direct causal effect on indicators of potential and future deployment.

This supports our theory that major transmission infrastructure programs facilitate elevated levels of deployment by increasing transmission capacity to alleviate existing congestion and to accommodate and integrate more wind. This in turn attracts wind developers to select project sites near the upgraded or expanded transmission segments.

Findings from SK paint a mixed picture but this is likely due to a shortage of information from SaskPower after the wind data study and the wind power deployment strategy they planned for 2009 did not materialize or whose results were not made public. With limited data we were unable to determine the extent to which the province's 'reactive' approach to grid infrastructure improvements poses a barrier.

Findings from TX and WA support Alagappan et al.'s (2011) theory that the 'anticipatory' approach promotes deployment and poses an effective solution to the transmission-planning chicken-and-egg dilemma described in the literature. Further, our findings suggests that while a 'reactive' approach does not seem to impede wind deployment initially, when penetration levels are low, as more wind capacity is installed it appears inevitable that transmission constraints will be encountered, at which point an ‘anticipatory’ approach becomes necessary if future wind deployment is to occur.

9.3. CONCLUSION

After comparing findings from the three within-case analyses in a cross-case analysis in this chapter, drawing conclusions about our hypotheses and reformulating our theories in dialogue with the literature, we found:

TABLE 5. CONCLUSIONS ABOUT HYPOTHESES

Hypothesis	Conclusion
H1: Federal wind energy production tax incentive	Confirmed - TX and SK findings strongly support theory
H2: Mandatory renewable energy quota	Disconfirmed - TX findings contradict theory
H3: Electricity market type	Confirmed - TX, WA and SK findings support theory
H4: Planning, permitting & siting model	Disconfirmed - WA and SK findings contradict theory
H5: Grid infrastructure	Confirmed - TX and WA findings support theory

The broader implications of these conclusions will be discussed in the next chapter.

10. CONCLUSION

The threats of climate change, impaired public health, energy insecurity, and rising fossil fuel prices have served as impetus for the deployment of renewable energy technologies in many countries, particularly in the electricity sector. While wind energy technology has made considerable inroads over the last two decades climate scientists warn we are not transitioning away from fossil fuels quickly enough to avert a climate catastrophe. With some urgency scholars and policymakers have been studying real-world experiences with wind energy technology to figure out how best to stimulate accelerated deployment. This thesis aimed to contribute to this body of knowledge by studying the deployment experiences of 'most similar cases' Texas, Western Australia, and Saskatchewan from 1997 to 2012. Despite starting at similar points, these oil- and gas-producing jurisdictions took different trajectories to arrive at divergent deployment outcomes in 2012.

Seeking explanations for these outcomes, we first turned to the literature for ideas about factors known to influence wind deployment generally. Next we identified our comparative case study research design, and described how our analytical approaches leverage a 'most similar cases' case selection strategy. Next we speculated that five factors from the literature seemed most promising for our research, and defined them conceptually and operationally. Then, in three separate within-case analyses, we assessed the predictions made in the theoretical framework against empirical evidence, looking in particular at causal mechanisms. Finally, we performed a cross-case analysis and discussion of findings from the within-case analyses to draw tentative conclusions about our hypotheses.

10.1. MAIN FINDINGS IN DIALOGUE WITH THE LITERATURE

We found that a federal wind energy production tax incentive influenced deployment via the predicted causal mechanism – it improved the financial viability of projects, thereby attracting developers, as we saw in Texas and Saskatchewan. This factor was able to explain both the timing of project commissioning in Saskatchewan, and why its total installed capacity per 100 people was (less than) half of Texas'. However, while it has a clear positive influence on deployment, a federal tax incentive was not, as Toke et al. (2008) suggest, a "sine qua non for large-scale deployment", as Western Australia demonstrated (p.1137).

Against our predictions, a mandatory renewable energy quota did not influence deployment on the basis of the goal's ambitiousness. We found no evidence in Texas and Western Australia that market demand for renewable energy was related to the goal's ambitiousness, the predicted causal mechanism. Other causal mechanisms suggested in the literature seem better able to explain the value of this policy instrument. Langniss and Wiser (2003) advised that a quota works best when paired with a federal tax incentive (the stick-and-carrot approach), and Hurlbut (2008) suggested a quota (preferably of low-ambition) works best in a competitive market context. These theories offer reasonable explanatory power for Texas' high levels of deployment.

We found that the amount of competition in an electricity market shaped the ability of wind IPPs to participate in electricity generation, as predicted, and the number of IPPs and their share of wind capacity ownership, in turn, influenced deployment outcomes. Findings from Texas and Saskatchewan supported this theory, which was suggested by Ferguson-Martin and Hill (2011). In Western Australia, which liberalized its electricity market in 2006, it appeared that major IPP-owned wind farms timed commissioning for after the wholesale market became active, and the number of IPPs and the amount of wind capacity they own rose following the reforms.

Counter to expectations, we found that the simplicity of a jurisdiction's planning, permitting and siting (PPS) model did not influence deployment outcomes and thus contradicted Bohn and Lant's (2009) theory. Use of a complicated PPS model did not deter prospective wind developers in Western Australia and Saskatchewan, although in Saskatchewan it did delay projects. We found no evidence of the predicted causal mechanism whereby a jurisdiction's appeal to prospective wind developers was related to the simplicity of its PPS procedures. Therefore, Texas' use of a 'minimal' PPS model cannot explain its high deployment levels.

An 'anticipatory' approach to grid infrastructure improvements encouraged potential and future deployment via the predicted causal mechanism – it promised to enable new generators to connect to the grid by expanding transmission capacity, according to our findings from Texas and Western Australia. This is consistent with Alagappan et al.'s (2011) theory. We add to it that the 'reactive' approach does not seem to hinder wind deployment until enough wind capacity is added that transmission congestion occurs. Once the threat of system overloading due to congestion arises, bringing further growth to a standstill, an 'anticipatory' approach becomes a necessity it seems.

10.2. RESEARCH QUESTION, REVISITED

Our research question asked: *What factors can explain divergent wind energy deployment outcomes across these three similar jurisdictions?*

The answer begins with a disclaimer: even the 'most similar' of jurisdictions will have fundamental dissimilarities whose influence cannot be ruled out, and, more pertinently, we could not test all the factors suggested in the literature. Rather, we focused on five within the purview of state/province-level decision-making. Our findings suggest that federal tax incentives have stimulated deployment in Texas and Saskatchewan, and competitive electricity markets along with proactive grid infrastructure improvements have bolstered deployment Texas and Western Australia. However, the ambitiousness of mandatory quotas and the simplicity of planning models were less important. Where supportive factors were weak or absent, deployment levels were generally lower, and where such factors were strong and present, as in Texas, deployment levels were higher.

10.3. BROADER IMPLICATIONS

Our research identified other supportive factors that appear to bolster deployment levels.

Policy stability

Beyond confirming that a higher-value tax incentive is more effective at stimulating deployment than a lower-value one is a lesson about policy stability. In Texas and the US as a whole, the boom-bust cycles in annual capacity additions were caused by legislative uncertainty surrounding the PTC. During the period of legislative stability for the PTC, from 2004 to 2009/2010, wind energy grew steadily. The instability of the PTC may be part of the reason why it pairs so effectively with a stable RPS with medium-term and longer-term goals.

Public investment in infrastructure

We found that ‘anticipatory’ projects like the CREZ and MWEP are effective solutions to the chicken-and-egg dilemma of transmission planning described in the literature. This is consistent with the assertion of the DOE (2008) that its ‘20% wind energy by 2030’ scenario, which would see an estimated 300 gigawatts (GW) of installed wind capacity nationally, would be most cost-effectively facilitated by a $20 billion federal investment in transmission expansion (p.2, 19). Our research suggests this may be money well spent as renewable energy developers are likely to flock to areas near the new transmission routes.

Leveling the playing field

Politics is responsible for the instability of the PTC in the US and the termination of the ecoERP in Canada. Although the tax revenues and community benefits outweigh the incentives’ costs, these programs have been political lightning rods (Szarka et al. 2012). Meanwhile, fossil fuels and nuclear industries quietly receive – and have for decades – massive subsidies that distort the costs of these generation technologies (Owen 2004), incentivizing their overuse, which then results in more GHG emissions. Moreover, these subsidies cause price distortions that mislead the public into believing renewable energy is more expensive than conventional energy, which, in turn, galvanizes political opposition to relatively meagre subsidies like the PTC.

In the short term, renewable energy production tax incentives are a valuable tool for promoting deployment. However, a longer-term, wholesale transition to sustainable energy systems is unlikely to occur until subsidies to nuclear and fossil fuels industries are ended. Additionally, carbon taxes and emissions-trading can be used to internalize the costs of air and atmospheric pollution created by conventional generation, which would also boost renewable generation.

Ultimately political will is the driver of change and policy innovation. Our five IVs arise from political decision-making, and Texas legislators and policymakers have succeeded at optimizing these factors to stimulate wind deployment. However, if scientists are correct about the urgency of anthropogenic climate change, far more drastic changes are required, and strong political leadership is needed at the national and international levels.

10.4. FUTURE RESEARCH DIRECTIONS

Due to this thesis' limited scope, we studied only a handful of potentially causal factors in the context of three cases, over a fifteen year period. There are still many gaps in our understanding, and revisiting these cases in the future could yield further insights. The CREZ and MWEP infrastructure projects were still underway at the time of writing so we expect that their full effects will surface over the coming years. Furthermore, there may be effects related to Australia's 2009 adoption of its '20% renewable energy by 2020' quota that develop closer to that compliance year. Also, longer data records may facilitate a better understanding of the impact of the 2006 electricity market reforms on wind deployment in Western Australia.

The research process also brought to light a number of other factors that may influence wind deployment and upon which future research could be based. These include: the use of 'smart grid' and advanced wind-forecasting technologies; natural gas price fluctuations; the influence of coal, gas and oil industry lobby groups; and the division of transmission-related expenses between developer, grid operator and consumers.

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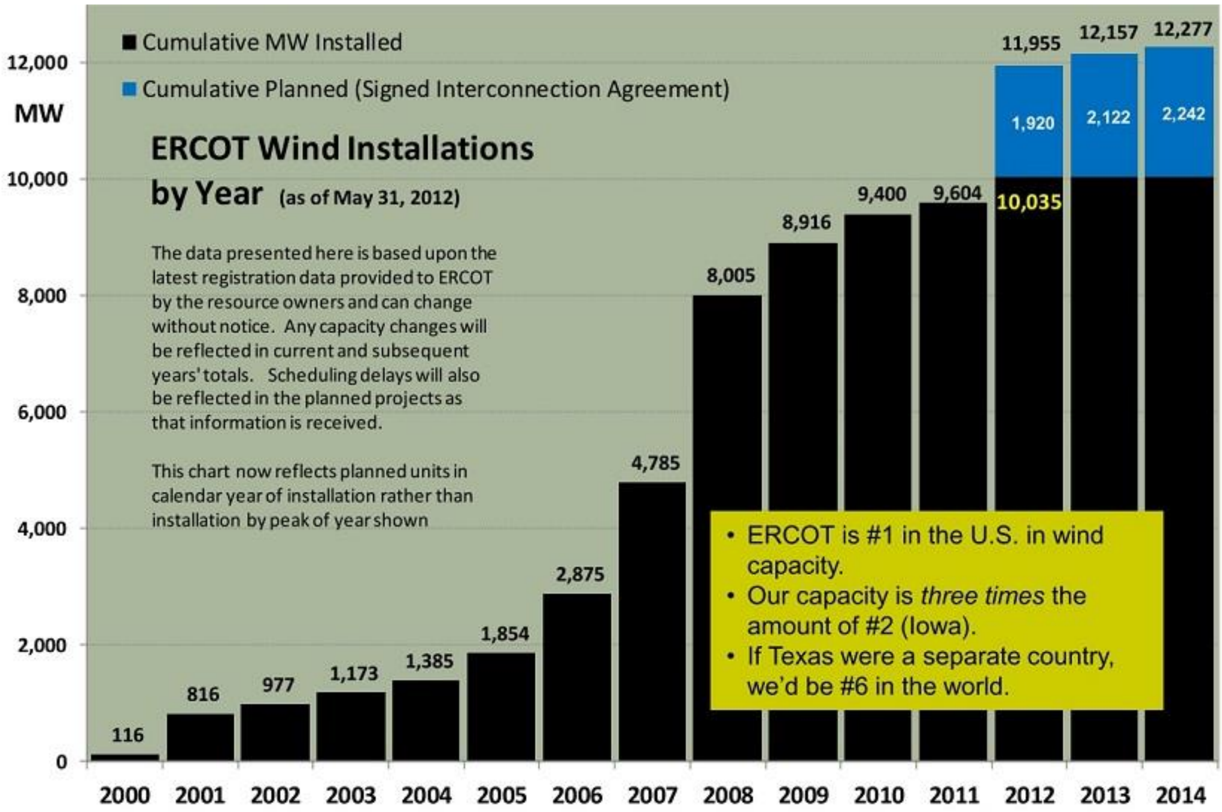
APPENDIX I - TEXAS


ERCOT Wind Installations by Year (as of May 31, 2012)

The data presented here is based upon the latest registration data provided to ERCOT by the resource owners and can change without notice. Any capacity changes will be reflected in current and subsequent years' totals. Scheduling delays will also be reflected in the planned projects as that information is received.

This chart now reflects planned units in calendar year of installation rather than installation by peak of year shown

- ERCOT is #1 in the U.S. in wind capacity.
- Our capacity is *three times* the amount of #2 (Iowa).
- If Texas were a separate country, we'd be #6 in the world.

Figure AI.1. ERCOT wind installations. Source: Doggett 2012, p.17.

TABLE 6. LEGISLATIVE HISTORY OF THE US PRODUCTION TAX CREDIT

Legislation	Date Enacted	PTC Eligibility Window (for wind)	PTC Lapse Duration	Effective Duration of PTC Window (considering lapses)
Section 1914, Energy Policy Act of 1992 (P.L. 102-486)	10/24/92	1994-June 1999	n/a	80 months
Section 507, Ticket to Work and Work Incentives Improvement Act of 1999 (P.L. 106-170)	12/19/99	July 1999-2001	6 months	24 months
Section 603, Job Creation and Worker Assistance Act (P.L. 107-147)	03/09/02	2002-2003	2 months	22 months
Section 313, The Working Families Tax Relief Act, (P.L. 108-311)	10/04/04	2004-2005	9 months	15 months
Section 1301, Energy Policy Act of 2005 (P.L. 109-58)	08/08/05	2006-2007	None	24 months
Section 201, Tax Relief and Health Care Act of 2006 (P.L. 109-432)	12/20/06	2008	None	12 months

Source: Wiser et al. 2007, p. 2.

APPENDIX II – WESTERN AUSTRALIA

TABLE 7. OPERATING AND PROPOSED WIND FARMS IN WESTERN AUSTRALIA

REGION	WIND FARM	STATUS	MW	COMPLETION	COST ($M)
Far north	Coral Bay	Operating	0.8		$4
	Carnarvon (Horizon power)	Proposed	5		
	Denham, Shark Bay	Operating	1		
North coast	Geraldton (Walkaway)	Operating	89.1	2006	$210
	Emu Downs, Badgingara	Operating	79.2		
	Kalbarri	Operating	1.6		
	Mumbida	Construction	55	Late 2013	
	Dandaragan	Proposed	513		
	Nilgen (north Lancelin)	Proposed	132.5	TBC	$280
	Warradarge	Proposed	250		$600
Inland	Collgar, Merredin	Operating	206.5	2011	$750
	Flat Rocks, Kojonup	Proposed	150	TBC	
Perth metro	Fremantle	Proposed	6.4	TBC	$16-18
Islands	Rottnest	Operating	0.6	2006	
South Coast	Albany	Operating	21.6	2001	$45
	Grasmere (Albany)	Operating	13.8	2012	
	Bremer Bay				
	Denmark Community Wind Farm	Construction	1.6	2013	
	Esperance:				
	Nine Mile Beach		3.6	2003	
	Ten Mile Lagoon		2.025	1993	
	Mt Barker Community Windfarm	Operating	2.4	2011	$8.5
	Hopetoun	Operating	1.2	2009	
	Milyeannup (near Augusta) (Verve)	Proposed	55		
		Total installed	**424***		

Source: Australia Greens 2013, p.53.

APPENDIX III – SASKATCHEWAN

TABLE 8. COMMERCIAL-SCALE WIND PROJECTS OPERATING IN SASKATCHEWAN

Project name	Year/month of installation	Turbine specifications / Total installed capacity	Owner
Centennial Wind Power Facility	2006/02	83x Vestas 1.8 MW (90 MW On-line in 2005/12) / 149.4000 (MW)	SaskPower International
Cypress Wind Power Facility	2001/09	9x Vestas V47 (660 kW) / 5.9400(MW)	SaskPower International
Cypress Wind Power Facility	2003/12	7x Vestas V47 660 kW / 4.6200 (MW)	SaskPower International
Sunbridge	2001/09	17x Vestas V47-660 (660 kW) / 11.2200 (MW)	Suncor & Enbridge
Red Lily Wind Energy Project	2011/02	Vestas V-82 / 26.4000 (MW)	Red Lily Wind Energy Partnership/Algonquin Power

Source: Adapted from CanWEA 2013, retrieved from http://www.canwea.ca/farms/wind-farms_e.php

TABLE 9. WPPI AND ECOERP INCENTIVES (VALUE PER KWH)

Nominal value (CAD)	Real value, 2012 CAD
1.2 cents on 1 April 2002	1.46 cents
1 cent on 1 April 2003	1.19 cents
1 cent on 1 April 2004	1.16 cents
1 cent on 1 April 2005	1.14 cents
0.8 cent on 1 April 2006	0.89 cent
1 cent on 1 April 2007	1.09 cents
1 cent on 1 April 2008	1.05 cents
1 cent on 1 April 2009	1.06 cents
1 cent on 1 April 2010	1.05 cents

Source: Data from OECD/IEA 2008; calculations using Bank of Canada inflation calculator.