The German Feed-in Tariff for PV:

Managing Volume Success with Price Response

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Overview

— *Germany is poised for continued renewable energy market growth through 2020 and beyond in order to meet binding renewable electricity targets and compensate for its upcoming nuclear power phase out. The German government has convened a commission to discuss the feasibility of accelerating the phase out of nuclear energy all together by 2017-2025. The preliminary findings from the government's study are expected to be released in June 2011 and could further support the development of solar energy beyond the projections discussed in this report. We believe that Germany exhibits best in class climate and renewable energy policy structures. We project that photovoltaics (PV) will grow to more than 7% of national electricity supply by the end of the decade. Investment in the German PV sector will be determined by the transparency, longevity, and certainty (TLC) of the national feed-in tariff (FIT) policy. Of particular interest is the way in which the policy is linked to national and EU-level renewable energy and climate policies and the mechanisms that the government uses to manage progress towards those goals.*

— *Part I of this report presents an overview of the evolution and future trajectory of the German PV market with a focus on recent and pending policy adjustments. Part II of this report builds off of the German example to frame a broader theoretical discussion of the delicate balance of PV policy longevity and transparency under different volume management scenarios in Europe and beyond.*

— **Best-in-Class FiT**: Germany's policy continues to drive renewable energy at scale, supported by binding, ambitious targets, a mature renewable energy sector, and an integrated climate and energy policy framework that exhibits longevity and supports investor security. We believe that Germany's integrated climate and energy policy has been and will remain a key contributor to making solar energy competitive with on-peak fossil-fuel-fired electricity by 2014.

— **Evolving Policy Structure:** The rapid decreases in PV pricing over the past two years, the lack of hard caps in Germany's FIT, and PV markets' ability to rapidly scale in response to adequate price signals, has meant that Germany has served as a demand "backstop" for the global solar market even as other markets have contracted or been capped (e.g. Spain), and that Germany will be able to meet its national 2020 energy targets. At the same time, Germany's FiT adjustment system, which consists of automatic annual decreases and periodic review, could not adequately correct for sharp declines in PV costs in 2009. As a result, German policy makers instituted several unscheduled downward adjustments to the PV rate in 2010 and 2011, but did not institute capacity caps. Policy makers in other large European PV markets, faced with a similar challenge, placed significant limitations on PV growth. Thus far, Germany has "weathered the storm" of dynamic PV pricing and will continue to support rapid solar market growth in the wake of Japan's nuclear disaster whereas other countries have effectively shuttered their markets.

— **Managing Volume Through Price:** During 2000-2009, Germany's schedule of annual automatic price degression supported investor security by enhancing transparency, while at the same time driving PV prices toward grid parity. The more recent introduction of volume-responsive, or "corridor," degression systems under which FiT rates decline based on the amount of capacity installed during prior periods is further indication that Germany is committed to sustainable PV market growth and to managing volume by putting downward pressure on prices.

— **Impact in 2011:** In January 2011, the German government and the solar industry jointly concluded that there would be benefit in considering an additional mid-year 2011 tariff degression scaled to the amount of anticipated PV capacity additions. This would account for ongoing pricing declines and would avoid triggering the maximum tariff reduction at the beginning of 2012. As an alternative, the government established a new degression schedule for 2011 such that a portion of the 2012 tariff reduction might occur in mid-2011 on a scaling basis tied to volume of between 3% and 15% if annualized expectations of solar PV additions are between 4.500 MW and 7,500 MW; the balance of the degression would occur at the beginning of 2012. The amount of the 2011 degression—if any— that is "pulled in" from 2012 will depend on the amount of PV capacity additions installed during the first half of this year. (Please see pages 16-18 for more details on the mechanics of how this policy works)

— **Sustainable Solar Growth:** The lack of an explicit longer term concrete policy target or cap has raised speculation about potential PV market saturation and possible future changes in policy direction that might materially change the trajectory of solar PV penetration. While no explicit targets have been set, the combination of the National Renewable Energy Action Plan (NREAP) trajectory and the baseline specified in the 2010 corridor degression schedule are indicators that Germany is firmly committed to PV growth. However, there is a clear objective to slow the recent rate of growth, and as discussed, the government intends to utilize price to limit market volume to ~3,500 MW p/a during this decade, compared to ~7,400 MW of installation in 2010. Growth in 2010 likely represented the peak year-over-year growth, and a transition to more steady but sustainable growth should be expected. At the same time, however, Germany's plan to increase its reliance on renewables as it accelerates its nuclear phase out in response to the Japanese nuclear disaster means that PV growth could be higher than the 3,500 MW p/a forecast in the NREAP. In fact, industry projections for 2011 installations range from 4,500 MW to 10,500 MW according to a survey of analyst forecasts by PHOTON International.[1] On balance, we expect that the rate of growth will slow from the hyperbolic 2008-2010 period, but that Germany is still set to remain one of the dominant solar energy markets for at least the next 10 years, driving generation costs to grid parity.

In terms of cost, retail electricity prices have risen due to the surcharge for renewable energy, but there have been offsets in the wholesale market and other benefits. We look at the German Federal Environment Ministry (BMU) summary of these later in this document.

[1] *Hering, G., & Hirshman, W. P. (2011, February). Conquering the world: All major PV markets surged in 2010, though forecasters predict growth in some leading markets will slow in 2011 - while others may even shrink. PHOTON International, 52-66.*

Part I: The Evolution of the German PV market: Using price to control volume

Germany has a consistent history of innovation and leadership in renewable energy market development. During the past decade, Germany has fundamentally transformed its energy generation portfolio by setting ambitious goals and creating financeable policy environments that have attracted billions of dollars in new investment. The major components of Germany's low-carbon strategy have included:

Ambitious, but attainable targets. Germany has consistently set ambitious, but realistic renewable energy and climate targets. These targets have given investors and industry participants a clear view on the government's long-term commitment to supporting a clean energy economy. These targets have been established as legally binding minimums for market growth, rather than hard caps.

Integrated climate and energy planning. In addition to developing binding targets, the German government has also explicitly and transparently integrated its targets and policies through formal planning. Germany's greenhouse gas reduction targets, for example, are explicitly linked to a comprehensive energy policy targets for renewable electricity, renewable heat, and renewable transport fuels. Those targets are in turn linked to specific policies to achieve them. The clear linkage of these targets and mandates increases policy transparency, reinforces investor confidence and has as a result successfully driven sustainable renewable energy growth and cost reduction.

Balancing constructive regulatory policy with flexibility. The introduction of policy incentives inherently creates regulatory risk and investors typically have little long term visibility with respect to a policy's longevity. By having established a strong legal framework and a 20-year track record of renewable energy market support, Germany has built investor confidence in its renewable energy policies. At the same time, Germany has intervened to adjust its policies to reflect changing market conditions in order to support policy durability and navigate a fair cost/benefit balance. During the last two years, for example, Germany has made several unscheduled rate adjustments in response to major decreases in component costs but has not implemented hard caps or otherwise abruptly arrested market growth. These adjustments are discussed in detail later in this report.

Driving PV down the learning curve. The German FiT has explicitly been designed to drive PV down its learning curve. Although PV has historically had higher costs than other energy technologies, it also has significant potential for rapid cost reductions (as evidenced by recent market trends) and the potential for large-scale market penetration. It is argued that support for PV innovation and price reductions in the near term will unlock large-scale savings in the mid- to long-term as Germany seeks to achieve its climate and energy targets.[2] Research and development (R&D) initiatives, although an important component of innovation, are insufficient on their own to drive PV down the learning curve. An important component of PV innovation and cost reductions comes from the "learning by doing" acquired by industry and public sector players as the market scales up (rather than through advances in the lab). The FiT is a mechanism for deployment-led innovation that will enable PV to achieve learning by doing at scale and to become broadly cost competitive in Germany in the next few years. As discussed above, the German FiT has driven substantial PV panel cost reductions and the rate has been adjusted downward accordingly, the explicit goal of the German FiT has been to drive the costs down to grid parity.

"Best in class" renewable electricity policy. Through our global analysis of international climate and energy policy, we have singled out Germany's feed-in tariff (FiT) for renewable electricity as "best in class" for minimizing investor risk and cost-effectively scaling up renewable generation.[3] Germany's advanced feed-in tariff maximizes investor transparency, longevity and certainty (TLC) while charting a pathway to grid parity within an overall cost/benefit framework (see below).

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[2] *For a discussion of the potential for policies that encourage dynamic efficiency to unlock long-term savings by driving down policy costs in the near-term, see e.g. Menanteau, P., Finon, D., & Lamy, M.-L. (2003). Prices versus quantities: Choosing policies for promoting the development of renewable energy. Energy Policy, 31(8), 799-812.*

[3] *DB Climate Change Advisors. (2009). Paying for renewable energy: TLC at the right price - Achieving scale through efficient policy design. New York, NY: The Deutsche Bank Group.*

Cost/Benefits of German Energy Policy: Direct and Indirect Impacts

Estimating cost and benefits for renewable energy deployment turns out to be highly complex and includes costs borne by consumers, environmental benefits, industry and job creation and energy security. Two well discussed cost effects have been:

1) The direct surcharge of the feed-in tariff (i.e. Erneuerbare-Energien-Gesetz , or EEG) to rate paying consumers
2) The merit-order effect (MOE) in wholesale electricity markets where increased supply of lower marginal cost renewables have forced prices down (see Appendix page 32 for further discussion of MOE).

The interaction of these two drivers in a complete systems analysis is again complex. Further, there are important distributional effects within the power market creating winners and losers among consumers, those that pay wholesale prices and the suppliers of power such as utilities and generators.

Since 2008, the Federal Ministry for the Environment (BMU) has been working with Fraunhofer ISI to develop an integrated, economic framework to assess the cost and benefits of renewable energy deployment more broadly beyond just the EEG surcharge and the merit-order impact and has laid out a framework for assessing the cost/benefits at a systems level which we show below in Exhibit 1.[4] We note that the BMU study does not identify a specific carbon price nor does it explicitly detail how the cost/benefits net out. In this regard the EU ETS price is reflected in the differential costs of electricity. In tracking these costs and benefits the government has grouped its analysis into three categories:

1) Systems impact to the electricity grid, including distributional impact on winners and losers. This is a classic societal cost/benefit assessment, which compares the benefits of avoided environmental damages to the incremental costs of renewable energy—e.g. who pays and who benefits;

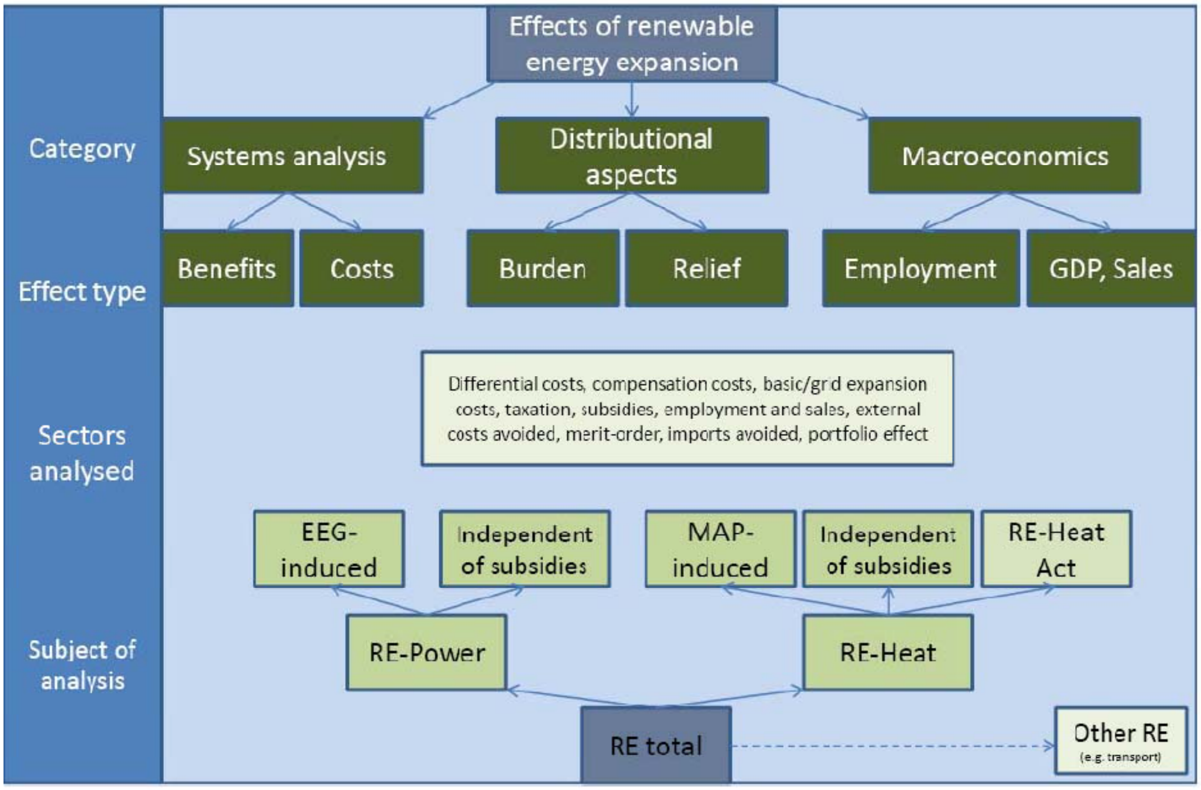
2) Distributional impact—e.g. who gains and who loses throughout the economic value chain as a result of the policy; and

3) Macroeconomic impact to the broader economy, which tracks the impact on job creation, sales receipts from renewables and other interactions such as improved energy security.

With respect to the so-called distributional effects, which attempt to measure the impact of renewable energy policy on different stakeholder groups, we note that the government has addressed this issue both as part of an electricity systems analysis overall (#1 above) and also outright as its own category--#2 above (see Exhibit 1 below). We note, however, that the methodology in these distributional impacts assessments is different, which accounts for why the differential costs for electricity and for the EEG/FiT surcharge differ as illustrated in Exhibit 2 below.

[4] *Cost and Benefits of Renewable Energy Expansion in the Power and Heat Sectors, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety,Van Mark, M 2010, www.bmu.de*

Exhibit 1: Effects of Renewable Energy Expansion



Source: ISI/GWS/IZES/DIW

Certainly there has been a direct impact on retail consumers as the EEG surcharge has risen from about 7 to 12 euros per month for an average household. However, the fall in wholesale power prices that has been evident up until the Fukushima accident has benefited anyone such as “power intensive non-tariff customers” contracting against that rate and possibly the average price in retail markets to some extent. In distributional terms, the wholesale market has seen utilities and generators lose out to end customers. In terms of measuring all this, the table below presents the latest estimates from the BMU. This also includes an estimate of avoided environmental damages and macroeconomic effects. The overall cost/benefit appears well balanced especially when macroeconomic considerations are taken into account. Nonetheless, we believe that more analysis of this cost/benefits approach is warranted and will appear in the future.

Exhibit 2: Cost/Benefits Assessment of Renewable Energy Deployment 2008-2009

BMU Cost/Benefit Analysis of Renewable Energy Expansion (EUR $bn)

	2008	2009	Winners	Losers
Electricity Sector Benefits				
Avoided environmental damages	5.90	5.70	Environment, human health & welfare	N/A
Total Sector Benefit Impact	**5.90**	**5.70**		
Electricity Sector Costs				
Differential costs, electricity	4.30	5.60	Renewable developers/plant operators	Electricity consumers
Load balancing	0.60	0.40	Utilities/grid operators	Electricity consumers
Grid expansion/upgrade	0.02	0.03	Utilities/grid operators	Electricity consumers
Transaction costs	0.03	0.03	Utilities/grid operators	Electricity consumers
Total System Cost Impact	**4.95**	**6.06**		
Net system analysis of cost/benefit	0.95	-0.36		
Distributional effects				
EEG differential costs	4.70	4.70	Renewable plant operators	Electricity consumers
Merit-order effect (RE power)	3.80	3.80	Wholesale power customers	Fossil generators
Taxation of RE power	1.00	1.05	Federal budget/state pension plan	Electricity consumers
Federal subsidies for RE	0.45	0.80	Renewable plant operators	Federal budget
Special compensation provision in EEG	0.70	0.65	~500 power intensive companies and railways	Electricity consumers
Macroeconomic and other effects				
Sales effect (RE overall)	31.00	33.00	Federal budget	
Employment (RE overall)	278K	300k	Federal budget	
Energy imports avoided (RE overall)	6.60	5.10	Wholesale power customers/environment	Energy companies
Energy price effect on GDP	~150mn	~150mn		
Energy security	N/A	N/A	not quantified in the study	

Source: BMU and DBCCA Analysis

A Look Ahead 2011-2020

Nuclear energy has always been controversial in Germany. The clear shift in sentiment over the course of the past two months including the decisive March 27, 2011 Green Party Baden-Wurttemburg victory, won on back of anti-nuclear sentiment, has reduced the likelihood that the older nuclear reactors remain in the energy mix through 2020. For now, we anticipate that half of the 7,000 MW of nuclear capacity that have been temporarily shut down will remain permanently shut down. We also expect that the government support for renewable energy will remain undiminished. Consequently, there is likely to be some tension in the short-term about the potential integration cost of renewable energy to the consumer since amortized nuclear energy will be replaced by higher cost alternatives until later this decade when costs of some renewables technologies will reach grid parity. However, given the sharp upward trajectory in renewable additions that we foresee, with an average of 3,500 MW of PV added each year, and the falling costs of solar PV, we believe that the merit order benefit will to some extent offset incremental increases in the integration charge for some consumers..

Job creation and industrial development. While Germany's PV FiT has driven deployment-led cost reductions and technological innovation, it has also generated significant job growth.[5] In 2009, the German renewable energy industry employed 340,000 people, up from 160,000 in 2004. Of these, 64,700 were created by the PV industry alone, up from 25,000 in 2004.[6] Germany believes that job expansion will continue, and that the country's strong domestic market will

[5] *DB Climate Change Advisors. (2009). Creating jobs & growth: The German green experience. New York, NY: DB Climate Change Advisors.*
[6] *van Mark, M., Nick-Leptin, J., Lehr, U., Lutz, C., Khoroshun, O., Edler, D., et al. (2010). Renewably employed! Short and long-term impacts of the expansion of renewable energy on the German labour market. Berlin, Germany: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.*

position it well as an exporter going forward. By 2030, the range for job creation is 500,000 to 600,000. Recent German government projections[7] see the value of renewable energy exports rising from €7 billion in 2007 to ~€20-30 billion by the end of the decade. This focus on potential export opportunities is consistent with earlier government statements that PV should be supported not "from the point of view…of energy policy, but of…industrial policy.[8]"

Renewable Energy Market Growth in Germany

Germany appears poised to further accelerate its domestic renewable energy market dramatically. In its 2010 National Renewable Energy Action Plan (NREAP), Germany projected that it would achieve 38.6% renewable electricity by 2020[9], exceeding its legislated target of 30% by 2020 set in 2008. The NREAP projection also exceeds the 35% by 2020 goal delineated in the government's recently published Energy Concept. The Energy Concept lays out a formal minimum target, whereas the NREAP is a reasonable projection of how the market might actually grow. The Energy Concept further charts a path to 80% renewable electricity by 2050, with interim goals of 50% by 2030 and 65% by 2040. Such an energy pathway would contribute to an 80-95% reduction in greenhouse gas emissions below 1990 levels.[10] An added near term challenge to meeting this emissions target is the future role of nuclear energy. Against the backdrop of these projections, Chancellor Merkel recently announced a three-month closure of seven German nuclear power plants for safety review following the crisis at the Fukushima nuclear plant in Japan, calling into question the future of nuclear power in Germany and how that capacity will be replaced over the longer term.[11] Germany has had legislation in place to phase out its nuclear fleet since 2002 and the 2050 targets in the Energy Concept document assume a full nuclear phase out. In 2010, the Merkel government extended the lifetimes of nuclear plants (which had been scheduled to be phased out by 2022) by 8-12 years, meaning that the last nuclear plant would go offline in 2035. Now, however, there is cross-party consensus that the nuclear plant lifetimes again be shortened with proposals of target years for full nuclear phase out ranging from 2015 – 2025. New legislation setting a revised nuclear phase out timeline is expected this June. In order to reorganize the electricity industry in anticipation of the nuclear phase out, Chancellor Merkel recently outlined a six-point plan to German state Governors in April 2011 that includes an increased reliance on solar, wind, and biomass, increased energy efficiency, expanded grid infrastructure and storage, research and development, citizen engagement, and a greater reliance on flexible conventional generators that can rapidly balance intermittent renewable generation.

In order to meet its mid-term and long-term targets – whatever happens with the nuclear fleet - Germany will rely heavily on new renewable non-hydropower capacity.[12] As can be seen in Exhibit 3 below, Germany has quintupled its amount of renewable electricity production from 17 terrawatt-hours (TWh) in 1990 to 93 TWh in 2009, primarily through the addition of new onshore wind and biomass capacity. In response to its 2020 targets, Germany projects that it will further increase its renewable electricity generation to approximately 217 TWh. It should be noted, however, that these NREAP projections were created in advance of the recent nuclear disaster and that renewable energy growth could be greater than projected.

In order to meet its national targets and NREAP trajectories, Germany projects that the two fastest growing renewable energy technologies during the period 2010-2020 will be wind and PV. As can be seen in Exhibit 3 below, wind will account for 104 TWh by 2020, whereas PV will account for 41 TWh under the NREAP trajectories. Wind will therefore contribute 48% of total renewable electricity in 2020, whereas PV will account for 19%. When measured as a share of the national electricity portfolio (conventional and renewable resources), the German government projects that wind will supply 18.5% and PV 7%.

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[7] *van Mark, M., Nick-Leptin, J., Lehr, U., Lutz, C., Khoroshun, O., Edler, D., et al. (2010). Renewably employed! Short and long-term impacts of the expansion of renewable energy on the German labour market. Berlin, Germany: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.*

[8] *Nitsch, J., Krewitt, W., Nast, M., Viebahn, P., Gärtner, S., Pehnt, M., et al. (2004). Environmental policy: Ecologically optimized extension of reneawble energy utilization in Germany (Summary). Berlin, Germany: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.*

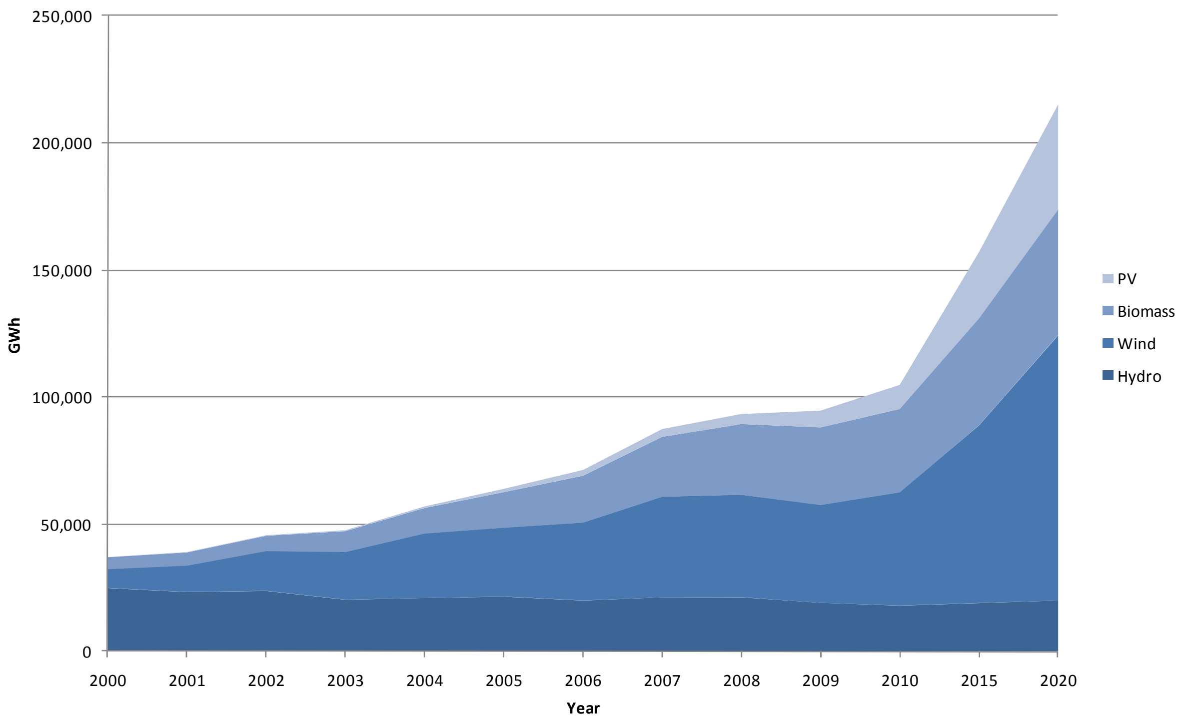
[9] This figure is taken from the official NREAP scenario, which assumes that additional energy efficiency measures are installed after 2009. The German government was also required to calculate a "reference scenario" under which no further energy efficiency is installed after 2009. Under the reference scenario, the projected renewable energy generation would total 35.5% of national generation. For the purposes of the NREAP reporting, the additional energy efficiency scenario is the official scenario.

[10] *Federal Ministry of Economics and Technology, & Federal Ministry for the Environment Nature Conservation and Nuclear Safety. (2010). Energy concept for an environmentally sound, reliable and affordable energy supply. Berlin.*

[11] *Germany had previously committed to a phase out of nuclear power by 2022. In 2010, however, the Merkel government extended the lives of Germany's fleet of 17 plants by an average of 12 years to 2034, calling them a "bridge" to low-carbon energy. The recent shut-downs signal another potential reversal of direction.*

[12] *In 1990, hydropower accounted for 91% of renewable electricity generation in Germany. By 2020, it is projected that hydropower will account for only 9%*

Exhibit 3: Electricity Generation in Germany, 2000 – 2020 (GWh)



Source: Federal Republic of Germany (2010) & BMU (2010)

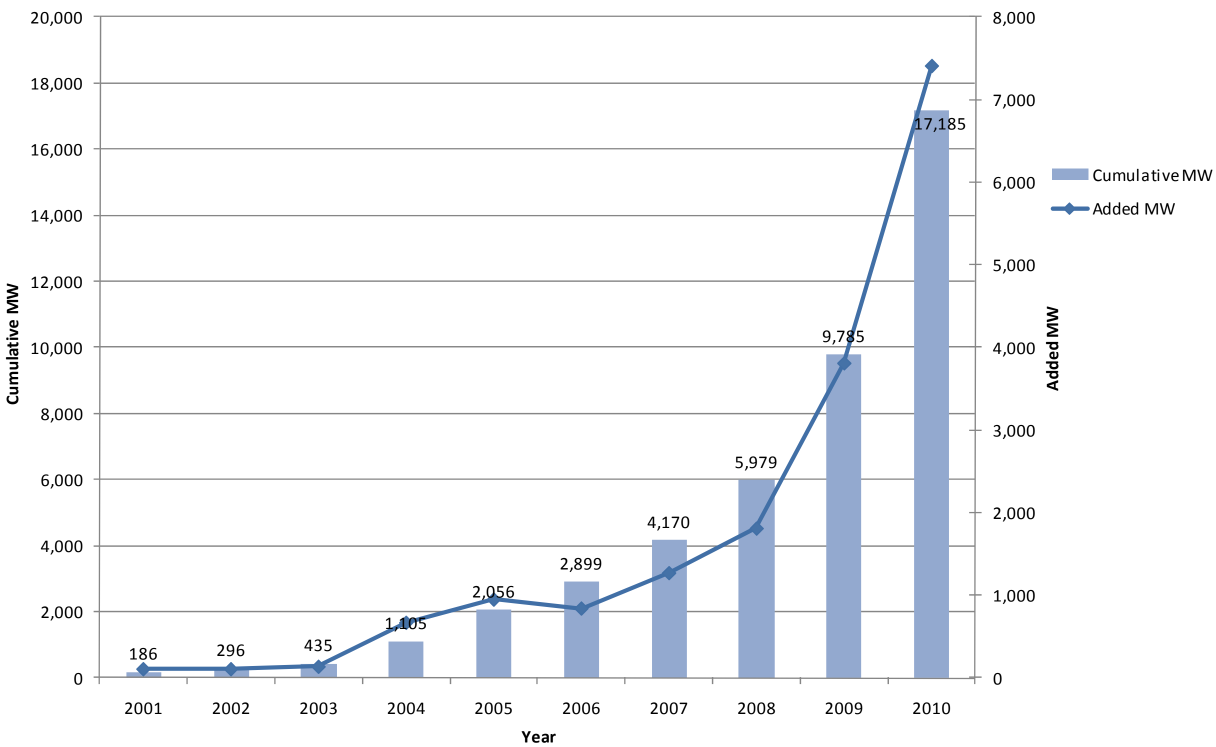
The rapid increase in intermittent renewables has raised questions about Germany's grid integration strategy. Although the feed-in tariff policy requires that the grid be strengthend on an ongoing basis to accommodate new renewable energy interconnections, there are legitimate concerns about the ability of current grid infrastructure to accommodate the planned massive scale-up of renewable generation. In its Energy Concept, the German government outlines a range of proposed initiatives to support renewables integration including: an acceleration of transmission grid expansion and the development of a north-south overlay grid to more efficiently move electricity over long distances, widespread implementation of smart grid and smart meter technologies, an expansion of ancillary services and capacity markets, greater control over generation, the use of biomass and biogas plants to balance wind and solar plants, a maximiation of existing storage options, and the introduction of innovative new storage strategies.[13] As discussed above, Chancellor Merkel's six-point plan to accelerate the transition away from nuclear also envisions the introduction of new grid integration strategies, which will ultimately require measures to improve the distribution grid so that larger volumes of renewables can be deployed.

Photovoltaic market growth in Germany: a testament to policy driving a market response

Since initiating a national feed-in tariff for PV in 2000, Germany has rapidly emerged as a dominant global solar energy player, and has been the world's largest single PV market for six of the past seven years. Germany has installed more than a gigawatt of capacity each year since 2007, and installed an estimated 7,400 MW in 2010 alone. As can be seen in the graph below, Germany is now host to ~17,000 MW of PV in total -- more than half of the PV capacity installed globally to date.

[13] *Federal Ministry of Economics and Technology, & Federal Ministry for the Environment Nature Conservation and Nuclear Safety. (2010). Energy concept for an environmentally sound, reliable and affordable energy supply. Berlin.*

Exhibit 4: German PV Installed Capacity



Source: BMU (2010) and DBCCA Research (2011)

In contrast to Germany's continued market growth, recent market contractions in other gigawatt-scale markets in Europe, such as Czech Republic, France, and Spain, have raised questions about how best to structure PV policy and manage issues such as market saturation and policy cost. We believe that the German approach to PV volume management to date has represented a best-in-class approach to achieving PV market growth at scale within an acceptable cost benefit framework and that the market will continue to grow at approximately 3,000-4,000 MW per year through 2020. The sections below discuss the evolution of German PV policy adjustments to date and discusses uncertainties that may impact market growth in the mid- to long-term.

The Integration of Photovoltaics into German National Targets

As discussed above, the German government has indicated its commitment to supporting renewable electricity by establishing long-term targets and by clearly linking its feed-in tariffs to those targets. This section briefly reviews the complement of Germany's target setting mechanisms and discusses implications for future PV market growth. The following section then discusses the evolution of Germany's approach to managing PV market growth within the context of these targets.

Low-Carbon Energy Targets and Planning

During the past two decades, Germany has established a series of ambitious renewable energy plans and targets. These efforts have been linked to both EU-level energy policy Directives and to national climate targets.

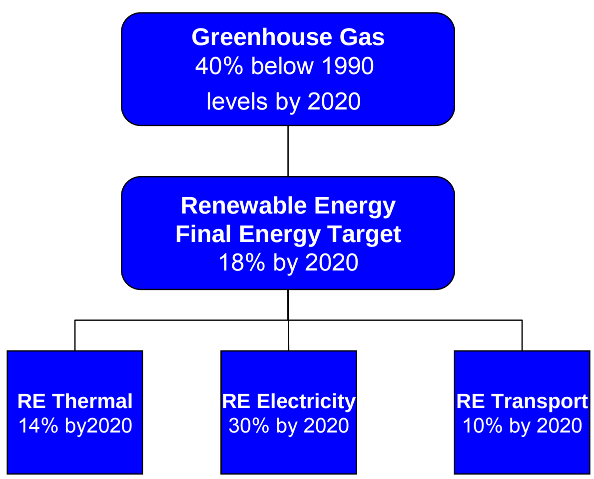
EU Directives: The most recent EU Directive, 2009/28/EC, was passed in 2009 and sets out an EU-wide target to achieve 20% of final energy consumption from renewable energy sources by 2020. The Directive requires each member nation to adopt a biofuels target of 10% by 2020 and establishes specific national final energy targets which are legally binding. Germany's final energy target is 18% by 2020. Directive 2009/28/EC replaces an earlier 2001 Directive on renewable energy (2001/77/EC) and a 2003 Directive on biofuels (2003/30/EC). Germany has formally enacted each of these Directives as binding national law as required by the European Union.

German National Targets: In addition to the final energy and biofuels targets required by the EU Directive, Germany has also actively developed its own climate and energy targets. These have included:

- **Greenhouse gas reduction targets.** Germany announced a target of 40% below 1990 levels by 2020 in advance of the 2007 United Nations Climate Change Conference in Bali. Although the target has not been formally passed into law, the current government confirmed this target as national policy in its 2009 Coalition Agreement[14] and again in the 2010 Energy Concept.
- **Renewable heat target.** Germany established a binding target to supply 14% of its thermal energy from renewable sources by 2020 as part of its 2008 renewable heat law.[15]
- **Renewable electricity target.** In its 2008 feed-in tariff amendment, Germany established a binding target to supply at least 30% of its electricity from renewable sources by 2020.[16] As noted above, the Energy Concept outlines a revised goal of 35% by 2020.

The manner in which these targets interact and layer can be seen in the figure below. The renewable thermal, electricity and transport targets aggregate to meet the overall final energy target of 18% by 2020. The renewable energy target in turn contributes to meeting the overall greenhouse gas target. The previous German government quantified and articulated the relationships between these targets in 2007 as part of its Integrated Climate and Energy Programme.[17] The Programme projected the greenhouse gas emissions reductions that would be achieved by a broad portfolio of proposed renewable energy, efficiency, and power plant measures, and renewable electricity, renewable heating, and renewable transport targets were each explicitly quantified as part of the integrated plan. The new *Energy Concept* document also stresses the integration of the national climate and energy targets. The interaction between national renewable energy policy and the European Trading scheme is more complex and is discussed in greater detail in Part II.

Exhibit 5: Map of Germany's Low-Carbon Targets



Source: DBCCA Research

[14] *Merkel, A., Seehofer, H., Westerwelle, G., Kauder, V., Ramsauer, P., & Homburger, B. (2009). Growth. Education. Unity. The Coalition Agreement between the CDU, CSU and FDP for the 17th legislative period. Berlin, Germany: Christian Democratic Union of Germany, Christian Social Union, and Free Democratic Party.*
[15] *Act on the Promotion of Renewable Energies in the Heat Sector of 2008, the Erneuerbare-Energien-Wärmegesetz – EEWärmeG*
[16] *Act on granting priority to renewable energy sources of 2008[16]*
[17] *Bundesministerium für Umwelt Naturschutz und Reaktorsicherheit. (2007). Report on implementation of the key elements of an integrated energy and climate programme adopted in the closed meeting of the Cabinet on 23/24 August 2007 in Meseberg. Berlin.*

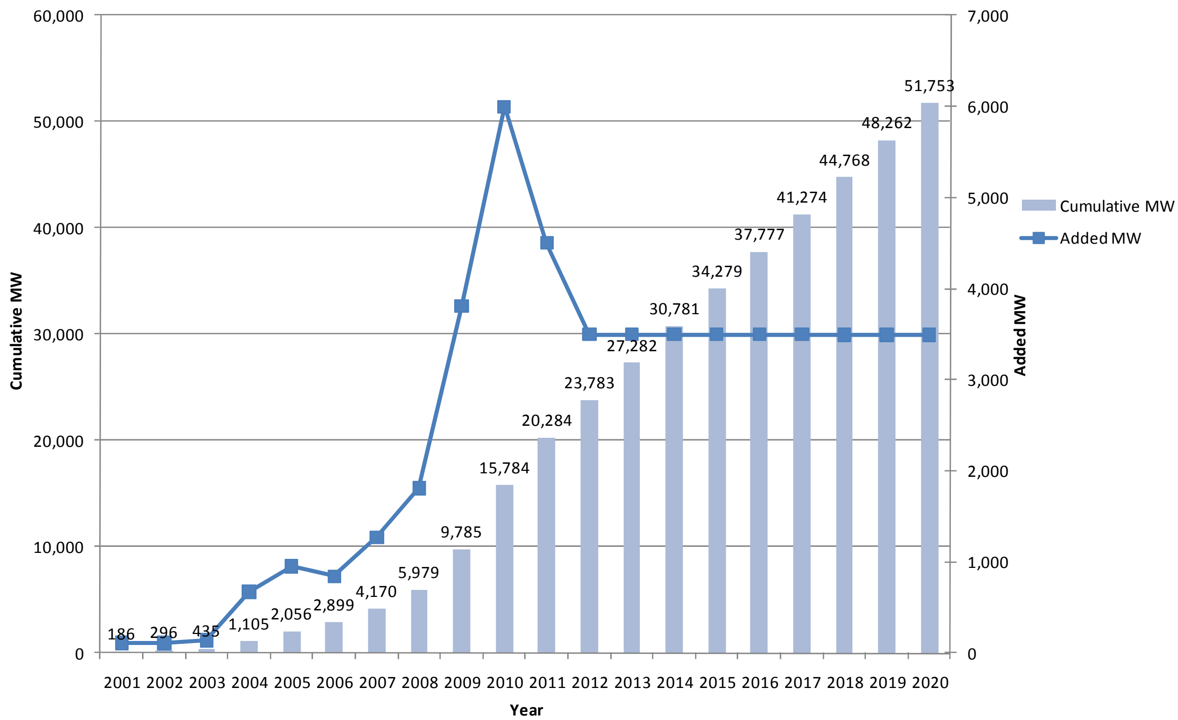
National Renewable Energy Action Plan (NREAP): Although the German government has established binding minimum targets for renewable energy, it has not laid out specific targets for individual technologies. It has also not established hard caps on the belief that a structural transition toward a cleaner energy supply is fundamental to Germany's industrial policy goal of being a world leader in low carbon energy system goods and services. The closest that the government has come to setting individual technology goals was in responding to Directive 2009/28/EC, which requires that each country submit a National Renewable Energy Action Plan (NREAP) to demonstrate how it planned to meet or exceed its specific 2020 target.

The NREAP includes trajectories for how Germany expects specific renewable energy technologies to develop through this decade. The German government has reiterated that the NREAP trajectories do not represent binding targets for any of the technologies and should instead be thought of as a pragmatic roadmap which could be subject to repeated updating and amendment in response to changes in energy market fundamentals (e.g. the proposed acceleration of nuclear power plant retirements).

The NREAP trajectory for PV through 2020 is included in the graph below, including both the cumulative installed capacity and the projected annual additions. As can be seen in the graph, the government projects that annual additions for PV will peak in 2010 at 6,000 MW and will then contract to 4,500 MW in 2011 and 3,500 MW p/a through 2020. By 2020, a total of 51,753 MW of capacity is projected to be installed in Germany.

It is important to note that the German market exceeded the projected trajectory in 2010 by 1,400 MW. It is also important to note that, although the NREAP does not represent a formal target, the 3,500 MW annual figure has also been set as the baseline for Germany's new annual rate adjustment mechanism. The relationship between 2010 market growth and the outlook for the German PV growth will be discussed in greater detail below. **In brief we believe that Germany will not implement a hard cap, but will instead continue to utilize price to manage market volume in line -- at least -- with the trajectory outlined in the NREAP.** The transparency of this 10-year solar PV energy trajectory is instrumental in guiding industry toward making appropriate capital allocation decisions. In turn, it provides investors with reasonable expectations of solar PV saturation levels within the context of the total national energy market as costs fall to grid parity.

Exhibit 6: German PV Installled Capacity



Source: BMU (2010), German NREAP (2010)

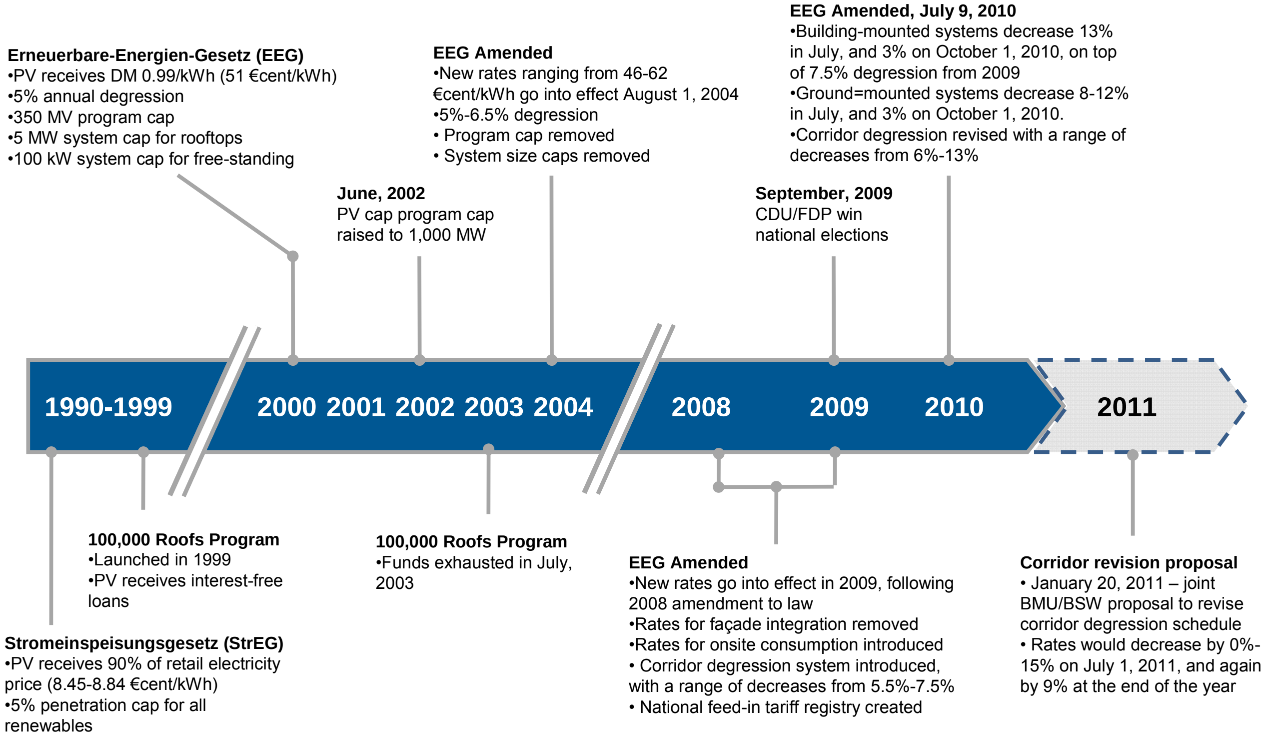
PV Volume Management Strategies in Germany (1990-present)

Overview
Germany has supported PV growth at the regional and national levels since the early 1990s using a range of different policy mechanisms. This section reviews the evolution of German PV policy, with a specific focus on the volume management strategies employed for feed-in tariffs at different times. Germany managed PV volumes for much of the last decade utilizing pre-determined rate decreases, but a recent breakthrough in policy development has been the introduction of PV rates that decline based on the amount of capacity installed in prior periods. In other words, the price paid is tied to PV market volume.

As will be discussed in Part II, we believe that from an investor perspective, time-triggered automatic rate adjustments based on volumes, whose calculation formulae are transparent and methodologically grounded, best deliver TLC. When combined with highly transparent, periodic reviews, such adjustments can provide the flexibility required to support policy longevity.

German PV policy has evolved over time and now exhibits many design best practices from a TLC perspective. A summary timeline of both German PV policy and the government approach to managing PV market volume is included in Exhibit 7 below. After utilizing hard caps during its PV FiT policies in the 1990s and early 2000s, the German government has since relied on strategies for limiting (or enabling) market growth by controlling feed-in tariff price levels.

Exhibit 7: History of German Solar PV Policy



Source: DBCCA Research (2011)

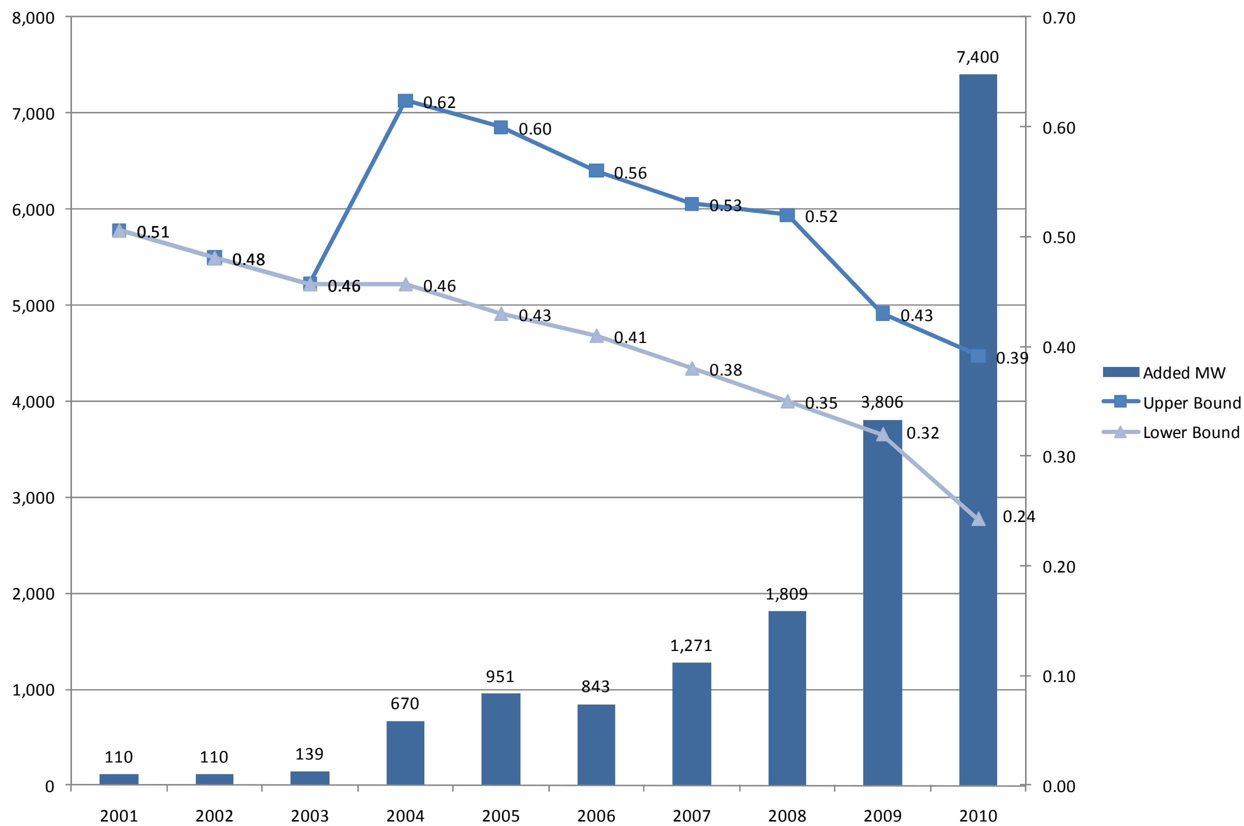
Exhibit 8 overlays the PV rates available with the amount of capacity added each year. There was only a single rate available for PV available during 2000-2003. Starting in 2004, Germany introduced PV rates that were differentiated by size (e.g. capacity) and by application (e.g. façade integrated or free-standing). Instead of providing a detailed accounting of all rates available each year, the graph below provides only the highest and lowest rate for each year (i.e. upper bound and lower bounds).

As can be seen in the graph and as described in the timeline above, Germany has consistently exerted downward pressure on PV prices through degression during the past decade. During 2000-2009, degression was set as a fixed annual amount. During 2009-2011, however, the German government introduced volume-responsive "corridor" or "flexible" degression schedules. During the same period, the German government also implemented "non-scheduled adjustments" as a result of "unforeseen developments in the prices of photovoltaic systems.[18]" Since 2008, PV component prices have declined sharply, with panel prices falling approximately 40% in 2009 alone. The impact on the German market and the government response is apparent from the graph below: there is a comparatively sharp decline in rates starting in 2009-2010 in reaction to a significant acceleration in market growth. This dynamic is discussed in detail in this section.

[18] *Federal Republic of Germany. (2010). National Renewable Energy Action Plan in accordance with Directive 2009/28/EC on the promotion of the use of energy from renewable sources. Berlin, p. 63*

The German Feed-in Tariff for PV

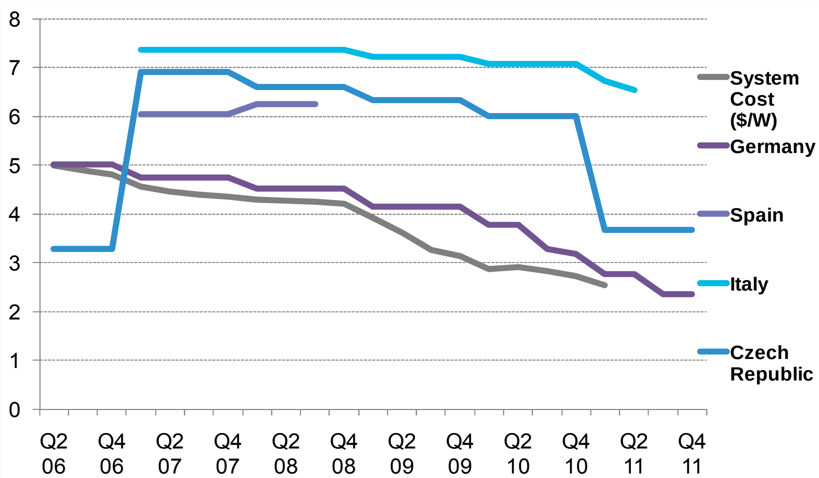
Exhibit 8: PV Rates (Euro cents / kWh) and Capacity Additions



Source: DBCCA Research (2011)

The graph below from Bloomberg New Energy Finance takes another view on German PV price decreases over time by comparing the net present value of feed-in tariff payments in major European PV to the cost of PV systems. As can be seen in the graph, the German government's efforts to reduce its PV FiT rates (purple line) have allowed their rates to more closely track to system cost decreases (grey line) than the rates of other major markets such as Czech Republic, Italy, and Spain. Of note, because of the scale of the PV industry, transaction costs—including grid connection fees and installation—are significantly lower in Germany compared to other European countries.

Exhibit 9: NPV of European Feed-in Tariffs and System Cost ($/W)



Notes: NPV calculated at 4% discount rate; system cost represents German average and excludes impacts of "value-based pricing" in high FiT markets
Source: Bloomberg New Energy Finance

Policy History: Learning by Doing and Responding to Changes in Market Fundamentals

As described in the timeline above, Germany has supported PV using different policy approaches during the last two decades that have utilized different volume management strategies. Each of the major feed-in tariff policy periods is characterized here according to the volume management strategy employed, the rates available, and the PV market growth resulting from the policy.

1990-1999 – Stromeinseisungsgesetz (StrEG) – Generation and Cost Caps

The StrEG, or "Electricity Feed-in Law", was Germany's first feed-in tariff and did not have rates high enough to support PV installations.

- **Rates:** Under the StrEG, both PV and wind generators were eligible for a feed-in tariff payment set at 90% of the retail electricity rate, which meant that the FiT rate fluctuated between 8.45-8.84 €cent/kWh over the course of the decade.
- **Market growth:** Although this rate was insufficient to drive PV markets on its own, PV generators were eligible for rebates equal to 70% of system cost (starting in 1990) and low-interest financing under the 100,000 roof-top program (starting in1999). Additionally, municipal PV feed-in tariffs existed in over 50 cities (e.g. Hammelburg, Aachen, and others) and drove modest market growth during the decade. By the end of 1999, 67 MW of PV were installed due in large part to capital cost subsidies.
- **Volume management:**
  The volume management strategy during this period consisted of caps triggered by the amount of renewable energy in each utility service area. Under the StrEG, policy costs were recovered regionally, rather than distributed nationally. Initially, local utilities were only required to recover policy costs from within their service territories, up to a 5% renewable energy penetration level. Above that level, the costs would be socialized more broadly among ratepayers served by the regional transmission system. In addition to the generation caps, utilities were exempt from renewable energy purchases if the purchases substantially impacted ratepayers. In 1998, the law was amended to limit cost recovery above 5% penetration across the any transmission system.

2000-2003 – Erneuerbare-Energien-Gesetz (EEG) - Program and Project Caps to Control Ratepayer Impact

In 2000, Germany passed the EEG, or "Renewable Energy Law," which first introduced national rates that approximated the generation cost of PV systems and proved more effective than a direct linkage of incentives to retail rates. The generation cost method typically sets a targeted internal rate of return (IRR) which decreases risk and provides investors with a high level of certainty. In Germany, the target IRR has been approximately 5-7%.[19]

- **Rates:** The first EEG established a rate of 0.99 DM/kWh (~0.51/ €cent/kWh) for PV starting in 2001.
- **Market growth:** In combination with the 100,000 Roofs Program (which offered zero-interest loans starting in 1999) the EEG drove cumulative capacity to 435 MW by the end of 2003, or an average annual capacity addition of ~120 MW.
- **Volume management:**
  The EEG initially specified that a hard cap would be implemented once 350 MW of capacity was reached in order to limit policy costs. In June, 2002, however, the law was amended to increase the capacity that would trigger the cap to 1,000 MW. The EEG also included caps on individual system sizes: building-mounted PV projects were capped at 5 MW, whereas free-standing systems were capped at 100 kW. In addition to the capacity limitations and project size caps, the incentive rate decreased automatically by 5% each year (i.e. along a 5% degression schedule), based on PV's projected experience curve. The EEG law specified that the rates would be reviewed every four years.

2004-2008 – The Caps Come Off

In 2003, the EEG rates were revised one year ahead of schedule when the 100,000 Roofs Program ran out of funds.

- **Rates:** The new rates, which were established and went into effect in January 2004, were differentiated by system size and by application type (façade mounted, roof-mounted, or free-standing), and ranged from 46-62 €cent/kWh.
- **Market growth:** Market growth accelerated under the amended EEG, with cumulative capacity expanding to 5,979 MW by the end of 2008, or an average annual capacity addition of ~1,100 MW.
- **Volume management:**
  The revised EEG removed the 1,000 MW program cap, as well as the system size caps, creating the first uncapped PV market in the world. Annual degression was set at 5% for all systems, except for free-standing systems which decreased annually at 6.5% starting in 2006.

2009 – The First Corridor System

The EEG was revised in July, 2008, according to the 4-year review cycle established in the 2000 law, and new rates went into effect in 2009.

- **Rates:** The new law removed rates for façade integrated PV but introduced payments on top of the retail electricity rate for PV electricity consumed onsite.
- **Market growth:** In 2009 alone, 3,806 MW of PV were installed
- **Volume management:**
  The amendment established a "corridor" or "flexible" degression system for PV whereby the rate would decrease each year based on the volume of MW installed during the previous year (defined as October 2008-October 2009). The 2009 amendment projected that 1,500 MW would be installed in 2009, 1,700 MW in 2010, and 1,900 MW in 2011. If the actual installations matched the projections, then the next year's degression would be 6.5%. If actual installations were below or above the projections, the degression would decrease or increase by an additional 1% (a political decision). The corridor degression schedule is summarized in the table below. In addition to the corridor system, the 2008/2009 law also established a registry for feed-in tariff applicants, managed by the Federal Network Agency (Bundesnetzagentur) in order to more easily track installed and pending capacity.[20]

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[19] *Fell, H.-J. (2009). Feed-in tariff for renewable energies: An effective stimulus package without new public borrowing. Berlin, Germany.*

[20] *Erneuerbare-Energien-Gesetz, EEG of 2008*

Scenario	2009 (MW)	2010 (MW)	2011 (MW)	Degression
Low case	< 1000	< 1100	< 1200	5.5%
Base case	1500	1700	1900	6.5%
High case	> 1500	>1700	> 1900	7.5%

Source: NREAP (2010)

2010 – Unscheduled Adjustments to the Rate

In 2010, the Government introduced two "non-scheduled" decreases (in addition to the scheduled degression) to reflect PV component price declines and altered the corridor degression schedule.

- **Rates**: The rates decreased from 2009 to 2010 by 7.5% since the amount of capacity installed exceeded the projected 1,500 MW projection.
- **Market growth**: In 2010, 7.4 GW of PV was installed, compared to government projections of 6 GW.
- **Volume management**: In order to account for rapid declines in PV module prices, the new CDU/FDP government (elected September, 2009) called for additional cuts beyond the degression introduced in 2009. In July 2010, a law was passed that immediately decreased rates for building-mounted systems by 13%, and rates for ground-mounted systems by 8-12%. The law further decreased rates on all systems by an additional 3% in October 2010. The law also set out a revised corridor degression system with a 3,500 MW annual installation projection. Each GW installed in excess of the 3,500 MW baseline in 2010 would result in an additional 1% degression in 2011, up to a maximum degression of 13%. In 2012, each GW of excess capacity would result in a 3% decrease, for a maximum degression of 21%. The revised corridor system is summarized in the table below. If installations were lower than the base case, then the degression rate would decrease.

Scenario	MW installed	Degression (2010)	Degression (2011)
< -2 GW	< 1500	6%	1.5%
-2 GW	1500	7%	4%
-1 GW	2500	8%	6.5%
Base case	3500	9%	9%
+1 GW	4500	10%	12%
+2 GW	5500	11%	15%
+3 GW	6500	12%	18%
> +3 GW	> 6500	13%	21%

Source NREAP (2010)

2011 – Anticipating the Degression with a Mid-Year Decrease

- **Volume management**: In February, 2011, the German government issued a revised corridor degression schedule.[21] In anticipation of continued robust growth enabled by additional system cost reductions, the revision split the potential degression for 2012 into two parts: one that would occur in July 2011[22] and one that would occur on January 1, 2012. Both adjustments are to be based on the amount of capacity installed. As can be seen in the table below, the total degression for 2011-2012 could be as low as 1.5% or as high as 24%, depending on the actual PV market growth.
  - For the July, or, "interim" degression, the amount of capacity installed between March and May 2011 is multiplied by four in order to estimate the total projected annual capacity. The projected annual capacity determines the rate adjustment. If between 1,500 and 3,500 MW of capacity additions are projected for the year, then there is no interim rate adjustment. Beyond 3,500 MW and up to 7,500

21 http://www.erneuerbare-energien.de/inhalt/47055/4613/
22 For roof´mounted systems. Free-standing systems would be adjusted in September

MW or greater in projected capacity additions results in a sliding degression rate of 3% up to a maximum interim rate adjustment of 15% as shown in the table below.

- For the January 1, 2012 adjustment, the total actual capacity installed between 1 October 2010 and 30 September 2011 is used as a reference to compare with the projection made in July 2011. The total degression that will occur in January 2012 is shown in the right hand column in the table below. The additional degression that occurs is equal to the total degression amount minus the amount of the interim degression. In other words, if it was projected in July 1, 2011 that 4,500 MW would be installed, then rates would have decreased by 3%. If the actual installations, however, were 5,500 MW, then the rate would decrease by an additional 12% in January 2012 (i.e. 15%-3%).

Scenario	MW to be installed in 2011 (projected)	Interim Degression (July 2011)	Total degression (January 2012)
-2 GW	1500	0%	1.5%
-1.5 GW	2000	0%	4%
-1 GW	2500	0%	6.5 %
Base case	**3500**	**0%**	**9%**
+1 GW	4500	3%	12%
+2 GW	5500	6%	15%
+3 GW	6500	9%	18%
+4 GW	7500	12%	21%
> +4 GW	>7500	15%	24%

Source: BMU (2011)[23]

2012 and beyond – What does the future hold?

The next formal revision of the EEG is scheduled to be completed and implemented by January 1, 2012. The degression schedules that are proposed for 2011 and also between 2011-2012 can already be projected, based on the proposals made in January. In the graph below, the red line represents the highest PV feed-in tariff rate (e.g. building mounted systems < 30 kW), whereas the blue line represents the lowest PV feed-in tariff rate (i.e. freestanding systems). The lines each diverge in 2011 to reflect the base and high scenarios contemplated under the mid-year corridor degression schedule described in the chart above.[24] During the period 2013-2016, the graph assumes for the sake of illustration that the 2010 corridor degression rules apply and that the rates decrease by 9% p/a under a scenario where 3,500 MW is installed per the NREAP trajectory.

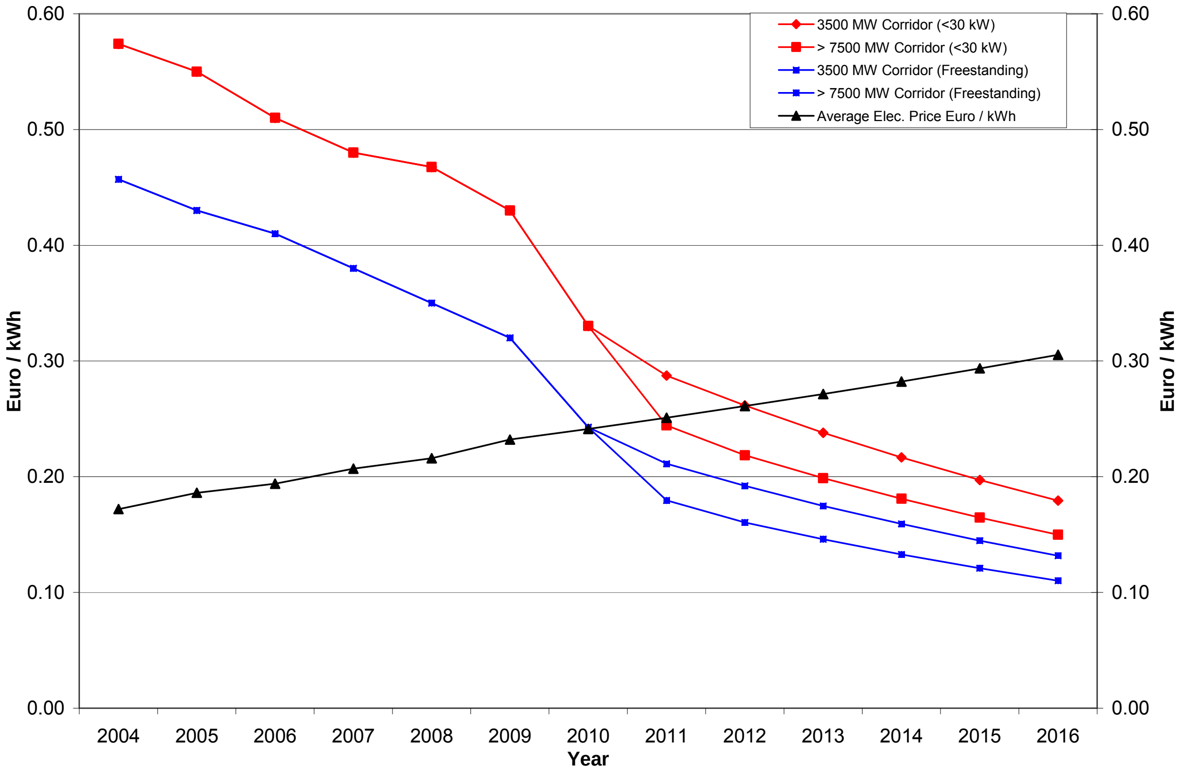
The black line represents average retail residential rates, projected forward from 2010 with a 4% annual rate of increase.[25] The rapid decreases in feed-in tariff rates during 2009-present, and those envisioned for 2011 mean that building-mounted PV will likely be below retail electricity rates in 2011-2012, and that freestanding systems are already ~15% below retail rates.

[23] *See Änderungsantrag zum Entwurf eines Gesetzes zur Umsetzung der Richtlinie 2009/28/EG zur Förderung der Nutzung von Energie aus erneuerbaren Quellen, Availalbe at: http://www.erneuerbare-energien.de/inhalt/46976/4590/*

[24] *The low scenarios (i.e. those lower than the 3500 MW base scenario) are not considered in this graph.*

[25] *This is a conservative assumption. Residential retail rates in Germany increased an average of 6% each year during the period 2004-2009. See Böhme, D., Dürrschmidt, W., & van Mark, M. (Eds.). (2010). Renewable energy sources in figures: National and international development. Berlin, Germany: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.*

Exhibit 10: Retail rates vs. PV degression



Source: DBCCA research

Discussion and Conclusions

Germany's best in class feed-in tariff policy continues to drive renewable energy at scale, supported by binding, ambitious targets, and an integrated climate and energy policy framework.

- The dynamic nature of the global PV pricing, the lack of hard caps of Germany's FIT, and PV markets' ability to rapidly scale in response to adequate price signals, have created the conditions for Germany to "backstop" PV demand while other markets have contracted or been capped (e.g. Spain).
- During 2000-2009, Germany's schedule of annual automatic price degressions supported investor security and confidence by enhancing transparency and was one of the key drivers for fostering the growth of the solar market while at the same time driving PV prices toward grid parity.
- The recent series of non-scheduled and mid-year price decreases in 2010 and 2011 were in response to rapid component cost declines but in turn also reduced market transparency. However, these interventions appear to have been necessary to account for rapidly changing market conditions and ensure longer term policy durability. Based on interviews and internal analysis, we conclude that, in the view of the market, the decreased transparency during the past two years is preferable to the sharp reduction in policy longevity (or retroactive changes that have undermined revenue certainty) that has occurred in several other European PV markets. In effect, this helps longevity, as rate payer value for money spent on incentives is increased.
- The lack of a concrete policy target or cap has raised speculation about potential PV market size and possible policy horizons. While no explicit targets have been set, the combination of the NREAP trajectory and the baseline specified in the 2010 corridor degression schedule are an indicator that Germany intends to utilize price

in response to past volume trends to support market volume of ~3,500 MW p/a during this decade, in line with its integrated climate and energy projections. The recent nuclear crisis could result in upward revisions to the NREAP trajectories in the future, but no such revisions have been announced to date.

- The analysis of the EEG cost has taken place in the context of a full cost/benefit framework.

Although Germany appears to be effectively steering its PV market through waters where others have sunk, there are several uncertainties that may shape near-term or mid-term PV policy. In particular, investors and industry participants should pay close attention to:

- **Price/volume trends:** Since the feed-in tariff rate automatically adjusts based on installed volume, there is a risk that the resulting rate could "overshoot" the market – i.e. be too low to attract investment and development. A related risk could be that rate decreases would prevent German PV manufacturers from selling panels into the market, but not shut out lower cost panels from overseas (e.g. China). Since one of the goals of the feed-in tariff in Germany is domestic industrial development, such a scenario would be politically challenging. Of the methodologies that govern the German PV FIT structure, the somewhat arbitrary nature of the formula that ties degression adjustments to capacity growth is one of the least robust and could benefit from more rigorous analysis.
- **FiT Arbitrage:** The commoditization of PV panels means that there are significant opportunities for policy arbitrage. The German FiT has provided lower rates of return than other FiT policies and has therefore served as a "market of last resort" for unsold panels. The rise of significant demand in other markets (e.g. China or the US) in the near-term could relieve pressure on Germany as the world's panel backstop, but it could also significantly reduce supply of panels to Germany if demand in more attractive markets is high enough.
- **Generation cost:** The proximity of German FiT rates to retail electricity prices raises the promise and the complication of grid parity. There has been debate as to whether FiTs remain an appropriate or relevant policy once onsite generators are able to make more from offsetting their electricity bills than from the FiT rate itself. This is a topic that could benefit from further research and analysis.
- **Adjustments to energy policy:** The policy revision scheduled to go into effect on January 1, 2012 raises uncertainties as to the direction that the German PV market will take. On the one hand, there has been speculation from some analysts that a hard cap will be "likely," rather than price responses to volume. On the other hand, the German government has made statements to contrary. In our view, the nuclear controversy is likely only to increase momentum for the planned renewable energy transition, rather than constrain it.
- **Implementation of the six-point plan.** Although some analysts have been bearish about the future of PV markets in Germany (typically as part of critiques of PV markets in Europe more broadly), the recent nuclear disaster in Japan has focused German policy makers on the goal of transitioning more rapidly away from nuclear. As part of this transition, Chancellor Merkel has announced a six-point plan that includes a greater emphasis on renewable energy technologies, including solar power. Depending on how the plan is translated into policy, support for the PV market is likely to be sustained through the decade and potentially accelerated.

Part II: An Investor Perspective on PV Volume Management

DBCCA has stated that advanced feed-in tariffs can scale renewable energy markets at a fair price by creating transparency, longevity and certainty (TLC). Experience from Germany, as well as the recent rapid growth and contraction of several key gigawatt-scale PV markets in Europe, has raised important questions about how to balance policy longevity while supporting investor security. A key component of the TLC perspective is how feed-in tariffs link to and integrate with broader climate and renewable energy goals. A closely related issue is how market growth under feed-in tariffs is managed or regulated in relation to those goals. Part II of this report draws on the experience of Germany outlined in Part I to examine the balance of PV policy longevity and transparency under different volume management strategies.

Low-carbon infrastructure will require massive investment during the next ten years, but there is a significant financing gap that must be bridged to reach scale. It has been estimated that clean energy alone will require $5-$10 trillion through 2020 in order to restrict temperature rise to 2°C, the range thought to be necessary to avert dangerous climate change. In contrast, new clean energy asset investment financing amounted to only $127.8 billion in 2010.[26] The continued aftershocks of the global recession have put renewed pressure on public sector budgets, which has increased the need for private sector resources to fill the financing gap.

To set the stage for a massive scale-up in capital deployment for renewable energy, which is a fundamentally necessary building block for a lower carbon energy system, DB Climate Change Advisors (DBCCA) has joined close to 270 investors, representing assets totaling over $15 trillion, to call for new tools to optimize private investment in the low-carbon economy.[27] Constructive public policy will be necessary to transition from a high carbon to a low carbon energy system.

In previous analyses, DBCCA has concluded that low-carbon policies should maximize Transparency, Longevity, and Certainty (TLC) for investors.

- **Transparency** – How easy is it to navigate through the policy structure, understand the risks/rewards and execute transactions?
- **Longevity** – Does the policy match the investment horizon and asset life, create a stable and enduring environment for public policy support, and provide sufficient tenor to attract sustainable capital flows?
- **Certainty** – Does the policy deliver measurable and sufficient revenues to support a reasonable rate of return?

Of the policies in place internationally, advanced feed-in tariffs most clearly deliver TLC and have the potential to drive renewable generation at the **scale and pace required** and—importantly—**at a fair price** that adequately balances short run cost impacts with long run benefits such as job creation and lower average electricity prices.[28] In previous work, we have defined advanced FiTs as, "supporting a mandated renewable energy target by creating investor TLC, with a pathway to grid parity subject to transparent price discovery.[29]"

Broadly, experience-to-date has reinforced the fact that advanced FiTs can both create TLC and drive renewable energy scale-up. The steady growth of wind and biomass markets in Europe under feed-in tariffs has attracted significant amounts of capital and fundamentally transformed the EU's generation portfolio to include cleaner sources of electricity.

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[26] *Bloomberg New Energy Finance (2011)*
[27] *IIGCC. (2010). Global Investor Statement on Climate Change: Reducing Risks, Seizing Opportunities & Closing the Climate Investment Gap.*
[28] *DB Climate Change Advisors. (2009). Paying for renewable energy: TLC at the right price - Achieving scale through efficient policy design. New York, NY: The Deutsche Bank Group.*
[29] *DB Climate Change Advisors. (2009). Paying for renewable energy: TLC at the right price - Achieving scale through efficient policy design. New York, NY: The Deutsche Bank Group.*

The rapid boom and bust of several gigawatt-scale European PV markets under FiTs – in particular those in Spain, France, and the Czech Republic – has highlighted a key tension within the TLC framework. In each of these cases, the PV market contractions have been attributed to the fact that the markets "grew too fast" and incurred politically untenable costs, or met their targets ahead of expectation and were not backstopped by an integrated and adaptive energy plan. This dynamic raises a question of balance: investors need transparency and certainty in order to finance PV at scale; but too much scale too quickly may undermine policy longevity if policy makers are compelled to intervene and adjust or curtail FiTs unexpectedly.

Although some analysts have used these examples to question the effectiveness of feed-in tariffs broadly, for our part, we remain convinced that advanced feed-in tariffs provide the most effective mechanism for achieving the scale of energy transformation that will be required during the next decade and can strike a fair balance between providing investor certainty and managing ratepayer costs.

The market contractions in Spain, France, and Czech Republic say less about feed-in tariffs than they do about attempts to scale-up markets for a technology with PV's unique characteristics and cost structure without a well thought out plan to adapt to abrupt changes in PV volume and changes in market fundamentals. In particular, recent experience with photovoltaics has demonstrated a need to place greater emphasis on two of the criteria outlined in the TLC framework: the explicit "linkage" of FIT policies to energy and climate targets, and the evaluation and management of progress towards those targets. A high degree of transparency in these two areas can be critical to investors, particularly for those investing in technologies that can scale to the degree that PV can. In order to explore these issues in greater depth, this report reviews the recent evolution of the German policy environment as a case study.

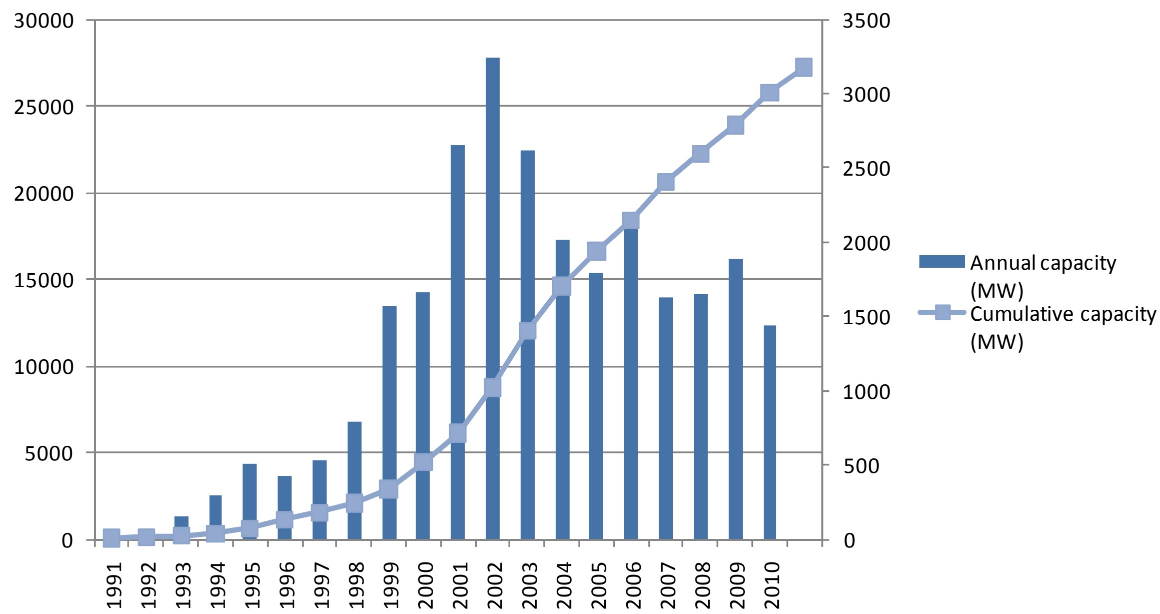
Section 1: Reviews the unique characteristics of PV
Section 2: Discusses the linkage of FIT policies with climate and energy policies
Section 3 Characterizes market adjustment mechanisms

Section 1: Managing Renewable Energy Diffusion

The market penetration for renewable energy technologies follows typical product diffusion curves, which are characterized by initial periods of steady but restrained growth, followed by market acceleration, and then by a leveling-off after reaching maturity and saturation. The graph below, for example, shows the development of the onshore wind market in Germany during 1990-2010. After relatively steady growth from 1990-1998, the amount of new capacity additions accelerated sharply in 1999, before peaking in 2002 at 3,247 MW. Annual additions have since declined to 1,551 MW installed in 2010. Some analysts have argued that onshore wind energy is reaching a saturation point because the majority of available wind sites have been developed.[30]

[30] *Previous projections have estimated that greenfield onshore wind development in Germany will cease in 2020, but that onshore repowering will then continue to increase installed capacity. See e.g., Deutsches Windenergie Institut, 2008,Germany, Prepared for HUSUM WindEnergy*

Exhibit 11: German Wind Energy Capacity Trends (MW)



Source: German Wind Energy Association, 2011

Although PV market diffusion will likely follow a similar "S" pattern, the scale and speed at which PV can penetrate a market has been demonstrated to be far greater than that of other technologies (e.g. wind). Some of the characteristics that distinguish PV markets and enable policy to drive rapid adoption are summarized in the Exhibit below.

Exhibit 12: Solar PV Characteristics

Resource availability. Solar energy is distributed relatively evenly and universally across countries. Resource availability (e.g. the availability of sunlight) is unlikely to be the primary constraint on PV market development.

Ease of siting. PV systems can be relatively easily integrated into the built environment or landscape, and can be designed to have a low visual impact

Modularity. PV systems can be sized to fit a wide range of parcel sizes, from small rooftops to multi-megawatt fields

Ease of installation. PV systems can be installed quickly compared to most other power generation technologies

- PV markets can respond to adequate incentives in binary fashion – switching from "off" to "on" and vice versa– in relatively short order.
- PV development has been characterized by policy arbitrage between countries, with capital deployment flocking to regions that offer the most attractive risk adjusted returns.

Source: DBCCA research, 2011

The ability of PV to quickly scale presents significant opportunities and challenges to policy makers. On the one hand, PV can rapidly deliver a range of economic and environmental benefits, such as new power generation capacity, job creation, domestic investment, and emissions reductions.

On the other hand, PV component costs are rapidly commoditizing and have decreased sharply in recent years in response to policies that have stimulated growth. Historically, the levelized cost of energy (LCOE) from PV has been higher than that of other renewables. Consequently, as PV markets have accelerated, they have disproportionately increased FIT policy costs relative to other technologies, and have been perceived as making the overall policy costs for renewable energy expensive. In Germany, for example, PV accounts for 9% of the electricity delivered under the FiT, but 40% of the incremental policy cost.[31] At the same time, PV is advancing rapidly down a steep experience curve, with module prices falling up to 40% in 2009 alone. It is projected that PV prices will fall further over the next few years[32] and that PV will be broadly competitive with traditional fossil-fueled electricity in many countries by 2014.

These cost factors create a tension between investors and government policy makers with investors uncertain about PV market longevity and policymakers at times struggling to justify the cost. In the near-term, policy-driven market growth may result in politically untenable ratepayer (or budgetary) impacts. In the mid-term, PV cost “breakthrough” scenarios may unlock market growth that outpaces the capacity of grid and/or electricity market infrastructure to absorb it. We believe that the core goal of an advanced feed-in tariff should be to create a glide path to grid parity—that is to say, providing temporary financing support until such time as the renewable industry scales and can compete on its own with traditional energy generation sources. The upfront policy costs can be justified by future savings or avoided costs in wholesale markets from dispatching fossil fuel fired generation, which can be substantial.

Given concerns over sustainable PV growth, policy makers can increase confidence in PV markets by giving investors a clearer view of PV policy horizons. Specifically, perceived policy risks can be decreased when policies exhibit the following characteristics:

- **Linked and integrated:** the policies are explicitly and transparently linked to well-defined and binding targets.
- **Ample TLC:** the mechanisms for managing progress towards those targets are transparent and well-established.

Linking FIT policies to well-defined targets

The linkage of feed-in tariff policies to broader climate and energy targets can increase investor confidence in PV markets because this demonstrates that renewable energy is an explicit part of formal government commitments, such as industrial policy and targeted competitiveness. PV has the potential to be a transformational technology, and targets that acknowledge this potential signal that the transformation is desired and intentional. Depending on how the targets are structured, linked policies can also provide investors with a better sense of expected PV market size. Finally, confidence in policy longevity is increased if the targets are binding mandates that include some form of compliance requirement or penalties, rather than simply goals that lack “teeth” and are merely a reflection of ambition.

Different governments have pursued different approaches to integrating their renewable energy policies with formal mandates and targets. In some countries, national renewable energy policies are not connected to any explicit goal. The federal Production Tax Credit (PTC) in the United States, for example, has driven significant investment in wind power since 1995, but is not tied to any national target. By contrast, some countries — notably Germany — have grounded their renewable energy incentives in fully integrated climate and energy plans.

Examples of the different levels of climate and energy targets are included in the Table below. Each of these can be developed as stand-alone targets or developed as parallel and linked policies. From an investor perspective, a strong

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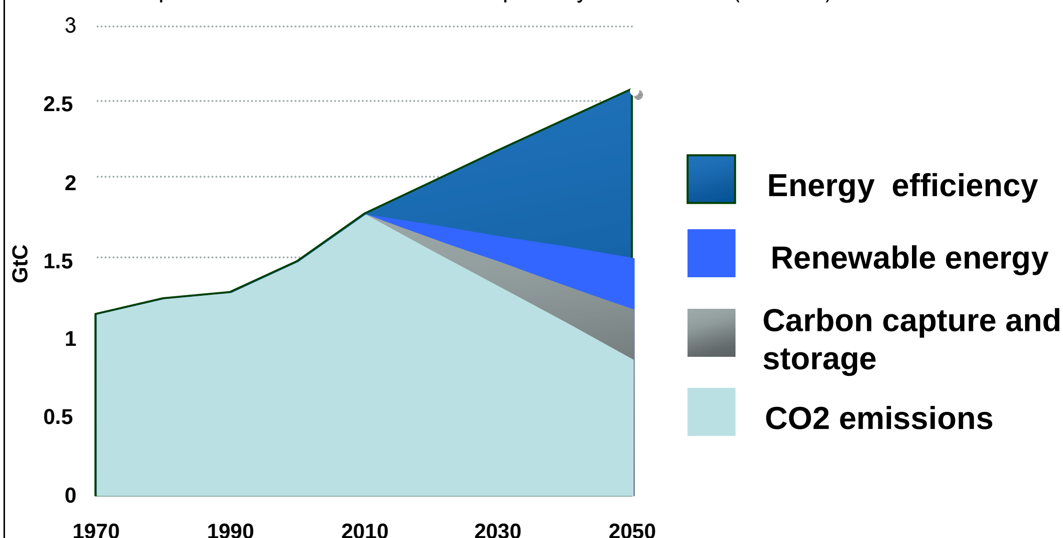
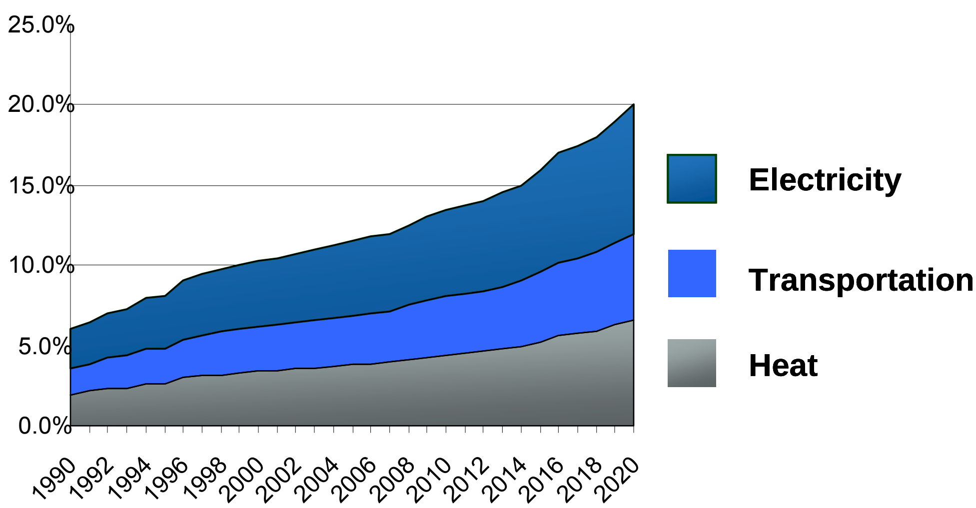
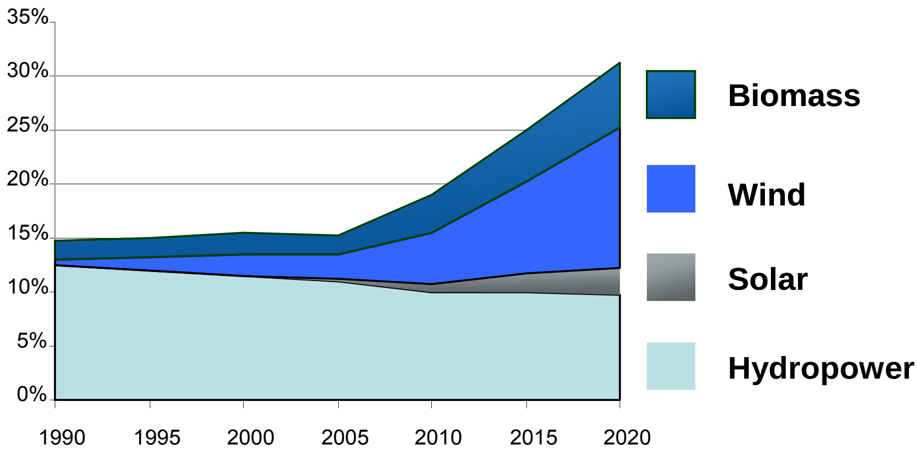
[31] Federal Ministry of Economics and Technology, & Federal Ministry for the Environment Nature Conservation and Nuclear Safety. (2010). *Energy concept for an environmentally sound, reliable and affordable energy supply*. Berlin.
[32] *See* e.g. Wienkes, M., Benson, S., Song, A., & Lefty, D. (2011). *2011 global solar outlook*. New York, NY: Goldman Sachs.

climate and energy framework sets out transparent and inter-related targets that are supported by the appropriate policies to meet them.

<table>
<tr><th>Policy Decision</th><th>Description</th></tr>
<tr><td>Is there a climate target?</td><td>Climate targets are over-arching policies designed to achieve economy-wide greenhouse gas emissions reductions. The target is typically expressed as emissions reductions goals by a certain year relative to a baseline. The graph below show an example carbon emissions reduction target of 40% below 2010 levels by 2050. As can be seen in the graph, the projected emissions reductions will be achieved through a mix of energy efficiency, renewable energy and carbon capture and storage. It should be noted that the international carbon cap-and-trade systems can introduce complex interactions with national policies – this issue is treated separately in Exhibit 13 (text box) below.

</td></tr>
<tr><td>Is the climate target linked to a specific renewable energy target?</td><td>Renewable energy targets can be integrated within climate targets and are typically expressed as a share of final energy consumption. The graph below shows a final energy target of 20% by 2020. As can be seen in the graph, the final energy target can be further subdivided into targets for specific end-uses (i.e. electricity, transportation, and heat).

</td></tr>
</table>

Is there a renewable electricity target?	Renewable electricity targets (which can also be called renewable portfolio standards) are typically expressed as a share of electricity supplied within a given area. The graph below shows a renewable electricity target of 32% by 2020. Although renewable electricity goals need not be technology specific, many such policies include explicit sub-targets for individual technologies, known as carve-outs, bands or tiers. In the example below, annual declines in hydropower generation are more than offset by specific carve-outs for biomass, wind, and PV. 

Source: DBCCA Research, 2011

Exhibit13. Renewable energy and the EU Emissions Trading Scheme

Generally speaking, the linkage of mandatory targets for climate and energy – such as Germany's national targets as described in Part I -- increases investor security. The use of different policy mechanisms to achieve these targets, however, can introduce complexities and unintended consequences that reduce transparency depending on how these different policies interact.[33]

In the EU, the renewable energy mandate established in Directive 2009/28/EC strengthens national-level renewable energy policy activity. The existence of the EU Emissions Trading Scheme (ETS) in tandem with national renewable electricity policies, however, has raised questions as to how the policies interact.

The amount of emissions allocated to electricity generators in each EU country under the ETS is fixed. If emissions in the electricity sector are reduced under fixed caps because of new renewable electricity generation, then emissions allowances can be sold to emitters in other sectors or countries. Such a structure could mean that national renewable electricity policies might not have a net effect on greenhouse gas emissions. This dynamic can be alleviated by adjusting emissions caps to account for renewable electricity market growth and/or introducing carbon credit price floors.[34] The third phase of the ETS (which starts in 2013) does account for the impact of renewable energy markets on GHG emissions. The third phase will help achieve the EU's goal of reducing greenhouse gas (GHG) emissions 20% below 1990 levels by 2020. Since the EU's 20% by 2020 renewable energy target is integrated into its 2020 GHG target, renewable energy can be said to have an effect on GHG reductions.[35] In the future, the ETS should be

Exhibit13. Renewable energy and the EU Emissions Trading Scheme (continued)

[33] Fischer, C., & Preonas, L. (2010). Combining policies for renewable energy: Is the whole less than the sum of its parts? (RFF DP 10-19). Washington, DC: Resources for the Future.
[34] Lewis, M. C., & Curien, I. (2009). The ETS review: Unfinished business. London, UK: Deutsche Bank AG / London.
[35] Lechtenböhmer, S., & Samadi, S. (2010). Brief analysis on the current debate about costs and benefits of expanding the use of renewable energies in electricity generation (Final Report). Wuppertal, Germany: Wuppertal Institute for Climate, Environment and Energy.

regularly adjusted to account for renewable energy market growth in order to ensure that renewable energy installations directly impact GHG emissions.

Even if these policy interaction complexities were not present, some argue that renewables should not be supported because they are not the least cost source of greenhouse gas emissions reductions. Although renewables may not be the cheapest reduction in the near-term, credible scenarios for achieving climate stabilization over the long-term (i.e. 2050 and beyond) recognize the need for significant renewable energy market development. Moreover, carbon pricing alone is insufficient to drive renewable energy market growth. The private sector is hesitant to invest in research and development and project installation on its own because of spillover effects from which competitors might profit. As a result, targeted incentives – such as FiTs -- are required to drive renewables toward grid parity through deployment-led cost reductions. Lastly, renewable energy can achieve policy objectives beyond greenhouse gas reductions, such as portfolio diversity, energy security, air emissions reductions, industrial policy, job creation, and others.[36]

The policy interaction between the ETS and renewable electricity policies has been used to critique Germany's feed-in tariff.[37] The German government's articulation of integrated climate and energy goals for 2050 in the *Energy Concept*, however, and its explicit recognition of policy objectives beyond greenhouse gas emissions[38] are clear indications that the country is committed to renewable energy development over the long-term.

Differentiating renewable electricity targets: Objectives and constraints

As discussed above, policy makers need to consider whether renewable electricity targets will be further subdivided, and if so, how. When creating carve-outs or bands, policy makers can define an optimal "mix" of specific technologies in order to achieve policy objectives or acknowledge constraints.

For example, a national target could be set in order to transform the national generation portfolio, to position domestic industry to compete internationally, or to support economic development in regions with abundant renewable resources and/or chronic unemployment.

Alternatively, targets can be set to reflect constraints, which could include:

- total domestic resource (e.g. the amount of wind that can feasibly be developed)
- grid infrastructure (e.g. the total amount of intermittent renewables that can be integrated),
- cost (e.g. the maximum politically tenable policy cost)

Transparency as to what objectives and constraints underlie the choice to support specific technologies can provide greater confidence in the potential durability and longevity of policy-driven markets. Some government policy makers, particularly in a developing market context, may seek to limit volume growth in order to maintain an acceptable cost impact within their budget for solar PV. In this respect, a cap does provide policy cost certainty but also limits market growth.

Adjustments and limitations

In addition to understanding the relationship between different energy and climate targets, it is also important for investors to have a clear understanding of how progress toward those targets is governed. Although adjustments reduce policy transparency, they are needed in order to ensure the longevity and durability of the feed-in tariff and to strike a fair cost/benefit balance.

[36] *Philibert, C. (2011). Interactions of policies for renewable energy and climate (Working Paper). Paris, France: International Energy Agency.*
[37] *Frondel, M., Ritter, N., & Vance, C. (2009). Economic impacts from the promotion of renewable energies: The German experience. Essen, Germany: Rheinisch-Westfälisches Institut für Wirtschaftsforschung*
[38] *Van Mark, M. (2010). Cost and benefit effects of renewable energy expansion in the power and heat sectors. Berlin: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.*

Key issues related to investor evaluation of policy-driven markets include:

- **Constrained or uncapped:** Whether or not market growth is limited (e.g. is there an explicit volume or budget cap to fund the policy?).
- **Flexibility mechanisms**: The different adjustment mechanisms that policy makers use in response to changes in market fundamentals.

In cases where the FIT is being utilized to achieve a broad policy objective (e.g. market transformation), formal policy targets may instead set a minimum floor which can be surpassed without consequence. This has been the case, for example, with renewable electricity targets in Germany.

In many other cases, targets connote some form of limitation, constraint or ceiling (rather than a floor). The simple distinction between renewable energy markets as "capped" or "uncapped," however, is misleading. Different jurisdictions have adopted an increasingly varied range of approaches to managing progress towards targets which require more detailed characterization. Instead of discussing caps, **this paper employs the concept of triggers, adjustments and reviews** in order to more precisely characterize the Transparency, Longevity, and Certainty (TLC) implications of different renewable energy volume management strategies:

- **Triggers** are defined as market growth thresholds that initiate some type of policy adjustment
- **Adjustments** refer to the changes that can occur when trigger points are reached
- **Reviews** refer to periodic policy analyses that can also result in adjustments

It is possible for policies to be subject to unexpected adjustments or amendments – such as the non-scheduled PV market adjustments in Germany during 2010 - but such approaches can undermine investor confidence in the market. This paper assumes that some governance framework for adjusting policy is in place unless otherwise noted.

Triggers
The types of triggers can be characterized as volume-based, cost-based, and time based. These are summarized in the table below and their implications from a TLC perspective are discussed in the text that follows. It should be noted that triggers primarily impact policy transparency and do not have implications for policy longevity or certainty.

Exhibit 14: Triggers

Trigger		Metric	TLC
Time		Specified period of time (e.g. 1 year)	●
Volume-based	Capacity	MW installed	◕
	Generation	MWh generated and sold	◔
Cost		Budget or ratepayer impact	◔

Source: Meister Consultants Group, DBCCA Analysis, 2011.

TLC Considerations: The type of triggers employed can have important implications for policy transparency.

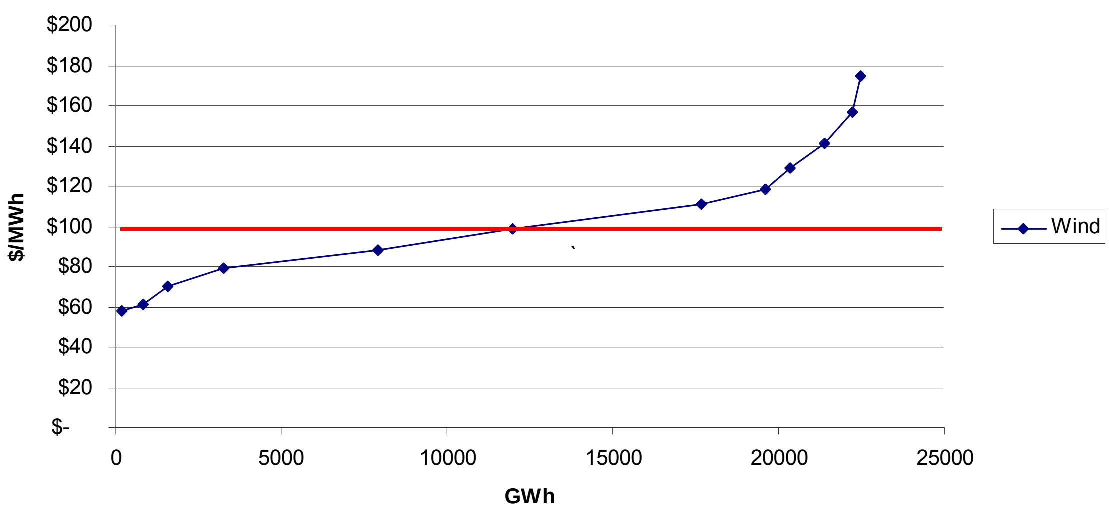
- **Time-based** triggers are the most transparent since they create a stable and known investment horizon.
- **Capacity-based** triggers are less transparent than time-based triggers since it may be difficult for investors to assess how quickly the trigger is being reached and how much capacity is at risk of being shutout. This lack of transparency can be partially alleviated through the use of registry systems that monitor progress toward the trigger.

- **Generation-based** (MWh) and **cost-based** triggers are the least transparent because progress is difficult to assess in real-time, with a full accounting only possible retrospectively.

Adjustments

Once a trigger point is reached, there are a range of different adjustments which can result. Broadly, the different types of adjustments can be categorized as demand-side or supply-side strategies. Demand-side strategies limit the total amount of renewable energy that can participate under a policy (e.g. a cap). Supply-based strategies, on the other hand, seek to control volume by limiting supply through price. As can be seen in the wind generation supply curve below, a certain market response can be expected depending on the price. If the price is set at $100/MWh (red line), then it can be projected that the amount of generation that will come into the market will be limited to ~12,000 gigawatt-hours (GWh).[39] It is assumed that all generators that could produce energy at $100/MWh or below would do so, whereas all those that could only deliver at higher prices would not sell into the market.

Exhibit 15: Wind Generation Supply Curve



Source: DBCCA research, 2011

Adjustments have implications for policy transparency and longevity, but they should not impact revenue certainty. In other words, we assume that once a generator locks into a given rate, the policy cannot be adjusted to retroactively amend the contract and decrease the expected revenues. If this does occur – such has been the case for PV in Spain and the Czech Republic - it can seriously undermine investor confidence.

Demand-side adjustment

The primary type of demand-based adjustment is a **hard cap**. Once the trigger point is reached, the policy is adjusted so that no new generators can participate. Hard caps can be applied to the overall program, or can also be applied annually. The TLC considerations related to hard caps are summarized in the table below:

[39] *Note: This wind example illustrates how price can control volume. In many instances, solar PV supply curves may be flatter than wind energy supply curves with less certain optimal price levels*

Exhibit 16: Hard Caps

TLC		Discussion
Transparency	◑	Hard caps are transparent to the extent that they are known in advance. The transparency of a hard cap mechanism depends, however, on the rules that govern how generators "get in line" under the cap. As markets approach the cap, transparent queuing rules become critical. Key queuing design considerations include the requirements that must be in place in order to queue (e.g. security deposits, permits and/or site-control), milestones to stay in the queue (e.g. construction starts after a certain time), and methods for selecting those in the queue (e.g. first-come, first-served vs. a lottery)
Longevity	○	Program caps represent a firm limitation on policy longevity. The degree to which longevity is limited depends on whether the caps are annual or overall, and the size of the cap compared to the size of the market. Annual, or “rolling,” hard caps, for example, can strike a balance between containing volume growth on the one hand and extending policy longevity on the other.

Source: DBCCA Analysis, 2011.

Supply side – Using price to govern volume

One of the primary types of supply-based adjustments is an **automatic rate adjustment**. Once the trigger point is reached, the rate that is available to generators adjusts either upward or downward. France and Spain, for example, each previously indexed their PV feed-in tariff rates such that that the rate increased each year, whereas Germany’s adjustment framework has tracked downward in line with technology cost declines, with grid parity as the underlying target. Our view is that rates should generally decrease over time in order to chart a path to grid parity.

Automatic rate adjustments can be structured in a range of different ways. Examples include:

- **Uniform steps**. The rate adjusts by the same amount whenever a trigger point is reached. These steps may not necessarily be based on other market factors.
- **Experience curves**. The rate is set to decline according to the expected decline in a technology’s cost based on projected market volume, e.g. it is often cited that PV panel prices decline by 20% with every doubling of demand based on its experience curve.
- **Decreases pegged to market volume**. The rate declines based on the volume of the market in a prior period, e.g. the previous year. In 2010, the German PV adjustment schedule was set up such that the rate decreased by an additional 1% for each 1 GW above 3.5 GW installed in 2011 (see Section 1, page 18).

The TLC considerations related to automatic adjustments are summarized in the table below.

Exhibit 17: Automatic Adjustments

TLC		Discussion
Transparency	◕	Automatic adjustments generally provide a transparent framework for investors since they are specified in advance. The transparency of adjustments can depend on the frequency with which they occur. Frequent and/or unscheduled rate adjustments decrease policy transparency. Also, uncertainties in the adjustment formula can decrease transparency.
Longevity	◑	Establishing automatic adjustments is an inexact science, particularly for technologies with dynamic pricing (e.g. PV). With any automatic adjustment, there is the risk that the adjustment will "overshoot" the market and result in prices that are too low to support market development. This can adversely impact policy longevity, depending on whether or not the adjustment mechanisms correct themselves over time.

Source: DBCCA Analysis, 2011.

The Role of Reviews

In addition to automatic triggers and adjustments, formal policy reviews are included as part of many feed-in tariff policies. Policy reviews typically result in a binding change to the feed-in tariff. In our view, periodic review is a necessary part of ensuring that FiTs reflect market conditions and support policy longevity. At the same time, reviews can decrease transparency if not carefully structured. Several key design considerations include:

- **Triggers**. From an investor perspective, it is good to know ahead of time what triggers the review (see above). In Spain, for example, a PV review was triggered when installed capacity reached 85% of a 400 MW goal. In Germany, a review occurs every four years (i.e. a time-based trigger) in parallel with automatic annual adjustments. Recent significant drops in PV panel prices led to "out-of-cycle" or unscheduled reviews and adjustments in several countries, notably Germany and France.
- **Outcomes**. The range of possible outcomes should be communicated by policy makers so that the process does not appear to be a "black box" to the market. In some other countries it has been unclear whether the outcomes of a review could include rate adjustments, hard caps, and/or other fundamental policy changes (including policy curtailment).
- **Frequency**. The timing of the reviews can also have important implications for transparency. Overly frequent review cycles can create investor uncertainty, decrease policy transparency, and lead to a greater risk of stranded investment – i.e. projects that must be abandoned in the middle of development because of policy changes.
- **Sequencing**. In some countries, the reviews have been initiated while the feed-in tariff rates are still available. In other words, the feed-in tariff rate is available until the review is complete. In other countries, however, the feed-in tariff has been halted while the review takes place. From an investor perspective, review processes that progress in parallel with FiT rate availability are preferable to temporary FiT moratoria.

The optimal approach to setting targets and governing progress towards them ultimately depends on the policy objectives and constraints of a given country, as well as the specific technologies supported. From an investor perspective, time-triggered automatic rate adjustments based on volumes, whose calculation formulae are transparent and methodologically grounded, best deliver transparency. When combined with highly transparent, periodic reviews, such adjustments can provide the flexibility required to support policy longevity.

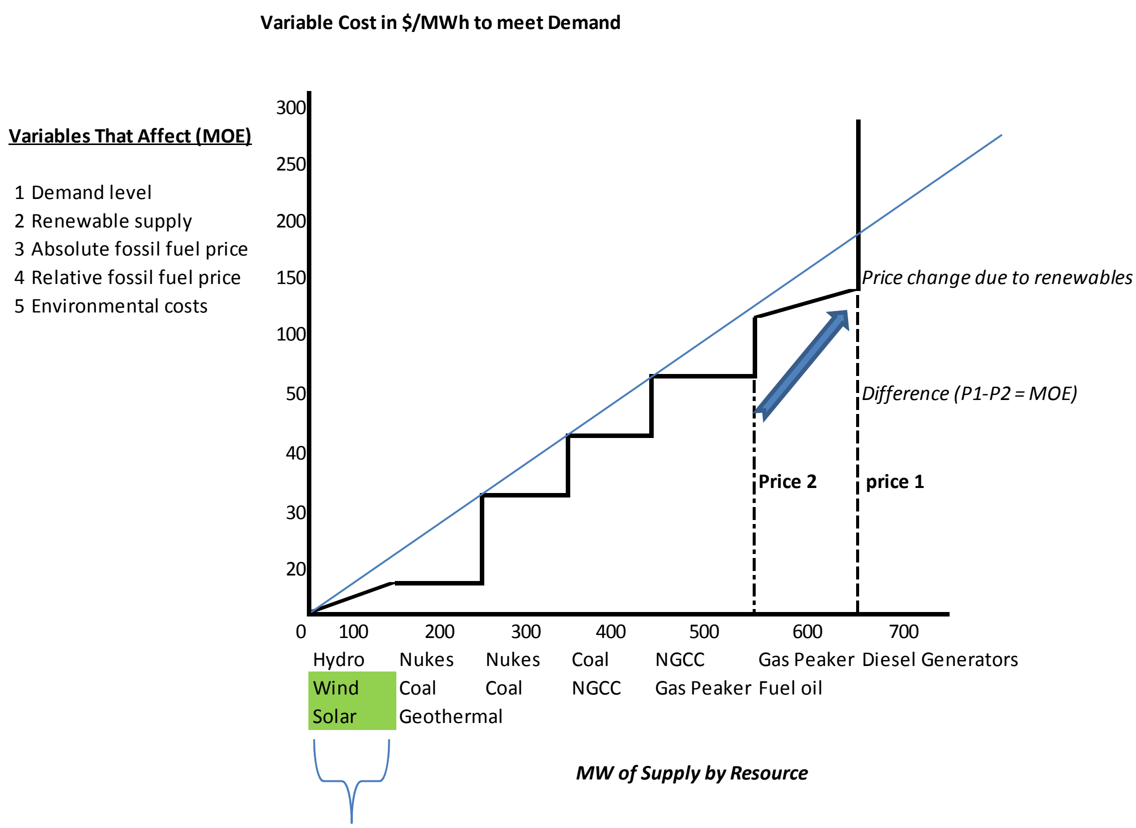
Appendix: The Merit-Order Effect (MOE)

Interactions between low-carbon policies designed to foster capacity additions of renewable energy (RE) and competitive wholesale electricity markets will shape the strategic landscape of the electric power sector in the years ahead, with far-reaching implications for investors, electric utilities, developers, and customers alike. Electricity market design and function is complex and wholesale power prices are an important system component as they impact new build decisions and bilateral contracts. Already in Germany, we have seen evidence of RE supply lowering wholesale power prices and power price expectations in the futures market. Power prices are determined by the marginal cost of production each hour needed to clear the market and balance supply with demand. Importantly, wholesale power markets and their impact on price are ***only one component*** of the systems cost of electricity, reflected in the retail, commercial or industrial price paid at the meter.

Increased RE supply, especially from wind and solar generation, is driving down power prices in wholesale markets due to the merit order effect, as RE substitutes higher marginal cost fossil resources. In Germany, RE has priority dispatch and therefore is always the first electricity supply delivered into the electricity grid. Consequently, RE has been displacing inefficient fossil fuel-fired generation and pushing the supply curve to the left as shown in Exhibit 18 below.

Exhibit 18: The Factors That Impact Merit-order Effect (MOE) in Wholesale Power Markets

Merit Order Effect (MOE) Impact on Wholesale Power Prices



Priority Dispatch--Acts as Demand Response e.g. reduces higher cost supply, shifting from P1 to P2

Source: Fraunhofer and DBCCA Analysis 2011

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