Accelerating the Deployment of Distributed Renewable Energy

Through Innovative Market-Driven Policy Programs

Travis Bradford and Jessica Lin,
Prometheus Institute

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CREDITS

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Executive Summary

Various governments throughout Europe and Asia have made strides in incentivizing distributed generation. Using the tools described above, this paper fundamentally analyzes the following questions:

1) What are the objectives of distributed renewable energy policy?

2) How do they conflict among stakeholder types?

3) Which elements have been used successfully to stimulate market growth?
4) Which policy type has the propensity to drive towards certain intended or unintended consequences?

One of the most robust conclusions of the study is that the ones that stimulated most growth over time have been **those that have chosen a portfolio approach**. One of the first integrated programmes in the world was the Japanese Sunshine programme which began in 1994. Japan had achieved market success and rapid deployment through a combination of system rebates (reducing upfront capital costs); net-metering (market enabler); project loan facility (financing options); and R&D programmes. Measured by originality and market growth metrics, this programme was a wild; success.

Subsequently, Germany deployed a combination of feed-in tariff (paying for output); interconnection (market enabler); and loan programmes (financing option) in 2004 in its revision to the EEG. While none of these was ideal, the combination created a fast growing market with over 45 percent of cumulative global PV installations to date.

While it is useful to understand how the combination of various programmes unlocked growth in some markets, **most analyses of the "success" of policy programmes still focuses on the volume deployed over a discrete time period as the only**

metric. This report suggests that defining success is still a matter of perspective, and different stakeholders' objectives interpret "success" differently.

Rather than normatively deciding which metric of success is the correct one, this paper looks at the metrics used by the three archetypical perspectives on objectives and concludes that it is not yet possible to determine success of the current "leading" programmes, as three important outcomes of current programmes are still not known, including:

- Eventual market size and robustness
- Eventual total cost of programme - or net cost versus displaced sources
- Future possibility of political backlash by ratepayers or policymakers.

In fact, the most recent evidence of the Japanese programme is that since it ended in 2005, the market has shrunk and has not shown an ability to stand on its own – quite possibly a failure from the perspective of establishment of robust, unsubsidized markets beyond theh programme horizon.

The current risk of unintended consequences is that programmes that are too focused on short-term growth – too weighted toward the objectives of "strict growth advocates" – **may grow too fast by being too rich in terms of the level of payment, and may yet limit market growth over a longer time horizon when the inevitable backlash occurs**. Recent experience in Spain with a boom-bust cycle and the institution of a market cap in 2009 and beyond is an example of this outcome. A global market relying on Germany for continued growth is highly exposed to a similar outcome there.

An alternative strategy would include more use of market enablers and innovative financing programmes, which are both the cheapest and broadest way to stimulate growth, though perhaps not the fastest. Compromising to meet mutual objectives may end up creating more robust and larger markets for distributed renewable energy over time.

1 Introduction and Methology

The world is rapidly moving toward increasing penetration of smaller, more local sources of energy. From solar energy to biomass and bio-fuel to small geothermal and wind systems, energy users are increasingly attempting to harness local resources to cost effectively provide them with vital energy. Governments around the world want to accelerate this transition for many, and sometimes conflicting, reasons. Policy makers are looking to maximize a number of variables simultaneously in their pursuit of good renewable energy policy, and different stakeholders as identified in this report may have different objectives about the intended outcomes of optimal policy.

The idea that motivated this study involved the existence and design of an optimal policy for building robust markets for distributed renewable energy solutions, specifically energy technologies that can be adopted at the point-of-use by energy users (as opposed to energy utilities) that are carbon-free and renewable.

While many technologies exist to fill this need, no technology has had such broad penetration and support around the world as direct electricity generation from the sun, or photovoltaic (PV) electricity. From Japan and Germany to Spain and the United States, PV has seen tremendous growth, averaging 25 percent growth for the last 25 years. Industry growth has accelerated in the last decade to over 40 percent annually, due mostly to aggressive policies of the nations of Japan, Germany, and Spain, as well as a few of the states in the United States including California, New Jersey, and Hawaii.

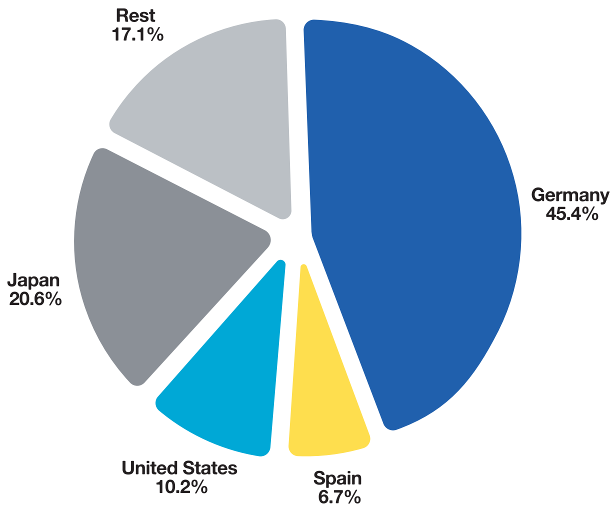
Though each has been successful in deploying distributed PV, no two of these actors has achieved it in exactly the same way or with exactly the same policy frameworks. Many other places have tried variants of these strategies and failed to stimulate similar growth. The purpose of this study is to understand why, in order to help inform policy makers in structuring new or modified programmes in the years ahead.

1.1 Methodology

To begin to understand the nuances among programmes, it is necessary to first identify and categorize various types of policies that have been successful in accelerating the deployment of distributed generation systems. In this paper we have provided case studies of leading policies in various countries (in Asia and Europe) and states (in the US) that have been on the forefront of solar manufacturing and adoption for distributed generation.

By including the policies – past, present, and proposed – of Japan, Germany, Spain, and various US States, these policy regimes *cover over 82 percent of distributed PV ever installed (Figure 1)*, comprehensive enough to make some assessment and generalization about policies that were effective in stimulating the development of the global PV industry. While it may be telling that 13 policy programmes have driven so much of the global market, it is the similarities and differences in design that are most revealing.

Figure 1: Cumulative PV Installations globally through 2007, by country



Source: Prometheus Institute

Next, by developing the taxonomy of policies which we intend to evaluate, this paper finds that each of the policies fit into one of four categories: 1) market enablers, 2) those that reduced upfront costs, 3) those that paid for output or 4) innovative financing options, which reduced the cost of capital. There are far more policies that enable markets or reduced upfront costs than newer polices that provide more innovative financing simply because the innovative financing options are a newer model and there are fewer examples available. In the final analysis, we tried to compensate for this uneven distribution by taking the average score of each type.

Our framework also included an analysis of the stakeholders involved. The difficulty with the stakeholder analysis is that the views of typical stakeholders – including companies, consumers, policy makers, utilities, etc. – do not easily break down into categories. It is easy to construct a scenario where any of these stakeholders might be conflicted – for example, a company may want to see both fast and stable market growth which are likely to be in direct tension.

So instead of developing objectives by stakeholder class, this analysis has chosen to use three archetypal points of view for our stakeholder assessment including: 1) strict growth advocate, 2) marginalist policy maker, and 3) economist or industry purist. By using this breakdown by interests, rather than function, we hope to have assessed the categories of stakeholders varying interests.

With our taxonomy and stakeholder assessment in mind, we defined the policy objectives that should be the target of each policy. There are approximately ten criteria (dimensions for measuring policy “desirability”) that are broken up among the three “archetypal” stakeholder groups, including:

- The **strict growth advocate.** This might include either an environmentalist or energy security person that would be most concerned about how much displacement of traditional energy with renewable energy there is, how quickly the policy decreases the time-to-market for deployments, and whether the policy increases political buy-in or the likelihood of passing the legislation. Essentially, this is a group that favors more and faster deployment, with less concern about the near term economic impact – or perhaps those who see the cost of slow growth to outweigh even a high cost of acceleration.

- A **marginalist policy maker** is more concerned about the social impact of change, including the degree of local job creation, the level of improvement of deployment economics or lessening the amount of public funding spent on incentive programmes. While probably not philosophically against renewable energy, clean energy goals are one of many competing policy concerns that must be traded off to get political buy-in and must use the limited resources available to best effect, even if such an approach might delay industry growth. This is a preference is for low-impact growth over any growth.

- An **economist or industry purist** would be most concerned about the degree to which policy developed a long-term, local sustainable markets for these technologies, increasing overall confidence through development of stable markets, lessening the amount of distortion caused by the policy and creating a robust and less centralized energy architecture to ease long-term adoption of these technologies. For these users, speed is not the appropriate proxy for market growth, but rather focusing on momentum and long-term reliable growth.

These three groups of priorities roughly mirror the tensions defined for general sustainability, as shown in Figure 2. For any given policy, many of these policy objectives may be in tension with one another. We explore the degree to which these aims are divergent as well as the places where they converge.

2 Frameworks for analysis

2.1 A taxonomy of policy pathways

There is enormous confusion about what is meant by an energy subsidy and limited information about the size of such subsidies. The narrowest and perhaps most commonly used definition is a direct cash payment by a government to an energy producer or consumer. But this is just one way in which governments can stimulate the production or use of a particular fuel or form of energy.[1]

Categorization of the existing and proposed programmes is necessary to group existing programmes by their design elements, as well as to begin to understand how each of these categories meets the various objectives stated above.

It is often difficult to find a single policy to equally meet all of these objectives, and a portfolio of them will eventually be required. Broadly, there are four classes of policy that are examined in this paper:

a. Market Enablers

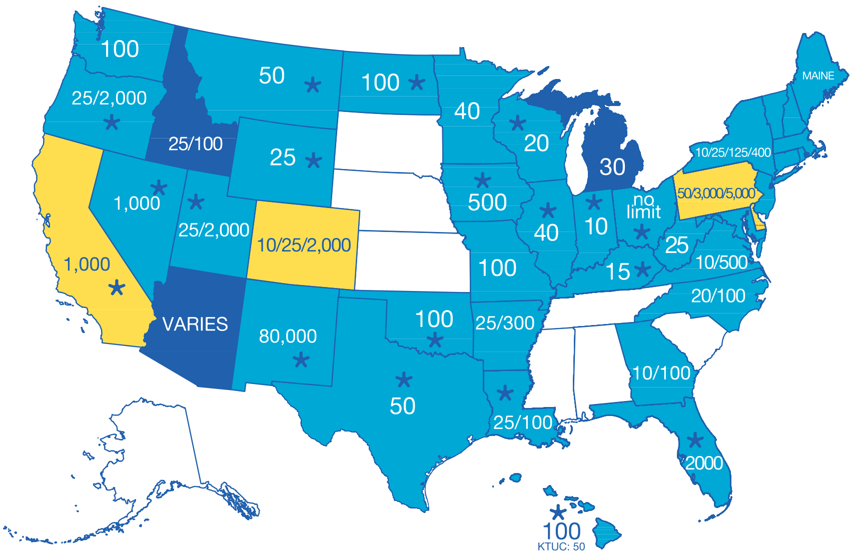
Being able to supplement existing energy producers in a fair and economic manner is vital to distributed energy technology success. Grid interconnection, fair payment for energy or electricity, and allocation of costs and value must be addressed before local alternatives for energy generation can develop into a robust market.

In this paper we have reviewed both California's and New Jersey's net metering programmes as examples of market enablers not only because these states have the best practice policies in place, but they also had the top number of MW installed in 2007 with 87.1 MW and 16.4 MW, respectively. However, there is a broad range of market enabling policies. While we have chosen to focus on net metering laws, net metering or allowing customers to generate their own electricity and store any excess electricity, usually in the form of a kWh credit-on the grid for later use, would not be possible without interconnection standards. Net metering is available in 42 states + DC, but state policies vary dramatically. Best policies are adopted by CO, NJ, PA, MD, CA.[2] The success of these programmes are also highly dependent upon the way in which rates are designed.

Figure 2: Net Metering Laws

Best Practices | State-wide net metering for all utility types | Net metering offered voluntarily by one or more individual utilities

★ State wide net metering for certain utility types only (e.g., investor-owned utilities)



VT: 250 **NH:** 100 **MA:** 60* **RI:** 1,000/1,650* **CT:** 2,000*
NJ: 2,000* **DE:** 25/500/2,000* **MD:** 2,000 **DC:** 100 **VA:** 10/500*

Net metering is available in 42 states + D.C.

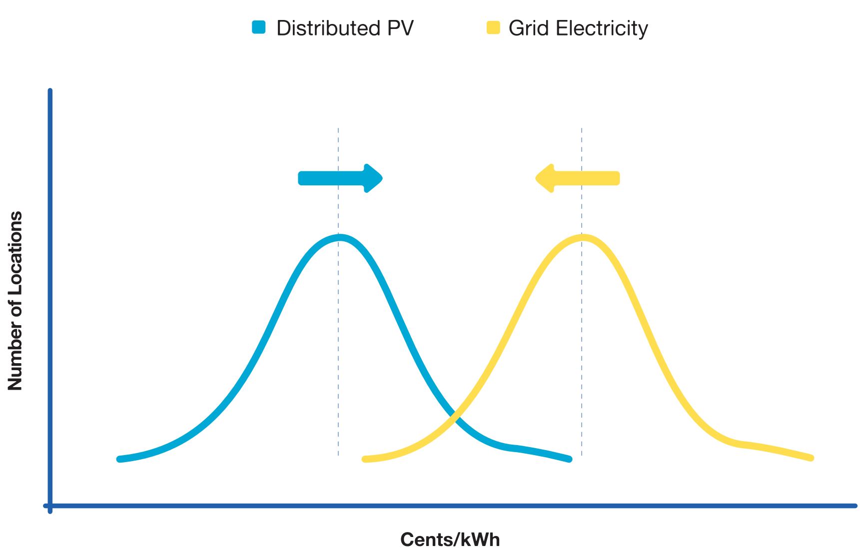
Source: DSIRE: www.dsireusa.org

In theory the deregulation of many countries, including the US, the UK, Chile, Australia, New Zealand, Japan and Finland should have decreased costs through increased competition. In practice, however, it has developed its own set of poorly structured incentives that still threaten the electricity infrastructure. For example, the current average age of the US electricity grid's components is increasing with some sections over 75 years old.[3] Aside from underinvestment in the energy infrastructure, critics argue that poorly designed deregulation has increased the volatility of electricity prices, such as the California energy crisis of 2000 and 2001. While we have not included as many policies in this paper that do so, policies that intend to restore aging grid infrastructure would also be considered a market enabler.

b. Reducing upfront costs

Two primary paths for improving the economics of distributed energy involve either buying down the upfront system costs or paying for the output of the energy generation in whole or part, thereby creating a reliable stream of revenue for the system owner. There are many examples of each strategy around the world, but these two choices both have the potential to distort markets if structured incorrectly. The long term implications of both, as well as the determinates of their success need to be understood if distortions are to be avoided. These policies can directly affect the criticism that alternative energies are not on grid parity with traditional fossil fuel sources.

Figure 3: Range of PV Prices vs. Range of Local Grid Prices

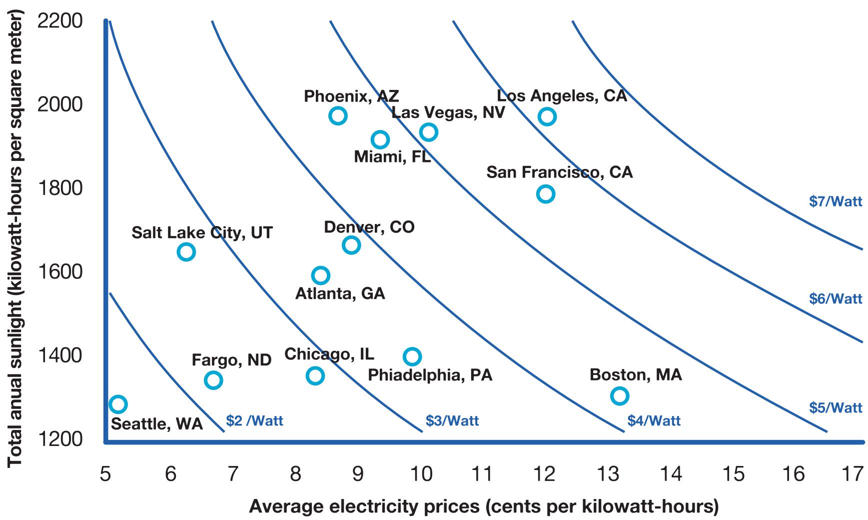


Source: World Solar Energy Market Update – Technology, Performance and Cost, Travis Bradford.

However, there are market enabling policies such as components of the 70,000 Roofs programme in Japan that have driven down the price of installations over time. There are a number of ways to get to grid parity. Either the price of traditional grid electricity can increase or the higher price of alternative fuels can be subsidized.

For example, in Europe, by 2020, 20-30% of energy needs could be met easily by solar, in part because of the high prices of energy in Europe. Similarly in the US, because of the varying prices of energy, many markets will be cost efficient soon.

Figure 4: Iso-Cost Curves for Solar



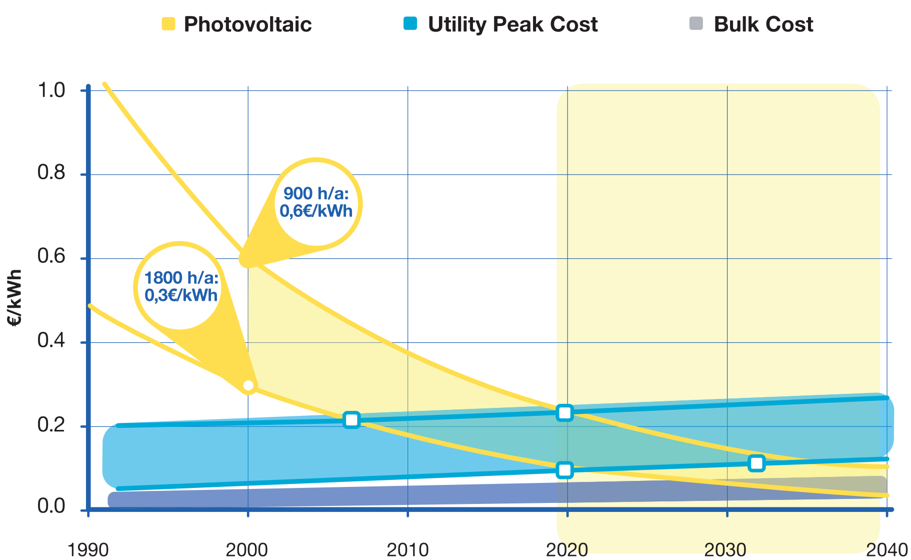
Source: Travis Bradford, Solar Revolution

Policies that reduce upfront costs will be most effective in countries or states that already have a high cost of electricity, such as Japan, Germany or Hawaii. In fact, two of the best examples of such policies are Japan's 70,000 Roofs programme, Germany's 100,000 Roofs programme. The US Federal Investment Tax Credit is another example of a policy that reduces upfront costs as well as parts of the California Solar Initiative.

c. Paying for output

If a cash upfront payment to reduce the installed system price due to lack of available political will or funding, then paying for output is another alternative to driving towards grid parity.

Figure 5: EPIA Scenario - Europe



Source: European Commission/ EPIA

Examples of policies that pay for output include: German EEG Feed-in tariff law and the law's predecessor, the German StrEG, as well as Barcelona's Solar Law. While these laws have been most effective in driving market growth internationally, their success is in part due to the consistent nature of the policies. They guarantee over 20 years of paybacks whereas other rebate programmes. Cash rebates generally pay customers some cost per kW on certification of the finished system. Even though rebates offset the initial cost of PV systems, they do so based on the expected output of the systems.

d. Innovative financing options (to reduce cost of capital)

With such large up-front capital expenses for these emerging distributed energy solutions, clever policy to aid in access to and cost of financing have a tremendous ability to accelerate their adoption. While many of these do not yet exist at large scale, many new and innovative approaches are being tested worldwide that can serve as models for future programmes.

Examples of these policies include: New Jersey's Solar Renewable Energy Credits programme, Berkeley's solar financing programme that was just signed into a mandate for the entire state, the California Zero energy homes mandate and Hawaii's Construction mandate for solar thermal. Although these programmes are too new for us to begin to understand their complete impact, in terms of scale, these mandates could have some of the farthest-reaching implications in terms of creating markets.

The goal of these policies should be to help create large-scale global markets for procuring the technology and components (driving down costs through scale of production) as well as local distribution and installation architectures (creating local resources, jobs, and income). But it requires understanding both the various stakeholder objectives to be met, and the real world experience of these programmes to determine which programme is "best" for distributed renewable energy.

2.2 Stakeholder Assessment

Defining the various stakeholders allows for two important insights – first, how the stakeholders are influenced and advantaged by the various policies, and second, the extent to which all (often conflicting) stakeholders' needs are being addressed in order to avoid resistance or unfair effects of policy programmes.

Some of the most glaring trade-offs include:

- Speed of market development VERSUS breadth of opportunity
- Targeted growth VERSUS minimizing distortions
- Low overall programme cost VERSUS fast green-sector job creation

The table below represents the possible weighting of the roles and key participants in furthering the successful development of small-scale hydro power (SHP) in Europe. Although hydropower is the largest and most mature application of renewable energy, with 678,000 MW of installed capacity, producing over 22% of the world's electricity (1564 TWh/year) in 1998[4] or 19% of EU electricity, there is still much room for additional deployments. It is estimated that only 10% of the world's total viable hydro potential is currently exploited.

Small-scale hydro power (SHP), or hydro systems rated at 10MW or less[5], is mainly 'run of river' and does not require the construction of large dams and reservoirs. In Europe, small hydro provides over 9 GW of capacity, which contributes over 30 TWH to the EU's electricity supply. There is an estimated extra 9 GW of European small hydro potential. The European Commission announced a target to increase small hydro capacity by 4200 MW by the year 2015[6]. European manufacturers dominate the world market for SHP equipment. Total employment from this sector in Europe has been estimated at 10,000 workplaces[7], and turnover at present is of the order of 400 million euros per year.[8]

Table 1: Weighing Scale for Role of Participants in Development of Small Hydro in Europe[9]

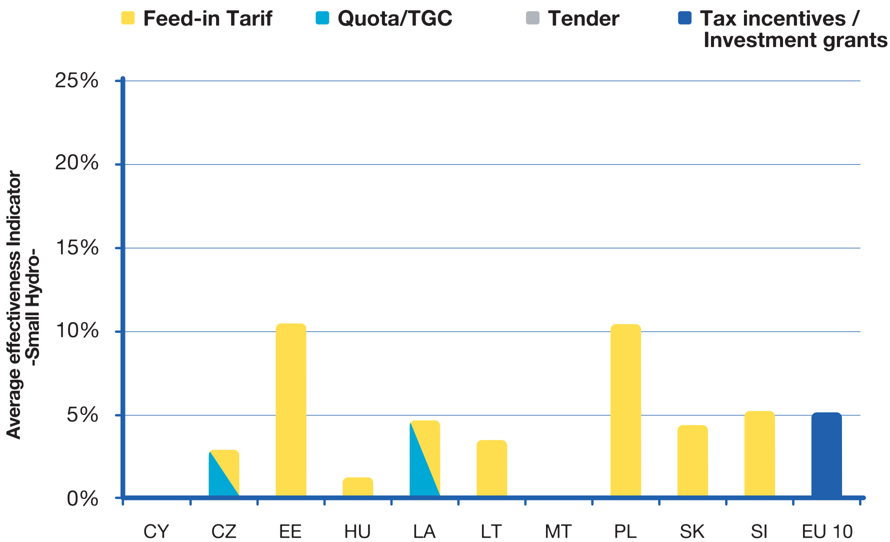
Key participants	Research	Development	Demonstration	Dissemination	Market Penetration
Research Centers (public)	1.0	1.0	2.0	1.0	
Industrial / professional associations				3.0	3.0
Financiers		1.0	0.5		3.0
Utilities	2.0	2.0	3.0	3.0	3.0
Local authorities			2.0	2.0	2.0
Regional authorities	1.0	1.0	3.0	3.0	2.0
National authorities	3.0	3.0	2.0	2.0	2.0
EU Institutions	1.0	1.0	3.0	3.0	
Consumer Associations			0.5	2.0	3.0
Civil society (NGOs, environmentalists, etc.)			1.0	3.0	2.0
Media	1.0	1.0	1.0	3.0	2.0
Manufacturers	2.0	2.0	3.0	3.0	3.0
Consultants	1.0	2.0	0.7	1.0	2.0
Installers/developers				0.7	3.0
Training/education centers			0.5	0.7	

(1=low, 2=medium, 3=high)

Source: Eurec Agency, Future for Renewable Energy 2: Prospects and Direction, UK, 2002

For the purpose of this paper we will not focus on research, development and demonstrations, but the maturation of these buckets will inevitably influence the market penetration. Part of Japan's market penetration of solar is the fact that the original sunshine project subsidized research and development projects for over 20 years while the market was gaining buy-in from kereitsu-like organizations that inevitably affect other sectors of society's embrace for renewables. While we acknowledge this contribution, we are focused primarily on those policies that directly effect deployment, such as the policies below.

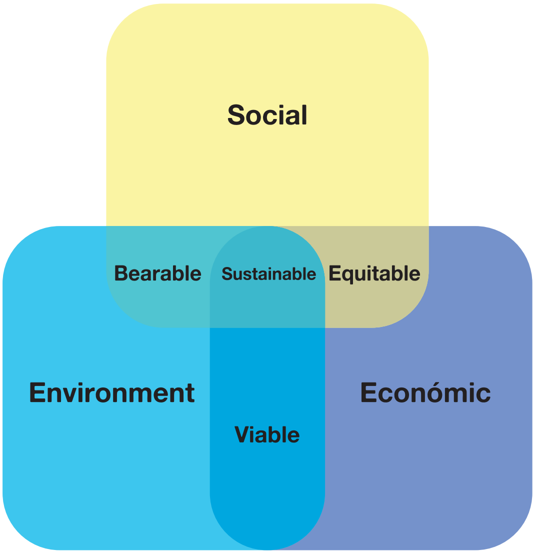
Figure 6: Effectiveness Indicator



Source: European Commission: Brussels, December 2005.

In addition, we have found that any given market participant, such as a utility could have two points of view on an issue. As a result, we are not limiting our scope of stakeholders to specific participants, but will instead focus on the interests of the participants. We find that there are three major categories of interests that we will focus on: 1) environmentalists/energy security, 2) fiscal conservatives/policy makers, and 3) economists/industry. While some of these groups will have overlapping interests, they are generally divergent. We explain this further in the next section.

Figure 7: Three Facets of Sustainability



Source: Wikipedia

2.3 Distributed, renewable energy policy objectives

This section will describe the (often conflicting) goals of distributed renewable energy policy. By defining the various inherent objectives of policy, these goals can be explicitly measured to determine efficacy of programmes and suitability for meeting the various needs.

For the purpose of this study, we focused on policies that directly incentivise distributed generation. However, various interest groups are apt to prioritize certain goals more heavily. While many of these represent archetypes of behavior and preference, many people share conflicting objectives and could find resonance with all of these objectives.

a. Strict growth advocate

A “strict growth advocate” might include either an environmentalist or energy security person that would be most concerned about:

1.a. Displacement of traditional energy with renewable energy - (more)

1.b. Decreasing the time-to-market for deployments – (faster)

1.c. Increasing political buy-in or the likelihood of passing legislation– (likely)

For environmentalists or those interested in energy security, the displacement of traditional energy with renewable energy will be a top priority. Ultimately, these individuals are searching for ways to increase the amount of clean energy as quickly as possible. In order to accomplish these goals, there must be enough political will to pass the legislation.

Today with the general acceptance of global climate change and rising fossil fuel prices it is easier to get buy-in to pass environmental legislation than it was 20-30 years ago. That said, any policy, especially those dependent upon large numbers of varying types of stakeholders, will need buy in order to get passed.

b. Marginalist policy maker

A “marginalist policy maker” is more concerned about the social impact of new policies including:

2.a. Decreasing the amount of public funding spent on incentive programmes – (less public $)

2.b. Improvement of deployment economics – (cheaper)

2.c. Creation of local jobs – (employing)

Decreasing the amount of administrative burden definitely aids in the ability to execute a given policy, but there are also other economic considerations that could aid in decreasing the time to market. If the price of a renewable option is on par or less than a traditional source then it is more likely to get adopted quickly. There are generally two ways to do so. Either one can increase the incentive to the renewable source to make it cheaper or take away the incentive for a traditional or competing source, thus increasing its price above that of renewables. Because of this tension both improving deployment economics and decreasing the amount of public funding spent on incentive programmes are equally weighed as secondary objectives of fiscal conservatives and policy makers, respectively.

Both groups would also be concerned with the effect of policies on the general economy as well. Clean technologies, such as solar, generally create comparatively more jobs than fossil fuels. Fiscal conservatives and policymakers alike will see this as a policy priority.

c. Economist or industry purists

These interests are most concerned about the degree to which policy develops stable and long-term growth for markets. Economists and industry interests will have the following priorities:

3.a. Development of long-term, local sustainable markets for these technologies - (robust)

3.b. Increasing investor confidence by stabilizing the markets – (low risk)

3.c. Decreasing the degree of distortion in the markets – (less distortive)

3.d. Creation of a robust and less centralized energy architecture to increase stability and ease of adoption – (broader)

Economist and industry interests would be most concerned with the long-term implications of policies that are set today. Their top priority is whether a policy has the potential to create a long-term, local sustainable market for renewable technologies. Even some market based solutions like New Jersey's Solar Renewable Energy Credit programme had a subsidized precursor programme called CORE. There are many such policies that use incentives to incubate markets. During the short term, these subsidies should aim to increase investor confidence by stabilizing the markets evenly over a long enough time horizon. In the long term, a policy maker would hope to be able to decrease the degree of distortion in the markets that are caused by a subsidy. A ratcheting down of subsidies or the degree to which one is able to make the transition to market based economics is a secondary goal that is in conflict with even distributions over the life of a policy, but we will measure both equally as sub goals of a robust long term market. Part of the long-term solution is also the creation of a robust and less centralized energy architecture, which will inevitably increase stability, and ease of adoption. Ease of adoption is therefore a secondary goal. Many policies have the ability create a finite demand at a cost, but the true test of sustainability will begin after the subsidies expire.

There are many means to incentivising deployment that are intentionally not measured in this paper. In particular, R&D is generally acknowledged to be one of the most important factors in creating new markets despite its disproportionately longer time horizons. We have not investigated policies such as the Japanese sunshine project that was responsible for nearly two decades of R&D that did not initially grow the commercial market, but definitely contributes to the fact that Japan is the main producer of PV today. In addition, we have not explored the extent to which in Europe, many government led policies have largely been initiated in response to EU directives. Spain's feed-in tariff policy is an example of a country that was not an early adopter of renewable policies, but that did conform once there was a portfolio standard to achieve. We are not looking at the effect of renewable portfolio standards, but do acknowledge that this is a driver of deployment incentives or other demand driven policies such as the RPS' of various states in the US. A cap and trade programme which counts the amount of carbon and charges for the amount of fossil fuel consumed is also an example of an overarching driver of policies that incetivise distributed generation. Again, by increasing the price of a competing technology the economics of renewables look better. Where possible, we have focused most specifically on the amount of growth that was possible over a specific time period due to a certain policy and that policy's lasting impacts, if available.

2.4 Frameworks for determining cost and value of different policy approaches

Aggregating the policy objectives across the various approaches and looking at the effects on various stakeholder groups allows for developing a comprehensive framework for evaluating the aggregate costs and benefits of various options. Above, we evaluate each actual programme on its own design and implementation merits, but here we force ranked the programme types on a scale of 1-4 with 4 being the best and 1 the worst to develop the rating of taxonomy below.

Two cautions are in order here. First, this preliminary analysis is intended to show how the various stakeholder desires above can be in conflict across different programmes types and is used only to begin to understand the conflicting objectives of various participants. It is not intended to be a determinative analysis of better or worse, more an attempt to show how things that are optimal in some dimensions may or may not be good across a broad range of objectives.

Second, specific programme characteristics are what determine the actual scores across the various individual and classes of priorities, not simply the type of programme, and so any real comparison must be done by programme type. An analysis of this type is attempted in a later section comparing the actual programmes in Japan, Germany, Spain, and the US.

Table 2: Strict Growth Advocate

Taxonomy	1a. More	1b. Faster	1c. Likely	Average score
Market Enablers	1	1	4	**2**
Reducing Upfront Costs	2	4	3	**3.0**
Paying for Output	3	3	2	**2.7**
Financing Options	4	2	1	**2.7**

- Most programmes that create economic incentives (i.e. buy-downs, or feed-in-tariffs) are easier to implement and can scale rapidly.
- Market enablers are easy to implement, but do not inherently grow the market.
- Innovative Financing programmes are very hard to implement, but can be powerful growth catalysts. (It is important to note that stand-alone financing programmes are only now becoming widely attempted, but they have played strong enabling roles in programmes from Japan to Germany.)

Table 3: Marginalist Policy Maker

Taxonomy	2a. Employing	2b. Cheaper	2c. Less public $	Average score
Market Enablers	1	1	4	**2.0**
Reducing Upfront Costs	2	4	2	**2.7**
Paying for Output	4	2	1	**2.3**
Financing Options	3	3	3	**3**

- Ideally, high impact per dollar spent is desired, and financing and market programmes score well on those metrics.
- Must be traded off against the degree to which the programme changes the “economic decision” of customers.
- Simply, more incentives create more demand, but at a rising cost to taxpayers or ratepayers.

Table 4: Weighing scale for role of participants in development of small hydro in Europe[9]

Taxonomy	3a. Robust	3b. Easier	3c. Evenly	3d. Less Distortive	Average score
Market Enablers	3	4	3	3	**3.25**
Reducing Upfront Costs	1	3	1	2	**1.75**
Paying for Output	2	2	2	1	**1.75**
Financing Options	4	1	4	4	**3.25**

- The best programmes will create broad, sustainable markets for deployment – minimizing distortions.
- To do this, they must appeal to a wide range of adopters, so must be simple and fair.
- One significant negative for the most aggressive programmes is the potential for political backlash (particularly as programme costs grow), i.e.:

  - Capping of the Spanish FIT in 2008.
  - Potential for the same in Germany.

Table 5: Rating of Taxonomy of Policies: Stakeholder Assessment

Taxonomy	Growth Purists	Policy Makers	Economists/Industry	TOTAL
Market Enablers	2.0	2.0	3.3	**7.3**
Reducing Upfront Costs	3.0	2.7	1.8	**7.5**
Paying for Output	2.7	2.3	1.8	**6.8**
Financing Options	2.7	3.0	3.3	**9.0**

3 Existing and proposed programmes

In this report, we have evaluated the following thirteen programmes, which combined cover some 82 percent of all cumulative PV installations to date, and over 85 percent of the current PV annual market worldwide. For the figure below, we have also listed how each of the programmes breaks out by classification category.

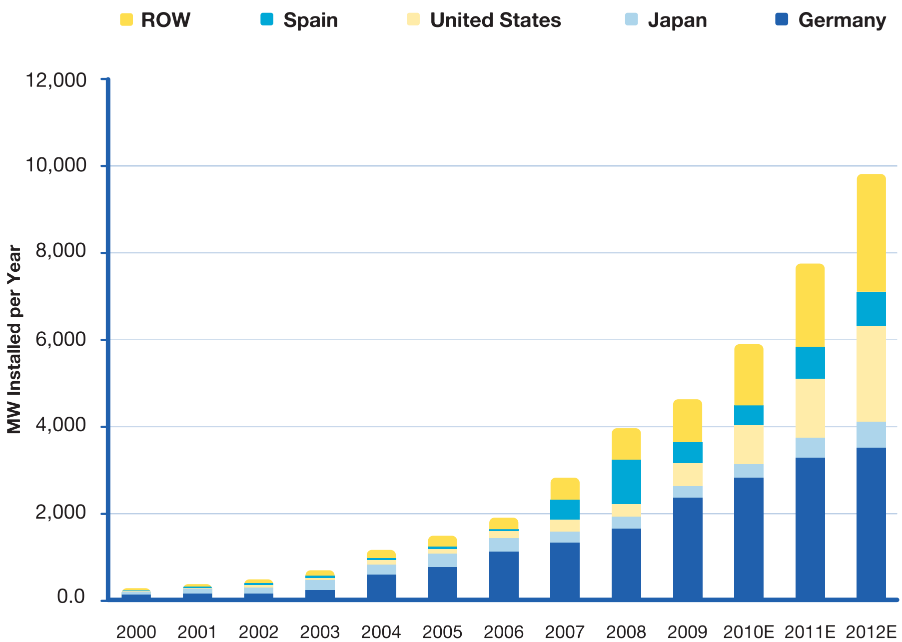
Table 6

Country/State	Programme Name	Classification
Japan	70,000 Roofs Programme	Reducing Upfront Costs
Germany	Federal Electricity Feed Law (StrEG)	Paying for Output + ME
Germany	100,000 Roofs Programme	Innovative Financing
Germany	Renewable Energy Law (EEG)	Paying for Output +ME
Spain	Royal Decree 436/2004	Paying for Output
US - Federal	Investment Tax Credit	Reducing Upfront Costs
California	California Solar Initiative	Reducing Upfront Costs
California	CEC New Solar Homes Partnership	Reducing Upfront Costs
California	Net Metering	Market Enabler
California	Berkeley First	Innovative Financing
New Jersey	Net metering	Market Enabler
New Jersey	Solar Renewable Energy Credits	Innovative Financing
Hawaii	Solar Thermal Mandate	Innovative Financing

To design our list of policies we used as a first cut the amount of consumers and manufacturing of PV systems. Japan and Germany are two countries that stand out as having put in place policies that have created local markets for distributed generation. Next the US with 9% of the PV manufacturing was disaggregated and we found that California and New Jersey are the two leading manufacturers.

So after Japan, Germany and Spain, we disaggregated the US markets and focused on the top five markets: Florida, California, Arizona, Hawaii and New Jersey. California was chosen because its policies have always been on the forefront and similarly New Jersey was our second choice in states. This is a subjective measurement, but we did not focus on Florida or Arizona whose policies are not as robust.

Figure 8: Global Annual PV market



Source: Prometheus Institute.

Germany and Japan have taken the lead in solar manufacturing and installations because of long-term national incentive policies designed to make solar power mainstream. Germany incentivizes solar installations by paying 3 – 4 times retail electric rates for the electricity generated from PV systems, while Japan instituted a carefully designed rebate programme that phased out over the last ten years.[10]

The United States, on the other hand, offers a patchwork of more than 50 distinct markets, each with its own interconnection and net metering rules, and until 2006 had no incentives for individual installations of solar. Yet, states have increasingly invested in solar power development; in the past decade, the number of states with solar rebates has risen from just one to 26, and the number of states with net metering increased from 11 to 36.[11]

Table 7: Key Economic Indicators of Case Study Countries, 2005

	GDP (constant 2000 US$ billion)	GDP per capita (constant 2000 US$)	Population, total (million)	Surface area (sq. km)	Electricity producction (kWh), billion	Electric power consumption (sq. billion)	Population density (people per sp. billion)
United States	**10,995**	**37,084**	**296.5**	**9,632,030**	**4,268.4**	**4,046.6**	**32**
Japan	**4,978**	**38,962**	**127.7**	**377,910**	**1,094.2**	**1,051.9**	**351**
Germany	**1,961**	**23,788**	**82.4**	**357,050**	**613.2**	**586.4**	**236**
Spain	**680**	**15,688**	**43.4**	**505,370**	**290.6**	**266.8**	**87**

Source: World Bank, World Development Indicators, 2005

3.1 Asian Policy Initiatives

In Asia, most activity has centered on the manufacturers with very little consideration to end use deployment. Older programmes centered on self-liquidating rebates, but newer programmes are following the European feed-in tariffs.

a. Japan

Japanese electricity prices have been significantly reduced from their peak levels. However they remain most expensive among IEA countries for all consumer types if exchange rates are used. If purchasing power parities are used, Japanese electricity prices for household consumers are 35% lower than in Germany and 27% lower than in the US.

There are several reasons for the high prices[12]:

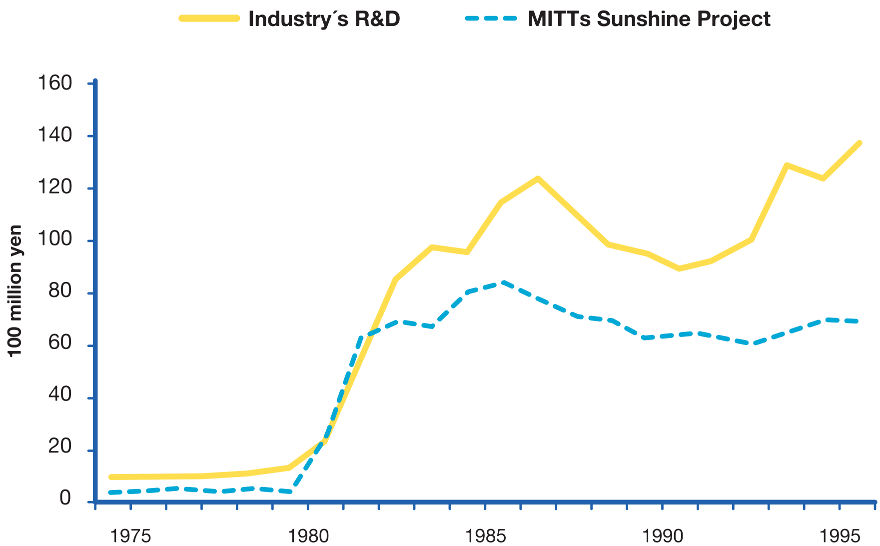
- High generation capital costs.
- High fuel costs
- High transmission and distribution costs
- Regulatory costs
- Low load factor
- Specific taxes
- Development of Renewables

Background:

Due to the lack of domestic resources and the growth of energy demand, Japan has heavily relied on imported primary energy sources. The Oil Crises of the 1970's had a tremendous impact on the economy that was highly dependent on oil from the Middle East (more than 70% of the primary energy in the early 1970's). This made energy security one of the top issues of the nation, and the government began increasing energy supply from gas, coal and nuclear, as well as increasing energy efficiency and investing in "new energy" development, such as solar and geothermal energy. PV development in Japan was started just after the Bell Institute invented silicon solar cells in 1953.[13]

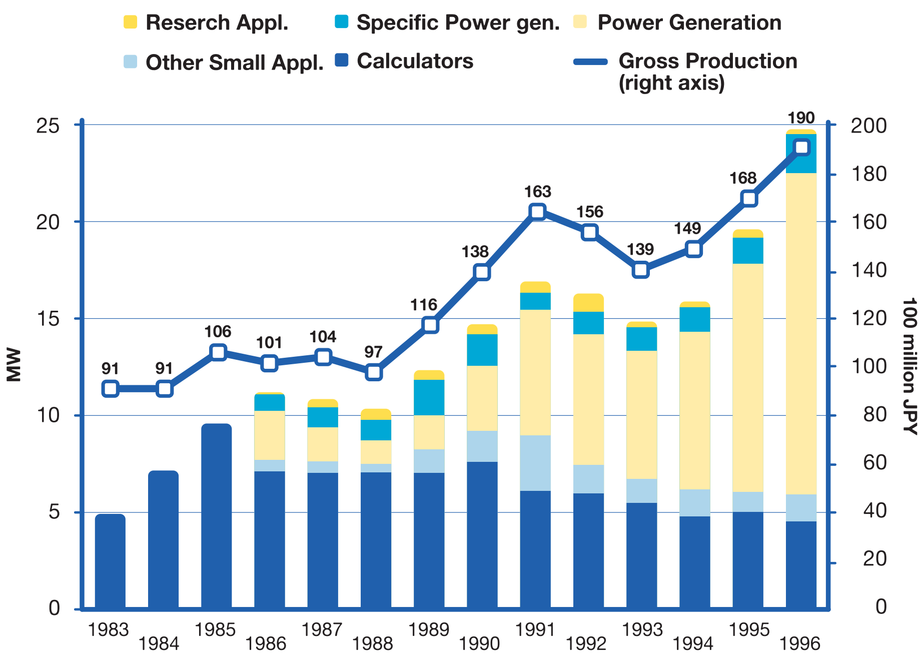
Private firms were supported by the R&D incentives provided under the Sunshine Programme from 1974 – 2004. The Programme promoted not only basic R&D but also a number of demonstration projects, including distributed small applications as well as a large-scale solar generation plant (1 MW plant in Saijo City). The result was the steady improvement of conversion efficiency and economics of PV in the 1980's.

Figure 9: Trends in R&D Expenditure for PV R&D in Japan (Adopted from Watanabe, 1999)



Source: Kimura, Osamu and Suzuki, Tatsujiro, Berlin Conference on the Human Dimensions of Global Environmental Change: "Resource Policies: Effectiveness, Efficiency and Equity", November 2006.

Figure 10: Trend of PV Production in Japan, 1983-1996 (Source: NEDO 1995, 2000)



Source: Kimura, Osamu and Suzuki, Tatsujiro, Berlin Conference on the Human Dimensions of Global Environmental Change: "Resource Policies: Effectiveness, Efficiency and Equity", November 2006.

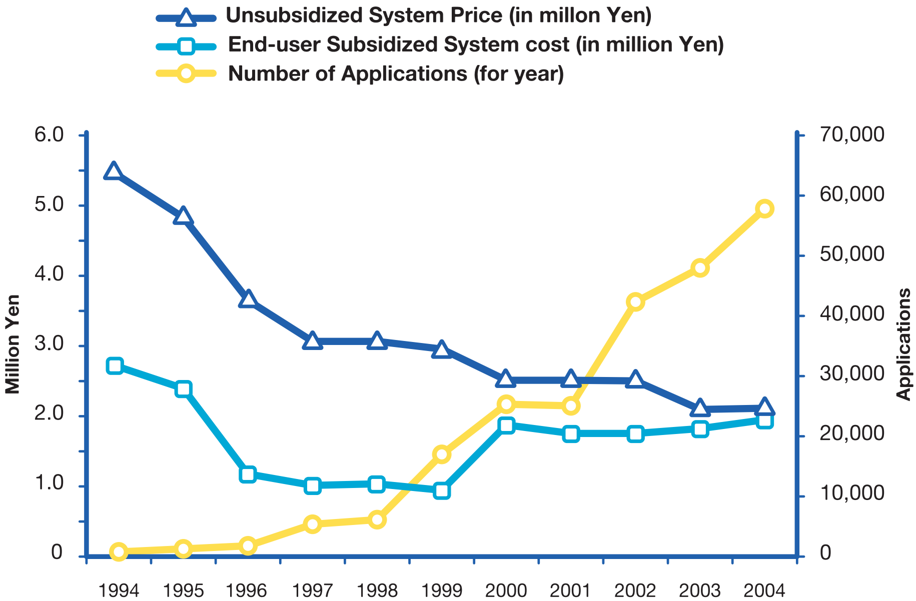
With broad support from universities, local governments, and businesses (including its highly integrated kieretsu holding companies), the Japanese government has sought to create a domestic manufacturing base to provide low cost PV solutions for both domestic electricity generation programmes (which originally paid up to half the cost of domestic PV systems), and incentives for business to adopt PV.

Programme: **70,000 Roofs Programme (1994-2005)**
Classification: **Reducing upfront costs**

1. Motivation:
In 1994, MITI and NEDO were under strong public pressure because despite USD$5 billion of investments in R&D through the Sunshine Programme over 20 years, almost none of the technologies had entered the market. After the announcement that MITI would request appropriation for the 700 Roofs Programme in 1993, PV producers quickly organized mass-production lines for their residential PV systems. The three major producers, Kyocera, Sanyo and Sharp, all started to sell 3kW residential PV systems at the price of JPY$ 6 million.

2. How it works:
The Seventy Thousand Roofs programme initially provided a 50% subsidy on the cost of installed grid tied PV systems. The subsidy levels were set so that the net electricity cost to the customer was competitive with conventional electricity options. The subsidy was for PV modules, BOS, and installation. The programme was open to participants from residential homes, housing complexes, and collective applications. In 1997, METI grew the programme to encourage mass production of PV systems. After achieving their price goals, the Japanese government rolled back the subsidy programme in 2003 with plans to phase them out by 2005.[14]

Figure 11: Subsidized and Unsubsidized PV System costs in Japan and Annual Applications for Rebates 1994 to 2004



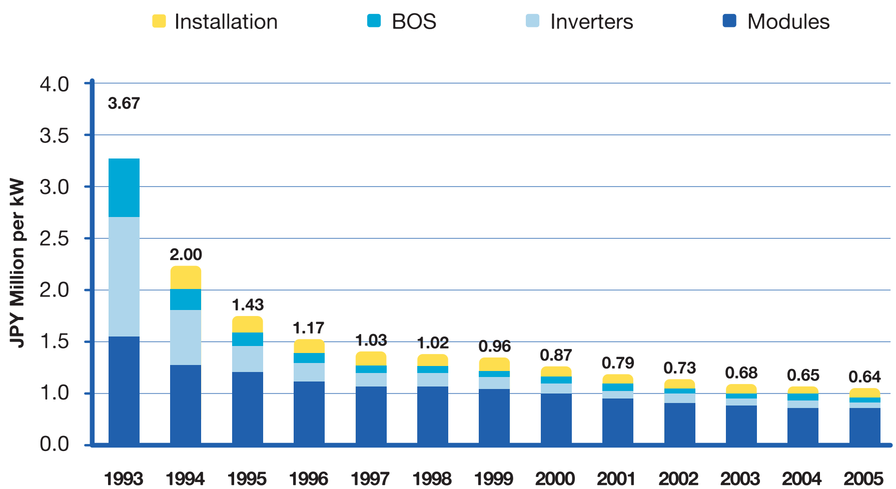
Source: NEDO

The Japanese residential PV programme expired in 2005, despite the strong opposition from the PV industry and renewable proponents, having achieved its goals of making PV cost competitive with conventional electricity options and building a solid base of manufacturers and installers.[15] The proponents asserted that the government had to keep strong support policies in order to achieve the ambitious target of 4,820MW PV deployment by 2010.

3. Impact:

By making the cost of PV systems competitive, the PV market rapidly grew. The unsubsidized price of PV systems in Japan has fallen from $11,500 per peak kWh in 1996 to a little more than $6,000 per peak kWh today. The programme incentivized a historic 30% growth rate from 2000-2004.[16] Japanese producers increased domestic production of PV cells by over 65% from 2003-4.[17] Japanese PV manufacturer continue to expand production, increase exports, and set up operations in places from China to Brazil to Mexico. The Japanese government's progressive PV policies of the last ten years have firmly established Japan as the world leader in PV technology.

Figure 12: Cost of Installing a Typical PV (3kW system) in Japan



Source: Kimura, Osamu and Suzuki, Tatsujiro, Berlin Conference on the Human Dimensions of Global Environmental Change: "Resource Policies: Effectiveness, Efficiency and Equity", November, 2006.

Table 8: Japanese Residential Systems are Fully Economic

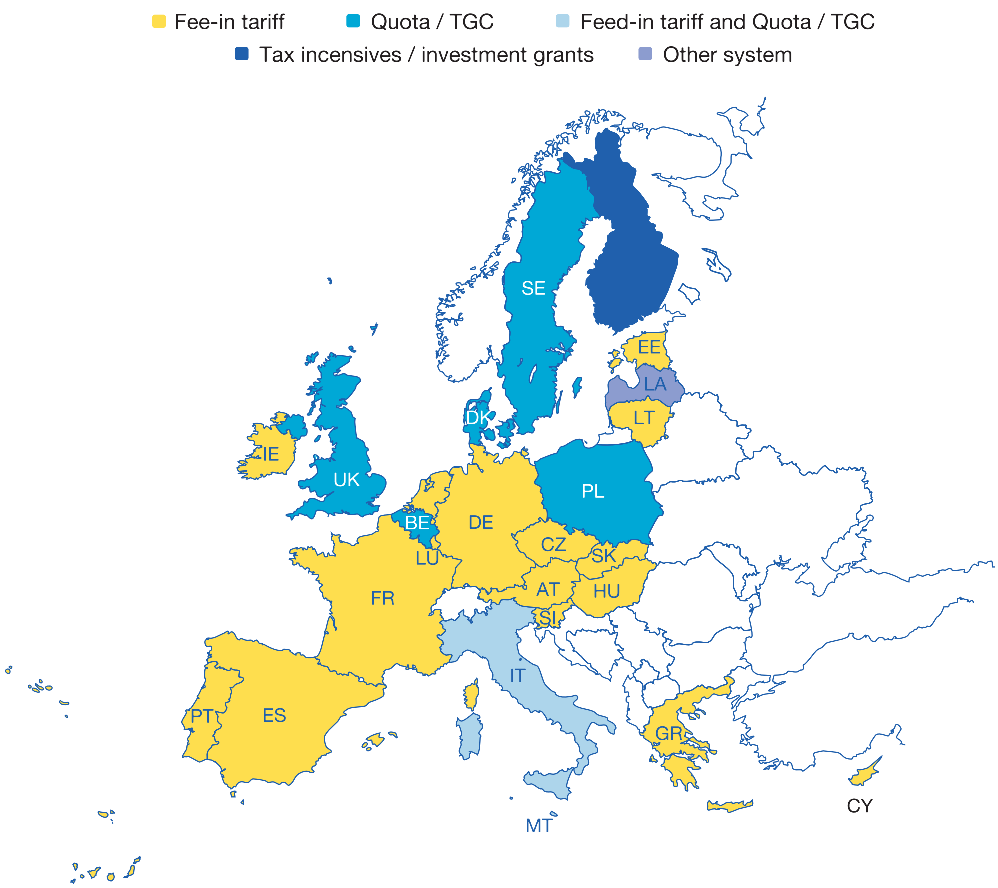
Solar Energy Hour/Year	Type of System	Installed Cost $/W	kWh/yr Capital	Cost of Recovery	Capital Cost	Energy C/kWh	Grid Energy Cost C/kWh
2000 hrs/yr	U.S. Residential (sunbelt)	$7.00 Wp(AC)	2	6%	7.4%	25.9	16-21
2000	CA (with tax credit)	$7-3=$4	2	6%	7.4%	14.8	351
1000	Japan Residence	$6.00	1	3.0	4.4	26.4	236
1000	Japan Zero Energy House	6.00	1	1.7	3.1	18.6	87

Source: World Solar Energy Market Update – Technology, Performance and Cost, Travis Bradford.

3.2 European Policy Initiatives

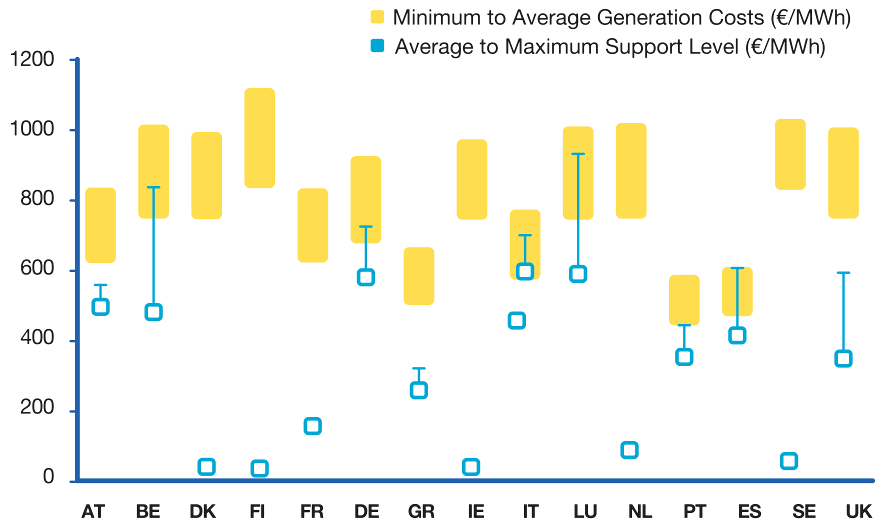
In Europe, distributed renewable energy policy has been heavily geared toward domestic job creation, with targeted goals for renewable energy deployment as a secondary motivation. The feed-in tariff methodology favored in Europe has been very successful in developing these markets, but at high cost and with many distortive effects on the supply and price of the solutions.

Figure 13: Dominating Support Schemes for RES-E in the EU



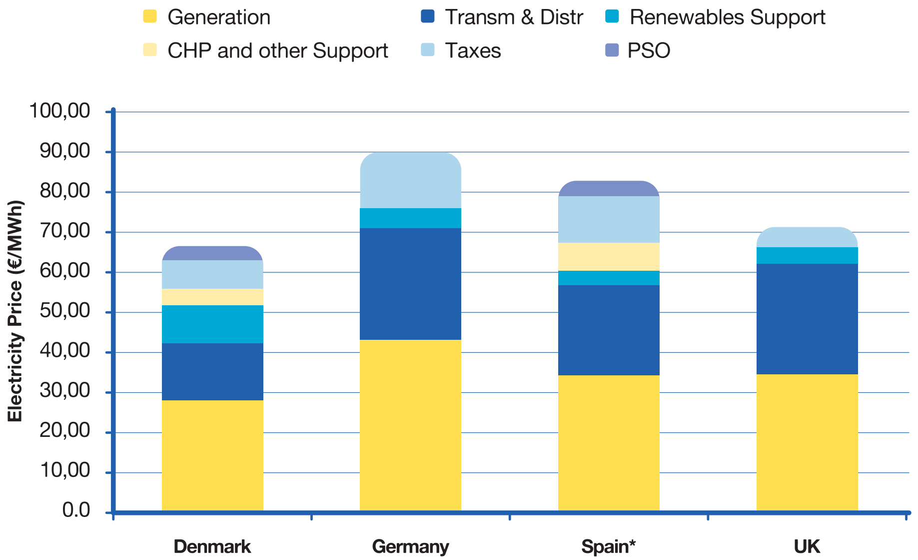
Source: European Commission: Brussels, December 2005.

Figure 14: Price ranges (average to maximum support) for direct support of photovoltaic electricity in EU-15 Members States (average tariffs are indicative) compared to the long-term marginal generation costs (minimum to average costs)



Source: Commission of the European Communities: Brussels, December 2005.

Figure 15: Electricity Prices end 2004 / Medium Industry Consumer (~20 GWh/year)



Source: Commission of the European Communities: Brussels, December 2005.

a. Germany

Official estimates of the BMU (Ministry of the Environment) are of 950 MWp for grid-connected installations, bringing German installed capacity to 2,863 MWp. These statistics are considered a compromise between the estimates of Photon Magazine (1,150 MW) and those of the German Solar Industrialists (753 MW). The German market is the world leader in solar cells, far ahead of Japan (286.6 MWp in 2006) and the US (145 MWp in 2006).[18]

Background:
Although Germany has enormous coal and lignite resources, the reliance on coal was ameliorated by the development of the nuclear industry in the 1960's. The nuclear accident in Chernobyl in1986 solidified the disenfranchisement with nuclear power.

The parallel development of environmental awareness and the emergence of environmental political parties in Europe provided an equally powerful rationale for government investment in renewable energy sources.

Programme: **Stromeinspeisungsgesetz (StreG) – (1991-1999) Years:**
Classification: **Paying for output**

1. Motivation:
By the early 1990s, environmental concerns, particularly global climate change, had become principle drivers of renewable energy policy. Germany has been a proponent of international policy action to address climate change and has adopted a broad set of domestic actions to curtail its greenhouse gas emissions.[19]

2. How It Works:
A federal Electricity Feed Law (StrEG) was adopted in 1991 and became the most important instrument for the promotion of renewable energy in Germany during the 1990s. The law met resistance from the Federal Ministry of Economics and Technology, but gained acceptance in parliament and from the

Ministries of Research and Environment. There was no initial reaction from the large utility companies.

The law obligated public utilities to purchase renewably generated power from wind, solar, hydro, biomass and landfill gas sources, on a yearly fixed rate basis, based on utilities' average revenue per kWh. Remuneration to wind producers was set at 90% of the average retail electricity rate; for other renewable power providers, compensation was set at 65-80%, depending on plant size, with smaller plants receiving the higher subsidy level. The StrEG effectively subsidized the operation of commercial wind installations at 4.1 Euro cents/kWh, and jump-started wind power's market breakthrough in the 1990s.[20] Generators were not required to negotiate contracts or otherwise engage in much bureaucratic activity.

A feed-in tariff generates consumer demand for installed systems by setting the renewable energy price at some level above the market rate. Instead of reducing upfront capital costs for the consumer, a feed-in tariff shortens the payback period on an installed system. The tariffs are typically set on a declining price schedule that reflects the effect of economies of scale on renewable technologies. Rates are locked in over the lifetime of a system from its installation date – typically 20 years.[21]

3. Impact:
The StreG was a good starting point for a fair price for electricity from RE. However, only allowed profitable business at very good locations for wind power operators. Inland wind plants and especially PV plants could not be operated profitably under the conditions established within the StreG. Against this background many cities and parishes introduced additional reimbursements to allow an economically viable as operation as incentive for investments.

By 1998 the resistance by German energy suppliers against the German Feed-in law (StrEG) reached the European level. The then German supplier PreussenElektra filed a lawsuit against the StrEG by the regional court of Kiel, which forwarded the case to the European Court of Justice (ECJ). In March 2001 the ECJ decided that the StrEG was not a state subsidy and therefore conformed to European competition regulations. Until this sentence there was no legal security for countries thinking about the implementation of a REFIT.[22]

Programme: **100,000 Rooftop (1999-2003)**
Classification: **Innovative Financing**

1. Motivation:
Solar photovoltaics had not been able to develop much during the 1990s. The red-green government wanted to provide new impulses. As the design of a new feed-in regulation was expected to take time, another market creation programmeme along the lines of the 100 MW wind and 1,000 roof programmeme (both 1989) was adopted in January 1999 as a stopgap measure.

2. How It Works:
Championed by the German Green Party, it provided for reduced loans for PV roof installations; the goal was to achieve an installed capacity of about 300 MW. The programme offered low-interest loans and partly a remission of a debit remainder of 1/10 of the loan amount, but did not offer an increased feed-in tariff (this is granted in the EEG from 2000).

3. Impact:
Installed PV capacity in Germany tripled from 41.9 MW in 1997 to 113.8 MW in 2000 and again to 385 MW in 2003. By 2003, 100,000 roof programmeme was terminated and PV market development turned over to improved feed-in tariffs.[23]

Programme: **EEG (2000 – present) Renewed in 2004, 2008**
Classification: **Paying for output**

1. Motivation
In response to the issues of StreG and the deregulation of the electricity market in 1998, the German RE policy was refined and replaced by the Erneurbare-Energien-Gesetz (EEG), or Renewable Energy Law of 2000.

2. How It Works:
The EEG was created to double the amount of renewable energy generated from 1997 to 2010—to a minimum of 12.5%. Unlike that of the StrEG, the EEG's remuneration system is not based on average utility revenue per kWh sold, but rather on a fixed, regressive feed-in tariff for renewable sources. Low-cost renewable energy producers are compensated at lower rates than higher-cost producers, providing strong incentives for the development and operation of renewable energy installations on lower-quality sites. Also, under the EEG, grid operators are obligated to purchase power from local producers; a nation-wide equalization scheme has been implemented to reduce the cost differentials paid by grid operators in different parts of the country for the purchase of renewably generated electricity.[24]

Since August 2004, the law obliged electricity suppliers to purchase photovoltaic electricity at a predefined tariff. In 2006, grid-connected systems benefited from a feed-in tariff varying between 51.8 eurocents per kWh and 48.74 eurocents per kWh for a period of twenty years, but with a 5% per year price digression. A 5-eurocent per kWh bonus is added for building façade-integrated systems.

"The German Renewable Energy Law has done such a good job of funding global PV that industry representatives and economists are increasingly concerned about the ability to pay the bill: starting now, funding over the next 20 years will amount to 14.3 billion euro ($19.1 billion) at the least – and that's only for systems presently on line according to calculations by German economic research institute RWI. Photon's calculations show that systems built in the future will cost much, much more – that is, if the EEG isn't adapted to reflect changing conditions."[25]

As of 2007, the EEG (including both solar and wind) costs ratepayers 5% of their electricity bill, with this total expected to climb dramatically over the next decade. See the chart below from Germany's Federal Ministry of Environment, Nature Conservation, and Nuclear Safety.[26]

Table 9: Breakdown of German Electricity Bill Components

	2000	2002	2004	2005	2006	2007
Electricity Bill €/Month (3,500 kWk/a)	**40.67**	**46.99**	**52.48**	**54.23**	**56.63**	**60.31**
Generation, Transmission, Marketing	25.15	28.32	31.56	32.73	34.53	35.70
EEG	0.58	1.02	1.58	1.84	2.20	2.94
KWKG	0.38	0.73	0.91	0.99	0.90	0.85
Concession Charge	5.22	5.22	5.22	5.22	5.22	5.22
Electricity Tax	3.73	5.22	5.97	5.97	5.97	5.97
Value-added Tax	5.61	6.48	7.24	7.48	7.81	9.63
Electricity Bill at 2000 prices	40.67	45.45	49.41	50.07	51.44	54.23

Source: Bundesverband der Energie - und Wasserwirtschaft (BDEW), calculations by ifne.

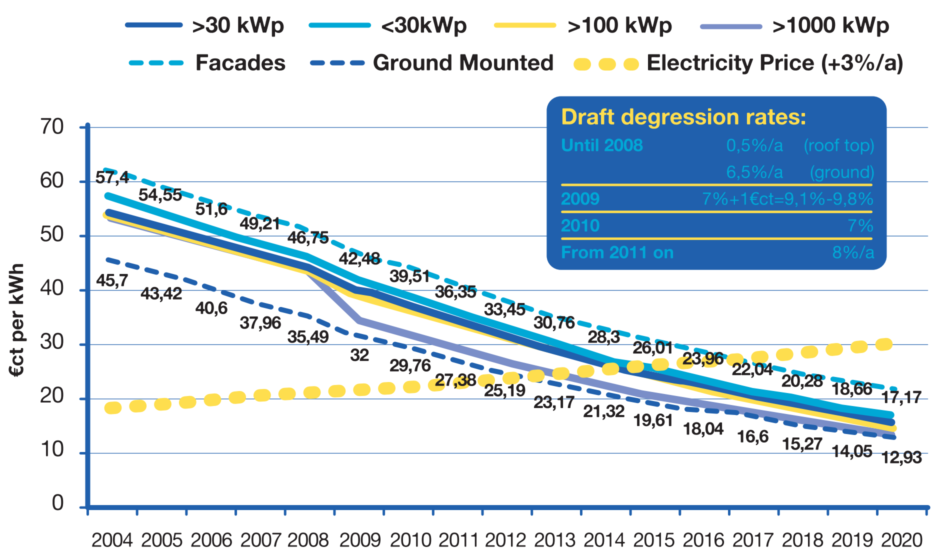
3. Impact:

The Act was considered effective because the costs for RE are largely dependent on cost of capital which derives from cash flow certainty, a facet the EEG programme scores really well on. The structure of the EEG guarantees a particularly high investment security, credit interest rates, and risk mark-ups are low compared with other instruments. The costs for installing PV systems dropped by 25% between 1999 and 2004.

After the re-election of the red-green coalition in autumn 2002, the responsibility of the EEG was transferred from the Economic Affairs Ministry to the Environment Ministry. The EEG was amended to regulate grid costs. In addition the tariffs paid for solar PV were increased.

In early 2004 the German government renewed the feed-in tariff programme, and the market for PV installations grew by over 150% from 2003.[27] Although the EEG is credited with the solar boom of 2004, critics, such as the German Electricity Association (VDEW), complain that the EEG has the following flaws: 1) it is too expensive, 2) it contravenes market rules, 3) it leads to the additional need for regulation energy and the need for a vast extension of the grid, 4) the expansion of renewable energies allows only few conventional power plants to be decommissioned, 5) it does not fit into the European internal market from a legal point of view.[28]

Figure 16: German Feed in Tariff



Source: BSW.

b. Spain

German citizens invest in renewables partly out of ‘Okologismus’, meaning that they assume a level of personal sacrifice in support of environmental gains. On the other hand, Spaniards are said to be lagging behind in terms of awareness and commitment, and are motivated more by the investment returns made possible through the FIT system.[29]

This cultural difference is made more evident in the evolution of feed-in tariff policies in Spain. The first policy was developed in 1980 with the 82/1980 Energy Conservation Law. The Ministry of Energy set the price annually by order of the law, but did not determine the contract length. It was not until 1997 that a target of 12% from renewable energy sources by 2010 was set. The 1999 Policy Plan for the Promotion of Renewable Energy (PFER) dictated the methods of reaching the 12% RES target.

Programme: **Royal Decree 436/2004 (2004-present)**
Classification: **Reducing Upfront costs**

1. Motivation:
The goal is to have 400 MWp connected to the power grid by 2010.

2. How it works:
Unlike the German feed-in tariff, the Spanish has no fixed price. It is calculated as a function of the mean price of electricity during the year in progress. For installations lower than 100 kW, the feed-in tariff corresponds to 5.75 times the mean price of electricity for twenty-five years (equivalent to 44.04 eurocent per kWh) and 4.6 times the mean reference price of electricity for the rest of installation lifetime. For installations greater than 100kWp, the tariff changes to 3 times the mean reference price of electricity for the first twenty-five years (equivalent to 22.98 eurocent per kWh) and to 2.4 times the mean reference price of electricity for the rest of the installation life.

Table 10

	Special Regime (previous policy)				Market Participation (current policy)			
Technology	**Tariff**	**Premium**	**Total Price**	**Technology**	**Tariff**	**Premium**	**Incentive**	**Total Price**
Micro-hydro <10 MW	6.49	2.94	**9.44**	**Micro-hydro <25 MW**	6.49	2.89	0.72	**10.09**
Hydro 10-50 MW		2.94	**2.95**	**Hydro 25-50 MW**	5.76	2.16	0.72	**8.65**
Wind	6.21	2.66	**8.88**	**Wind (on/off shore)**	6.49	2.89	0.72	**10.09**
Primary Biomass	6.86	3.32	**10.18**	**Primary Biomass**	6.49	2.89	0.72	**10.09**
Secondary Biomass	6.06	2.51	**8.57**	**Secondary Biomass**	6.49	2.89	0.72	**10.09**
Solar PV	39.67	36.06	**75.73**	**Solar PV (<100kWp)**	41.44			**41.44**
Solar PV (<5kWp)	21.63	18.03	**39.67**	**Solar PV (>100kWp)**	21.62	18.02	0.72	**40.36**

3. Impact:

According to the IDAE (Institute for Energy Diversification and Conservation), newly installed capacity in Spain amounted to 60.5 MWp, bringing total installed capacity to 118.1 MWp (including 15.2 MWp off grid) through the end of 2006. In 2007 and 2008, Spanish demand for PV was off the charts with nearly 2 GW installed in those two years, far higher than the original programme anticipated. In September of 2008, the programme was changed to institute a market cap for years 2009 and 2010 of 500 MW and 460 MW respectively.

3.3 US Policy Initiatives

The US policy environment, driven by various state initiatives have been much more experimental. These include performance-based incentives (California), SRECs (New Jersey), and most recently activities to potentially finance these systems through tax—

advantaged municipal bonds (Berkeley). These programmes are much harder to craft and have increased risk of unintended consequences but could offer important new models for market-enabling programmes.

State:	**Federal**
Programme:	**Investment Tax Credit (2005-present)**
Classification:	**Reducing Upfront Costs**

1. Motivation:

The Energy Policy Act of 2005 was the first comprehensive bill to be passed on energy in over a decade, since the EPACT 1992. Critics complain that the 2005 law gives unfair subsidies to nuclear and oil industries. This criticism is heightened by the fact that President George W. Bush, the House Majority Leader, Tom DeLay, and the Chairman of the House Energy & Commerce Committee, Joe Barton, were all from Texas. The fact that the bill passed 66-29 with wide support from Democrats for the bill has not calmed this criticism.

Despite criticism of the overall law, the 30% solar Investment Tax Credit (ITC) that was originally started for a two-year term through this law has been instrumental to tremendous growth of the US solar market. This law was extended for an additional year, through the end of 2008 in H.R. 6111, the "Tax Relief and Health Care Act of 2006."

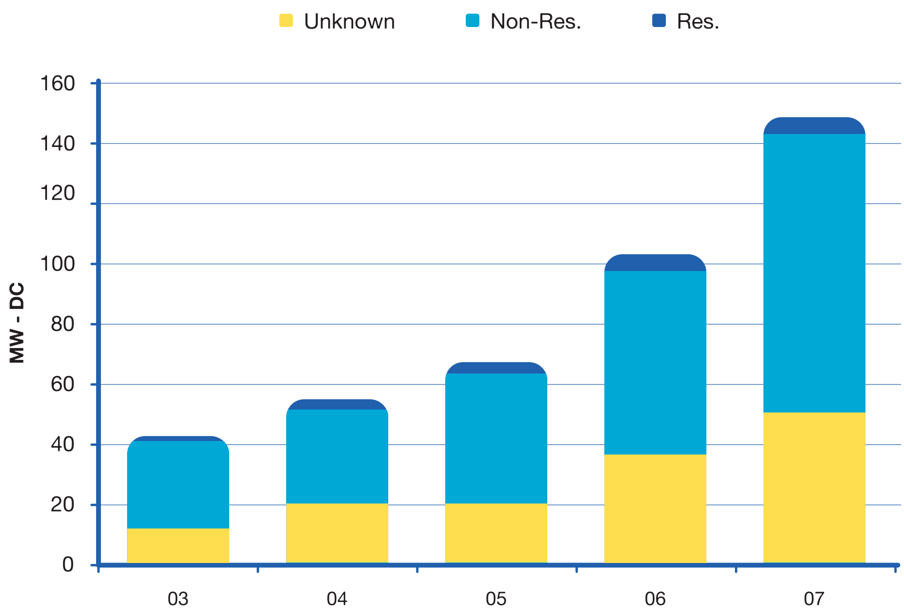
2. How it works:

The Investment Tax Credit (ITC) is a reduction in the overall tax liability for individuals or businesses that make investments in a variety of pre-determined areas. For solar-electric and solar water heating residential property expenditures, the credit is 30 percent of the cost, with a maximum cap of $2000 (26 USC 25D). For commercial installations the credit is 30 percent of the installed cost with no monetary cap (26 USC 48).[30]

3. Impact:

Annual grid-connected Photovoltaic capacity has grown year over year since the inception of this law. Although the Solar Energy Industries Association (SEIA) applauded the one-year extension of the solar ITC in H.R. 6111, the "Tax Relief and Health Care Act of 2006", the industry also cautioned that the lifespan of the credits is too short to encourage significant industry growth and cost reductions. The top legislative priority of the group is an eight-year extension of the ITC.

Figure 17: Annual U.S. Grid-Connected Photovoltaic Capacity



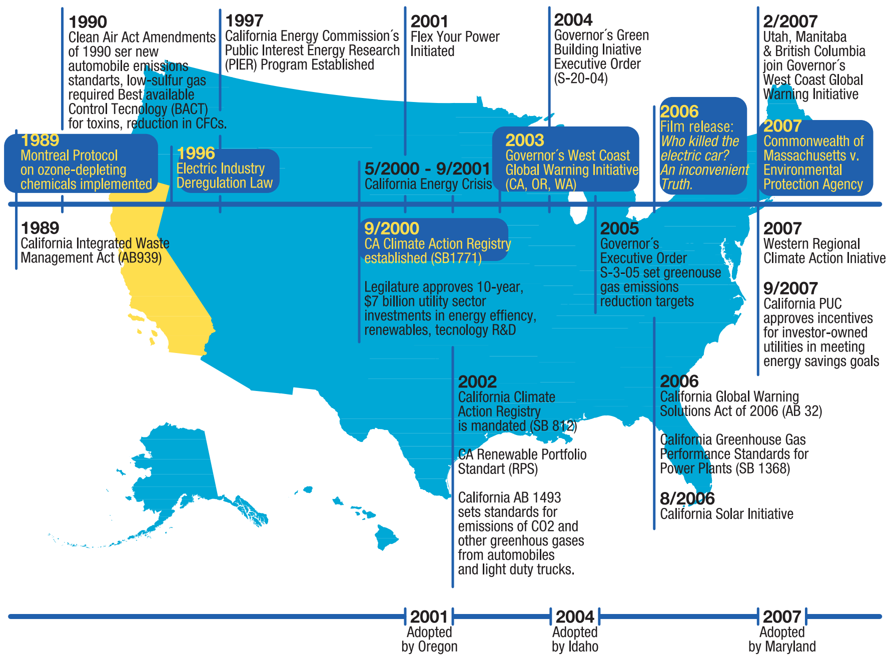
Source: Prometheus Institute, 2008

a. California

California is a huge market with over 36 million people. From 2006 estimates, California's GDP would qualify it as the eighth largest economy in the world if it were a separate country,[31] and a GDP per capita of approximately $45,000 that would also qualify it as one of the wealthiest countries in the world.[32] Therefore the California market is strong enough that no national business can afford to ignore the policies of the state. Furthermore, California has often preceded national environmental legislation[33] so preparing for California markets makes businesses ready for other jurisdictions when those jurisdictions implement proactive greenhouse gas reductions and global warming standards.

Republican Gov. Arnold Schwarzenegger and the Democratic-controlled State assembly have enacted an aggressive greenhouse gas standard for the US. The legislation, called the Global Warming Solution Act and adopted in 2006, establishes a strategy for achieving mandatory greenhouse gas emission reductions by the year 2012 and reducing greenhouse emissions to 1990 levels by the year 2020. The legislation also instructs the California Air Resources Board to develop a market-based programme to achieve compliance with the mandatory emission reductions, and Governor Schwarzenegger has ordered that the programme permit trading with the European Union, the Regional Greenhouse Gas Initiative and other jurisdictions. By adopting a trading programme and extending the programme to regional, US and international carbon markets, California has taken a global approach.[34]

Figure 18: Timeline of California Based Policies, 1989-2007



Source: California Green Innovation Index, 2008.

Programme: **California Solar Initiative (2006-2016)**
Classification: **Paying for output**

1. Motivation:

The California Solar Initiative is aimed at transforming the solar market in order to make solar more cost competitive without incentives by 2017. The law also has the objective of providing 3,000 megawatts (MW) of solar capacity by 2016. The California Public Utilities Commission (CPUC) manages the solar programme for non-residential projects and projects on existing homes ($2+ billion), while the California Energy Commission (CEC) oversees the New Solar Homes Partnership, targeting the residential new construction market (~$400 million). Together, these two programmes comprise the effort to expand the presence of photovoltaics (PV) throughout the state.[35]

2. How it works:

The California Public Utilities Commission recently created a 10-year, $3.2 billion programme to provide homeowners and businesses with rebates for installing grid-connected PV.[36] The programme is managed by the Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), and the California Center for Sustainable Energy.

The rebates are expected to ratchet down over time as solar becomes more cost effective, but the 2007 levels for the rebates are below. Systems that are 50kW and larger are offered Performance Based Initiatives (PBI) that will be paid monthly based on the actual amount of energy produced for a period of five years. Residential and small commercial projects under the 50 kW thresholds can also choose to opt in to the PBI rather than the upfront Expected Performance-Based Buy down approach. However, all installations of 50 kW or larger must take the PBI. Incentives under the Expected Performance-Based Buy down approach will be awarded as a one-time, up-front payment based on expected performance, which is calculated using equipment ratings and installation factors such as geographic location, tilt, orientation and shading.[37]

Performance-Based Incentives (PBI) for Systems 50 kW and larger:

- $0.39/kWh for first five years for taxable entities
- $0.50/kWh for first five years for government entities and nonprofits

Expected Performance-Based Buy down for Systems under 50 KW:

- $2.50/W AC for residential and commercial systems, adjusted based on expected performance

- $3.25/W AC for government entities and nonprofits, adjusted based on expected performance

3. Impact:
California is the dominant PV market in the US and the fifth largest market for PV in the world. More than 120,000 systems have been installed on homes and small businesses connected to the electric grid to date under the California Energy Commission's rebate programme.[38]

Programme:	**CEC New Solar Homes Partnership (2007-2017)**
Classification:	**Paying for output**

1. Motivation:
Under the California Solar Initiative that was adopted in 2006, two programmes serve the investor-owned electric service territories. The one described above is overseen by the CPUC, and provides incentives for existing residential homes and existing and new commercial, industrial, and agricultural properties. The other programme, the New Solar Homes Partnership (NSHP), is administered by the California Energy Commission (CEC) and provides incentives for solar on new home construction. The NSHP specifically targets the market-rate and affordable housing single-family and multifamily sectors, with the goal of achieving 400 MW of installed solar electric capacity on new homes, and to have solar electric systems on 50% of all new homes built in California by the end of 2016.

2. How it works:
Launched on January 2, 2007, the New Solar Homes Partnership (NSHP) is a 10-year, $400 million programme to encourage solar in new homes by working with builders and developers to incorporate high levels of energy efficiency and high-performing solar systems into the homes. To be eligible for the NSHP incentive, the home must receive electricity from one of the following investor-owned utilities: Pacific Gas and Electric

Company, Southern California Edison Company, San Diego Gas and Electric Company, and Bear Valley Electric Service.

Incentives are determined based on the housing type and the expected performance of the system. The performance of the system is based on a number of factors including equipment efficiency, geographic location, orientation, tilt, shading, and time-dependent valuation. These factors are then compared to a reference system in San Jose, California. To qualify for incentives, the residential dwelling unit must achieve at least 15% higher energy efficiency than the current Title 24 Building Energy Efficiency Standards. The incentive is paid once the system is installed, operational, and has met all programme requirements.[39]

All incentives will decline over time as specific megawatt targets are achieved. In 2007 there are four incentive levels available:

1) **Base Incentive:** Expected Performance Based Incentive (EPBI) level is $2.50/watt. The base incentive applies to custom homes, small developments (less than 6 homes), housing developments where solar is offered as an option, common areas of housing developments, and housing developments where solar will be installed on less than 50% of the homes.

2) **Solar as a Standard Feature Incentive:** The EPBI level in 2007 is $2.60/watt. To qualify, a builder of 6 or more homes in a development must commit to a minimum of 50% of the residential units in the subdivision or multifamily housing development, to installing solar electric systems that meet or exceed the California Flexible Installation criteria.

3) **Residential Areas of Affordable Housing Projects:** The EPBI amount starting in 2007 is $3.50/watt. This applies to affordable housing projects of all sizes.

4) **Common Areas of Affordable Housing Projects:** The EPBI level starting in July 2007 is $3.30/watt. This incentive level

applies to solar electric systems serving the common areas of affordable housing projects.

3. Impact:
By October 2007, the New Solar Homes Project had received applications for 1,287 building structures, primarily in Northern California, and has approved applications for 575 structures totaling about 1.2 MW of capacity. Housing developments represent most of the applications and include large developers like Lennar, Centex, Meritage, and Christopherson and smaller developers like Coastal View Construction, Pacific Century, KD Development and Armstrong Construction.[40]

State:	**California**
Programme:	**Net-Metering (1996-present)**
Classification:	**Market Enabler**

1. Motivation:
The California net metering programme law took effect in 1996. It requires most utilities to offer net metering to all customers for solar and wind-energy systems up to 1 megawatt (MW); investor owned-utilities are required to offer net metering for biogas-electric systems and fuel cells.[41]

During this time, NREL published a report that talked about the motivation of various states' net metering programmes. NREL found that the main objective for most states implementing net metering programmes is to encourage private investment in renewable energy resources. Other goals include stimulating local economic growth, diversifying energy resources, and improving the environment. [42]

2. How It Works:
Net metering simply uses a single, existing electric meter for customers with small generating facilities. After the programme is implemented, no regulatory interaction or supervision is needed.

As a policy option, it makes renewable energy technologies more economically attractive without requiring public funding. Net metering also addresses a perceived equity issue of utilities gaining an unfair advantage over customers by paying customers only avoided cost but charging them retail price for electricity.[43]

3. Impact:

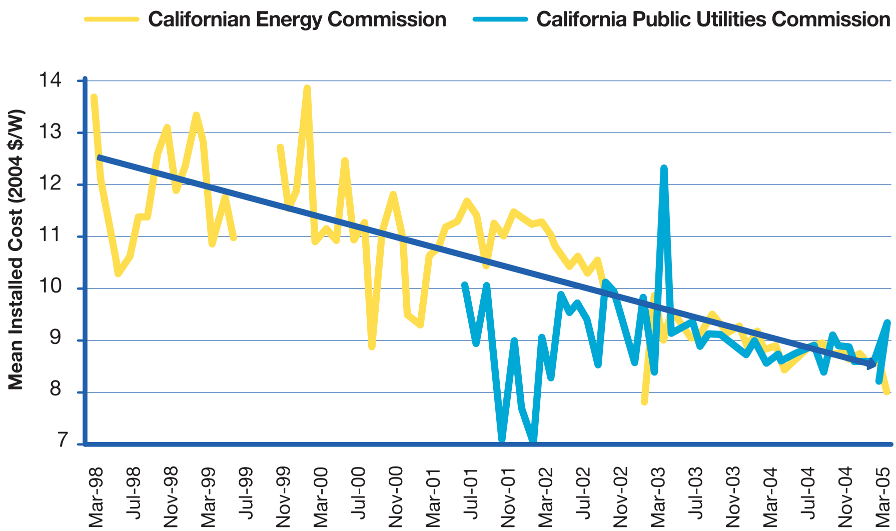
Although California, like several states, has enacted net metering programmes for some time, their impact on renewable energy technologies has been small to date. The interconnection, liability insurance, and indemnification requirements demanded by utilities discourage net metering customers. A bigger uncertainty facing net metering programmes is utility restructuring.[44]

Table 11: Summary of Rule 21 Activity - SDG&E

	# of Projects	MW
Authorized to Interconnect in 2006	1	0.5
Authorized to Interconnect in 2005	Not Available	Not Available
Authorized to Interconnect in 2004	10	15.5
Authorized to Interconnect in 2003	14	3.9
Authorized to Interconnect in 2002	19	28.3
Authorized to Interconnect in 2001	16	36.9
Total Authorized Since 2002	60	85.2
Pending Applications	6	9.9
Total Rule 21 Applications	66	95.0

Source: California Energy Commission: http://www.energy.ca.gov/distgen/interconnection/rule21_stats.html

Figure 19: Cost of Solar Installation in California, 1998-2005



Source: Developing State Photovoltaic Markets: Riding the Wave to Clean Energy Independence 2008.

Table 12: California Utility Rate Structures and Solar System Economics

	SCE	
	TOU-GS3 OPTION A	TOU-GS3 OPTION B
ENERGY CHARGES ($/kWh)		
Summer		
Peak	$ 0.335	$ 0.118
Part-peak	$ 0.146	$ 0.095
Off-peak	$ 0.064	$ 0.064
Winter		
Peak		
Part-peak	$ 0.104	$ 0.097
Off-peak		

Higher energy charges benefit solar

	SCE	
	TOU-GS3 OPTION A	TOU-GS3 OPTION B
DEMAND CHARGES ($/kWh)		
Facility charges	$ 7.62	$ 7.62
Summer Peak		$ 18.16
Summer Part-peak		$ 6.23
Winter		
PV SYSTEM NET PESENT VALUE SAVINGS		
Solar savings	$ 261,151	$ 185,276

Penalizing demand charges eliminated

Note: Southern California Edison´s new solar-friendly rate increase the savings from 150kW, $1.13 million solar system by an additional $ 76,000.

Source: Developing State Photovoltaic Markets: Riding the Wave to Clean Energy Independence 2008.

Programme: **Berkeley FIRST (Approved Nov 2007, not yet operational in Berkeley, CA. Approved July 2008 for statewide mandate.)**
Classification: **Innovative Financing**

1. Motivation:

Berkeley has set a goal of getting 51 percent of its energy from renewable sources by 2017. The city is looking for innovative means to meet these aggressive goals such as planning to partner with nearby cities Oakland and Emeryville to buy renewable energy using money raised in bonds.

2. How it works:

Berkeley FIRST is a programme in development by the City of Berkeley. It is being designed to allow property owners (residential and commercial) to install electric and thermal solar systems and make energy efficiency improvements to their buildings and pay for the cost over 20 –years through an annual special tax on their property tax bills. The City would provide the funding for the project from a bond or loan fund that it repays through assessments on participating property owners' tax bills for 20 years.[45]

The programme is being designed to address many of the financial hurdles that are dissuading some people from undertaking major energy projects. First, there would be little upfront cost to the property owner. Second, the upfront capital costs would be repaid through a voluntary tax on the property, thereby avoiding any direct effect on the property owner's credit. Third, the total cost of the solar energy system and energy improvements should be comparable to financing through a traditional equity line or mortgage refinancing because the well-secured bond will provide lower interest rates than are commercially available. Fourth, the obligation to pay the tax transfers with the property. Therefore, if you sell your property prior to the end of the 20-year repayment period, the next owner takes over repayment as part of their property tax bill.

The city claims it's the first in the nation to approve such a programme, but the idea for such financing is not new. Companies such as SunEdison, MMA Renewable Ventures and Recurrent Energy have been paying installation costs in exchange for agreements that commercial customers will buy the power and the same has been done for residential customers by companies such as Sun Run Generation. These companies coordinate financings with major corporations that can take advantage of the tax benefits of owning solar installations. The main difference is that Berkeley is the first government policy to do so and government agencies have the advantage of being able to tap into tax-exempt, low-interest financing such as bonds, potentially cutting costs in half compared to commercially financed installations.[46]

3. Impact:

As the programme has not been implemented yet, its impact is yet to be seen. There are currently more than 400 systems in Berkeley today, but experts agree that thousands could be possible through this type of financing scheme that both reduces upfront cost of capital and payback methods as well. However, the question remains about how this programme will affect the current solar market dynamics. For example, Paul Fenn, CEO of Local Power, which helps government agencies set up renewable-energy programmes, said that he expects to see more programmes like Berkeley's catch on. But if they do, it also could mean the role of companies that finance projects in exchange for power-purchase agreements will shift. "It influences them in terms of how they should plan for future markets," he said. "Public financing could be viewed as competition because the government is coming in, but I believe that would be a strategic mistake. Those companies that adapt to the market and shift to [add value by] participating in those programmes will win; those that try to compete against them will lose."[47]

California enacted a law that allows cities and counties to make low-interest loans to homeowners and businesses to install solar panels, high-efficiency air conditioners and other energy-saving improvements in July 2008. Participants can pay back the loans over decades through property taxes. And if a property owner sells his home or business, the loan balance is transferred to the next owner, along with the improvements.[48] Originally authored in Berkeley in the office of Mayor Tom Bates with the assistance of academics like Dan Kammen, director of the Renewable and Appropriate Energy Laboratory (RAEL), as part of the city's plan to reduce its carbon footprint. It also had the support of Palm Desert, a city with an aging population and high air-conditioning costs. The two cities did not have statutory authority for the strategy so they approached Assemblyman Lloyd Levine (D-Van Nuys), who sponsored AB 811, the new law.

Considering that title 24 may require additional energy efficiency and goals for zero net energy homes in the future, this law may make solar a feasible option to meet such goals.

b. New Jersey

New Jersey's 2006 population estimate was 8,724,560. Per capita personal income in 2007 was $49,194 making its population the 3rd richest in the nation. New Jersey has no fossil fuel reserves, but it does have high wind power potential located onshore and offshore along its Atlantic coast. Residential and commercial energy demand is high. New Jersey's industrial energy consumption ranks near the National average, although the energy-intensive chemical manufacturing and petroleum refining industries are well represented in the State.

In 2003, the New Jersey Board of Public Utilities established the Office of Clean Energy to administer New Jersey's Clean Energy Programme. Representatives from government, business, environmental, and public advocacy organizations also helped establish a Clean Energy Council to engage stakeholders in the NJCEP's development and provide input to the BPU regarding the design, budgets, objectives, goals, administration, and evaluation of New Jersey's Clean Energy Programme. The New Jersey Clean Energy Programme offers financial incentives, programmes, and services for residential, commercial, and municipal customers.

Programme:	**NJ Board of Public Utilities - Solar Renewable Energy Certificates (2001-present)**
Classification:	**Reducing upfront costs**

1. Motivation:

New Jersey's renewable portfolio standard (RPS) is one of the most aggressive in the United States and requires each electricity supplier/provider serving retail customers in the state to include in the electricity it sells 22.5% qualifying renewables by 2021. By 2021, 2.12% solar electricity, approximately 1,500 megawatts (MW) is required in New Jersey. The Solar Renewable Energy Certificates (SRECs) are used by NJ utilities to meet a state renewable portfolio standard (RPS), which requires an increasing amount of the power they provide to come from renewable energy.[49]

2. How it works:

New Jersey provides a $5.10 per watt rebate and an exemption from the sales tax.[50] Effective, June 2008, the maximum rebate was approximately $711 per MWh ($0.71 per kWh), but this amount is expected to decrease annually to about $594 per MWH in 2015. Owners of PV systems receive a solar renewable energy certificate (SREC) for each megawatt-hour of solar electricity produced by their system, which they can sell to utilities or middleman brokers on the open market.

All electric suppliers must use the SREC programme to demonstrate compliance with the RPS. New Jersey's on-line marketplace for trading SRECs, launched in June 2004, is the first such operation in the world. The price of SRECs is determined primarily by their market availability and the price of the Solar Alternative Compliance Payment (SACP) for the state RPS. The SACP is effectively a ceiling on the value of SRECs because it is the per MWh payment that electricity suppliers must make if they fail to obtain enough SRECs to cover their RPS obligation.[51]

SRECs have accrued from participating solar-electric facilities since March 1, 2004. Generators must register with the BPU in order to participate in this programme. In January 2008, S.B. 2936 specifically extended the right to generate RPS-eligible SRECs to non-net metered systems as well as net-metered systems. This special adoption may remain in effect for up to 18 months while the BPU addresses this and other rule amendments through the normal rule adoption process.

An annual engineering estimate is used to calculate the monthly SREC generation for systems with a capacity less than 10 kilowatts (kW). The programme website allows owners of systems 10 kW and larger to upload monthly meter readings and/or production information. When a generator has at least one SREC in an account, the generator can use the electronic bulletin board on the SREC website to announce a sale offering. Interested buyers can also use the website to request an SREC purchase. Buyers and sellers contact each other offline and execute a sale. After the sale is executed, the seller uses the website to transfer SRECs to the buyer. Electricity suppliers will also use the website to retire SRECs that have been used to meet their RPS requirements. Generators also have the option of recording and retiring SRECs for purposes other than for RPS compliance.[52]

In September 2007 the BPU issued an order revising the way it determines Solar Alternative Compliance Payments (SACPs) for the state RPS. Effective in June 2008, the SACP will be determined according to an eight-year schedule. Each year the BPU will review the SACP and add one additional year to the back end of the schedule.

The price for an SREC is expected to average approximately $100 per MWh lower than the SACP during a given year. Thus far in 2008 for instance, under the previous SACP of $300 per MWh or $0.30 per kWh, the SREC programme compensated system owners an average rate of about $230 per MWh ($0.23 per kWh) generated.

3. Impact:
From 2001 to date, 2.36 MW of solar power have been installed through 14 projects through the SREC programme. While this number does not seem large in absolute terms, New Jersey has actually installed 56.80 MW of solar installed capacity through 3,184 projects when you take into consideration both SREC-Only Pilot Programme and its predecessor Customer On-Site Renewable Energy (CORE) programme. The CORE Rebate Programme supported a variety of technologies, such as photovoltaics (solar electricity), small wind, and sustainable biomass equipment, such as fuel cells through subsidies.

In terms of scalability, New Jersey is part of the Clean Energy States Alliance. The Clean Energy States Alliance (CESA) is a nonprofit organization comprised of members from 16 clean energy funds and two state agencies; it provides information and technical services to its members and works with them to build and expand clean energy markets in the United States.

Maria Mossaides of the Massachusetts Technology Collaborative, another state-run REC programme that has been in place for over 8 years, said that much like New Jersey's SREC programme, in the beginning it was very difficult to attract people to the market, even with rebates. Most of the early adopters were environmentalists that did not mind spending comparatively more for clean technology. Today with rising energy prices and a higher acceptance of global warming the overall consciousness about the importance of "green" solutions has changed. There continues to be the challenge of scale because RECs are generally measured in MW and a residential installation could take over a year to generate one MW.

Table 13: All New Jersey Renewable Energy Technologies Installed Projects 2001 to 6/30/2008

CORE Programme	# Projects	Total kW	Total rebate $
Solar	3,170	54,431.7	227,825,470
Biomass	9	4,502.0	4,993,594
Fuel Cell	5	1,100.0	3,262,312
Wind	7	2,667.8	1,990,644
Total* CORE	3,191	62,701.5	238,072,019

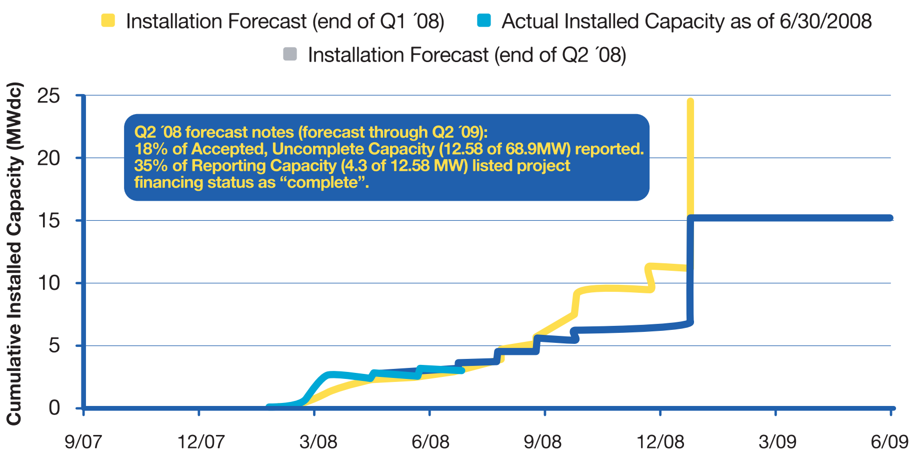
Source: New Jersey's Clean Energy Programme Database. Available at: http://www.njcleanenergy.com/renewable-energy/programme-updates/core-activity/core-activity

Table 14: NewJersey Solar Installation Projects Installed Projects 2001 to 6/30/2008

Solar Programme	# Projects	Total kW	Total rebate $
CORE	3,170	54,431.7	227,825,470
SREC-only	14	2,366.0	-
Total*	3,184	56,797.7	227,825,470

Source: New Jersey's Clean Energy Programme Database. Available at: http://www.njcleanenergy.com/renewable-energy/programme-updates/core-activity/core-activity

Figure 20: SREC Only Pilot Programme – Weekly Status Report, 7/12/08-7/18/08



Source: New Jersey's Clean Energy Programme Database. Available at: http://www.njcleanenergy.com/renewable-energy/programme-updates/core-activity/core-activity

Programme: **Net metering (1999-present)**
Classification: **Reducing upfront costs**

1. Motivation:

All over New Jersey, homeowners and small businesses are investing in new renewable energy systems that allow them to generate their own clean electricity," said the Network for New Energy Choices (NNEC) Executive Director Chris Cooper. "We can trace this rapid greening of New Jersey's electricity to the strong leadership of Jeanne Fox and the New Jersey Board of Public Utilities. While other states crafted burdensome rules and complex requirements for self–generation, New Jersey looked for ways to encourage energy self–reliance and helped jump–start a robust renewable energy services market in the state. The result has been nothing short of phenomenal. According to our analysis, New Jersey's programmes to encourage small–scale renewable energy have been the most successful in the nation and provide a model for other states to emulate."

2. How it Works:
New Jersey's net-metering rules and interconnection standards apply to all residential, commercial, and industrial customers of the state's investor-owned utilities (and certain competitive municipal utilities and electric cooperatives). Eligible systems include those that generate electricity using solar, wind, geothermal, wave, tidal, landfill gas or sustainable biomass resources, including fuel cells (all "Class I" technologies under the state RPS). The maximum individual system capacity is two megawatts (MW).[53]

Customer-generators have various compensation options for net excess generation (NEG), listed below:

- Customer-generator receives month-to-month credit for NEG at the full retail rate and is compensated for remaining NEG at the avoided-cost of wholesale power at the end of an annualized period.
- Customer-generator is compensated for all NEG on a real-time basis according to the PJM power pool real-time locational marginal pricing rate, adjusted for losses by the respective zone in the PJM.

- Customer generator may enter into a bilateral agreement with their electric supplier or service provider for the sale and purchase of NEG. Real-time crediting is permitted, subject to the applicable PJM rules.

Customers eligible for net metering retain ownership of all renewable-energy credits (RECs) associated with the electricity they generate. Customers with photovoltaic (PV) systems may apply to the New Jersey Board of Public Utilities (BPU) to participate in New Jersey's Solar Renewable Energy Certificates (S-RECs) programme, which tracks and verifies solar certificates, and allows the certificates to be sold on-line to electric suppliers to meet suppliers' solar renewable portfolio standard (RPS) requirements.

3. Impact:
There is no firm aggregate limit on net metering. Many supporters of distributed generation believe that New Jersey has the best standards for net metering in the United States. In 2006, the net metering programme ensured ease of access and compensation for more than 1,850 New Jersey solar residents, businesses and schools that have switched to solar electricity. New Jersey more than doubled its solar capacity in the first nine months of 2006.

"The success of this programme speaks volumes about what can be accomplished when government and the private sector work together to address tough public policy issues," said Fred Lynk, who manages PSE&G's demand side marketing programmes.

c. Hawaii

Hawaii had a population of 1.3 million people in 2007. Its GDP of $58.3 billion in 2006 ranked it the 39th in the US, but its per capita personal income of $39,239 in 2007 ranks 19th. Because Hawaii is isolated from the U.S. mainland, its energy infrastructure and consumption are unique among the States. Hawaii depends heavily on imported fossil fuels to meet energy demand. Close to nine-tenths of Hawaii's energy comes from petroleum. Hawaii uses small amounts of coal and very little natural gas. Hawaii is one of four States with geothermal power generation. State electricity demand is among the lowest in the country. Nearly one-half of all Hawaiian households use electricity as their primary energy source for home heating. Due to the mild tropical climate, many households do not use any energy for home heating.

Programme:	**Solar Thermal Mandate (2010 to future)**
Classification:	**Reducing upfront costs**

1. Motivation:
Hawaii must import about 90% of its energy sources (mostly from fossil fuels), which is part of the reason why the cost of living is famously high. Therefore, it makes a lot of sense for the sunny island chain to take advantage of its clean natural resources, and cut down on shipping and pollution.

2. How it works:
Hawaii has become the first state to mandate that all new homes be outfitted with solar water heaters through legislation (SB 644). This law requires solar water-heating (SWH) systems to be installed on all single-family new home construction, with a few exceptions. Beginning January 1, 2010, building permits may not be issued for new homes that do not include a SWH system.

3. Impact:
Hawaii already has 80,000 solar hot water heaters in operation. Residents can already get a handy 35% state income tax credit, in addition to taking advantage of the federal credit of 30% (up to $2,000) — however, the federal incentive is set to expire by the end of this year. To sweeten the deal even further, several of Hawaii's leading utilities are offering additional incentives worth $1,000 on a new system. Solar water heaters, also known as solar thermal systems, typically cost an affordable $1,500 to $3,500, and pay for themselves in four to eight years.[54]

4 From programmes to prescriptions

4.1 Matching policy to objectives

Looking at how each of the programmes and models compare on meeting various objectives for multiple stakeholders, their cost and benefit can be methodically assessed. The investment firm

Goldman Sachs has developed a cost curve for greenhouse gas emissions that offers insights into the possibility of targeting performance metrics with policies. Instead of quantifying the amount of greenhouse gases we intend to decrease, we will look at which policy types promote our top buckets of objectives.

For our three stakeholder groups, we have ranked them on a scale of 1-5 with 5 being the best and 1 being the worst, of how each programme meets the policy objectives described below:

Table 15: Growth Advocate

Country/ State	Programme Name	Classification	Ia. More	Ib. Faster	Ic. Likely	GROWTH ADVOCATE
Japan	70,000 Roofs Programme	Reducing Upfront	4	4	3	3,7
Germany	100,000 Roofs Programme	Reducing Upfront	3	3	3	3,0
Germany	Federal Electricity Feed Law (StrEG)	Paying for Output	4	3	4	3,7
Germany	Germany´s Renewable Energy Law (EEG)	Paying for Output	5	4	4	4,3
Spain	Royal Decree 463/2004	Paying for Output	4	5	4	4,3
US-Federal	Investment Tax Credit	Reducing Upfront	3	4	3	3,3
California	Californian Solar Iniative	Reducing Upfront	4	3	3	3,3
California	CEC New Solar Homes Partnership	Reducing Upfront	3	4	3	3,3
California	Net MeteringMarket Enabler					
California	Berkeley First	Innovative Financing	3	3	1	2,3
New Jersey	Net Metering	Market Enabler	1	1	5	2,3
New Jersey	Solar Renewable Energy Credits	Innovative Financing	3	2	3	2,7
Hawaii	Solar Thermal Mandate	Innovative Financing	3	5	1	3,0

For environmentalists and energy security interests, innovative financing mechanisms such as the Berkeley First programme that was recently signed into state law and Hawaii's solar thermal mandate have the ability to deploy the most generation of any of the policy types. Rather than simply offering a subsidy or eventually paying for output, mandates would require that all new construction would be built with energy efficiency measures. However, such far-reaching mandates could be most difficult to pass. For example, the zero energy homes mandate in California has come up for vote several times, but has never gained the support of industry which would be forced to incur the additional cost of paying for energy efficiency measures up front. On the contrary, market enablers such as the net metering programmes do not produce much volume, but they are the most likely to garner political buy-in.

In fact, the larger the potential scale, the more difficult it is to get political buy in. The US Federal Investment Tax Credit has came up for a vote unsuccessfully eight times last year and has been voted down each time due mostly to political push back during this election year. This is largely why states rather than the federal government have been pushing the policy envelope in the US. Similarly, the Portfolio standards of the EU may incentivize the need for policies to reach them, but it is largely the countries, such as Spain, that have had to develop the actual policy incentives.

Table 16: Marginalist Policy

Country/ State	Programme Name	Classification	2a. Cheaper	2b. Less Public $	2c. Employing	MARGINALIST POLICY
Japan	70,000 Roofs Programme	Reducing Upfront			4	2
3	3,0					
Germany	100,000 Roofs Programme	Reducing Upfront			4	2
3	3,0					
Germany	Federal Electricity Feed Law (StrEG)	Paying for Output	5	1	4	3,3
Germany	Germany´s Renewable Energy Law (EEG)	Paying for Output	4	1	4	3,0
Spain	Royal Decree 463/2004	Paying for Output	4	1	4	3,0
US-Federal	Investment Tax Credit	Reducing Upfront	3	3	2	2,7
California	Californian Solar Iniative	Reducing Upfront	4	2	3	3,0
California	CEC New Solar Homes Partnership	Reducing Upfront	3	3	3	3,0
California	Net Metering	Market Enabler	2	5	2	3,0
California	Berkeley First	Innovative Financing	4	4	3	3,7
New Jersey	Net Metering	Market Enabler	2	5	2	3,0
New Jersey	Solar Renewable Energy Credits	Innovative Financing	2	4	3	3,0
Hawaii	Solar Thermal Mandate	Innovative Financing	2	4	4	3,3

Those policies that improved deployment economics will by definition be at odds with those policies that require less public funding. For example, the German Feed in tariff will score high on improving deployment economics. In fact, it overpays for the price of output. Because the feed in tariff set the price of output for twenty years in advance, it will likely choose the wrong price. This leads to one of two problems – it either sets the price too low in which case it will not be enough of an incentive or it sets the price too high in which case there will be more political push back to continuing the programme. Furthermore, feed-in tariffs do not allow for an easy transition into the unsubsidized market, so it will continue to require public funding for the life of the programme.

The benefit of utilizing public funds is that this will likely cause more deployment and will lead to additional jobs. Therefore the employing metric and the cheaper metric are congruent.

Table 17: Economist/ Industry Purist

Country/ State	Programme Name	Classification	3a. Robust	3b. Evenly	3c. Distertive	3D. Breader	ECONOMIST INDUSTRY
Japan	70,000 Roofs Programme	Reducing Upfront	2	2	2	4	2,5
Germany	100,000 Roofs Programme	Reducing Upfront	1	2	2	4	2,3
Germany	Federal Electricity Feed Law (StrEG)	Paying for Output	2	2	1	2	1,8
Germany	Germany´s Renewable Energy Law (EEG)	Paying for Output	2	2	1	2	1,8
Spain	Royal Decree 463/2004	Paying for Output	2	2	1	2	1,8
US-Federal	Investment Tax Credit	Reducing Upfront	3	2	2	3	2,5
California	Californian Solar Iniative	Reducing Upfront	2	3	2	3	2,5
California	CEC New Solar Homes Partnership	Reducing Upfront	1	1	2	3	1,8
California	Net Metering	Market Enabler	3	3	5	1	3,0
California	Berkeley First	Innovative Financing	5	5	4	3	4,3
New Jersey	Net Metering	Market Enabler	3	3	5	4	3,8
New Jersey	Solar Renewable Energy Credits	Innovative Financing	4	5	5	3	4,3
Hawaii	Solar Thermal Mandate	Innovative Financing	5	4	4	5	4,5

For economists and industry, the long-term implications of policies are most important. It is interesting to note that feed-in tariffs and rebates, which have been seen as the ultimate policy in terms of increasing the amount of distributed generation, score very poorly by this group of interests.

In particular, feed-in tariffs are not a robust solution in large part because they clearly distort the markets. Rebates and subsidies, whose timelines are not certain, score particularly low on increasing investor confidence as well as distorting the markets. Where market enablers do not necessarily increase volume of deployment, it does score well on measurements of less distortion. The only group that consistently does well by this group of stakeholders is the innovative financing measures. These new programmes are not only less distortive, but because they are market based, they are also the most even solution possible.

Table 18: Summary of Policies and Objectives

Country/ State	Programme Name	Classification	GROWTH ADVOCATE	MARGINALIST POLICY	ECONOMIST INDUSTRY	TOTAL SCORE
Japan	70,000 Roofs Programme	Reducing Upfront	3,7	3,0	2,5	9,2
Germany	100,000 Roofs Programme	Reducing Upfront	3,0	3,0	2,3	8,3
Germany	Federal Electricity Feed Law (StrEG)	Paying for Output	3,7	3,3	1,8	8,8
Germany	Germany´s Renewable Energy Law (EEG)	Paying for Output	4,3	3,0	1,8	9,1
Spain	Royal Decree 463/2004	Paying for Output	4,3	3,0	1,8	9,1
US-Federal	Investment Tax Credit	Reducing Upfront	3,3	2,7	2,5	8,5
California	Californian Solar Iniative	Reducing Upfront	3,3	3,0	2,5	8,8
California	CEC New Solar Homes Partnership	Reducing Upfront	3,3	3,0	1,8	8,1
California	Net Metering	Market Enabler	2,3	3,0	3,0	8,3
California	Berkeley First	Innovative Financing	2,3	3,7	4,3	10,3
New Jersey	Net Metering	Market Enabler	2,3	3,0	3,8	9,1
New Jersey	Solar Renewable Energy Credits	Innovative Financing	2,7	3,0	4,3	9,9
Hawaii	Solar Thermal Mandate	Innovative Financing	3,0	3,3	4,5	10,8

In reviewing the programmes on their merits, it turns out that the German, Spanish, and Japanese programmes scored best on the conventional metrics of “market growth”, but poorly on the broader metrics of cost-effectiveness or stable market development. The next section explores the repercussions experienced in all these markets from rapid growth without concern for these other objectives, which lead to unintended consequences for each of them.

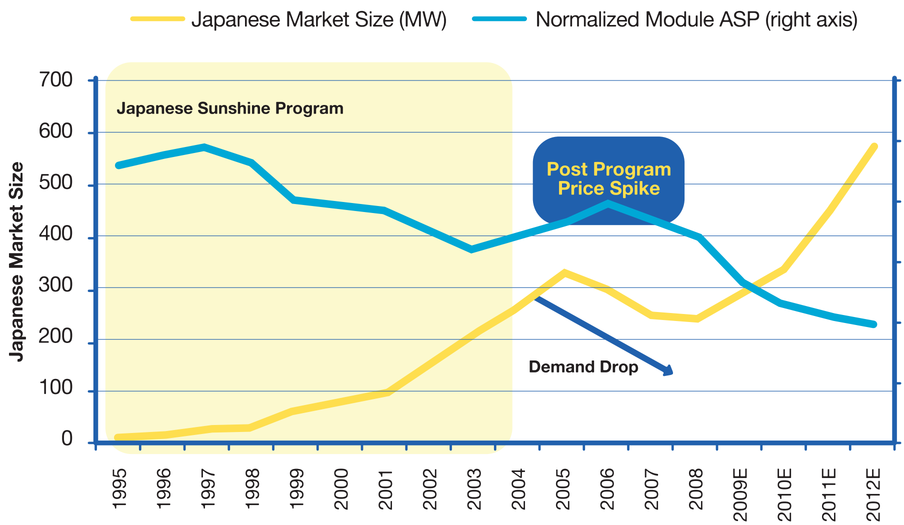
4.2 Avoiding Unintended Consequences

Policy programmes always carry the risk of unintended consequences – for example, feed-in tariffs in Germany and Spain have had dramatic impacts on global prices for PV. Trying to understand how these policies may change “in the wild” is necessary in any evaluation. Looking at the results of poor planning in both the Japanese and Spanish programme situations shows that the German market for PV may be at risk of similar outcomes.

a. Japanese PV Market: Programme Dependence

The chart below shows the market growth and global module average selling price (ASP) from 1995 to the end of the Sunshine Programme in 2005, and then the unsubsidized market after that. The intention of the Sunshine Programme was to create a market where PV was the same price as the grid electricity that it displaced – a situation referred to as “grid-parity”. By 2004, the market was approaching this point of grid-parity and anticipated additional improvements in module price should have continued to make PV more cost effective.

Figure 21: Japanese PV Market Growth VS. MODULE ASP



Source: Prometheus Institute

What actually occurred was that module prices began to rise around the time of the end of the Sunshine Programme, and rose further through the middle of 2008, due to strong global PV demand created by the policy programmes in those countries. This led to a period of market shrinkage that is not likely to reverse until either global module ASPs come down substantially or additional policy programmes are established by the Japanese government.

Fortunately, both of these are forecast to occur soon. Spain's situation below and global financial markets making it marginally harder to obtain PV project finance are causing demand issues, while normal supply expansion is bringing pricing back in line with historical trends. At the same time, the Fukuda vision announced in Japan in 2008 should help to support the cost of PV system installation by an additional 10 percent.

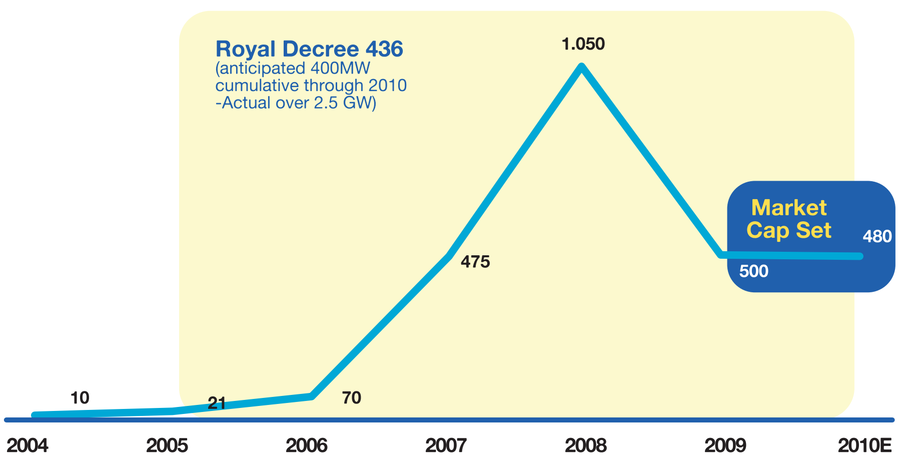
The lesson to be drawn is that programmes that support upfront costs must be responsive to market conditions – particularly changes in the market price for components or systems – or can find that market conditions create perverse outcomes Furthermore, market-based programmes must plan carefully to avoid problems caused by the transition from a subsidized to an unsubsidized environment.

b. Spanish PV Market: Victim of its own success

Underpricing, or premature de-subsidization, is one possible problem that creates a drop in demand – the opposite problem is over-stimulation. This occurs when the incentives are set too high and there is no mechanism to regulate the excess demand or cost of the programme, as in the case of the Spanish programme since 2005.

The chart below shows how violently the Spainsh PV market grew from the establishment of their feed-in tariff in the form of Royal Decree 436. The market's growth was over 5 times the expected cumulative market in just the first 2 years of a 5 year programme. What resulted was an expense rate for the programme of over 10 times the originally intended amount that occurred simultaneous with a national budget crisis. The governement responded by establishing a lower feed-in tariff as well as a programme cap of 400 MW per annum (with some additions for projects in the queue.

Figure 22: Spanish Market Boom and Bust

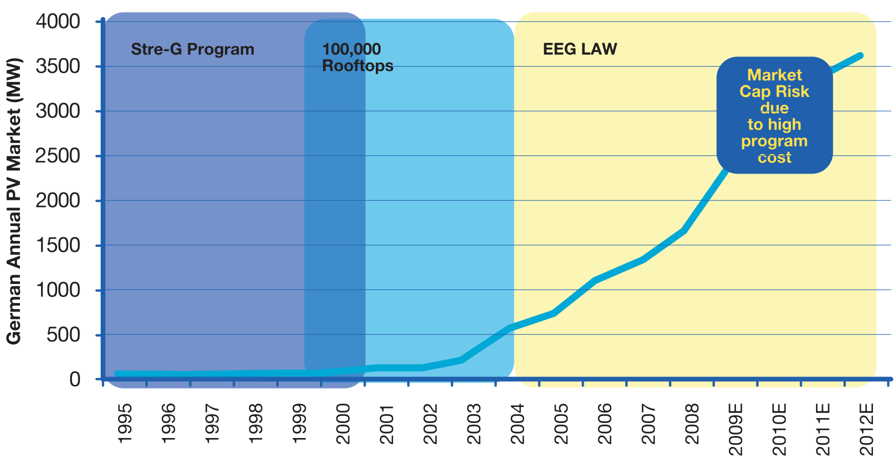


Source: Prometheus Institute

The net result is that all of the infrastructure that was so dearly paid for to create over 1 GW of annual capacity is now likely diminished in value. While the Spanish market may have scored well for growth, it failed abysmally at creating a stable, predictable regime, and has yet to find a pathway to a long-tem unsubsidized market for distributed renewable energy.

c. German PV Market: Risk to the global PV industry

Figure 23: German PV Market vs. Support Programme



Source: Prometheus Institute

Given the experience of Japan and Spain, the question is how long the German market can remain the market of last resort. Already in 2008, a coalition of politicians and electricity ratepayer advocates were calling for a one-time 30 percent drop in the feed-in tariff rate in Germany. With the German market already using PV to provide more than 100 percent of its load growth and the surcharge to pay for the programme expected to climb to over 20 percent of the retail electricity bill of every German household and business, the answer is likely to be "not much longer".

Beyond 3 or 4 GW of new PV installations per year, Germany is going to find it hard to justify the expense of new installations. If market prices for modules come down according to the forecasts above, the wealth transfer from electricity purchases to solar owners will be extreme, and the perceived value to the German clean energy position will be diminished. Germany will only be able to respond with either a physical cap on volume of the programme (such as Spain), a substantial change in the feed-in tariff rate (risky if under or over priced), or change in the design of the programme (very disruptive to the world's largest market). None of these will be to the benefit of German installers or global component manufacturers.

5 Conclusion

5.1 Toward an optimal design?

Many PV industry participants have favorite programmes, and in fact it is very common to look at the growth in the German and Spanish PV markets and make the leap that the FIT programmes that led to the growth are inherently the "best" programmes for driving PV deployment. This paper maintains that such a version of optimality is too narrow, and that things like cost-effectiveness, lack of distortions, and long term market growth are things that some stakeholders may also consider important. Policy as a mechanism must take into consideration many (in fact a majority in modern democracies) heterogeneous preferences or it will not persist.

Recent developments in the Spanish market give reason for caution. The boom-bust cycle there has really served no one well from the builders to the taxpayers to the consumers in the rest of the world who were crowded out by high Spanish tariffs. It did enrich many marginal producers of PV, lots of them in China, to a dubious long-term effect. The remaining question about FIT programmes is not if they can fail, but if they must.

They need not, as the German programme has shown resilience and flexibility – though not without serious political effort and risk. And it was the combination of programmes that has likely led to such robust and sustained growth, and not a single element of the FIT piece. Germany deployed a combination of feed-in tariff (paying for output); interconnection (market enabler); and loan programmes (financing option) in 2004 in its revision to the EEG. Perhaps the lesson to be drawn is that a single mechanism is never enough, and combinations are most effective.

The likely response from many FIT proponents is that this assessment is too harsh about the benefits FT programmes have been. However, this report has given substantial credit to FITs as the drivers of rapid growth in a number of markets but has also pointed out their weaknesses in distortive impacts and high potential cost, along with recent examples of how they have caused Spain and Germany to incur massive debt on behalf of ratepayers/ taxpayers.

The problem is not that this analysis has been too harsh, but that most FIT defenders are hyper-sensitive to any criticism of the programme and refuse to admit any failings of the design or implementation. Most people outside of PV proponents do not believe that growing the markets at any price is the optimal criteria on which to judge the worth of support programmes. Cost-effectiveness and long-term certainty for investment and jobs are also key concerns for many stakeholders.

Germany's FIT-based programme has admittedly improved over the last few iterations by including more flexibility, target ranges for growth (a method of capping the programme, it should be noted), and discussions of alternate mechanisms. Over 2009, these changes have become more common in design from Germany to the USA precisely because of the reasons this analysis suggested they would – that FIT programmes cannot remain unchecked or they will create massive costs and economic distortions. This leads to one of the most interesting elements of sub-optimality - that FITs inherent runaway nature causes governments to tap the brakes just as markets are taking off - versus others (financing mechanism or reducing upfront costs) that would create more convex demand functions and would enable growth just as system economics improve.

This study maintains that the point of distributed energy subsidy programmes is to create the most robust markets over time at the lowest cost. Others may disagree with this objective function, but the analysis above was solely designed to begin the process of unpacking the various characteristics so that the discussion of social objective functions can take on a more vigorous tone – using a common language set and framework.

In the end, it should also be noted that the higher scoring mechanisms that meet broader social criteria have not broadly "proven" themselves in the marketplace. This can be partially explained by 1) their low scores for growth which means they do not show immediate (often unsustainable) growth, 2) their higher scores for sustainability and balanced market development which is often less visible or noticeable (measured or observed only in the absence of distortions), and 3) their long term market impacts which have not played out in the marketplace.

Should the twin assumptions of 1) that scoring in this analysis reflects a good interpretation of optimal design and 2) that PV support programmes emerge over time to balance various broadly-defined stakeholder perspectives, we would over time see the most successful programmes arise from designs that scored higher above like financing programmes. If the past is any indication of the future, we can expect as many innovations in the policy mechanisms that emerge in the years to come.

Travis Bradford

Travis Bradford is the founder and President of the Prometheus Institute for Sustainable Development, a nonprofit organization focused on harnessing the power of the business sector to develop cost-effective and sustainable solutions in technologies. Travis is the COO/CFO of the Carbon War Room, a philanthropic initiative created to harness the power of entrepreneurs to implement market-driven solutions to climate change. Travis is also an Adjunct Professor of Management at Chicago Booth where his focus is on innovation in energy technologies.

Jessica Lin

Jessica Lin is an Energy Specialist in the Latin American and Caribbean region of the World Bank. She was a Catherine B. Reynold's Fellow for Social Entrepreneurship from the Harvard Kennedy School where she earned her Master's in Public Policy. She completed her undergraduate degree in Electrical Engineering and Computer Science at MIT.

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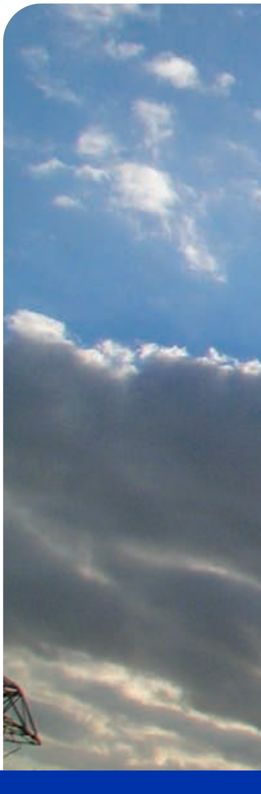

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