Photovoltaics and the Transition to a Carbon-Neutral Energy System in Canada*

Policy Report

PV Policy Frameworks: Lessons from Domestic and International Policy Engagement with Photovoltaics

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CONTENTS

LIST OF ACRONYMS

AB 32: California Global Warming Solutions Act of 2006
AEMTC: Advanced Energy Manufacturing Tax Credit
BMU: Ministry for the Environment, Nature Conservation and Nuclear Safety
BMWi: Ministry of Economics and Technology
CAISO: California Independent System Operator
CEC: California Energy Commission
CPUC: California Public Utility Commission
CSI: California Solar Initiative
DOE LGP: Department of Energy Loan Guarantee Program
EEG: Renewable Energy Act
FERC: Federal Energy Regulatory Commission
FIT: Feed-in Tariff
GEGEA: Green Energy and Green Economy Act
HTRP: Solar Roofs Program
IESO: Independent Electricity System Operator
IOU: Investor owned utilities
ITC: Investment Tax Credit
kW: Kilowatt
MASH: Multifamily Affordable Solar Housing
MW: Megawatt
NSHP: New Solar Homes Partnership
OEB: Ontario Energy Board
OPA: Ontario Power Authority
OPG: Ontario Power Generation
OSEA: Ontario Sustainable Energy Association
PG&E: Pacific Gas & Electric
POU: Publicly owned utilities
PV: Photovoltaics
RAM: Renewable Auction Mechanism
RESOP: Renewable Energy Standard Offer Program
RPS: Renewables Portfolio Standard
SASH: Single Family Affordable Solar Housing
SCE: Southern California Edison
SDG&E: San Diego Gas & Electric
StrEG: Electricity Feed-in Act
TW: Terawatt

INTRODUCTION

The global energy landscape is in flux, with many jurisdictions attempting to navigate towards a more sustainable low-carbon trajectory. Renewable energy technologies have emerged as key pillars of this reorientation. With the objective of steering the energy system towards a lower carbon configuration, among other goals, policymakers have developed incentive mechanisms aimed at encouraging renewable energy deployment. The electricity sector has surfaced as a focal point for this policy engagement, with numerous favourable policy frameworks implemented globally. Solar photovoltaic technologies (PV), in particular, have attracted increasing policy attention as a potential key role-player in the energy mix capable of realizing GHG reductions as well as a variety of economic benefits.

PV presents many promising opportunities for the transition to a low-carbon society. This technology has minimal variable costs as it generates electricity from solar radiation using semiconductor materials with no moving parts. PV is a carbon-free modular electricity source, which can be deployed at many scales and in various applications (centralized or decentralized). Decentralized solar installations generate electricity at the point of consumption, reducing the need to invest in costly transmission infrastructure and preventing line losses. Solar energy production also tends to follow peak periods of consumption as clear sunny days often coincide with energy-intensive uses like indoor cooling. As PV module costs fall, due to learning effects and economies of scale, this technology has become increasingly competitive with conventional sources. Moreover, industrial development opportunities have been realized by a number of jurisdictions through aggressive policy support.

However, PV and the policy frameworks that have been developed to support this technology face serious and growing challenges. Increasingly, technical issues related to renewable energy deployment are posing problems for grid operators. For example, maintaining system reliability is being complicated by the increased penetration of intermittent renewables. Solutions exist to technical problems (smart grid technologies, electricity storage, demand response, etc), but have largely been inadequately developed and supported to date. From a social and political perspective, renewable energy deployment (in particular PV) remains quite controversial. The perceived impact of renewable energy policy support on electricity rates has resulted in calls to terminate support in some jurisdictions. Moreover, government support for PV has been touted as a promising industrial development strategy (in the United States, Germany and Ontario for instance), but recent events – mainly, massive module price reductions and an extremely competitive environment brought about by the scaling up of Asian module production – call into question the feasibility of this approach and the economic justification for policy intervention. If social and technical challenges are not overcome, PV development may stagnate, marginalizing a potential key contributor to energy supply and GHG reductions.

In order to overcome obstacles and successfully realize the benefits of renewable energy technologies like PV, innovative policy solutions and best practices gleaned from international experiences will need to be developed and implemented. This report explores the policy frameworks surrounding PV in three jurisdictions – Ontario, California and Germany – and draws lessons from these experiences. Incentive mechanisms, challenges, contextual developments and deployment outcomes are analyzed, followed by broad lessons forming the basis for general policy advice.

PV POLICY FRAMEWORK IN ONTARIO

Introduction

The province of Ontario has had a relatively brief engagement encouraging the deployment of solar PV. Nevertheless, this jurisdiction has made significant progress in terms of PV diffusion. The adoption of this technology has been spurred on by a favourable policy framework consisting of key pieces of legislation and incentive mechanisms. The following sections will explore the support policies surrounding PV in Ontario. Before addressing the policy framework around PV in greater detail, a broad understanding of the province and its electricity system is necessary.

Context

Ontario is Canada's most heavily populated province with roughly 13 million inhabitants (Statistics Canada, 2010). As of 2012, the province's GDP amounted to $638 billion and the principal economic sectors in terms of nominal GDP included: real estate services (12.9%), health and education (12.8%), manufacturing (12.4%), retail trade (11.4%), finance (10.1%), construction (6.7%) and various other service industries (21.2%) (Ontario Ministry of Finance, 2012a & 2012b). Ontario is governed through a Westminster-style parliamentary democracy with a Premier acting as the head of government and a Lieutenant Governor acting as the ceremonial head of state. The Canadian constitution outlines the division of power between the provinces and the federal government. Historically, matters falling within provincial jurisdiction tend to be fiercely guarded by the provinces. Most importantly for this discussion, the generation, transmission and distribution of electricity fall primarily under provincial jurisdiction.

Electricity Sector in Ontario

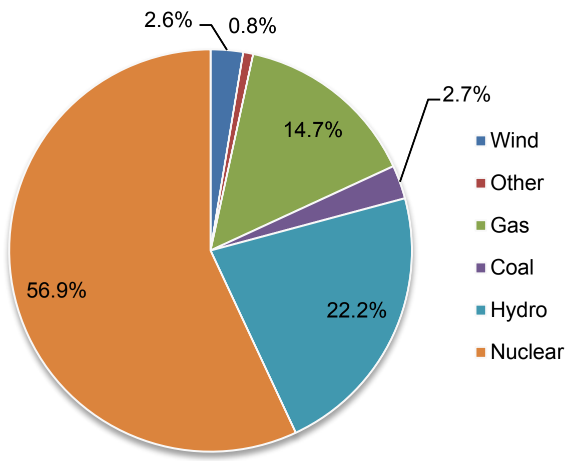
The primary actors surrounding the electricity system in Ontario have changed substantially over the last two decades. Before 1998, Ontario's electrical grid and power generating assets were owned and operated by the provincially owned monopoly, Ontario Hydro. The pricing regime under this system was regulated and prices tended to remain low due to a sizeable legacy fleet of inexpensive hydro facilities. However, Ontario Hydro encountered a number of increasingly acute problems from the 1970s until its demise in the 1990s. These included: overexpansion of capacity, ballooning debt, falling electricity demand, nuclear cost overruns, and the mismanagement of the nuclear file. Together, these forces led to a crisis of legitimacy for the public utility and in 1998 the Progressive Conservative government, under Mike Harris, restructured the government monopoly and introduce free market principles into the Ontario electricity system. The Electricity Act and the Energy Competition Act (1998) saw the division of Ontario Hydro into Ontario Power Generation (OPG), the Independent Market Operator (later renamed the Independent Electricity System Operator or IESO), Hydro One, the Ontario Electrical Safety Association and the Ontario Electricity Financial Corporation (for more information about specific actors, see Table 1). However, Ontario's market liberalization process was never fully realized, resulting in a hybrid regulated market. The hybrid system consists of a wholesale electricity market for large electricity consumers and a regulated price plan for designated consumers. The regulated rates allow smaller electricity consumers and households to remain insulated from market volatility. The regulated plan is reviewed by the Ontario Energy Board (OEB) every six months.

Table 1: Key Actors within the Electricity System in Ontario

Key Actors	Role
Ontario Ministry of Energy	The Minister of Energy sets the legal and policy framework by drafting legislation and regulations that govern the energy sector.
Ontario Energy Board (OEB)	The OEB was established under the Ontario Energy Board Act in 1960 to regulate the energy sector in the public interest.
Ontario Power Authority (OPA)	The OPA was established under the Electricity Restructuring Act in 2004 to plan for the current and future electricity system through the development of Integrated Power System Plans (IPSPs). This agency is responsible for ensuring the medium and long-term reliability of the electricity system in Ontario. The OPA is also mandated to establish objectives and implement programs related to conservation, demand management and renewable power generation.
Ontario Power Generation (OPG)	The OPG was created under the Electricity Act in 1998 as a crown corporation entrusted with the ownership and operation of the electricity generation assets divested by the former Ontario Hydro.
Independent Electricity System Operator (IESO)	The IESO is a not-for-profit corporate entity established in 1998 by the Electricity Act of Ontario to ensure reliability of the electricity system through forecasting and balancing supply and demand. This organization is responsible for operating the wholesale electricity market in Ontario.
Hydro One	Hydro One is a crown corporation mandated to procure, maintain and operate transmission and distribution infrastructure.
Ontario Hydro (now defunct)	Ontario Hydro was the crown corporation established to generate, transmit, distribute, supply and sell electricity in Ontario. Additionally, this entity was mandated to implement conservation and efficiency programs in the province. In 1998, under the Energy Competition Act, Ontario Hydro was split into five distinct entities (OPG, IESO, Hydro One, Ontario Electrical Safety Association and Ontario Electricity Financial Corporation).

The electricity supply mix in Ontario consists of a diverse portfolio of sources. Ontario's 34,079 megawatts (MW) of installed capacity is made up of nuclear (33%), gas (29%), coal (10%), hydro (23%), wind (4.4%) and other sources (0.8%) (IESO, 2012). This capacity does not factor in small electricity producers connected to the distribution network – mainly solar PV and other renewables. According to the OPA's 2011 fourth quarter report (2012a), solar PV accounts for an additional 419.4 MW of capacity or roughly 1.22% of total supply. As of 2011, electricity demand in the province amounted to 141.5 terawatt-hours (TWh). Most of this demand was met by generation from nuclear and hydro facilities (see figure 1 for details). Total electricity demand is projected to rise to 146 TWh by 2015 and 165 TWh by 2030 (Ontario Power Authority, 2010a). Ontario's system has interconnections with Quebec, Manitoba, New York, Michigan and Minnesota. According to the Long-term Energy Plan and ministerial directives, the province intends to meet rising demand through natural gas, renewable energy (10,700 MW of new capacity by 2018) and conservation. Nuclear is expected to continue to meet approximately 50% of electricity demand in the province through refurbishments and potential new reactor construction.

Figure 1: Electricity Generated by Source in Ontario in 2011 (IESO, 2012)



Renewable Energy Standard Offer Program (2006-2009)

A concerted effort to encourage the diffusion of PV was not made until the Renewable Energy Standard Offer Program (RESOP) was established by the OPA in 2006, following an extensive stakeholder consultation (Small & Rothman, 2008). In doing so, Ontario became the first North American jurisdiction to enact a Feed-in Tariff type system. The stated objectives of the program included: avoiding future costly investment in conventional generation sources; meeting renewable energy supply targets; encouraging the participation of small electricity generators in the provincial grid; and, minimizing environmental impacts of electricity generation (Ontario Power Authority, 2009). In order to satisfy these objectives, the RESOP offered 20 year fixed price contracts for electricity generated by grid-connected renewable energy sources less than 10MW in capacity. Contracts were available through a streamlined application process and offered a price of $0.42/kWh for solar PV and $0.11/kWh for other eligible renewables. Developers were responsible for connecting their projects to the distribution system, requesting connection impact assessments from the local distribution company and installing the required metering equipment.

The RESOP's design reflected a number of recommendations proposed by stakeholders – the Ontario Sustainable Energy Association (OSEA) played a central role in this process (Photiadis & Macdonald, 2011). However, the OEB and OPA resisted some recommendations that would have seen renewables receive highly favourable contract terms, stating that "the design of the standard offer program needs to balance the interest of the Government in securing generation from renewable resources against the interests of ratepayers and the statutory objectives of the OPA and the OEB" (Ontario Power Authority & Ontario Energy Board, 2006). In other words, the RESOP should avoid conflicting with the OEB and OPA mandates to provide electricity to ratepayers in a cost-efficient manner. To mitigate this conflict, the OPA implemented a value-based price rather than OSEA's proposed cost-based price which would have guaranteed a reasonable return on investment for renewable energy developers (Gipe, Doncaster, & MacLeod, 2005). In addition, the OPA did not provide a right to connect to the grid for renewable sources. Despite the divergence from OSEA's recommendations, the RESOP received a significant amount of attention from renewable energy developers. In the first year of the program, the 10 year contract target was exceeded. A total of 314 contracts were issued amounting to 1,300MW in capacity or $4.9 billion in potential investment (Ontario Power Authority, 2008).

The overwhelming number of contracts offered under the RESOP raised serious questions about the design of the program (Small & Rothman, 2008). In fact, a loophole existed that allowed large developers, who should have been competing under competitive procurement processes, to take part in the RESOP. The loophole permitted large developers to divide projects into numerous smaller projects of 10MW or less in order to qualify for the RESOP. Well-established developers were quick to take advantage of the program and far better organized than the smaller firms or community groups for whom the program was intended. Furthermore, there was no application fee, so developers could hold numerous contracts and exercise them as free options if conditions became favourable. In turn, the limited grid capacity available for renewable projects was rapidly taken up by large entities, forcing smaller and slower applicants to wait for capacity upgrades. Moreover, small developers met with a number of financial and institutional challenges that further complicated their involvement in the program (Adachi & Rowlands, 2010).

In light of the issues mentioned above, the OPA initiated the first program review after 18 months instead of the scheduled 24 months (Small & Rothman, 2008). Applications were frozen during the program review process and a series of revisions were proposed to rectify the challenges faced by the RESOP. Program revisions included: restricting projects to under 10MW per transformer station to prevent developers from breaking up large projects in order to fit under the 10MW cap; limiting proponents to no more than 50MW of uncompleted contracts at any one time; and improving efficiency by nullifying contracts that did not progress towards completion.

Overall, the program did succeed in increasing the amount of renewables in the supply mix and creating a burgeoning niche market for renewable energy technologies. As of 2012, the RESOP was responsible for encouraging the deployment of nearly 311.2 MW of PV with an additional 170 MW still under development. The majority of the province’s current PV installations were carried out under this program.

The Green Energy and Economy Act and the Feed-in Tariff (2009-present)

The Green Energy and Green Economy Act (GEGEA) is a central component of Ontario’s PV policy framework. The GEGEA was tabled in early 2009 and less than a month later it passed into law. The act was designed to attract investment in the electricity system, facilitate the coal phase out and position Ontario as a leading clean energy economy (Ontario Ministry of Energy, 2010). The development of the GEGEA was facilitated by three key events: (1) campaigns by stakeholders recommending the adoption of a European style FIT program, (2) the Minister of Energy’s visit to Europe with the purpose of learning about renewable energy policy options (Rand, 2010), and (3) the global financial crisis and corresponding employment losses in Ontario’s traditional manufacturing sector.

The GEGEA amended several pieces of legislation and ushered in the creation of a FIT program (Yatchew & Baziliauskas, 2011). The act articulated a series of ambitious objectives including the creation of 50,000 jobs in the first three years and the development of a green energy economy in Ontario.

The act streamlined the approval process for renewable energy projects, provided priority access for renewable energy to the grid and allowed for the development of a FIT system – replacing the RESOP. The GEGEA expanded ministerial direction of the OEB and OPA as well as added the promotion of renewable generation to the OEB mandate. This brought these bodies further under government control and shifted their objectives away from economic efficiency in favour of encouraging renewables.

In September 2009, the Minister of Energy directed the OPA to implement the FIT program (Ontario Power Authority, 2010b). The FIT program offers 20 year contracts for renewable energy projects of 10kW or more, whereas the microFIT is a streamlined version of the FIT program for sources under 10kW (Yatchew & Baziliauskas, 2011). The FIT incorporates a pricing schedule that takes into account the various costs associated with each type of renewable energy technology and allows for a reasonable rate of return on investment (see table 2 for the FIT price schedule for PV). The cost of the FIT is incorporated into energy prices and passed onto electricity consumers. The cost of connecting to the grid is borne by the developer, while the cost of upgrading the grid to accommodate projects is carried by ratepayers. Projects that require grid upgrades must pass an economic connection test to determine the financial feasibility of grid connection. In order to qualify for a FIT contract, projects must source a certain proportion of parts and labour from domestic sources (see table 3). Domestic content requirements are intended to stimulate regional economic development and the growth of Ontario's renewable energy technology industry. Additionally, the FIT offers eligible projects priority access to the grid over conventional energy sources. Since transmission and distribution infrastructure in Ontario is limited, the FIT shelters renewable projects from having to compete with conventional sources for access to the grid. Ultimately, the program sacrifices the traditional economic efficiency criteria in favour of advancing environmental and industrial policy objectives.

From October 2011 until July 2012, the FIT program underwent a scheduled two-year review. The central considerations that emerged from the review and consultation process included: the downward adjustment of FIT rates to reflect falling costs; the improvement of procedures and processes; and, the encouragement of community involvement in, and acceptance of, the program (Ontario Ministry of Energy, 2012a). The review prompted: (1) rates to be significantly reduced for rooftop and ground-mounted PV applications; (2) the further segmentation of the program into three project size categories – each with different rules – consisting of the microFIT (up to 10kW), smallFIT (10-500kW) and largeFIT (500kW-10MW); (3) the establishment of an annual cap for PV installed capacity under the largeFIT (capacity cap yet to be determined), smallFIT (200MW) and microFIT (50MW); (4) the introduction of an application window (October 1st – November 30th 2012) rather than the ongoing acceptance of applications; (5) the development of a point system for ranking applications (projects with a greater number of points are awarded contracts first); in addition to a number of other revisions. The point system ranks projects in terms of several criteria, including community involvement (see Table 4).

Table 2: Ontario FIT Price Schedule for PV (Ontario Ministry of Energy, 2012a)

Renewable Technology	Capacity	Original Price $/kWh	Revised Price $/kWh	% Change
Solar PV				
Rooftop (MicroFIT)	≤ 10 kW	0.802	0.549	-31.5%
Rooftop	> 10 kW ≤ 100 kW	0.713	0.548	-23.1%
		<250kW		
Rooftop	> 100 kW ≤ 500 kW	0.635	0.539	-15.1%
		> 250 kW ≤ 500 kW		
Rooftop	> 500 kW	0.539	0.487	-9.6%
Ground Mounted	≤ 10 kW	0.642	0.445	-30.7%
	> 10 kW ≤ 500 kW	0.443	0.388	-12.4%
	> 500 kW ≤ 5MW	0.443	0.350	-21%
	> 5 MW	0.443	0.347	-21.7%

Table 3: Ontario FIT Domestic Content Requirements for PV (Ontario Ministry of Energy, 2012a)

Minimum Domestic Content Level	Year of Commercial Operation
Solar PV projects over 10 kW and less than or equal to 10 MW	
25%	Before January 1, 2012
60%	On or after January 1, 2012
MicroFIT Projects	
40%	2009-2010
60%	2011 and later

Table 4: Ontario FIT Point System (Ontario Ministry of Energy, 2012b)

Project Type	Points
Local Community (min. 15% equity)	3
Aboriginal Participation (min. 15% equity)	3
Public Schools, Colleges, Universities, Hospitals & Long-Term Care Facilities (min. 15% equity)	2
Additional Points	
Municipal Council Support Resolution	2
Aboriginal Community Support Resolution	2
Project Readiness	2
Projects that applied on or before July 4, 2011	1
Projects that applied on or after July 5th, 2011	0.5
Education or Health Host	2
System Benefit (water and bioenergy)	1

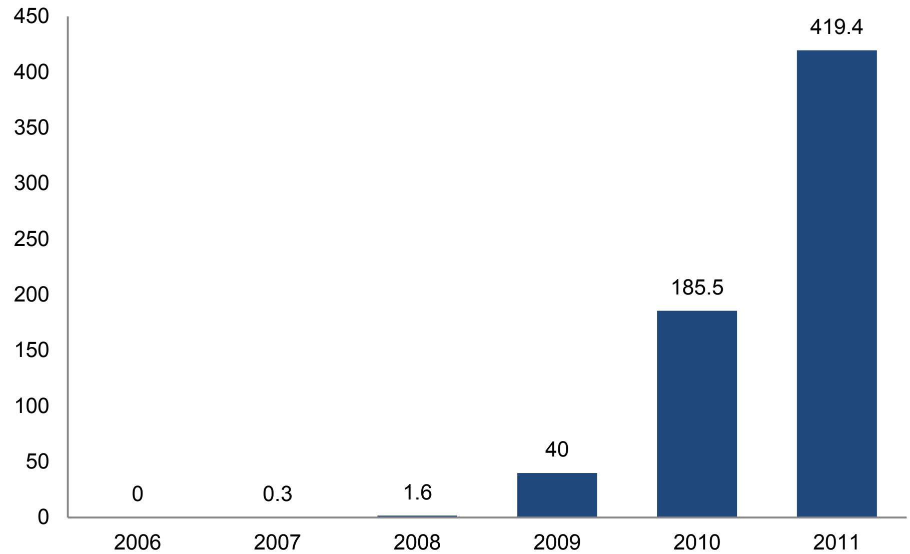
The FIT program (including microFIT) has been very successful in encouraging the deployment of PV. As of June 2012, 10,299 FIT applications totalling 21,292 MW of new renewable supply have been submitted (Ontario Power Authority, 2012a). Of these applications, 1,809 contracts amounting to 4,562 MW were either under development or in commercial operation. PV accounts for 90.38% (1,635) of total FIT contracts and 26.37% (1,203 MW) of total potential capacity under the program.

Despite the huge gains in PV penetration promoted by the FIT, the program and PV deployment are faced with a series of challenges. First, the limited transmission and distribution capacity available for additional generation remains a serious barrier. Many projects are stalled in anticipation for future grid upgrades (D'Aliesio, 2011). Second, the FIT is increasingly the target of ratepayer backlash due to rising electricity prices (Harvey, 2011). However, according to OPA's Long-term Energy Plan (2010a), renewable energy support is expected to account for roughly half of the 7.9% annual electricity rate increases with the rest attributable to other factors like nuclear refurbishment projects, investment in new natural gas generation as well as transmission upgrades. In an attempt to allay public displeasure with rising electricity rates, the Liberal government implemented a Clean Energy Benefit which credits residential and small business customers 10% of their electricity bills. In doing so, the Liberals have diluted their conservation and efficiency goals. Third, the domestic content requirements have resulted in much controversy internationally. Japan and the EU have launched challenges against the FIT domestic content rules with the World Trade Organization (Blackwell, 2010; Trew, 2012). International PV manufacturers have similarly argued that the domestic content rules will cost the province $2 billion in forgone investment annually (McCarthy, 2010). Domestic content rules are also faulted with creating market distortions as Ontario PV firms are effectively sheltered from foreign competition. Fourth, during the provincial election held in October 2011 the Progressive Conservative leader, Tim Hudak, vehemently opposed the FIT program. Initial polls indicated that Hudak would likely win the election, which created a tremendous amount of uncertainty for the Ontario solar industry. Fifth, community groups and their representatives have become increasingly critical of Ontario's electricity policy direction. For example, Wind Resistance Ontario (formerly Wind Concerns Ontario), a grassroots organization opposing wind turbine development, rallied behind the Progressive Conservative party during the 2011 provincial election in which the Liberals lost their majority and most of their rural support (Howlett & Ladurantaye, 2011). In addition, the Ontario Federation of Agriculture, under pressure from its membership, backed away from its initial support for renewable energy deployment and called for the suspension of wind development until "farm families and rural residents are assured that their interests are adequately protected" (Ontario Federation of Agriculture, 2012). More recently, some PV firms have expressed their discontent with the FIT review results, which were initially well received by stakeholders. More precisely, the SkyPower Group, Canada's largest solar energy firm, is suing the province for $100 million over recent rule changes (Stinson, 2012).

General Outcomes

Ontario's policy support for PV has resulted in some positive outcomes in terms of deployment and industrial development. In conjunction with the RESOP, support mechanisms for grid-connected PV have resulted in a dramatic increase in deployment over the last several years (see figure 2). PV capacity in the province has ballooned from 0 MW in 2006 – and less than 2 MW in 2007 and 2008 – to over 400 MW in 2011. The resulting surge in PV has created a number of economic opportunities. More precisely, employment in the sector has reportedly taken off, with module and inverter manufacturers locating in Ontario in order to take advantage of the generous FIT rates (ClearSky Advisors, 2010; Pollin & Garrett-Peltier, 2009). However, the employment benefits accruing from PV policy support have been questioned (Office of the Auditor General of Ontario, 2011). And, as the pervious section highlights, challenges abound for the technology and government support.

Figure 2: PV Deployment in MW from 2006-2011 in Ontario (Ontario Power Authority, 2012b)



PV POLICY FRAMEWORK IN CALIFORNIA

Introduction

In comparison with Ontario, California has had a relatively long history of policy engagement with solar PV. California's abundant solar resource, high electricity prices and scarcity of fossil fuels strongly favors investments in solar energy. However, until recently, the technology was not cost-competitive and required substantial government support. Historically, California's leaders and institutions have, for the most part, encouraged the adoption of PV through a variety of incentive programs and regulations (Taylor, 2008). The subsequent sections analyze California's most prominent policies surrounding PV, with a focus on the period following deregulation (2002 and onward). A brief overview of the electricity sector in California is also presented.

Context

With a population exceeding 37 million, California is the most populous state in the US (US Census Bureau, 2010). California's GDP amounted to $1.735 trillion in 2011 or about 13% of the US GDP (Glassman, 2012). The principal economic sectors include: real estate (18%), manufacturing (14%), government (10%), professional and technical services (10%) retail trade (9%) and information (8%) (Glassman, 2012). The state is a democratic republic governed by elected state senators and assembly members. The executive branch of government consists of a democratically elected Governor and an executive. The legislative branch consists of an assembly and a senate. These two houses have the power to draft and adopt legislation — subject to the governor's signature.

Electricity Sector in California

Due to its sizeable population and productive economy, California has one of the largest electricity use profiles in the country. However, per capita electricity consumption is about half the US average.

Progressive energy policy since the 1970s has made California a leader in energy efficiency. Over the past 30 years, per capita electricity consumption in the United States increased by nearly 50 percent while per capita electricity use in California remained nearly flat despite increasing economic activity (California Energy Commission, 2011a).

The chief agencies involved in energy regulation and distribution are the California Public Utilities Commission (CPUC), the California Energy Commission (CEC), Federal Energy Regulatory Commission (FERC) and the California Independent System Operator (CAISO). The authority of the CPUC and the CEC falls under the state executive branch. The governor, pending approval by the Senate, appoints five commissioners to both the CPUC and CEC to serve five-year staggered terms. The commissioners that make up FERC are appointed by the US president with advice and consent of the Senate to serve five-year terms. FERC oversees the CAISO. The CAISO Board consists of five Governors, nominated by the Governor of California and confirmed by the state senate, who serve staggered three-year terms.

Table 5: Key Actors within the Electricity System in California

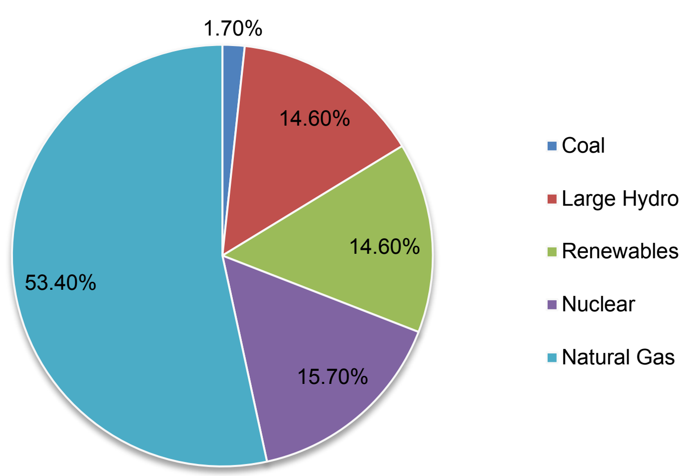
Key Actors	Role
California Public Utilities Commission (CPUC)	The CPUC regulates investor-owned electric and natural gas utilities operating in California. The primary responsibilities of the CPUC include: setting electric rates, protecting consumers, promoting energy efficiency and ensuring system reliability.
California Energy Commission (CEC)	The CEC is the primary agency for energy policy and planning. This includes, but is not limited to, forecasting future energy needs, siting and licensing large scale power plants, promoting and enforcing energy efficiency, supporting research, development and demonstration programs, and supporting renewable energy through market support mechanisms.
Federal Energy Regulatory Commission (FERC)	The FERC regulates the interstate transmission of electricity, gas and oil. Its responsibilities with respect to electricity include, but are not limited to, regulating the interstate transmission and the wholesale electricity market, ensuring the reliability of the high voltage interstate transmission system, and overseeing environmental matters related to major electricity policy initiatives.
California Independent System Operator (CAISO)	The CAISO – a non-profit public benefit corporation – was created in 1998 when the state restructured its wholesale electricity industry. It controls the flow of electricity through transmission lines, supervises the maintenance of this infrastructure, and balances supply and demand through daily market transactions.

Electricity is provided to retail consumers through either Investor Owned Utilities (IOUs) or Publicly Owned Utilities (POUs). The state's three large IOUs are: (1) Pacific Gas & Electric (PG&E), which serves most of Northern California; (2) Southern California Edison (SCE), which serves most of Southern California; and, (3) San Diego Gas & Electric (SDG&E), which serves most of San Diego County and parts of Orange County. These IOUs serve over 80 percent of the state's electricity demand and are mandated with developing both interim and long-term resource procurement plans under the supervision of the CPUC (CEC, 2003). POUs, including both municipal utilities and electric cooperatives, serve the state's remaining electricity load (CEC, 2003).

California's electricity system has changed significantly over the past decade. Prior to deregulation, incumbent IOUs were vertically integrated, providing generation, transmission, distribution, metering and billing services. Following the inauguration of the competitive electricity market in 1998, California's IOUs were forced to divest many of their assets to independent power producers and customers were given a choice in determining their electricity supplier. Electricity was traded on the Power Exchange, where power generators competed to sell their electricity in response to bids submitted by large industrial users and distribution companies, among others. After the California electricity crisis of 2000-01, the main institutions of the competitive market established through deregulation – the Power Exchange and retail choice – were dismantled. In their place, the CAISO was created to oversee power generators and grant access to transmission and distribution facilities. The electricity system now operates as a hybrid electricity market (State of California, 2003). It has a competitive wholesale electricity market and a regulated retail market. The California wholesale market operates as a commodity exchange through the centralized and autonomous system operator. The electricity markets use a full network model which predicts transmission losses and reactive power load to produce prices at every point in the system. By offering locational marginal pricing, the CAISO is taking progressive steps to create a transparent system that reflects the actual cost of generating and delivering electricity (CAISO, 2011).

As of 2010, total electricity consumption in California amounted to 290.187 TWh (CEC, 2011a). However, the state relied upon imports for 29% of its electricity generation. In-state generation in 2010 accounted for 205.018 TWh. The in-state portion of electricity output is made up of coal (1.7%), large hydro (14.6%), natural gas (53.4%), nuclear (15.7%) and renewables (14.6%). Solar PV accounted for roughly 0.4% of total output (although, more recent output is likely much larger). California imports more electricity than any other state, primarily hydroelectric power from the Pacific Northwest along with coal and natural gas from the desert Southwest.

Figure 3: Electricity Generated by Source in California in 2010 (CEC, 2011a)



Current Federal Policies

There are a number of federal incentive programs aimed at encouraging the deployment of solar PV. However, many of these programs have reached the limits of available funds or are nearing expiration. Furthermore, the focus of this report is on the state policies implemented in California rather than federal support. As a result, a brief overview of federal policies will be provided rather than an in-depth analysis. The most prominent policies include the Advanced Energy Manufacturing Tax Credit (AEMTC), Investment Tax Credit (ITC), 1603 Treasury Program, Department of Energy Loan Guarantee Program (DOE LGP) and several other Department of Energy initiatives.

As part of the American Recovery and Reinvestment Act of 2009, the AEMTC was introduced (Platzer, 2012). It provided a 30% tax credit to advanced energy manufacturers investing in manufacturing facilities in the United States. A number of prominent PV module manufacturers were funded by the AEMTC. The support mechanism has reached its funding cap of $2.3 billion and is awaiting potential renewal.

The DOE LGP, also part of the American Recovery and Reinvestment Act of 2009, provided loan guarantees to solar PV projects and renewable energy developers more broadly (Platzer, 2012). The DOE LGP provided $13.2 billion in funding for solar projects and manufacturers before expiring in 2011. A number of the PV manufacturers funded under this program have experienced financial difficulties, restructurings and bankruptcies as a result of the turbulent economic landscape surrounding PV over the last year.

The ITC for solar installations has been in effect since the Energy Tax Act passed into law in 1978 (Platzer, 2012). The ITC provides a 30% tax credit for solar project costs until 2016. Eligible projects include residential and commercial installations. After 2016, the program will revert to a 10% tax credit for commercial projects only. In 2009, the ITC was revised to allow for direct cash grants rather than tax credits to appeal to a larger group of investors.

The 1603 Treasury Program provided cash grants to eligible solar projects until the end of 2011 (Platzer, 2012). The grants amounted to 30% of the total cost of the solar system and were highly successful in encouraging deployment. The 1603 Treasury Program awarded over $2.1 billion in funds to roughly 33,000 solar projects.

The Department of Energy has also invested heavily in initiatives encouraging the development and commercialization of emerging PV technologies and advanced manufacturing processes.

Early Efforts (1970-2002)

California has a long and textured history of supporting the diffusion of solar technologies. Early efforts consisted of upstream investments, incentive programs and regulatory changes that can be traced back as far as the oil shocks of the 1970s. These early efforts have shaped the institutions surrounding the solar industry and informed the development of modern support policies. Prominent early initiatives included: favourable long-term contracts for utility-scale PV projects as part of the state's interpretation and implementation of the federal government's Public Utility Regulatory Policies Act in the late 1970s; the provision of installation rebates by IOUs for distributed PV systems, dating back to the 1980s (in particular, the Renewable Energy Program funded initiatives); and, various net-metering retail credits offered by IOUs, which have been in place since 1996 (Taylor, 2008). Until recently, many of the PV incentive mechanisms were carried out under a number of broad renewable energy programs (Self-Generation Incentive Program, Emerging Renewables Program, etc). However, in 2007, many of the PV incentives were consolidated under the Go Solar Initiative (outlined below) and therefore only their current iterations are discussed.

The majority of support policies have been funded through various system surcharges paid by electricity consumers and collected by utilities. It is worth noting that California has implemented an electricity rate schedule that mitigates price increases for low-income households related to modernizing the electric grid.

Renewable Portfolio Standard and Associated Programs (2002-Ongoing)

In 2002, California established a Renewables Portfolio Standard (RPS) Program, which was jointly implemented by the CPUC and the CEC. Under this legislation, utilities were directed to increase the proportion of renewable energy generation to 20 percent by 2017. In 2003, the CEC's Integrated Energy Policy Report recommended that the target date be moved forward from 2017 to 2010 (later extended to 2013). And, in 2004, the CEC's Energy Report Update recommended an even more aggressive target of 33% (CEC, 2011b). More recently, in April 2011, California adopted a 33% RPS by 2020, signing into law one of the most environmentally ambitious pieces of legislation to date.

The policy objectives articulated through the legislation include: achieving near-term GHG reductions along with facilitating a long-term low-carbon transformation of the electricity system; improving energy security through diversifying supply and reducing fossil-fuel dependence; improving local environmental outcomes and public health; realizing industrial development and economic benefits; and, providing value for ratepayers and the system (CPUC, 2009).

The RPS applies to all electricity retailers in the state, including POUs. All of these entities must meet the RPS goals of 20% of retails sales from renewables by the end of 2013, 25% by the end of 2016, and 33% by 2020. In order to meet these goals, utilities are required to select eligible renewable sources (excluding large hydroelectric facilities) that are least cost and best fit for the grid. While the CEC and the CPUC work in collaboration to implement RPS goals, it is the responsibility of the CEC to ensure the certification of renewable facilities as eligible for the RPS. The CEC has also developed a tracking and verification system to ensure proper accounting of renewable energy output within and outside of California. RPS Compliance Reports must be filed annually using CEC verified RPS procurement data. The CEC may impose penalties of 5 cents per kWh up to $25 million per year for non-compliance (CPUC, 2011a). To date, no penalties have been applied.

In order to better understand the impacts of reaching a 33% RPS, the CPUC published a preliminary Implementation Analysis report in 2009. The report found that: achieving 33% renewables by 2020 is a highly ambitious target requiring significant infrastructure investment; 11 new major transmission lines will be required at a cost of $16 billion; a tripling of renewable energy generation will be required, from 27 TWh in 2009 to 75 TWh in 2020; projected average electricity costs will be 16.7% higher in 2020 compared to 2008 (in real terms) even if California makes no more investments in renewable energy; and, the total statewide expenditures of achieving a 33% RPS is projected to be 10.2% higher than an all gas-scenario (whereby all new electricity needs are met entirely by natural gas generation).

The RPS has been successful in encouraging the uptake of PV as well as the shift towards renewable energy generation. Since 2003, 2,541 MW of renewable energy has come online under the RPS (CPUC, 2011a). Roughly 830 MW of renewable energy capacity was installed in 2011, much of which was PV and Wind. As of 2012, the renewable energy procurement status of California's three large IOUs was as follows:

- Pacific Gas and Electric (PG&E) – 20.09%
- Southern California Edison (SCE) – 21.70%
- San Diego Gas & Electric (SDG&E) – 20.80%

The RPS has met with resistance from other sectors and even environmental organizations. Critics of the legislation tend to argue against the anticipated higher electricity costs associated with the 33% target (Weintraub, 2011). Industry in California already pays electricity rates that are about 50 percent higher than the rest of the country. Opponents of the legislation argue for the continued use of cheaper, conventional energy sources such as coal and natural gas, keeping costs down for business and residential ratepayers.

There is also concern among environmental groups related to the potential impact of industrial-scale solar projects on land and habitat. The most notable case is that of a proposed 5,130-acre concentrating solar installation in the California Mojave desert by the solar firm BrightSource. The project caused intense friction between environmentalists and renewable energy developers and was temporarily shelved (Rosenthal, 2009). The key issue in the dispute was the use of public land and potentially adverse impacts on critical habitat. Utility-scale ground-mounted solar PV may be faced with similar challenges as penetration increases.

California Global Warming Solutions Act (2006-Ongoing)

The California Global Warming Solutions Act of 2006 (AB 32) has helped advance climate related objectives including the diffusion of renewable energy and in particular solar PV. The act set a statewide carbon reduction target capping emissions at 1990 levels by 2020. Meeting this target has been linked to the success of a variety of renewable energy programs (including the RPS and related renewable energy support). For instance, the Climate Change Scoping Plan by the California Air Resources Board reported that at least 40% of the State's emission reductions would need to be realized through the electricity sector (Wong Kup et al, 2008).

In response to this legislation, two Texas-based oil companies (Valero Energy Corp. and Tesoro Corp.) provided funding for the November 2010 statewide Proposition 23 initiative. The goal of the proposition was to freeze the provisions of AB 32 until California's unemployment rate dropped to 5.5% or below for four consecutive quarters. With current unemployment at roughly 11%, this would be highly unlikely. Supporters of the measure argued that it would halt a rise in energy costs at a time when California, hit hard by the financial crisis, could least afford it. However, Silicon Valley investors, who have been traditional supporters of renewable energy technology, launched a competing campaign opposing Proposition 23 (Groom, 2010). And, in November 2010, California voters rejected Proposition 23 with a vote of 59%.

Go Solar California Initiative (2007-Ongoing)

In 2007, the state established the Go Solar California Initiative which encompasses the CEC's New Solar Homes Partnership (NSHP) and the CPUC's California Solar Initiative (CSI). The overall budget of the initiative is USD $2.167 billion and the objective is to deploy 1,940 MW of solar projects by the end of

2016 (CPUC, 2011b). The CSI offers either cash rebates or attractive rates for grid-tied solar technologies. The rebate option (Expected Performance-Based Buydown) provides an upfront lump sum payment per watt installed based on expected performance, whereas the rate option (Performance-Based Incentive) is paid out monthly per kWh generated over 5 years. The rate option is required for systems greater than 30 kW, however smaller systems may opt into this mechanism. The incentive, under both mechanisms, is linked to the number of installed projects and declines based on predetermined capacity steps (see table 2). IOUs are responsible for administering the CSI incentives. Currently, the program has reached the lowest incentive levels – between the 8th and 10th step, depending on the service area and market segment (residential, commercial or government). However, more than 14 MW are presently under review as part of the program, indicating that the incentives remain sufficient to spur on deployment. As of May 2012, 839 MW of PV have been installed under the program with 348 MW pending installation (CPUC, 2012a).

Table 6: California Solar Initiative Incentives

		Expected Performance-Based Buydown (per Watt)			Performance-Based Incentive (per kWh)		
			Non-Residential			Non-Residential	
Step	Statewide MW in Step	Residential	Commercial	Government/ Non-Profit	Residential	Commercial	Government/ Non-Profit
1	50	n/a	n/a	n/a	n/a	n/a	n/a
2	70	$2.50	$2.50	$3.25	$0.39	$0.39	$0.50
3	100	$2.20	$2.20	$2.95	$0.34	$0.34	$0.46
4	130	$1.90	$1.90	$2.65	$0.26	$0.26	$0.37
5	160	$1.55	$1.55	$2.30	$0.22	$0.22	$0.32
6	190	$1.10	$1.10	$1.85	$0.15	$0.15	$0.26
7	215	$0.65	$0.65	$1.40	$0.09	$0.09	$0.19
8	250	$0.35	$0.35	$1.10	$0.04	$0.04	$0.14
9	285	$0.25	$0.25	$0.90	$0.03	$0.03	$0.11
10	350	$0.20	$0.20	$0.70	$0.03	$0.03	$0.09

In addition to the above program, the CSI includes a low-income instrument consisting of the Single Family Affordable Solar Housing (SASH) and Multifamily Affordable Solar Housing (MASH) programs. The primary objectives of low-income mechanisms are to encourage the adoption of PV in the low-income housing market as well as decrease electricity costs for low-income households (DSIRE, 2012). The MASH program provides incentives per watt installed to building owners that offset tenant electricity consumption or electricity use within common areas. As of February 2012, this program has resulted in over 20 MW of PV deployment (reserved or completed) (Southern California Edison, 2012a). In contrast, the SASH program offers low-income households fully or heavily subsidized 1kW PV systems. The program is operated by GRID Alternatives, a not-for-profit organization that has engaged with low-income communities and solar deployment since 2001. As of April 2012, the program deployed over 5 MW of PV (GRID Alternatives, 2012).

The NSHP provides incentives to new home builders to encourage the adoption of grid-connected solar PV systems within the new construction market. The program aims to install 400 MW of PV on new homes and have solar PV systems on 50% of all new homes by 2016 (DSIRE, 2012). Eligible new buildings must exceed efficiency standards by 15%, rewarding efficiency in addition to encouraging PV deployment. Four incentive levels are available through the program (see table 3). Similar to the CSI, incentives are set to decline once a predetermined installed capacity is reached. The NSHP has received a significant amount of interest with over 45 MW of PV capacity approved and 2.5 MW under review as of July 2012 (Go Solar California, 2012).

Table 7: California New Solar Homes Partnership Incentive Levels (as of July 2012)

Incentive Level		Expected Performance Based Incentive ($/watt)	Eligibility
Base		$2.00	Fewer than 50% of units equipped with PV systems.
Solar as a Standard Feature		$2.25	50% or more units in subdivision to be equipped with PV systems
Affordable	Residential Areas of Affordable Housing Projects	$2.90	Affordable housing development
	Common Areas of Affordable Housing Projects	$0.00 (originally $3.30)	Common areas of affordable housing projects

Feed-in Tariff (2008-Ongoing)

In February 2008, the CPUC implemented a feed-in tariff (FIT) for distributed renewable energy projects up to 1.5 MW (now expanded to 3 MW or less) (DSIRE, 2012). The FIT offers 10, 15 or 20 year standard contracts administered by the state's IOUs. Eligible renewable energy projects are paid for electricity generation based on the Renewable Market Adjusting Tariff. Unlike the Ontario FIT, California's program does not guarantee a reasonable rate of return and is instead based on market determinants – more precisely, the weighted average of the three highest executed contract bids from the Renewable Auction Mechanism (discussed in more detail in the following section). The latest rate is expected to be USD 0.089/kWh. This rate will be adjusted upward or downward every two months based upon the number of applicants that accept the rate and the capacity allocated to the project. The available capacity under this program is capped at 750 MW (expanded from 480 MW) for the life of the program, although this cap may be increased by CPUC.

The FIT has facilitated the deployment of a sizeable quantity of solar PV. At present, over 200 MW of renewable capacity is under development or has entered service (CPUC, 2012b). Solar PV accounts for the vast majority of the capacity being deployed under this program (Southern California Edison, 2012b; PG&E, 2012).

Renewable Auction Mechanism (2010-Ongoing)

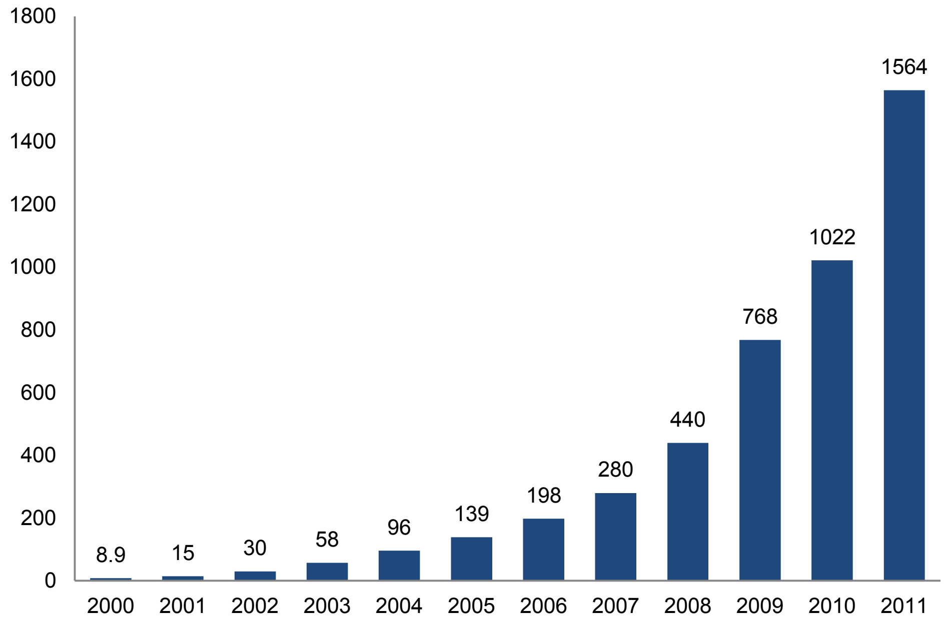
In preparation for the more aggressive RPS goal of 33%, the CPUC approved the Renewable Auction Mechanism (RAM) in December of 2010. The RAM is a simplified and market-based procurement mechanism for eligible renewable energy projects between 3 MW and 20 MW of capacity (DSIRE, 2012). IOUs are responsible for carrying out the auctions and entering into 20 year power purchase agreements with successful renewable energy developers. Each IOU is required to determine the types of products (e.g. baseload, peaking, non-peaking) they intend to procure under the RAM to ensure their procurement is consistent with their portfolio needs (CPUC, 2010). IOUs also identify interconnection sites for bidding developers and have the discretion to reject certain bids if they fail to meet cost criteria. The RAM evolved from the CPUC's interest in expanding the existing feed-in tariff program in order to stimulate renewable energy procurement. However, the RAM is distinct from a traditional feed-in tariff. Like a FIT, it is a streamlined contracting mechanism and utilizes a standard contract. Unlike a traditional FIT, the RAM relies on market-based pricing and selects projects based on least cost rather than on a first-come first-served basis. The rules adopted for the RAM are "intended to reduce transaction costs, promote regulatory certainty, and provide value to the market, utility, regulator, and ratepayer" (CPUC, 2010). The competitive solicitation process is expected to elicit the lowest costs for ratepayers, encourage the development of resources that can utilize existing transmission and distribution infrastructure as well as contribute to meeting RPS goals. The CPUC has directed California's three IOUs to use RAM to procure 1,000 MW (now expanded to 1,299 MW) over two years through four auctions (DSIRE, 2012). The capacity available for bidding is allocated proportionally by the retail sales of each IOU.

Results from the 2011 auction reflect favourably for PV deployment. Out of a total of 130 MW of winning bids, the vast majority were PV projects (Vote Solar Initiative, 2012). Most importantly, the weighted average of the highest executed contract prices was USD 0.089/kWh. This rate is far less than residential electricity prices of just under USD 0.20. And, since this figure reflects the highest bids it is likely that many of the successful PV projects were even lower cost. Apparently, this instrument has resulted in exceptionally competitive rates in comparison to generous incentives paid through traditional support instruments.

General Outcomes

California's PV support policies have spurred on considerable growth in the PV sector in terms of both deployment and industrial development. More precisely, incentives for PV implemented over the past decade or so – including, but not limited to, the RPS, the Go Solar California Initiative, the FIT and the RAM – have resulted in a significant increase in PV cumulative installed capacity (see Figure 2) as well as growing employment in the sector. According to the Solar Energy Industry Association (2012), in 2011 alone California saw over 500 MW of solar PV capacity installed. And, as of 2012, employment in California's PV industry amounted to nearly 50,000 jobs. Despite recent turmoil in the PV industry, future prospects appear promising, with an anticipated addition of 18,000 to 24,000 jobs over the next three years (Lindstrom & Marquez, 2012). Moreover, utilities operating in the state have managed to shift their generation heavily towards renewables. Collectively, utilities have increased the renewable energy portion of electricity sales from 4% in 2003 to nearly 20% in 2010 (North American Wind Power, 2012). However, a sizeable gap remains between current progress and commitments under the RPS (33% renewable generation by 2020) along with other initiatives (3,300 MW of PV by 2016). California's PV industry is also faced with many of the same issues (grid integration challenges, opposition by actors within the electricity sector, volatile markets and economic conditions, etc) as other jurisdictions. In particular, greater penetration of variable renewable energy sources will continue to be a challenge for system operators, requiring costly and often controversial grid upgrades (CPUC, 2009).

Figure 4: PV Deployment in MW from 2000-2011 in California (Solar Energy Industry Association, 2012; US Department of Energy, 2011; CEC, 2009)



PV POLICY FRAMEWORK IN GERMANY

Introduction

Germany is widely hailed as one of the prime successes of renewable energy policy, having several times reached and surpassed its objectives for both renewable electricity production and greenhouse gas emissions reductions. Since the beginning of the 1990s, the share of renewable energy generation in total electricity production has increased from 3% in 1990 to 20% in 2011 and solar PV installed capacity has multiplied by roughly 25,000 (BMU, 2012a). In the process, the country has: become one of the largest markets in the world for solar panels; developed a top-ranked domestic PV manufacturing industry; and, employed 380,000 in the German PV industry (BMU, 2012b). These achievements are generally attributed to two legislative landmarks: the 1990 Electricity Feed-in Act (StrEG) and the 2000 Renewable Energy Act (EEG). The following sections provide a detailed analysis of the German policy framework surrounding solar PV, including a brief history of particularly important policies and critical challenges that lie ahead.

Context

With a GDP of USD 3.57 trillion in 2011, Germany is the largest economy in Europe and the 4th largest economy in the world. In 2011, the main economic sectors in terms of GDP were manufacturing (22.0%), trade, transport, accommodation and food services (15.2%), public services, education and health (17.9%), real estate activities (11.6%), and business services (10.7%) (Federal Ministry of the Interior, 2012). The country has a population of 81.7 million, placing it 1st in Europe and 16th in the world in terms of inhabitants. It is a federal parliamentary republic comprised of 16 regional states (Länder). The national parliament is formed by a lower house (Bundestag) elected directly by the people every four years and an upper house (Bundesrat) populated by delegates from state governments. While all legislation must originate in the Bundesrat, the Bundestag is considered more powerful, needing the Bundesrat's consent only for legislation related to revenue shared by the federal and state governments (and the dispensation of additional responsibilities to the states). Nevertheless, in practice this occurs often, as federal legislation usually has to be carried out by state and local agencies.

In contrast to Ontario and California, Germany is characterized by coalition politics and is home to a moderately strong Green Party, which participated in the federal government from 1998 to 2005. The executive power is vested in a cabinet headed by the Chancellor, who is elected as head of government by – and is responsible to – the Bundestag. The ministries exert a large amount of legislative influence through administrative competency, which means that bills are likely to be drafted outside of the Bundestag and Bundesrat by the relevant ministry. In practice this can have significant consequences since administrative conservativeness sometimes clashes with the current priorities of the administration.

The responsibility for energy policy and legislation rests with the federal government, while states are primarily charged with policy implementation (states participate in shaping energy policy mainly through the Bundesrat). Traditionally, authority and responsibility for energy policy rested with the Ministry of Economics and Technology (BMWi). However, for the last decade, the Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) has seen its role greatly expand to include the market adoption of renewable energy sources, research on renewables and more importantly the administration of the Renewable Energy Sources Act (EEG, discussed below). Over this period, the BMU's resources devoted to energy policy also significantly increased (Duffield, 2009).

Electricity Sector in Germany

Up until the late 1990s, the German electricity sector enjoyed the favourable terms granted in the Energy Supply Industry Act of 1935 in addition to an exemption under the Monopolies Act which allowed for significant concentration of market power within the sector. Early reform attempts (from 1945 until the 1990s) failed repeatedly, encountering resistance from politically powerful industry actors (Lauber & Mez, 2004, p. 605). More effective restructuring efforts began in 1998 as part of the European Union (EU) liberalization process. This process had the somewhat unintended effect of leading to further consolidation, with the number of supra-regional utilities involved in large-scale power generation and high voltage transmission dropping from eight to four after a series of mergers and acquisitions (Laird & Stefes, 2009, p. 2627).

At present, four utilities (Amprion GmbH, 50Hertz Transmission GmbH, Tennet TSO GmbH and Transnet BW GmbH) control 90% of the market and despite EU requirements that generation, transmission and marketing of electricity be unbundled these companies continue to exert considerable control over all market segments. These large utilities have also diversified horizontally (through the acquisition of gas companies) and vertically (by swallowing several local and regional utilities). Nevertheless, the influence of the Association of German Electrical Utilities (VDEW) – the main lobby group for the utilities – has declined since liberalization, weakening opposition to renewable energy. Moreover, the creation of the Federal Network Agency for Electricity, Gas, Telecommunications, Posts and Railway in 2005, which regulates grid access fees, has further eroded the power of the utilities by preventing unfair business practices targeting unwanted competition (Laird & Stefes, 2009, p. 2627).

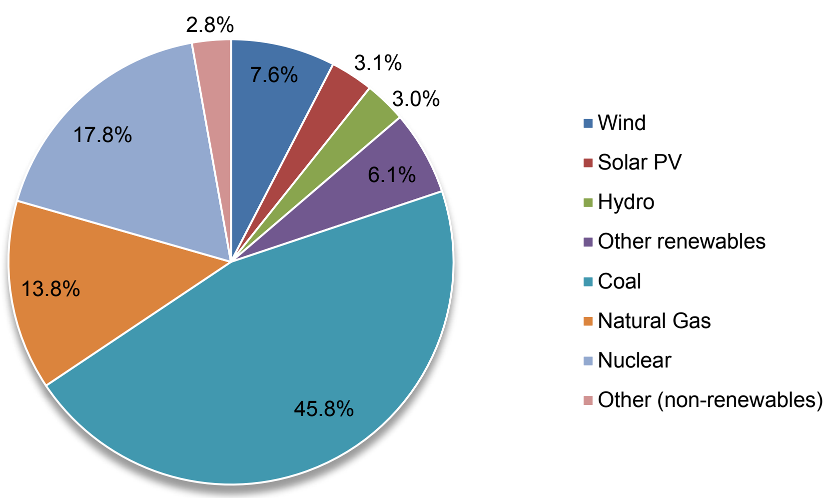
Table 8: Key Actors within the Electricity System in Germany

Key Actors	Role
Federal Ministry for the Environment, Nature Conservation and nuclear safety (BMU)	Regulates nuclear safety, radiation protection, climate change mitigation, and pollution abatement. Also in charge of managing the Renewable Energy Act since 2004.
Federal Ministry of Economics and Technology (BMWi)	Responsible for electricity policy, jointly with the BMU.
Federal Network Agency for Electricity, Gas, Telecommunications, Posts and Railway (BNetzA)	Main network regulator. Oversees utilities with more than 100,000 customers. For utilities with less than 100,000 customers, authority rests with state regulatory offices. The Agency reports to the BMWi.
Transmission Systems Operators	Operates transmission across the country. Dominated by four companies: Amprion GmbH, 50Hertz Transmission GmbH, Tennet TSO GmbH and Transnet BW GmbH.

In regards to ownership, the largest utilities are typically private companies with some public ownership (including at different times foreign state companies like Dutch TenneT, French EdF, and Swedish Vattenfall), whereas local utilities are often owned by municipalities. At least prior to liberalization this allowed for local political influence, which led to policies such as feed-in tariffs for solar energy at the community level (Wüstenhagen & Bilharz, 2006, pp. 1683-4).

Electricity output in Germany is dominated by coal, which meets nearly half of electricity demand. Nuclear is the next largest generator followed by natural gas. Renewables (including hydroelectricity) reached 20% in 2011, up from around 3% in 1990. This has largely been the result of staggering growth in installed capacity for wind energy (from the early 1990s) and photovoltaics (from the early 2000s). This ramp up is associated with the enactment of the feed-in tariff laws (in 1990 and 2000), the details of which are discussed in the following sections.

Figure 5: Electricity Generated by Source in Germany in 2011 (estimates) (IEA, 2012)



Early Efforts (1973-1999)

Germany's early engagement with PV and renewables in general was founded on: fuel affordability and scarcity concerns, underscored by the oil shocks of the 1970s; anti-nuclear sentiments stemming from the 1986 Chernobyl disaster; the release of a Ministry of Research and Technology study in 1986, which concluded that nuclear energy was incompatible with the basic values of a free society; and, a growing recognition of climate change as a major policy issue.[1] These events culminated in the Electricity Feed-In Act (StrEG) in 1990, which established a feed-in tariff for renewable energy producers.

The StrEG required utilities to connect renewable energy producers to the grid and buy their electricity at a fixed percentage of the average retail price (between 65% and 90%). These tariff rates seem to indicate that the law was intended for smaller wind and hydro projects. The StrEG was a resounding success for wind. However, with regard to PV, this first feed-in law had little effect since the tariff covered barely 10% of the capital costs (Laird and Stefes 2009, p.2622).

Instead, PV deployment was encouraged through the 1,000 Solar Roofs Program launched in 1989, which subsidized up to 70% of investment costs for 1-5 kW systems. By the time the program ended in 1995, it had resulted in a total of 2250 rooftop installations – with an average size of 2.6 kW – amounting to 6 MW of installed capacity (Hass, 2001). The withdrawal of subsidies at the completion of the program threatened to collapse the burgeoning market. To prevent this collapse, substantial efforts were made by solar activists, municipal utilities and state governments (through their utilities) to maintain and expand the PV market, which strengthened the resolve of solar associations. The slow PV capacity growth rates and the absence of a national support program led German PV firms to start moving their production elsewhere, which exerted further pressure on government to develop a new market creation strategy (Jacobsson & Lauber, 2006, pp. 265-7; Lauber & Mez, 2004, pp. 604-5).

The main opponents to the StrEG during the 1990s were utilities (especially supra-regional utilities), supported by the BMWi. Utilities were opposed to the policy because they were excluded as beneficiaries while still expected to develop renewable energy sources (Lauber & Mez, 2006, p. 110). In addition, given their interests in conventional power sources and their control over the grid, utilities were generally inimical towards both decentralized energy systems and production from renewable sources. Their opposition was at first irresolute, mostly because it was believed that the law would not have a noticeable impact, and because they were too busy with seizing expansion opportunities in East Germany after reunification began. After the success of the StrEG for wind power, however, utilities began challenging the law politically and through the courts (including at the EU level) (Laird & Stefes, 2009, pp. 2622-2624; Agnolucci, 2006, pp. 3544-3546).

The 100,000 Solar Roofs Program (1999-2003)

The 1998 election saw the formation of a coalition government made up of the Social Democratic Party (SPD) and the Green Party. This new administration launched the 100,000 Solar Roofs Program (HTRP) in 1999, with the initial goal of installing 300 MW of PV by 2004. The program provided low-interest loans and grants which covered roughly 35% of total system costs. This support was insufficient however, and the program achieved little success in its first year. When new higher FIT rates for PV were

[1] For a detailed history, see Jacobsson & Lauber (2006) and Lauber & Mez (2004).

introduced in late 1999, the market for PV installations markedly accelerated. The passage of the EEG in 2000, which carried forward these rates, prompted legislators to reduce the incentives under the HTRP. Consequently, interest rates for loans under the program were increased while the waiver for the last loan instalment was removed (Stryi-Hipp, 2004a; Stryi-Hipp, 2004b).

Despite the fact that the original targets for installed capacity were increased substantially in 2000, the program still ended earlier than initially planned. The program was terminated in June 2003, having surpassed its goals. FIT rates were raised to compensate for the completion of the program (see next section). Overall, over 45,000 PV systems were supported through the HTRP, adding 346 MW to Germany's installed capacity (Stryi-Hipp, 2004b).

The Renewable Energy Act (2000-Ongoing)

The Renewable Energy Act (EEG), introduced in 2000, remains the primary support legislation for PV in Germany. The current configuration of the FIT law offers PV developers a 20-year fixed-rate contract differentiated by installation size, type and location. As of June 2012, rates ranged from €0.135 to €0.195[2]. The tariff structure incorporates a monthly rate decrease of around 1%, adjusted based on prior installed capacity to ensure a 'growth corridor' of 2,500–3,500 MW per year. A cap for terminating government support has also been established, triggering once installed capacity reaches 52 GW (total installations amount to 28 GW as of mid-2012).

The primary objectives of the EEG include: facilitating sustainable energy development through reductions in GHG emissions and environmental impacts; increasing the portion of renewable energy capacity in the supply mix; and, increasing the share of renewable energy in consumption (BMU, 2000).

The EEG addressed opposition to renewable energy deployment more effectively than previous mechanisms. In order to appease opposition from the utilities, two concessions were built into the EEG. First, unlike the StrEG, utilities were now eligible to participate under the law, allowing support for large-scale projects. Second, the law provided a mechanism to spread costs evenly among utilities, an issue that had become contentious as the share of renewables was nearing the 10% mark in some service areas[3]. Nevertheless, the law was not immune to difficulties.

[2] For installations put into service as of April 1st. See Table 2 below for details.

[3,3] The StrEG had provided a hardship clause that forced the upstream electricity supplier (usually the large transmission operators) to take over the purchase obligation if the lower-level utility faced 'inequitable hardship' (i.e., if more than 5% of the electricity it distributed within its area came from renewables eligible to the tariff). Although this was rarely a problem in the 1990s, one of the complaints of the large supra-regional utilities was that there was no compensation scheme to spread the burden evenly between regions, and utilities from northern regions paid most of the tariff payments. Eventually the 1998 Energy Supply Industry Act, which was adopted to transpose the European Electricity Directive 96/92/EC, provided more specific rules, essentially limiting the share of renewables that was eligible to the feed-in tariff for a given region to 10% (5% at two different levels). Over that cap, utilities did not have to pay the tariff to the producer, and given that some regions were approaching the 10% mark at the time, the new rules were at best a very temporary solution and produced uncertainty in the industry. The EEG 2000 came with a more elaborate mechanism, where local grid operators could always transfer costs to higher up utilities, and costs were equalized at the transmission line level across the entire country (see Wüstenhagen & Bilharz (2006, pp. 1684, 1687) and Lauber & Mez (2006, p. 107)). This has been replaced by a market-based system where electricity generated under the EEG is sold by the grid operators in the day-ahead market (Neeser, 2011).

Although the EEG is largely responsible for the significant growth in PV deployment over the last decade (see Figure 2), the policy experienced a series of changes and encountered a variety of challenges since its inception. Throughout the early years (2000-2004), the tariff rates under the EEG were too low to support PV. Expansion was only the result of the overlap of both the FIT and HTRP incentives. Complicating matters further, the earliest iteration of the EEG had a fairly limited capacity ceiling of 350 MW (later increased to 1,000 MW). Together, these factors created a degree of uncertainty for the PV industry. However, when the HTRP was terminated in 2003, the capacity ceiling was removed and tariff rates were raised to prevent a market collapse. This amendment, which officially passed in 2004, made PV financially viable under a single policy for the first time, resulting in a solar boom (Laird & Stefes, 2009, p. 2626).

A particularly significant early development for the EEG involved the transfer of policy authority from the BMWi to the BMU in 2002. Given that legislation drafting expertise mostly rested with the ministries, the amendment process would now be dominated by the BMU – a traditional proponent of renewable energy development – with the BMWi limited to arguing for additional downward adjustments to the tariff rates. This is one of the reasons why the 2004 amendment, with its corresponding higher FIT rates, passed with relatively little resistance. Over the ensuing years, other major amendments were enacted, but support for the law was generally unwavering and the changes were usually designed from a policy improvement perspective.

The emergence of a conservative-led coalition in 2005 did create concerns about cuts to the program. However, the result of the election forced the Christian Democratic Union (CDU) to include the Social Democratic Party (SPD) in a coalition government. Consequently, the core principles of the EEG were kept intact. Moreover, by this juncture the momentum for the EEG, reinforced by the remarkable growth of the PV sector, made it increasingly uncomfortable for the new Merkel government to make substantial revisions to the law. This illustrates the maturity of the EEG in German politics as most modifications were implemented to enhance the operation of the system (while still reducing rates). Prior to 2012, the most prominent modifications included: an improved equalisation mechanism to distribute the costs of the policy among utilities (through the AusglMechV and the AusglMechAV)[3]; the introduction of a sliding scale for PV compensation, where the tariff rate is dependent on the capacity installed in the previous years; the introduction of a self-consumption premium to incentivize onsite consumption; and, the expansion of reporting requirements by solar system operators. More recently, the Fukushima disaster has intensified efforts to phase-out nuclear and deepened the societal commitment to renewables. The controversy surrounding several tariff cuts since 2010 have however indicated that government support for PV will continue to decrease rapidly.

The German solar sector, like the global market, experienced a turbulence year in 2011. While annual installed capacity across the country reached a record high of 7.5GW, the vast overcapacity worldwide among cell and module manufacturers led to price drops that destabilized the industry. As a result, several companies have encountered financial difficulties. These events have not yet affected job numbers for Germany, but it is expected that there will be an impact by the end of 2012 (BMU, 2012b, p. 9).
Additionally, the massive deployment of PV in 2011 provoked a series of changes to the EEG. In June 2012, the German parliament agreed on a new structure for tariff reductions. Under the amendment, solar

PV FIT rates suffered a one-time cut of 20%-30% (depending on the type and size of the installation) along with a new monthly reduction rate of 1% (mentioned above). Starting in November 2012, this monthly reduction rate will be adjusted depending on installed capacity in order to respect the growth corridor. If installations exceed targets, rates will be decrease by up to 2.8%. In contrast, if installations are insufficient, rates will decrease by less than 1%, or will even increase by up to 0.5% if the targets are substantially missed. Finally, new installations over 10MW will cease to receive support (see Table 2 for further details).

The June 2012 amendment marked a pronounced shift in PV policy support, with the more explicit aim of guiding PV into a post-FIT era (it is important to note that PV generation is already competitive with retail electricity rates in several regions). Under the new amendment, FIT incentive payments are now capped at 90% of electricity generation for installations between 10kW and 1MW (commercial size). The remaining 10% must either be consumed onsite or sold on the spot or wholesale market, encouraging the siting of PV installations in regions with higher electricity prices. The premium for electricity consumed onsite (instituted in 2009) was also removed, while a market premium system was introduced to encourage developers to participate in wholesale market operations and maximize the market value of PV generation. Overall, the amendment attempts to initiate the integration of PV into conventional electricity markets and highlights the context of waning policy support.[4]

Figure 6 – PV Deployment in MW from 2000-2011 in Germany (BMU, 2012a)

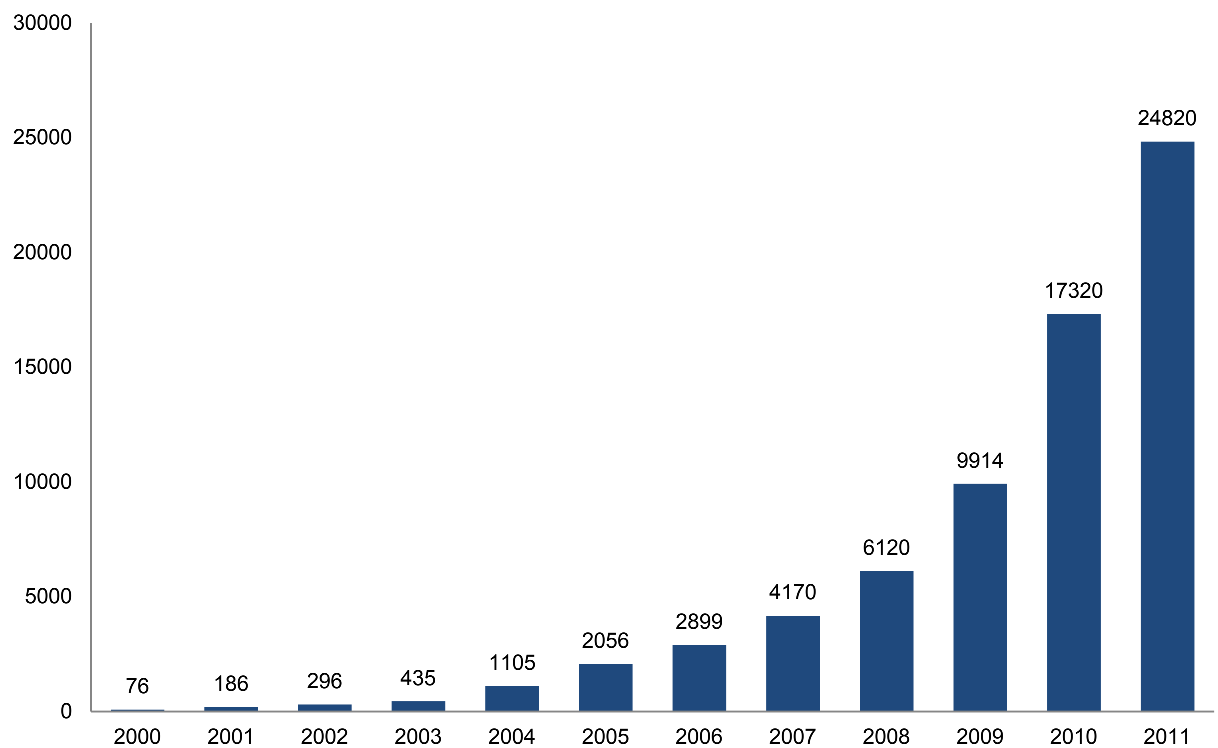


Table 9: German FIT schedule for solar PV after 2012 amendment, in Euro ct/kWh (BMU, 2012c)

[4] For a detailed analysis of the changes introduced in the 2012 amendment, see Fulton & Capalino (2012).

	Installed in, at or on building or noise protection wall				Freestanding facility ≤ 10 MW
	≤ 10kW	≤ 40kW	≤ 1MW	≤ 10MW	
Generation covered by FIT	100%	90%	90%	100%	100%
Put into service as of April 1st, 2012	19.50	18.50	16.50	13.50	13.50
Put into service as of May 1st, 2012	19.31	18.32	16.34	13.37	13.37
Put into service as of June 1st, 2012	19.11	18.13	16.17	13.23	13.23
Put into service as of July 1st, 2012	18.92	17.95	16.01	13.10	13.10
Put into service as of August 1st, 2012	18.73	17.77	15.85	12.97	12.97
Put into service as of September 1st, 2012	18.54	17.59	15.69	12.84	12.84
Put into service as of October 1st, 2012	18.36	17.42	15.53	12.71	12.71
Put into service as of November 1st	To be announced by the Federal Network Agency by October 31st, 2012 at the latest. Will depend on newly installed capacity in July, August and September				

General Outcomes

PV is thus paying a price for its success, one which follows from its passage from a niche industry to an important economic sector. The considerable growth in new installations in recent years has intensified the debate over appropriate levels of support. With the overwhelming success PV incentive programs have enjoyed in terms of deployment and price reductions, it has become easier to argue that the industry should now be able to stand on its own (as recurring debates on reducing EEG tariffs have indicated). Nevertheless, negotiations over tariff cuts since 2009 have revealed the maturity of the policy, and changes are usually enacted to quickly resolve any gaps or issues within the rule structure. As a result, Germany's FIT program has gradually become a highly sophisticated instrument, although the FIT rates themselves have continued to be set politically and administratively.

Overall, despite encouraging results, PV faces several key short- and medium-term challenges in Germany. First, the German grid is grappling with increased penetration of intermittent renewables and capacity issues. The 10-year grid upgrade plan, released in draft version in May of 2012 (BNetzA, 2012), represents another instance where the additional costs of renewables will likely be brought to the forefront of public debates. Second, the growing dominance of Chinese firms within the solar market is raising concerns for the domestic industry. The drop in cell and module prices and the ensuing turbulence in the PV industry in 2011/12 have left several domestic manufacturers in financial difficulty. Lastly, anti-dumping measures are now being considered by the German government to prevent further adverse impacts from cheap asian cell and module imports (Reuters, 2012; Bradsher, 2012).

These challenges are not German-specific by any means as other jurisdictions around the world face similar difficulties. However, the size of the German market and the massive public investments made by this jurisdiction in support of PV make these issues all the more important.

LESSONS

Overview

In many ways, the developments surrounding PV illustrate the challenges of long-term policy engagement. Well-developed proponents and opponents have emerged and organized around PV policy issues. These actors have influenced public debate with respect to the future of incentive mechanisms and policy support in general. Social and technical challenges have also gained traction within these debates and complicated the rollout of PV. The industrial landscape surrounding solar has experienced severe turbulence as plant closures and bankruptcies have become commonplace. It is within this context that PV policy is now being developed and maturing.

The above case studies reveal a number of key lessons for policymakers engaging or seeking to engage with PV policy support. The following sections outline the importance of: (1) adapting policy objectives to recent developments, (2) developing an integrated approach to PV deployment and support; (3) balancing electricity consumer and PV developer interests; and, (4) encouraging participation and maintaining equity in PV policy development.

Adapting policy objectives to recent developments

Policy support for PV has been developed to address several policy objectives. In the case of Germany, the country's long-term investment in PV has primarily been associated with shifting the electricity system towards a more sustainable configuration. That is, German renewable energy policy has been concerned with achieving GHG reductions as well as moving away from nuclear power. In California, recent engagement with PV support has largely been founded on commitments surrounding climate change. The RPS targets and related support framework are principally linked to reducing the electricity system's reliance on fossil fuels and the associated GHG emissions. Support for PV in both these countries can also be understood in terms of energy security, local environmental improvements (air quality for instance) as well as encouraging technological advancement and industrial development.

Ontario has also articulated similar goals within its PV policy framework. In particular, successfully phasing out coal has been promoted as a key justification for encouraging PV and other renewable energy technologies. However, the most prominent objectives embedded within the current policy framework are economic in nature. Several stated policy objectives correspond to the development of a local industry for renewable energy technology manufacturing and installation. Policy documents often emphasize the employment benefits stemming from PV and renewable support. Recently, these objectives have become increasingly problematic.

Given recent developments, a primarily economic rationale for PV support presents a number of interrelated perils for long-term policy engagement surrounding PV. The current industrial landscape – involving the scaling up of Asian module and cell manufacturers, massive price reductions and competitive global PV market – has limited the economic benefits associated with PV support. Countries hoping to develop a domestic module manufacturing industry through aggressive policy support are now forced to compete with established low-cost manufacturers or erect contentious trade barriers. Ontario has a domestic content requirement which functions as a kind of trade barrier, while the United States has enacted trade tariffs on Chinese PV imports. Germany is now contemplating similar trade barriers in order to prevent further domestic PV manufacturing declines. These barriers, although sheltering domestic producers, result in inefficiencies for the market as the cost of PV systems are artificially inflated. In turn, the cost of support – often reflected in electricity rates – increases. Consequently, PV installations suffer and public acceptance issues arise (as is the case in Ontario).

The industrial landscape surrounding PV is now far riskier for new entrants and the industrial development benefits flowing from policy support are becoming increasingly questionable. This context makes PV support grounded on an industrial policy rationale vulnerable to change as objectives (the development of a profitable and competitive domestic module manufacturing industry) are unlikely to be achieved within this highly commoditized market. Nevertheless, substantial industrial development opportunities do exist within specialized and niche markets (building-integrated PV for instance).

An integrated approach

The case studies illustrate that the integration of PV and other intermittent renewables into conventional electricity systems has resulted in numerous difficulties for system operators. Transmission and distribution capacity constraints have emerged as key barriers to additional renewable deployment. Variability has made balancing supply and demand increasingly challenging, undermining the reliability of the electricity system. While improvements to forecasting and investments in natural gas (as backup) may help mitigate some of these problems, difficulties continue to escalate as more and more intermittent renewables come online. In brief, it appears that leading jurisdictions for renewable energy support are becoming victims of their own success as renewable deployment outpaces the capacity of existing electricity systems.

Potential solutions involve the modernization of the electricity system through the development of a smarter, more distributed grid (involving two-way information and energy flows, distributed community energy systems, the adoption of demand response technologies, electricity storage, electric vehicles, etc). The redesign of the electricity system along these lines is well placed to handle the increased penetration of variable renewables. Since PV and other renewables are a component of this broader system, their advancement should be considered within the context of the advancement of the system as a whole. This system transformation requires an integrated approach aimed at simultaneously rolling out several emerging technologies and new practices. Fundamentally, expansion plans need to consider grid infrastructure (transmission and distribution), smarter technologies (integrating information technology), changing practices (conservation and time of use pricing) in addition to individual generating technologies like PV.

Support for PV should thus be embedded within an integrated policy framework aimed at encouraging a low-carbon transformation of the electricity system. With respect to electricity supply, the deployment of renewable energy technologies should continue. However, new incentive mechanisms should be crafted to help bring complementary technologies online. In terms of electricity demand, smart devices capable of demand response as well as conservation opportunities should be explored. Moreover, this framework should consider potential linkages between PV and other sectors (the construction industry for instance) and attempt to open up new industrial development opportunities (such as building-integrated PV).

Balancing electricity consumer and PV developer interests

Balancing the interests of electricity consumers and PV developers within a PV support framework is a difficult task that if addressed inappropriately may open up the policy to criticism. As the case studies indicate, the German and Ontario approaches are predominantly government-directed. That is, incentive rates are largely politically and bureaucratically determined. These jurisdictions use installation capacity feedback to gauge appropriate levels of support but do not incorporate a market mechanism to ensure cost-efficiency. Consequently, there is an opportunity to set rates too high and for too long if adequate care is not employed in studying market conditions and fine tuning rates and rules.

Much of the controversy surrounding PV support in Ontario can be linked to a failure to appropriately set and revise rates. Rates were left at incredibly favourable levels for roughly two years following the FIT program's inception. As a result, cost reductions and innovation were not reflected in the incentive rate structure and ratepayers were burdened with unnecessary costs related to overgenerous contracts. FIT incentive rates (in conjunction with wind turbine siting issues) catalyzed opposition against renewable energy support during the 2011 provincial elections. Inflated incentive rates drew the ire of electricity consumers and provoked calls to terminate the FIT program, resulting in tremendous uncertainty for PV developers. In doing so, overgenerous incentives undermined the objectives they were meant to achieve.

California, on the other hand, has taken considerable care to avoid potential ratepayer backlash. The state employs a market-directed framework which incorporates feedback from auctions and requests for proposals to set appropriate incentive rates. In other words, support levels are based on market competition rather than administratively determined. Basing inventive rates on competition helps to legitimize the rate structure, protects ratepayer interests and ensures that least-cost production is secured. Price reductions appear to be more effectively encouraged under a market-directed approach as is reflected by the low support levels in California. However, an abundant solar resource and other contextual factors certainly play a role in determining costs, making comparisons difficult.

Encouraging participation and maintaining equity

The potential of a targeted and inclusive approach has emerged as a key theme in this study. Ontario and many European countries (Germany, France, Italy, and others) rely heavily on a single policy instrument (the FIT) to incentivize PV deployment, whereas, in California, a portfolio of policies (the FIT, RAM, RPS and Go Solar California programs) have been implemented to encourage the diffusion of PV. California's policy framework targets individual segments of the PV market and facilitates the adoption of PV by a variety of actors. An inclusive approach is well-suited to building support for PV deployment, breaking down potential barriers and capitalizing on new market opportunities for PV.

The PV policy framework in California has attempted to mitigate potential negative impacts for vulnerable households by enlisting them in the rollout of PV. There is an interest in encouraging the participation of lower income individuals through various tailored incentives (SASH and MASH), a more equitable distribution of benefits (decreased electricity consumption and bills) and a relatively progressive electricity rate structure which blunts the costs associated with grid upgrades. This involvement may have interesting implications for changing practices and public acceptance amongst low-income communities who are often left out of PV incentive schemes.

Interestingly, Ontario's recent FIT revisions have attempted to increase the amount of equity communities and local organizations hold in PV installations. Yet, it is unclear whether Ontario's new point system will be sufficient to encourage participation from a wider group of stakeholders.

An inclusive approach to PV support should continue to be explored and expanded. New ownership and financing models should also be considered to allow for more diverse community participation. In contrast to traditional external ownership models, local participation may help to mitigate public acceptance challenges and siting issues as well as facilitate more active involvement in energy use.

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