Renewable Energy Policy Experience

Lessons for Japan

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Renewable Energy Policy Options

Renewable energy is undergoing dramatic price reductions, accompanied by—and driven by—high volume sales. This creates a terrific moment for governments to make a strategic move: With the right policies, it is possible to capture the benefits of renewable energy and own a large part of the market for these technologies.

But getting the policy right is crucial. Historically, many policies have supported dead-end technologies, or promoted research but let new technologies die without a market signal, or followed a boom-bust cycle. It turns out that there are many more ways to design bad policy than good. This memo surveys international experiences, and synthesizes the best practices in five realms relevant to Japan's policy choices.

The most common renewable energy policies support technologies that are on the verge of commercialization, but need an extra push to compete with incumbent technologies (for example: wind, solar photovoltaics). Fundamentally, there are three ways to use policy to support this type of renewable energy:

1. Buy clean energy directly, or mandate the purchase of clean energy.
2. Improve the business case for clean energy by providing cash, reducing tax burdens, or reducing risk.
3. Streamline or remove non-price barriers (for example: transmission access, siting).

Smart policy can also help invent the renewable energy technologies of the future (for example: offshore wind, enhanced geothermal) so that Japan's energy costs continue to come down while keeping pollution low. Thus the fourth group of policies:

4. Support research, development, and demonstration.

Finally, as new technologies are commercialized and the share of renewable energy grows, another group of policies is required to manage grids for intermittent sources.

5. Address intermittency.

It is also worth noting that there are many energy efficiency policy options, which are not covered in this memo, but which will be critical to reaching Japan's energy goals. Efficiency can considerably reduce both consumer costs and system costs, making it easier to reach higher penetrations of clean energy.

Within each of these five realms, there are several policy options. Some designs work better than others. Best practices for effective policies can be gleaned from international experience.

Recommendations for Japan

Drawing on the international case studies and policy descriptions described below, several priorities rise to the top for Japan.

Japan has several solid policies in place to encourage renewable energy today:

- ✓ Japan's feed-in tariff is among the most generous in the world. This program should be carefully maintained, with any appropriate rate adjustments announced well in advance of the current policy's end date.
- ✓ Japan is currently leveraging demand response to reduce—or shift—peak load. As the nation faces capacity challenges in a future without nuclear, expanded demand response programs could continue to play a very important role in balancing electricity supply and demand.
- ✓ Japan's passage of a small tax on carbon dioxide emissions is an important step toward making renewable energy more competitive in the generation market. This tax could ramp up further over time, and the revenue could be used to fund renewable energy research or deployment.

Still, there are important next steps that policymakers in Japan could take to support renewable energy:

- ☐ Expand and update the electricity transmission and distribution grid. A streamlined process should be established to allow distributed generators and other renewable energy generators to easily interconnect to the grid. In addition, enhancing interconnection of regions across Japan can help grid balancing authorities draw upon a more diverse and reliable set of renewable energy resources.
- ☐ Encourage competition by reducing the power of utility monopolies. Unbundling transmission assets from generation assets is an important first step in this transformation. Next, it is important for Japan to establish an independent grid balancing authority to make generation and transmission decisions at both regional and national scales.
- ☐ Policies specifically aimed at geothermal, solar hot water, and biomass can complement those policies now in place to support solar photovoltaics and wind. All three of these technologies may require specific policy attention. For example, to take advantage of Japan's vast geothermal potential large geothermal projects could benefit from favorable financing terms or bankable production pricing guarantees.
- ☐ Build an even more vigorous research and development program, coupled tightly with deployment strategies. Japan can lead the world in the commercialization of new technologies by combining research with aggressive deployment.

The following sections lay out best practices for renewable energy policy design and international case studies with lessons for Japan's policymakers.

Best Practices in Renewable Energy Policy Design

As Japan considers different policy options for supporting renewables, it is useful to look at best international practices in each realm. This is a short summary: For a more detailed explanation of each policy option, please turn to the referenced pages.

I. Buy clean energy directly, or mandate the purchase of clean energy.

Technologies that use government or utility support to purchase new energy technology can be very powerful. They have been used, together with feed-in tariffs, to drive the price of solar PV down 75 percent in the last three years, and wind by about half in the last eight years.

These policies should be **technology neutral** for the most part, but exceptions may be appropriate for important new technologies that are close to—but not quite yet—commercial. See page 11.

Renewable Electricity Standards[1] (RES) require utilities to buy a certain share of their electricity from clean sources. It is crucial that RESs are serious and reliable. RESs have the advantage of using the market to find the right price for renewable energy, rather than setting a price. See page 11. Renewable electricity standards should also:

- ✓ Incorporate steady improvements. For example, set a percentage goal for 2020 (e.g., 20%) and then have that increase a fixed amount annually (e.g., 2% per year), for the long term. This signal will motivate companies to spend serious money developing new technologies and increasing performance.
- ✓ Establish tranches within the overall target for important new technologies (e.g., 5% from solar) or supplement the RES with a feed-in tariff to help those important new technologies compete.
- ✓ Be complemented by removing non-price barriers. See page 21.

Public procurement requires government agencies to buy technologies that meet specific standards. Procurement can kick-start a new renewable energy industry by providing an assured market. See page 12. Our top recommendations are:

- ✓ Use public procurement to accelerate the top-runner program. The top-runner program, invented in Japan, is one of the best examples of steady improvement in performance by creating incentives for the top of the market. It could be accelerated by requiring government agencies to buy only technologies within the top 10 percent of their class.
- ✓ Require that government buildings and agencies are powered by clean energy.

II. Improve the business case for clean energy by providing cash, reducing tax burdens, or reducing risk.

Smart government policy can help build the business case for renewable energy without having to take on risk or choose winners and losers. To get there, a few basic rules are in order.

[1] Many jurisdictions call them Renewable Portfolio Standards. There are analogous policies for liquid fuels, called low carbon fuel standards.

- ✓ Any policies in this realm must be predictable over the long term so that they are bankable. Policies designed to improve the business case for renewable energy should be consistent, and never suddenly disappear.
- ✓ If adjustments in price support are needed, such change should ramp down according to a well-defined schedule announced ahead of time or they should be replaced by re-calibrated programs announced at least two years in advance.

There are several ways governments can help the business case for new technology. Many of these complement and reinforce each other.

Feed-in tariffs (FiT) require utilities to pay a fixed price per kilowatt-hour to renewable energy generators. This well-tested policy mechanism has proven very effective at bringing new renewable energy technologies to scale. See page 13.

- ✓ Either auction the FiT to let the market determine the right price, or build in a structured rate decline over time. This gets maximum energy and maximum technology change per dollar.
- ✓ Long-term predictability makes a FiT bankable. For example, when the current FiT is half-way done, announce the follow-on program with re-calibrated rates so that investors and developers can plan ahead.
- ✓ Complement the FiT by removing non-price barriers. See page 21.

Rebates and direct support are interchangeable. Rebates (distributed after project completion) reduce the risk to government by ensuring that projects are completed, but exposes the private sector to some greater risk. Direct support (distributed before project completion) reduces the risk to the private sector, but exposes the government. Both rebates and direct support are more efficient ways to support renewable energy than tax credits. See page 14.

- ✓ Define the program well by giving clear timelines and guidelines for what kinds of projects will qualify. Transparency and timeliness are essential.
- ✓ Don't change the rules part-way through the program.
- ✓ Use this policy to leverage strong business plans. The government should be a disciplined second investor, and should not pick winners by acting as the first investor.
- ✓ Tiered programs work well. For example, when the current program is half-way done, announce a follow-on program with re-calibrated rates so that investors and developers can plan ahead.

Accelerated depreciation allows project developers to claim larger tax deductions during the early years of a project. This is useful with renewable energy projects as they tend to have a very high capital cost and low annual costs, in contrast to the pattern of conventional technologies. See page 16.

- ✓ Provide more favorable terms of depreciation for renewable projects than for non-renewable projects.
- ✓ Publish clear guidelines and timelines.

Tax credits reduce tax liability. They are generally less efficient at encouraging renewable energy development than direct support or rebates. See page 17.

- ✓ Tax credits should be based on energy production, not capacity investment.
- ✓ Tax credits should be tradable; often project developers do not have sufficient tax liability to take advantage of their credits themselves.
- ✓ Never let programs expire without clear next steps. Either ramp down tax credit rates over time or create tiered programs. For example, when the current program is half-way done, announce the follow-on program with re-calibrated rates so that investors and developers can plan ahead.

Green banks are infrastructure banks that specialize in green projects. They are a natural next step beyond simple low-interest loans. See page 18.

- ✓ Be a one-stop-shop with specific expertise in clean energy loans and an appropriate variety of credit products.
- ✓ Set clear criteria for clean energy loans. Again, transparency and timeliness are essential.
- ✓ Act as a disciplined second investor and gain experience by overseeing loans over a long period of time.

Loan guarantees provide a government backstop in case projects default on their private loans. They are an excellent way to drive down the cost of money for low-risk, capital-intensive projects. Loan guarantees are not appropriate for speculative investments, even though they have been used this way in other countries. See page 19.

- ✓ Choose projects that already have:
  - a proven technology,
  - existing private investors,
  - regulatory approval, and
  - a contract to sell electricity.

Guarantees are generally budgeted assuming around 10 percent default, but using the above criteria to select projects can accelerate project development with much lower default rates.

Taxing fossils to fund renewables drives at the solution from two directions. First, it internalizes some of the externalities associated with fossil fuels, raising the target price that renewables must reach to compete. Second, it helps drive down the cost of renewables via the cost reductions that come with expanded capacity. Together one obtains a virtuous cycle, accelerating the transformation to a clean energy economy. See page 20.

- ✓ Steadily ramp up the rate at which carbon is taxed.
- ✓ Use tax revenue to fund the other policies described in this paper.

III. Streamline or remove non-price barriers.

The government can—in theory—create conditions for clean energy businesses to thrive, but if those businesses can't sign contracts, or find suitable sites, or gain access to transmission lines, other policy support is unimportant. Disruptive policy is necessary in this realm if renewable energy is to grow quickly. It would be valuable to:

- ✓ Design a simple project checklist. If a project meets all requirements, designate it as "green." If it meets most of the requirements, designate it as "yellow." If it meets only a few of the requirements, designate it "red."
- ✓ "Green" projects are guaranteed siting, permitting, connection, and power purchase within three months; "yellow" projects within ten months if they meet key conditions; and "red" projects must adjust and re-apply.
- ✓ Transparency and even-handedness should be emphasized at every turn.
- ✓ Grant authority to one government agency to help expedite projects. Designate an ombudsman to help overcome barriers.

Market access for small generators can be encouraged through *net metering* and *time-of-use* rates. Net metering allows distributed renewable generation to be counted and credited against retail electricity prices. Time-of-use rates pay more for electricity generated during peak times (which often correspond with solar output). This is especially important for capacity-constrained electricity systems like Japan's. See page 22.

- ✓ Establish net metering, and distributed generation will flourish.
- ✓ Establish time-of-use rates to encourage distributed generation during times of peak load.
- ✓ Upgrade distribution network hardware to be able to handle two-way electricity flows.
- ✓ Note that here too, the process must be simple, fast, and transparent.

Unbundling transmission from generation disallows the same entity from owning both generation and associated transmission assets. Unbundling increases competition. Unbundling can be achieved many ways. See page 23.

- ✓ Assure that decisions about transmission access are made by different entities than those profiting from transmission.

Transmission and generation siting can either hinder or streamline renewable energy development. See page 24.

- ✓ Transmission and generation siting should move forward in partnership with local populations.
- ✓ The government should designate a single agency as a one-stop-shop for all permit authorizations.
- ✓ The green-yellow-red methodology described above can also apply here.

Financing transmission requires predictable mechanisms that take into account the large capital requirements, broad geographical distributions, and long payback periods. See page 25.

- ✓ Transmission is much more likely to be financed when sales are guaranteed from qualified buyers or via a regulatory authority.
- ✓ Encourage long-term transmission contracts, but be ready to use the government as a back-stop if contracts fail. Ensure that access to transmission is non-discriminatory: All generators should have equal access.

IV. Support research, development, and demonstration.

Government support for research, development, and demonstration (RD&D) of clean energy technologies can help develop low-cost clean energy options for Japan's future. Strong RD&D programs can mean the difference between owning the energy future and renting it from foreign companies. Our work with the American Energy Innovation Council in the United States revealed the following set of policy recommendations.[2]

- ✓ Government support for clean energy should be approximately equal to 1 percent or more of the nation's annual energy bill. This still puts energy RD&D at a lower rate than most other technology intensive industries.

Public funding for basic science can illuminate new options for future energy technologies. See page 26.

- ✓ Quantitative science and technology targets ("stage gating") should be set in consultation with the private sector so that funding can be redirected if projects do not meet targets.

Centers of Excellence can cluster research and manufacturing expertise. It is important to build scale in each technology; this makes it possible to buy expensive equipment, build complex labs, recruit great researchers, and attract new companies. Together, these elements create a profoundly powerful ecosystem for innovation. See page 27.

- ✓ Research and testing platforms should be designed to allow enable advanced testing and prototyping that small technology developers would not be able to afford on their own.
- ✓ Public-private partnerships can streamline public RD&D support into projects with clear commercial potential by connecting directly to market demand signals.

V. Address intermittency.

As solar and wind increase in share on the electricity grid, policy becomes crucial to maintain reliability.

Demand-response fundamentally changes the game of electricity grid balancing by allowing system operators to control load in a similar way to generation. See page 28.

- ✓ Use demand response to achieve both load curtailment and load shifting.
- ✓ Develop contracts with private demand aggregators.

[2] Energy Innovation manages the American Energy Innovation Council, which Bill Gates, Jeff Immelt, John Doerr, and others founded to promote clean energy RD&D in the USA. We have a series of policy publications on energy RD&D available upon request.

- ✓ Prioritize demand-response in the resource dispatch order.

Expanding balancing areas can help reduce intermittency by drawing on diverse weather patterns – if it's windy and cloudy somewhere, it may be sunny and still somewhere else. See page 29.

- ✓ Establish an independent grid system operator that can balance across utility regions.
- ✓ Expand transmission to be able to handle larger distances between generation and load.

Thermal backup can play an important role when there is a high penetration of renewables on the grid. See page 30.

- ✓ Fossil fuels can be a fast-acting balancing tool, supplying on-demand energy rather than base-load energy.
- ✓ Premium pricing could be tied to the speed and scale of the change in generation.
- ✓ Reward resources that can ramp quickly to provide back-up to intermittent renewables. This is a largely untested territory, but getting the incentives right will enable higher shares of renewables on the grid.

International Case Studies of Renewable Energy Policy Design

I. Buy clean energy directly, or mandate the purchase of clean energy.

Renewable Electricity Standard

A **Renewable Electricity Standard** (RES) requires electricity retailers to gradually work towards providing a certain percentage or quantity of renewable electricity to its consumers by a certain date. An RES generally sets a target but relies on the market to decide which specific resources will provide the needed production.

- RES ambition varies depending on the potential for cost-effective renewable power in a region.
- Often, RESs have carve-outs for specific technologies. For example, the policy will specify that a certain share must come from solar to stimulate technology development and cost reduction.
- Much of the cost of RESs is considered to be absorbed by consumers, as utility companies often pass costs through to all electricity consumers via increased rates to pay for renewable capacity expansions.

Best Practices

✓ Build in steady improvements. For example, set a percentage goal for 2020 (e.g., 20%) and then switch to annual percentage increases (e.g., 2% per year).

✓ Establish carve-outs within the overall target for important new technologies (e.g., 5% from solar) or complement the RES with a feed-in tariff to help those important new technologies compete.

✓ Complement the RES by removing non-price barriers.

Japan's Current State

Japan's Ministry of Economy, Trade, and Industry currently administers an RES with a target of 16 billion kWh by 2014. Electricity retailers can meet the standard by: (1) generating renewable energy themselves; (2) purchasing it from another party; or (3) purchasing "New Energy Certificates." If an obligation cannot be met within the year, utilities can 'borrow' up to 20 percent of their obligation and carry over that obligation to the next year. If the standard is not met, utilities are fined up to 1 million yen, or $12,773.

Typical Actors

- ***Legislatures*** and ***regulatory agencies*** have most often been responsible for setting and enforcing RESs
- ***Utilities*** make purchasing decisions to meet the standard at least cost

Typical Beneficiaries

- ***Renewable energy generators and investors*** benefit from utilities' purchase of their energy itself or of Renewable Energy Credits

Scale of Investment

One U.S. study[3] analyzed data from 28 U.S. states with RESs and found that the median electricity price increased by about 0.7 percent or $0.0004/kWh.

Examples

- In **Nova Scotia (Canada),** utilities are subject to either a voluntary or a mandatory RES. After initial implementation in 2007, the policy was successful enough that the near-term RES target was increased from 10 percent by 2013 to 25 percent by 2013.[4]
- Although there is no federal RES in the **United States**, 31 states currently have their own RESs, and 16 of those states have specific carve-outs for solar or other distributed generation. **California** has adopted an RES requiring 33 percent of all electricity to be produced from renewables by 2020. There is no solar carve-out in California, but the state provides a complementary feed-in tariff for solar.

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[3] Chen, Cliff, Ryan Wiser, and Mark Bolinger. 2007. "Weighing the Costs and Benefits of State Renewables Portfolio Standards: A Comparative Analysis of State-Level Policy Impact Projections." Lawrence Berkeley National Laboratory. Report LBNL-61580.

[4] International Energy Agency. "Nova Scotia Renewable Portfolio Standard." IEA/IRENA Global Renewable Energy Policies and Measures database. Webpage. Accessed 5 Sept. 2012. Accessible at: http://www.iea.org/textbase/pm/Default.aspx?mode=re&id=4680&action=detail

Public Procurement

Recognizing that the public sector is one of the largest purchasers of energy, governments can themselves procure clean energy at a large scale. Public procurement is best for targeting technologies that have proven potential, but remain too expensive for widespread private sector investment. This assured market for clean energy can bring down the cost. Local, regional, or national governments can achieve this by either:

- Generating renewable energy through public sector installations and facilities (e.g., installing solar panels in city buildings), or
- Establishing agreements to purchase power from private renewable energy producers.

Best Practices

- ✓ Use public procurement to accelerate the top runner program. For example, require government agencies to buy only technologies within the top 10 percent of their class.
- ✓ Require that government buildings and agencies are powered by clean energy.

Japan's Current State

Japan has developed 'green procurement' laws and programs in the past for environmentally-friendly projects, but the nation does not appear to have a procurement program specifically for renewables.

Typical Actors

- ***Local government agencies*** and ***groups of public sector energy purchasers*** agree to purchase the energy
- Those government agencies sign Power Purchase Agreements with ***renewable energy installers and developers***

Typical Beneficiaries

- ***Government agencies*** often see electricity cost reductions
- ***Renewable energy developers*** sign contracts that guarantee return.
- ***Private technology developers*** see an assured market, and ***consumers*** in turn benefit from lower electricity costs

Scale of Investment

In 2011, the city of Milpitas in the United States agreed to purchase 10 years' worth of solar electricity from 2,174 kW of new solar systems installed by a private company on city property. Initial procurement rates ranged from **$0.175 - $0.215/kWh**, escalating 3 percent each year. A similar project at the Santa Clara Valley Transportation Authority achieved an initial **cost reduction** for the city (compared to utility prices) of about **$0.04/kWh**, with savings growing to $0.10/kWh by the tenth year of the contract.

Examples

- The **United States** Department of Defense (DoD) is the single largest consumer of liquid fuels in the world. Recognizing the security risks posed by its dependence on oil, the DoD has become an early adopter of advanced biofuels technology. The DoD procures contracts for large quantities of biofuels (e.g. a 150,000-gallon contract for algal biofuel), which it then tests and certifies through use in its planes and ships. The U.S. Air Force has a 50 percent alternative fuel procurement target for its domestic aviation needs by 2016.
- The Silicon Valley Collaborative Renewable Energy Procurement (SV-REP) Project in the **United States** is a partnership between towns, cities and counties seeking to increase public sector adoption and installation of renewable energy. The project now features 70 sites at 43 locations, collaborating across 9 public agencies, with carport, rooftop, and ground-mounted systems at various public buildings and institutions.[5] It has achieved 10-15 percent reductions in energy costs, greenhouse gas reductions, and 50 percent savings in administrative and transaction costs.[6][7]

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[5] Joint Venture Silicon Valley. "Our Renewable Energy Procurement Project." Website. Accessed 6 Sept. 2012. Available at: http://www.jointventure.org/index.php?option=com_content&view=article&id=189&Itemid=287

[6] U.S. Environmental Protection Agency. Jan 2011. "Clean Energy Collaborative Procurement Initiative – Metro DC: Fact Sheet." Available at: http://www.epa.gov/greenpower/initiatives/cecp/documents/EPAGPP-CECP-MWDC-FactSheet.pdf

[7] This initiative has produced a handbook on Best Practices for Collaborative Solar Procurement, available at: http://www.jointventure.org/images/stories/pdf/purchasing.power_best.practices.guide.to.collaborative.solar.procurement.pdf

II. Improve the business case for clean energy by providing cash, reducing tax burdens, or reducing risk.

<table>
<tr><th colspan="2">Feed-In Tariffs</th></tr>
<tr><td colspan="2">A feed-in tariff (FiT) requires utilities to pay renewable energy producers a fixed price per kWh of production over a period of 10-25 years. As renewable capacity increases and manufacturing costs decline, the FiT rate generally ramps down. Note that FiTs have two benefits: They purchase renewable energy, and they drive down the price of the technology. The latter benefit may exceed the former by many times; governments are, in effect, buying future options along with current energy.
• FiT rates can either be set by the government or can be auctioned off to let the market determine the price.
• FiT rates vary, depending upon the type of technology being implemented and the size of the installation.
• FiT schemes can include an installed capacity cap, after which point a FiT ends or comes under new terms.</td></tr>
<tr><td colspan="2">Best Practices
✓ Either auction the FiT to let the market determine the right price, or build in a structured rate decline over time.
✓ Long-term predictability makes a FiT bankable. For example, when the current FiT period is half-way complete, announce the follow-on program with re-calibrated rates so that investors and developers can plan ahead.
✓ Complement the FiT by removing non-price barriers.</td></tr>
<tr><td colspan="2">Japan's Current State
As of July 2012, Japan's FiT scheme is considered among the most generous in the world. It guarantees rates between 25.20-57.75 yen ($0.32-0.73) per kWh, depending upon the type of renewable energy technology and the size of installation. Japan's Ministry of Economy, Trade, and Industry forecasts that this new policy will net an increase of 32-35 million kW of renewable energy by 2020, and spur at least $9.6 billion of investment in new solar installations alone.</td></tr>
<tr><td>Typical Actors
• Government agency (e.g., METI in Japan) sets and modifies the FiT rate, determines approvals, etc.
• Established utilities provide payment</td><td>Typical Beneficiaries
• Renewable energy manufacturers and installers benefit from expanded markets
• Project investors benefit from guaranteed rates for their project's energy</td></tr>
<tr><td colspan="2">Scale of Investment
As of April 2012, Germany's FiT is $0.32/kWh for geothermal and $0.17-0.25/kWh for solar. Germany also provides FiTs for hydropower and on- and off-shore wind generation.</td></tr>
<tr><td colspan="2">Examples
FiTs are established and effective. Germany's experience shows that an ambitious FiT can achieve tremendous gains in installed capacity, though the rate and program length need to be chosen carefully.
• In 2000, Germany introduced a EUR 0.62/kWh ($0.79/kWh) FiT for solar, but the rate has since declined to EUR 0.135-0.195/kWh ($0.17-0.25/kWh). Over the last twelve years, this policy has led to the installation of 22 million kW of solar and brought solar installations down to a record average cost of $2.24/watt.
• Australia's New South Wales initially offered a FiT rate and capacity cap that were considered "too generous" and were shut down by the government. The region then replaced the initial FiT with a lower rate that is only paid in addition to the generators usage. Elsewhere in Australia, states' FiT rates range from AUS 0.30-0.60/kWh (US$0.31-0.62/kWh).[8]</td></tr>
</table>

[8] Energy Matters. "Feed-In Tariff: Solar and wind power in Australia." Webpage. Accessed 5 Sept. 2012. Available at: http://www.energymatters.com.au/government-rebates/feedintariff.php

Rebates versus Direct Support	
Rebates and direct support are interchangeable. Rebates (distributed after project completion) reduce the risk to government by ensuring that projects are completed, but increase private sector risk exposure. Direct support (distributed before project completion) reduces the risk to the private sector, but exposes the government. Both rebates and direct support are more efficient ways to support renewable energy than tax credits. Direct grants often cover a percentage of project cost, but can also be distributed as a fixed amount per project. • Rebate amounts can be based on a percentage of eligible project costs, typically between 20-50 percent. • Alternatively, rebate amounts can be based on a set rate per capacity installed. • Direct support can take the form of taxable grants based on production (as a replacement for Production Tax Credits) or based on investment (as a replacement for Investment Tax Credits). • Another model of direct support provides loans for the implementation of renewable energy projects, then converts a percentage of the loan into a grant upon successful completion of the project.	
Best Practices ✓ Define the program with clear timelines and guidelines for what kinds of projects will qualify. ✓ Don't change the rules part-way through the program. ✓ Use this policy to leverage strong business plans. The government should be a disciplined second investor, and should not pick winners by acting as the first investor. ✓ Tiered programs work well. For example, when the current program is half-way done, announce a follow-on program with re-calibrated rates so that investors and developers can plan ahead.	
Japan's current state Japan's Solar Rebate Program is credited with increasing installed capacity and driving down costs for the solar industry in the 1990s, but the Solar Rebate Program has since ended and was not replaced. Japan does not currently offer direct support for the procurement of renewable energy systems either. The nation does, however, offer tax incentives and subsidies that could be converted to grants to increase their effectiveness.[9]	
Typical Actors • A branch of the country's ***central or state government*** (e.g. METI) • ***Treasury Department*** or other public lending organization	**Typical Beneficiaries** • ***Renewable energy project developers and installers*** of all sizes and all tax statuses; direct support usually has more favorable terms for larger projects
Scale of Investment Rebates: As total capacity installed grows, the California Solar Initiative steps down investment-based rebate payments from $2.50/watt to $0.20/watt installed, or production-based rebates from $0.39/kWh to $0.03/kWh. [10] Direct support: In 2011, the United States distributed $6 billion in direct support for renewable energy projects in 2011, covering 30 percent of qualified investment costs. Since 2004, Bulgaria has distributed about $33 million, covering 15 percent of qualified investment costs.	
Examples • Rebates: **Australia**'s Photovoltaic Rebate Program (PVRP) (later called the Solar Homes and Communities Plan) started in 2000 with a budget of AUD$31 million ($32.2 million). It provided rebates of up to AUD$8,000 ($8,314) for installation of household photovoltaic systems, and up to 50 percent rebates for the first 2 kW installed at schools and non-profits. This program spurred over 130,000 system installations worth over AUD$1 billion, as well as a growth of approximately 80 new solar panel installation businesses per month in the final year of the program.[11] *--continued on next page--*	

[9] See Vadarajan, Uday et al. 2012. "How Effective and Efficient are Federal Tax Incentives for Wind and Solar?" CPI Brief (Working Paper). Unpublished.

[10] California Solar Initiative. "California Solar Initiative Rebates." Webpage. Accessed 5 Sept. 2012. Available at: http://www.gosolarcalifornia.org/csi/rebates.php

[11] Australian Department of Climate Change and Energy Efficiency. "Solar Homes and Communities Plan." Webpage. Accessed 6 Sept. 2012. Available at: http://www.climatechange.gov.au/what-you-need-to-know/renewable-energy/solar-homes.aspx

- Rebates: The **California** Solar Initiative is a ten-year, $2.16 billion program with the primary target of facilitating the installation of solar panels on 1 million roofs in the state, totaling 1.9 million kW. Rebate amounts are calculated through a 'step' program that diminishes rebates based as capacity installed under the program increases, and can be calculated based on either expected or actual performance.
- Direct support: The **United States** has seen some success with its "Treasury Grant" program, which allows project owners to receive a cash payment equal to 30 percent of eligible project investment costs instead of an investment tax credit. In 2011, almost $6 billion were distributed through this program. The Climate Policy Initiative (2012)[12] found that "government could maintain the same effective level of support for renewable projects but at significantly lower budgetary cost through a taxable production-based cash grant in lieu of the PTC," and that "the savings arise from two factors – *upfront support allows investors to achieve higher returns at lower cost* and *cash incentives eliminate the risks and costs involved in making use of tax credits*." A recent Bipartisan Policy Center paper came to similar conclusions.[13]
- Direct support: The **Bulgarian** Energy Efficiency and Renewable Energy Credit Line (BEERECL), a partnership between the EU and banking partners, offers a unique program in which project owners receive a grant equal to 15 percent of their qualified loan upon completion of a renewable energy project, again akin to an investment tax credit. As of July 2012, BEERECL had financed 217 sustainable energy projects with 138 million Euros ($176.6 million) of loans and 23 million Euros ($29.4 million) in grants disbursed.

[12] Vadarajan, Uday et al. 2012. "How Effective and Efficient are Federal Tax Incentives for Wind and Solar?" CPI Brief (Working Paper). Unpublished.
[13] Bipartisan Policy Center. 2011. "Reassessing Renewable Energy Subsidies: Issue Brief." Available online at: http://bipartisanpolicy.org/sites/default/files/BPC_RE%20Issue%20Brief_3-22.pdf

Accelerated Depreciation

An **accelerated depreciation** (AD) tax incentive allows a renewable energy producer to claim larger tax deductions on select equipment during the early years of a project, softening the up-front capital requirement. AD defers taxes in exchange for increased taxable income in future years, serving as an incentive to invest.

- AD is usually applied on a 5-year tax schedule for renewable production projects, often with a 'bonus' 100 percent depreciation should the project meet basic requirements.
- This incentive generally applies to large-scale renewable energy projects, as it usually applies only to corporate tax rates.

It is important to note that AD does not necessarily encourage renewables over other types of generation, as many other types of corporate equipment investments often qualify for similar accelerated depreciation.

Best Practices

- ✓ Provide more favorable terms of depreciation for renewable projects than for non-renewable projects.
- ✓ Publish clear guidelines and timelines.
- ✓ Establish a long time-horizon so that businesses can make more substantial investments and plans.

Japan's current state

Japan currently offers an AD program at a 100 percent depreciation rate, but it expires in 2013. It does not appear as though Japan offers a bonus AD incentive for clean energy projects, as is the case in some other countries.

Typical Actors	Typical Beneficiaries
• ***Central and state governments*** both apply this incentive through income tax acts	• ***Corporate taxpayers (large project developers)*** are the traditional recipients of this incentive

Scale of Investment

- AD refers to a shift in tax payment timing, so there is no net cost.
- A previous study of large U.S. corporations found that those which claimed bonus depreciation (at 30% and 50% levels) were much more likely to have positive net income, while those not utilizing bonus AD incentives had a negative average net income in 2002 and 2003.[14]

Examples

- The recent boom in **India**'s wind market has been partially attributed to the implementation of an AD tax incentive. At one point, close to three-quarters (75%) of consumers took advantage of the AD benefit. ICRA has estimated that discontinuation of the AD benefit in April 2012 will result in a major decline in capacity addition in the near term.
- The **United States** federal government and the state of **Minnesota** each offer AD incentives to qualifying investors in equipment. The Modified Accelerated Cost-Recovery System is a popular incentive that has been in place since 1986 for select renewable investments, and which has recently added a 'bonus' depreciation of 100 percent. It has been estimated that this federal incentive could produce as much as a 25 percent net project cost reduction over the first three years of a project.

[14] United States Department of the Treasury. 2010. "The Case for Temporary 100 Percent Expensing: Encouraging Business to Expand Now By Lowering the Cost of Investment." Report by the U.S. Department of the Treasury's Office of Tax Policy. p. 3. Available online at: http://www.whitehouse.gov/sites/default/files/expensing_report.pdf

Tax Credits

Tax credits are among the most common incentives, and have proven their effectiveness in boosting installed renewable capacity. However, they cannot apply to non-taxed entities with high renewable production potential (such as schools, non-profits, and government agencies). Tax credits are also perhaps the most-criticized renewable support policy for their role in fueling the boom-bust cycle of investment as credits expire and renew. In addition, renewable power developers often do not have the tax liability necessary to take advantage of the tax credit, and therefore need to go to secondary markets to make the incentive worthwhile. This substantially decreases efficiency of the incentive. There are two primary types of renewable deployment tax credit:

- **Production Tax Credit:** Calculated from a set rate per kWh of energy produced by enrolled projects. This ensures that projects actually produce electricity.
- **Investment Tax Credit:** Based on a percentage of the initial investment amount, which helps lower up-front costs but is not tied to actual production. (This amount might also be disbursed in the form of a cash grant, as is the case with the United States' Treasury grants.) One unintended consequence of ITCs is that projects can be built but never be connected to the grid, as has happened in both California and China.

Best Practices

- ✓ Tax credits should be based on energy production, not capacity investment.
- ✓ Tax credits should be tradable; often project developers do not have sufficient tax liability to take advantage of their credits themselves.
- ✓ Create a long time horizon for tax credits, and don't let programs expire without clear next steps. Either ramp down tax credit rates over time or create tiered programs: for example, when the current program is half-way done, announce the follow-on program with re-calibrated rates so that investors and developers can plan ahead.

Japan's current state

Japan's "Green Investment Tax Credit" applies to small and medium enterprises, providing a tax credit equal to 7 percent of the standard acquisition price for green technologies.[15]

Typical Actors	Typical Beneficiaries
• ***Tax revenue authorities*** generally administer all tax credits	• ***Tax-paying project investors*** with projects of all sizes, though generally directed towards larger-scale projects

Scale of Investment

Significant government investment, which is ultimately paid by the taxpayer. Benefit to private sector is great, though, as seen by the level of investment that has been spurred by tax credit incentives.

Examples

- The **America**n Reinvestment and Recovery Act (ARRA) provides approximately $30 billion in tax-based incentives for renewable energy production. ITCs are equal to 30 percent of project costs and PTCs are at approximately $0.021/kWh. In evaluating U.S. states' individual tax credit incentives, the National Renewable Energy Lab (2002) found that low caps on eligible costs, as well as restrictions on the maximum yearly claims for smaller investors, can notably diminish effectiveness of the incentive. It is widely noted that the off-again, on-again nature of U.S. tax credits has seriously undermined their effectiveness.
- The **Netherlands**' "Green Funds Scheme" offers a tax exemption for capital invested in "green projects" in addition to a simple tax credit of 1 percent of invested capital, applied to a maximum amount of EUR55,476 ($70,992).[16,17]

[15] Katayama, Yoichi and Minako Wakabayashi. 2012. "February 2012 Energy Alert: Green Rush Hits Japan." Orrick, Herrington, and Sutcliffe LLP. Webpage. Accessed 6 Sept. 2012. Available at: http://www.orrick.com/fileupload/4493.htm
[16] KPMG. June 2011. *Taxes and Incentives for Renewable Energy*. Industry Report. KPMG International Cooperative. p. 30
[17] Thornley, Ben, David Wood, Katie Grace, and Sarah Sullivant. Jan 2011. *Green Funds Scheme: Impacting Investing: A Framework for Policy Design and Analysis*. Insight at Pacific Community Ventures & The Initiative for Responsible Investment at Harvard University. Case Study Report.

Green Banks
A "Green Bank" or "Green Investment Bank" is a publicly-supported banking entity that provides favorable terms to companies that invest in renewable energy technologies. These terms could include lower interest rates, financing of large loan volumes, and lower cost of debt. These loans might also include provisions requiring co-financing from private banking institutions. Restrictions on the types of projects funded (e.g. offshore wind energy projects in a particular geographic area) have been included in such schema to encourage a targeted form of project desirable to a country's larger low-carbon growth goals. The ultimate goal of these efforts is to instigate private sector investment in large-scale projects.[18]
Best Practices ✓ Be a one-stop-shop with specific expertise in clean energy loans and an appropriate variety of credit products. ✓ Set clear criteria for clean energy loans. ✓ Act as a disciplined second investor and gain experience by overseeing loans over a long period of time.
Japan's current state Japan does not currently have a designated Green Bank, or any similar programs within other government-supported banking entities.

Typical Actors	**Typical Beneficiaries**
• ***New banking schema*** instituted by central governments • ***Existing central government banks***	• ***Large-scale developers*** of renewable energy projects that help meet low-carbon goals

Scale of Investment
One group estimated that the **United States** proposal for a Green Bank (never-implemented) could have used $50 billion of initial capital to support up to $500 billion in loans over 20 years.[19]
Examples ***Green Banks are new but hold significant promise***. Provided that they are appropriately capitalized and explicitly linked to private investment needs, they offer sustainable results, particularly in the area of offshore wind or geothermal. • A £3 billion (US$4.8 billion) government-supported funding scheme known as the *Green Investment Bank* is currently underway in the **United Kingdom**, and is credited with being the first of its kind. It will invest in offshore wind and waste energy. The new bank is headed by leaders from the private sector, and its goal is to attract significant co-investment from private companies.[20] The bank will progress through stages of incubation and establishment before achieving full borrowing powers from the government. However, this scheme has been criticized for not being a "proper" bank with a banking license, which limits its borrowing power and slows its progress.[21] • **Germany's** development bank offers favorable loan rates (around 1-2%) to energy efficiency projects and offers a program to boost investment in offshore wind energy. This program provides loans at fixed rates, up to 700 million Euros (US$886 million), and requires private banks to provide loans under the same conditions at equal or greater amounts. An 80 turbine, 288,000 kW (288 MW) project is currently being built in Germany's Exclusive Economic Zone (EEZ) using a loan from this scheme.[22]

[18] Center for American Progress Action Fund. 2009. "Primer on the Green Bank." Americanprogressaction.org. Available at: http://www.americanprogressaction.org/wp-content/uploads/issues/2009/06/pdf/green_bank.pdf

[19] Center for American Progress Action Fund (2009)

[20] Leftly, Mark. 03 Sept 2012. "Green bank ready to commit £3bn to environmental firms." *The Independent*. Available at: http://www.independent.co.uk/news/business/news/green-bank-ready-to-commit-3bn-to-environmental-firms-8101524.html

[21] Khalique, Farah. 20 Jun 2012. "Green Investment Bank facing 'ridiculous' constraints.'" *Efinancialnews.com***.** Available at: http://www.efinancialnews.com/story/2012-06-20/uk-green-investment-bank

[22] BusinessWire. 7 Aug 2012. "Construction Commences on German Offshore Wind Farm Meerwind Sud a'eOst." MarketWatch.com. Available at: http://www.marketwatch.com/story/construction-commences-on-german-offshore-wind-farm-meerwind-sud-aeost-2012-08-07

Loan Guarantees	
A government **Loan Guarantee** provides a government backstop in case projects default on their private loans. They are an excellent way to drive down the cost of money for low-risk, capital-intensive projects. Loan guarantees are not appropriate for speculative investments, even though they have been used this way in other countries. • Loan Guarantees for *generation* projects are generally considered less risky than guarantees for *manufacturing* companies because generation projects are often bolstered by power purchase agreements or similar contractual mechanisms, making them less susceptible to shifts in the market.[23] • Guarantees are generally budgeted assuming around 10 percent default, but using the criteria below to select projects can accelerate project development with much lower default rates.	
Best Practices ✓ Set requirements so that projects must already have a proven technology, existing private investors, regulatory approval, and a contract to sell electricity.	
Japan's current state Japan does not appear to have any Loan Guarantee programs targeting renewables, although it may have supported such projects in the past.	
Typical Actors • ***Departments of Energy*** • ***Central governments' Treasury Departments***	**Typical Beneficiaries** • ***Investors*** in large-scale *generation* and *manufacturing*
Scale of Investment The **United States** has provided close to $40 billion in loan guarantees since 2009 through the Department of Energy's Loan Programs Office. Of these, the government expected to actually end up paying around $5 billion on defaulted loans (12.5%), but to date has only paid around $3 billion (7.5%).[24]	
Examples • The **United States** Department of Energy backs certain private loans for renewable (and nuclear) energy projects. Loan guarantees have not typically been successful in pushing nuclear projects to fruition, in large part because regulatory uncertainty still drives risk too high to attract private investors. Recently, it has supported two large-scale, high-profile solar installation projects: a $1.237 billion guarantee for the 250,000 kW (250 MW) California Valley Solar Ranch Project[25] and a partial guarantee on a $1.4 billion loan for a nationwide project that seeks to install 752,000 kW (752 MW) of rooftop solar panels.[26] • The U.S. Department of Energy also offers loan guarantees up to 80 percent of project costs on geothermal energy projects through its *Geothermal Technologies Program*.[27] To date, this program has supported three large-scale geothermal projects in the United States, including one in Nevada that will create nearly 600 jobs and increase by one-quarter the amount of geothermal production in the state.[28]	

[23] Brown, Phillip. 2011. *Solar Projects: DOE Section 1705 Loan Guarantees*. Congressional Research Service Report #7-5700
[24] Caperton, Richard W. "DOE Loan Guarantee Program Cost $2 Billion Less Than Initially Expected." *Climate Progress*. Available at: http://thinkprogress.org/climate/2012/02/10/423270/doe-loan-guarantee-program-will-cost-2-billion-less-than-expected/
[25] United States Department of Energy. 30 Sept 2011. "Energy Department Finalizes $1.2 Billion Loan Guarantee to Support California Solar Generation." Press Release. Available at: http://energy.gov/articles/energy-department-finalizes-12-billion-loan-guarantee-support-california-solar-generation
[26] United States Department of Energy Loan Programs Office. 30 Sept 2011. "DOE Finalizes Loan Guarantee for Transformational Rooftop Solar Project." Press Release. Available at: https://lpo.energy.gov/?p=5320
[27] United States Department of Energy. "Geothermal Technologies Program: Loan Guarantees." Website. Accessed 7 Sept. 2012. Available at: http://www1.eere.energy.gov/geothermal/loan_guarantees.html
[28] United States Department of Energy Loan Programs Office. 23 Sept 2011. "Energy Department Finalizes Loan Guarantee for Ormat Geothermal Project in Nevada." Press Release. Available at: https://lpo.energy.gov/?p=5226

<table>
<tr><th colspan="2">Tax Fossil Fuels to Fund Renewables</th></tr>
<tr><td colspan="2">Taxing fossils to fund renewables drives at the solution from two directions. First, it internalizes some of the externalities associated with fossil fuels, raising the target price that renewables must reach to compete. Second, it helps drive down the cost of renewables via the cost reductions that come with expanded capacity.
• Taxes can be levied on all carbon emissions.
• Specific fossil fuels can be taxed: for example, coal or heating oil.
Oftentimes revenue from fossil fuel taxes is not set aside for supporting renewables, but instead reduces corporate or income tax rates. However, using this tax revenue to fund renewables can stimulate a virtuous cycle that accelerates the transition to clean energy.</td></tr>
<tr><td colspan="2">Best Practices
✓ Slowly ramp up the rate at which carbon is taxed.
✓ Use tax revenue to fund the other policies described in this paper.</td></tr>
<tr><td colspan="2">Japan’s current state
Japan passed a carbon tax this year, and the rate is designed to increase over the next three years. Revenues could be used to fund renewable energy incentives.</td></tr>
<tr><td>Typical Actors
• Tax revenue authorities generally levy these taxes
• Carbon emitters or fossil fuel consumers pay a fixed price per volume</td><td>Typical Beneficiaries
• Low carbon and non-fossil industries benefit from a higher price targets for their technologies</td></tr>
<tr><td colspan="2">Scale of Investment
Sweden collected a EUR108/tonne (about $138/tonne) tax on carbon emissions (2009), while Australia’s tax rate is AUD$23/tonne (about $24/tonne) this year (2012). Japan’s tax rate is set to ramp to 289 yen/tonne (about $4/tonne) over the next three years. The United Kingdom and India both tax fossil fuels directly (rather than emissions). For example, coal taxes have been about $8/tonne in the UK and about $1.10/tonne in India.</td></tr>
<tr><td colspan="2">Examples[29]
• As of December 2011, China charges end-users a small fee per kWh (CNY 0.008/kWh or $0.0013/kWh) of electricity consumed. This small tax will result in about $3.14 billion of revenue annually, which China is putting directly into a renewable energy development fund, managed by the nation’s Ministry of Finance.
• India’s INR 50/tonne ($1.10/tonne) tax on coal applies to every tonne of coal consumed, whether it is imported or domestically produced. The funds raised by the tax go into a national clean energy fund, which is then used to finance clean technology research and innovative clean energy projects.</td></tr>
</table>

[29] For additional carbon tax case studies, see Aggarwal, Sonia. *Carbon Tax Experience: Lessons for Japan*. 2011.

III. Streamline or remove non-price barriers.

The government can—in theory—create conditions for clean energy businesses to thrive, but if those businesses can't sign contracts, or find suitable sites, or gain access to transmission lines, other policy support is unimportant. Disruptive policy is necessary in this realm if renewable energy is to grow quickly. It would be valuable to:

- ✓ Design a simple project checklist. If a project meets all requirements, designate it as "green." If it meets most of the requirements, designate it as "yellow." If it meets only a few of the requirements, designate it "red."
- ✓ "Green" projects are guaranteed siting, permitting, connection, and power purchase within three months; "yellow" projects within ten months if they meet key conditions; and "red" projects must adjust and re-apply.
- ✓ Transparency and even-handedness should be emphasized at every turn.
- ✓ Grant authority to one government agency to help expedite projects. Designate an ombudsman to help overcome barriers.

Market Access for Small Generators

Market access for small generators can be encouraged through *net metering* and *time-of-use* rates. Net metering allows distributed renewable generation to be counted and credited against retail electricity prices. Time-of-use rates pay more for electricity generated during peak times (which often correspond with solar output). This is especially important for capacity-constrained electricity systems like Japan's.

- Net metering and time-of-use rates are most effective at incenting distributed clean energy generation when used in combination.
- Net metering usually applies to systems under a certain capacity (e.g. less than 500 kW), and credits for excess generation may expire if they are not used for a certain length of time (e.g. a year). Upon credit expiration, generators are often paid retail rates for excess generation.

Best Practices

- ✓ Establish net metering, and distributed generation will flourish.
- ✓ Establish time-of-use rates to encourage distributed generation during times of peak load.
- ✓ Upgrade distribution network hardware to be able to handle two-way electricity flows.
- ✓ Note that here too, the process must be simple, fast, and transparent.

Japan's current state

Japan currently uses net metering to allow distributed generators to use their production whenever it is needed, and net metering pay-outs for excess generation are administered separately from the feed-in tariff rates. Japan also uses time-of-use rates to incentivize load shifting and make more efficient use of electricity generation capacity.

Typical Actors	Typical Beneficiaries
• ***Utilities*** *or* ***public energy commissions***	• ***Small, distributed electricity generators***

Scale of Investment

In a strict sense, net metering has no direct costs. Distributed electricity generation just runs the on-site meter backward during periods of excess generation, and the meter runs forward as normal when on-site generation does not meet demand. In reality, net metering costs utilities money because they are effectively paying retail rates for distributed electricity generation, rather than the traditional model of generating electricity at lower costs and then profiting from retail consumption.

Time-of-use rates also have no direct costs in a strict sense. Time-of-use rates are just adjustments to the retail electricity price structure to reflect times of day when electricity use is at a peak or generation is most expensive. From the utility perspective, however, time-of-use rates increase revenue during times of peak generation, but also increase payout to distributed generators in jurisdictions that allow net-metering.

Examples

- Net metering originated in the **United States**, and is now in effect across many states. State by state rules vary for project eligibility: Some states cap eligible projects at 10 kW, while others cap eligibility at 80,000 kW, and still others cap project sizes based on their share of total on-site electricity consumption. Some states enforce a cap on total allowable state-wide net metering capacity, a rule which is intended to ease utility planning.
- Regions of **Canada** and **Australia**, as well as several nations in the **European Union** all use net metering and time of use rates.

Spinning off Transmission Assets from Generation Assets ("Unbundling")

Regulators can require that electricity generators divest from transmission assets in order to increase competition. Especially in cases where vertically-integrated utilities have long dominated a country's energy production, this strategy can provide more market access for new technologies and new producers. While it is not explicitly intended to do so, 'unbundling' typically lowers household electricity prices. There are several types of unbundling:

- **Accounting Unbundling:** Compliance is achieved through separate books for regulated and unregulated activities.
- **Legal Unbundling:** An independent third party carries out regulatory activity.
- **Managerial Unbundling:** Policy sets and enforces rules regarding the appointment, roles, and decisions of officials in charge of assets.
- **Ownership Unbundling:** Policy requires power generators to sell or divest interest in their transmission assets.

Best Practices

✓ Assure that decisions about transmission access are made by different entities than those profiting from transmission.

Japan's current state

Japan has a history of powerful, vertically-integrated power producers, particularly for nuclear generation, which create challenges as the country attempts to diversify its energy portfolio. Recognizing this, Japan is currently implementing a form of Ownership Unbundling. The nation will require that large power producers to sell their transmission assets to be managed by other companies, thereby removing their longtime guaranteed access to the grid. Although this move has damaged these companies' market valuation,[30] the policy is expected to significantly improve market access for renewable producers and strengthen the effectiveness of the new feed-in tariff scheme. Once unbundling is complete, the grid will be managed by an independent inter-regional balancing authority. It will be very important to get the specific regulations right for this new grid operator.

Typical Actors	Typical Beneficiaries
• Mandated by ***energy and utility regulatory agencies*** and carried out by ***utilities*** or other ***owners of electricity generation***	• ***Small-scale, distributed, or other new electricity generators***

Scale of Investment

There are no direct costs of this policy, but indirect transaction costs can arise as a new system is implemented.

Examples

- Several countries in the **European Union** have pursued various forms of unbundling as part of the EU's liberalization of its energy markets. **Germany** has achieved Legal Unbundling, but large portions of the transmission grid are still owned by large utilities. **France** also has implemented a form of Legal Unbundling, which involved the creation of an independent company in charge of managing the electricity transmission system. **Spain** has implemented both Legal and Ownership Unbundling, as the government now owns the transmission system operator. A 2007 European Commission report[31] showed that Ownership-Unbundled markets in Member States saw a 23.6 percent lower increase in electricity rates between 1998 and 2006.

[30] Inajima, Tsuyoshi. Aug 12, 2012. "Japan's Utilities Lose $46 Billion as End of Era Nears." Bloomberg.com. Accessed 28 Aug 2012. Available at: http://www.bloomberg.com/news/2012-08-13/japan-s-utilities-lose-46-billion-as-end-of-era-nears-energy.html

[31] European Commission. 2007. Commission Staff Working Document: SEC(2007) 1179. p. 37-38. Accessible at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52007SC1179:EN:HTML

Transmission and Generation Siting

A major challenge in expanding renewable penetration is the land requirements and concurrent expansion of transmission capacity. Public engagement and transparency are crucial to this process in order to address environmental, health, and property concerns. Best practices include:

- Explain why new transmission and generation are vital investments,
- Share planned locations and provide a system for public feedback, and
- Create a transparent and streamlined regulatory approach that limits burdens on applicants.[32]

Best Practices

- ✓ Transmission and generation siting should move forward in partnership with local populations.
- ✓ The government should designate a single agency as a one-stop-shop for all permit authorizations.
- ✓ The green-yellow-red methodology described above can also apply here.

Japan's current state

The Japanese government has recently relaxed restrictions on renewable energy project siting, allowing land leasing in national forests for biomass and geothermal projects. Relaxed restrictions have also encouraged construction of renewable energy projects on abandoned farmland. These actions, and others like them, could help expand options for the siting of transmission resources.

Typical Actors	**Typical Beneficiaries**
• ***Public utilities commissions*** or ***national grid regulators*** • ***Land management bureaus*** • ***Transmission providers*** might propose an initial route plan	• ***Generators*** benefit from streamlined processes and increased access to the grid

Scale of Investment

Putting a dollar figure on transmission or generation expansion is hard, as the actions required following public input vary widely. Denmark provides perhaps the most extreme example, as it plans to bury its transmission and distribution grids underground at a cost of about $4 billion. As an example, the cost of an above-ground 24.2 mile, 345 kilovolt line in Wisconsin (United States) was $119 million in 2007, while installation of an underground line for the same system was more than four times as much.[33]

Examples

- **California**'s Renewable Energy Transmission Initiative (RETI) consists of a 30-person stakeholder steering committee, whose diverse members have successfully avoided excessive opposition by planning and assessing transmission options via transparent, consensus-based procedures. This group works closely with utilities and developers.[34]
- In **Germany**, the 2009 Power Grid Expansion Act seeks to ease the planning and permission processes for installation of high-voltage renewable energy transmission, including early public involvement in the planning process. German Transmission System Operators are also raising awareness through a website and in-depth public consultations.

[32] These Best Practices selected from Cochran et al. (April 2012).

[33] American Transmission Company. 2005. "Exploring the underground options: Rockdale-West Middleton transmission line proposal." Accessible at: http://www.atcllc.com/RWMundergroundpage.shtml

[34] California Energy Commission. "Renewable Energy Transmission Initiative (RETI)." Webpage. Accessed 6 Sept. 2012. Available at: http://www.energy.ca.gov/reti/

Financing Transmission

Investment in transmission grids enables tremendous growth in renewable energy generation; a sufficient grid is required to transport and flexibly manage the new electricity being produced. Historically, vertically-integrated companies have taken on costs related to the siting and construction of transmission lines, but this old model is less relevant in an era of independent power producers and distributed generation. Modern transmission financing requires predictable mechanisms that take into account the large capital requirements, broad geographical distributions, and long payback periods associated with transmission expansion. Discussion of how to finance new transmission infrastructure often falls into two camps:

- The "beneficiary pays" model, wherein transmission lines continue to be financed by private generators and distributors, with this cost being passed on to the electricity consumers; or
- The "socialization of transmission infrastructure" (e.g., through government investment), wherein transmission infrastructure expansion costs are distributed to taxpayers.[35]

Best Practices

- ✓ Transmission is much more likely to be financed when sales are guaranteed from qualified buyers or via a regulatory authority.
- ✓ Encourage long-term transmission contracts, but be ready to use the government as a back-stop if contracts fail. Ensure that access to transmission is non-discriminatory: All generators should have equal access.

Japan's current state

As part of its recent efforts to **unbundle** transmission from generation assets, the Japanese government is establishing a new inter-regional grid operator, which will be responsible for developing a national investment plan. At this time, it is not clear how this body's work will impact overall strategies to finance new transmission projects.

Typical Actors	**Typical Beneficiaries**
• ***Private electricity generators*** • A green bank or ***infrastructure bank***	• ***Grid operators*** and ***new electricity generators***

Scale of Investment

During the 2006-2009 period, investor-owned transmission companies were predicted to have invested approximately $31.5 billion in transmission construction for the United States electric grid.[36]

Examples

- In the **United States**, a fractured system of transmission investment has emerged, driven in part by disputes over who benefits from transmission lines crossing regional and state boundaries. Baldick et al. (2007)[37] therefore argue that a unified (possibly federal) system that addresses the national benefits of transmission—in addition to the existing state systems—would be a positive step towards ensuring appropriate financing.

[35] Baldick, Ross, Ashley Brown, James Bushnell, Susan Tierney, and Terry Winter. Sept. 2007. *A National Perspective On Allocating the Costs of New Transmission Investment: Practice and Principles*. Working Group for Investment in Reliable and Economic Electric Systems (WIRES). p. Accessible at: http://www.hks.harvard.edu/hepg/Papers/Rapp_5-07_v4.pdf

[36] Edison Electric Institute (EEI). Nov. 10, 2011. "Transmission Investment Surpasses $10 billion in 2010." EEI.org. Accessed 8 Sept. 2012. Available at: http://www.eei.org/newsroom/energynews/Pages/20111110.aspx

[37] Baldick et al. (2007)

IV. Support research, development, and demonstration.

Government support for RD&D of clean energy technologies can help improve low-cost clean energy options for Japan's future. Strong RD&D programs can mean the difference between owning the energy future and renting it from foreign companies. Government support for clean energy should be approximately equal to one percent or more of the nation's annual energy bill. This still puts energy RD&D at a lower rate than most other technology intensive industries. [38]

<table>
<tr><th colspan="2">Public Support for Basic Science Research in Energy</th></tr>
<tr><td colspan="2">New technology industries require extensive research, development, and demonstration to continue innovating and become competitive. However, private companies that are developing expensive new technologies often lack the capacity to invest in RD&D at the required scale, and the smaller companies that drive innovation in the renewables market are in particular need of public support. Governments must therefore provide support for basic science research in energy that:
• Provides clear targets and identifies gates that redirect projects that are unlikely to meet market viability goals,
• Is accessible to diverse stakeholders in a collaborative environment, and
• Is targeted at the particular needs of the country's renewables sector, and aligned with national goals.</td></tr>
<tr><td colspan="2">Best Practices
✓ Quantitative science and technology targets ("stage gating") should be set in consultation with the private sector so that funding can be redirected if projects do not meet targets.</td></tr>
<tr><td colspan="2">Japan's current state
As a percentage of GDP, Japan's RD&D investment exceeds many other industrialized countries. The government has shown a solid commitment to expanding RD&D, particularly for renewables. The Japanese government spent $3.9 billion on energy RD&D in 2008 alone, but just five percent of that was spent on renewables (65% was spent on nuclear).</td></tr>
<tr><td>Typical Actors
• Central governments provide the large amounts of funds needed for these programs, and use it to attract private sector and university investment</td><td>Typical Beneficiaries
• Small to medium sized technology developers
• Universities</td></tr>
<tr><td colspan="2">Scale of Investment
In industrialized nations, public support for basic science research can reach billions of dollars per year. Short-term investments in RD&D cannot ensure continued innovation in the sector; this type of support requires commitment over long periods to keep pushing technology ahead.</td></tr>
<tr><td colspan="2">Examples
• The United States' Advanced Research Project – Energy (ARPA-E) was created to develop fresh, creative, 'out-of-the-box' energy technologies that the private sector especially lacks the capacity to develop on its own. It was initially funded with $400 million through the American Recovery and Reinvestment Act (ARRA) in 2009. As of August 2011, 11 projects that received a cumulative $39 million from ARPA had attracted over $200 million in private capital investment (five times the government investment).[39]
• The government of South Korea uses 'roadmaps' to organize its energy RD&D efforts. It has established 5- and 10-year roadmaps for investment and research, which include environmental and economic analyses of each technology to best align research with broader social and climate goals.[40]</td></tr>
</table>

[38] Energy Innovation manages the American Energy Innovation Council, which Bill Gates, Jeff Immelt, John Doerr, and others founded to promote clean energy RD&D in the USA. We have a series of policy publications on energy RD&D available upon request.

[39] Advanced Research Projects Agency – Energy. "About". ARPA-E. Webpage. Accessed 6 Sept. 2012. Available at: http://arpa-e.energy.gov/About/About.aspx

[40] Breakthrough Institute and Information Technology & Innovation Foundation. Nov 2009. *Rising Tigers, Sleeping Giant: Asian Nations Set to Dominate The Clean Energy Race by Out-Investing the United States*. Policy paper. p. 23 Available at:

Centers of Excellence

Centers of Excellence are clusters of research and manufacturing expertise. It is important to build scale in each technology: This makes it possible to buy expensive equipment, build complex labs, recruit great researchers, and attract new companies. Together, these elements create a profoundly powerful ecosystem for innovation. Tactics to foster this ecosystem include:

- Create regional research centers that bring together universities, companies, and government agencies to collaborate on large projects.[41]
- Use data to identify gaps in cluster performance and develop a modest grant program to fill those gaps.
- Reorient existing economic policy instruments to support local cluster development.[42]

Best Practices

- ✓ Research and testing platforms should be designed to allow enable advanced testing and prototyping that small technology developers would not be able to afford on their own.
- ✓ Public-private partnerships can streamline public RD&D support into projects with clear commercial potential by connecting directly to market demand signals.

Japan's current state

Japan's keiretsu model of horizontal and vertical integration builds complete supply chains in one geographic area, strengthening all actors in that chain. To expand on this concept, Japan could benefit from targeted policies and RD&D centers that address specific gaps in renewable energy manufacturing and deployment.

Typical Actors	Typical Beneficiaries
• Both local and national ***economic development agencies***	• ***Universities***, ***small-to-large companies***, and ***local government agencies***

Scale of Investment

Grants as small as $40,000 and as large as $2.5 million are used in the U.S. to support research and ensure that clusters are well-defined and sustainable.

Examples[43]

- **Colorado**'s Cleantech Cluster consists of over 1,500 cleantech companies, which benefit from research projects at the Colorado Renewable Energy Collaboratory (a collaboration between the National Renewable Energy Lab and the region's universities) and the presence of manufacturing giants like Vestas and Siemens. State policy nurtured this cleantech cluster and helped it grow and diversify.
- Similarly, **Michigan**'s Battery Cluster serves the local auto industry and takes advantage of its resources (e.g. 65,000 engineers; 330 automotive RD&D centers) to tackle the challenge of developing advanced battery components. Targeted incentives and investments have helped to build a viable advanced battery supply chain.[44]
- Hamburg, **Germany** hosts one of many burgeoning cleantech cluster networks. Hamburg's public-private cluster collaboration has helped to increase job growth by 50 percent in the local renewables industry since 2008. The cluster association provides support from networking and marketing resources to research acceleration.

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http://thebreakthrough.org/blog/Rising_Tigers.pdf

[41] Duderstadt, James J., Mark Muro, and Sarah Rahman. Jun 2010. "Hubs of Transformation: Leveraging the Great Lakes Research Complex for Energy Innovation." Brookings Institution. Policy Brief No. 173. Available at: http://www.brookings.edu/research/papers/2010/06/02-innovation-muro#ref-id=352bf1b3ee21d45233f673be7e4bdfdde2aafc72

[42] Muro, Mark and Kenan Fikri. Jan 2011. "Job Creation on a Budget: How Regional Industry Clusters Can Add Jobs, Bolster Entrepreneurship, and Spark Innovation." Brookings-Rockefeller Project on State and Metropolitan Innovation. Available at: http://www.brookings.edu/~/media/research/files/papers/2011/1/19%20clusters%20muro/0119_clusters_muro

[43] See also the American Energy Innovation Council's (AEIC) "A Business Plan for America's Energy Future" (2010) for recommendations regarding Centers of Excellence and other strategic investments in RD&D.

[44] Muro and Fikri (2011) p. 3

V. Address intermittency.

As solar and wind increase in share on the electricity grid, policy becomes crucial to maintain reliability.

Demand-response	
Demand-response fundamentally changes the game of electricity grid balancing by allowing system operators to control load in a similar way to generation. • Demand response can be designed to assist with peak load reduction, intra-hour variability, ramp smoothing, and load shifting.	
Best Practices ✓ Use demand response to achieve both load curtailment and load shifting. ✓ Develop contracts with private demand aggregators. ✓ Prioritize demand-response in the resource dispatch order.	
Japan's current state Japan already has important policies in place to take advantage of demand response, but there are important opportunities to expand demand-response capability.	
Typical Actors • Demand response programs can be administered by ***independent grid operators***, other ***balancing authorities*** or ***utilities*** • ***Private demand aggregators*** provide real-time load shifting or load curtailment	**Typical Beneficiaries** • ***Grid balancing authorities*** benefit from low-cost load shifting or load curtailment enabled by demand response
Scale of Investment Demand response has been proven to decrease electricity costs considerably. For example, PJM (a regional transmission organization in the United States) saw an 85 percent price decline in its capacity pricing attributed in large part to the introduction of new demand response resources (almost 9 million kW of new demand response capacity bid into the market this year).[45] Demand response itself can be achieved without much capital expense, but early investment in education for electricity consumers pays off well.	
Examples • Two of the regional transmission organizations in the **United States** (PJM and ISO New York) administer capacity markets for third parties, giving demand aggregators a direct market for their assets. The California grid region leverages demand response in a different way: It allows individual utilities to contract directly with demand aggregators to buy demand-response as an alternative to generation. • In **Korea**, the Korean Power Exchange and the utility work together to administer demand response programs. As Korea saw electricity demand double with one of the fastest growth rates of any industrialized nation, demand response is credited with easing the transition.	

[45] King, Chris. "How Demand Response Cuts Wholesale Power Costs." *GigaOm.* Published online 24 July 2012. <http://gigaom.com/cleantech/how-demand-response-cuts-wholesale-power-costs/>

Expanding Balancing Areas	
Expanding balancing areas can help reduce intermittency by drawing on diverse weather patterns – if it's windy and cloudy somewhere, it may be sunny and still somewhere else. Balancing authorities can be expanded by: • Developing interconnections with other regions and • Expanding wholesale power markets.	
Best Practices ✓ Establish an independent grid system operator that can balance across utility regions. ✓ Expand transmission to be able to handle larger distances between generation and load.	
Japan's current state Historically, Japan's power grid has been balanced by utilities. Now that the nation is undergoing transmission unbundling, independent grid balancing authorities will need to be established. Once these inter-regional grid balancing authorities are in operation, Japan can begin to balance across wider geographies and take advantage of diverse clean energy resources.	
Typical Actors • Balancing areas can be expanded by ***independent grid operators***, ***regional transmission organizations***, or other ***balancing authorities***	**Typical Beneficiaries** • ***Balancing authorities*** benefit from a broader range of clean energy generation options to meet electricity demand
Scale of Investment Expanding balancing areas does not have direct costs, but it often requires transmission expansion, which can be costly. Still, smart financing mechanisms for transmission expansion (as described on page 25) can lower costs.	
Examples • The largest synchronous grid is in **Europe**, where one interconnected grid serves 24 countries. Proposals have been made to interconnect Europe's grid with grids in North Africa as well as Western Asia. It is important to note, however, that simple interconnection is not enough to enable true balancing across such large geographies; at such large distances, transmission congestion can become a real bottleneck. Additional transmission capacity near large generation or load centers can help ease congestion. • The PJM regional transmission organization in the **United States** is the world's largest competitive wholesale electricity market. PJM has 167 million kW of generation capacity under management, with 1325 generation sources and 90,000 kilometers of transmission lines. PJM balances supply and demand across 13 US states and the District of Columbia. Balancing across such a broad geography allows PJM to leverage differences in weather across its wide geography to smooth intermittency from renewable energy resources.	

<table>
<tr><th colspan="2">Thermal Backup for Grid Flexibility</th></tr>
<tr><td colspan="2">Thermal backup can play an important role when there is a high penetration of renewables on the grid. Fast-ramping back-up sources should be properly rewarded so as to incentivize investment in fast-ramping technologies.</td></tr>
<tr><td colspan="2">Best Practices
✓ Fossil fuels can be a fast-acting balancing tool, supplying on-demand energy rather than base-load energy.
✓ Premium pricing can be tied to the speed and scale of the change in generation.
✓ Reward resources that can ramp quickly to provide back-up to intermittent renewables. This is a largely untested concept, but getting the incentives right will enable higher shares of renewables on the grid.</td></tr>
<tr><td colspan="2">Japan’s current state
Japan currently has substantial fossil fuel generation capacity but not a lot of domestic fossil fuel resources. Thus, it makes good sense for Japan to transition to using fossil fuels as back-up generation for domestic renewable resources. In particular, natural gas resources could be used in fast-ramping combined cycle plants to complement intermittent solar and wind.</td></tr>
<tr><td>Typical Actors
• Balancing authorities or independent grid operators can purchase fast-ramping thermal generation as backup to renewables
• Electricity regulatory authorities can design markets or premium pricing for fast-ramping technologies</td><td>Typical Beneficiaries
• Back-up electricity generators are paid a premium for their service to the grid</td></tr>
<tr><td colspan="2">Scale of Investment
Premium pricing for flexibility (using thermal generation as a backup for renewables) has not yet been tested at large scale, so the required scale of investment is still unknown.</td></tr>
<tr><td colspan="2">Examples
Premium pricing for flexibility (using thermal generation as backup for renewables) has not yet been tested at a large scale, but important research on the topic is being conducted by several research organizations and private companies.[46]
• Two turbine technologies are particularly promising for inexpensive fast-ramping with natural gas: Siemens’ Flex-Plant technology and General Electric’s 7FA Gas Turbine.</td></tr>
</table>

[46] See work from the Regulatory Assistance Project, Stanford University, and General Electric.

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