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Using Economic Incentives to Accelerate Development of Green Technologies

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ABSTRACT

A portfolio of policies has been used over the last two decades in national efforts to accelerate the development of green technologies. Many are well established, especially in the United States, Europe and Japan. The purpose of most policies is to improve the economics and marketability of green technologies by: 1.) lowering the capital cost of renewables; 2.) reducing the market risk associated with investment in new technologies; and 3.) stimulating and conditioning the marketplace for renewables.

Such strategies are needed because of the disadvantages that renewables encounter in the marketplace. Some of these disadvantages include: the absence of energy prices to reflect the externality costs arising with the generation of electricity from conventional fuel sources. These costs are being borne by third party sources, mostly the general public (in the form of health complications) and ecosystems that are sensitive to air and water pollution. In addition, conventional energy technologies have historically benefited from substantial government subsidies, which have distorted market prices. In particular significant public investments have been made in research, development and demonstration of fossil fuel and nuclear energy technologies, as well as the provision of tax and regulatory incentives favorable to investors in these technologies (e.g., oil depletion tax allowances, special fuel-based tax credits, public lands regulations that offer drilling and mining rights well below market value, insurance indemnities against nuclear accidents, and public subsidies for nuclear waste disposal). Also, historically, new technologies have been unable to effectively exploit economies of scale because of low market share, which keeps production volumes low and maintains high unit costs. The incentives that are being applied to green technologies have been designed to overcome these disadvantages.

The policy portfolio used to accelerate the development of green technologies usually includes measures in four areas:

1. Commercializing incentives
2. Regulatory Action
3. Financing
4. Stakeholder Alliances

Each is discussed below and, where available, estimates of the economic impacts of these measures are reported.

COMMERCIALIZATION INCENTIVES

A number of policies have been designed primarily to defray the high up-front capital cost of renewable technology. These incentives range from:

1. Tax Incentives - Investment tax credits (e.g., in the US, a 10% investment tax credit is available on purchase and installation costs of solar equipment – which is supplemented by individual state incentives that can be as high as 35%, such as in North Carolina); income tax deductions; accelerated depreciation; reduced energy taxes (e.g., if renewables are used, the energy provider is given a reduction in their energy taxes); sales tax incentives. Tax incentives have been very useful in reducing the

2. Rebates / Buy-downs - on the purchase of renewable energy technologies (which in California can be as high as 4.50/watt or 50% of system purchase

price -- whichever is less; and Japan has also used this tool).

3. Production Incentives – Government-set feed in or buy-back rates for energy produced by renewable energy technologies (e.g., in Germany, under their Renewable Energy Source Act,[1] PV is guaranteed a buy-back price of approximately 1 DM/kWh or 3.64 Yuan/kWh for new installations and the amount is reduced by 5% annually). These preferential feed-in tariffs are widely used in Europe but have also been applied to wind energy resources in the US.)

4. Capital grants – Governments provide subsidies for a percentage of the capital costs of equipment (e.g., in the EU, the range of grants is between 40-60% of capital costs of renewables).

5. Green pricing – customers are (voluntarily) charged a premium for electricity provided by a renewable technology (this strategy is widely popular in the U.S. where more than 20 utility jurisdictions introduce the option to customers to pay the additional cost of renewable energy in return for a guarantee that the collected premiums will be entirely dedicated to the purchase of 'green energy' from special providers or to utility investment in such technologies – for wind, the premium is normally US$0.02 per kWh, or 0.017 Yuan per kWh; Japan is also using this policy option)

REGULATORY ACTION

Government regulatory intervention is widespread in the energy sector and is often justified to ensure reliability of service, to protect the public interest in fair pricing and environmental protection, etc. Regulatory action can significantly affect technology choice.

Regulatory strategies used to promote green energy and green buildings include:

1. Renewable Portfolio Standards - requires that a minimum percentage of electricity sold by utilities must be produced from renewable resources (in the U.S., this tool is being used by 13 states[2] and typically involves a requirement that 2-4% of electricity sold is from renewable sources).

2. System Benefits Charges – under electricity deregulation, a surcharge is applied to customer bills to fund renewable energy projects (in the U.S. this is typically around US$.005 per kWh or 0.042 Yuan per kWh).

3. Net Metering - a policy allowing customers to offset the cost of electricity by selling back to the utility at its retail price, any excess electricity produced by a renewable technology (there are currently 34 states in the U.S. taking advantage of this policy tool).

4. Tighter Environmental Standards – Both the U.S. and Europe are revising their air quality standards with regard to power plant emissions. Such action will increase the cost of fossil fuel use and should improve the competitiveness of renewables.

5. Emissions Disclosure – In most states, utilities are now obliged to disclose the fuel mix used for power generation and associated emissions (typically expressed in pounds per kWh generated). Combined with retail electricity choice, this enables customers to decide if they wish to change suppliers due to the environmental characteristics of generation used to serve customers (while studies of this requirement have not been completed, the experience in Pennsylvania indicates that with this information, customers will change providers – indeed, switching to 'green' providers was the single most important reason for changes in suppliers in this state).

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[1] Act On Granting Priority to Renewable Energy Sources (Renewable Energy Sources Act, Germany, 2000). Solar Energy, 70(6). 489-504

[2] http://www.dcs.ncsu.edu/solar/dsire/regulatory.html

6. Green Certification – Many states in the U.S. have adopted standards for energy suppliers that allow them to apply for 'green' certification so that they can market renewable energy products to customers. A similar movement in the buildings sector enables builders and real estate developers to advertise their new projects as meeting strict 'green' standards. In the US, a coalition of building industry interest (US Green Building Council) has developed a rating system for buildings (Leadership in Energy and Environmental Design – LEED program), which evaluates a building's environmental performance, and uses the rating to provide a definitive standard for what constitutes a 'green building.'[3]

FINANCING

Several financial instruments are also used policies, mainly to reduce system costs and debt loads.

1. Low Interest Loans – Below market loan rates have been used in the U.S., Japan and Europe to encourage investment in renewable energy projects. Green Mortgages – In addition to loan programs targeting equipment purchases, building finance instruments have been used to reward builders and buyers of homes and commercial buildings that incorporate energy efficient designs and renewable energy (one version is the 'energy efficient mortgage' in the U.S. which takes into account the lower operating costs of green buildings and enables buyers to qualify for higher mortgage amounts).

3. Green Investment Funds – With this tool, capital is raised from mostly private investors at below market rates for renewable energy projects (in the Netherlands, the nationally administered fund is used to provide low interest loans for renewable energy generation at 1% below market rates – see Schoen, 2001).

[3] http://www.usgbc.org/programs/index.htm

STAKEHOLDER ALLIANCES

Partnerships can and have been formed between various stakeholders in promoting green technologies. Stakeholder groups are varied and can include government, industry, the design community (e.g., architects), community development organizations, real estate developers and building owners. While these alliances may grow out of mutual interests of market participants, formal policies can also be used to encourage their creation.

Programs that have been established under government-encouraged alliances include:

- Million Solar Roofs (US)
- PV-GO (Netherlands)
- Sunshine Program (Japan)

GREEN BUILDINGS

The cooperation of the four policy strategies of commercialization, finance, regulation and stakeholder partnerships, is realized through the concept of *Green Buildings*. Green buildings can be loosely defined as buildings, which are environmentally sound and resource efficient, thereby reducing adverse impacts on the environment and building occupants. These buildings will be more energy efficient, utilize renewable energy resources to meet electricity needs, reduce waste streams, conserve water, use environmentally friendly building materials, and be more in harmony with the environment and, often, occupant health. In an attempt to promote this type of development, the State of New York has adopted a 'Green Building Tax Credit,'[4] the first of its kind in the US. This innovative tax credit has various components to it but specifically includes a photovoltaic module credit. For eligible new building projects, the PV tax credit is 20% of the incremental cost for BIPV modules and 5% for non-BIPV renewables, both for five years.

[4] Green Building Tax Credit.
Statutory Authority: Tax Law Section 19.
http://www.dec.state.ny.us/website/dar/ood/gbr517.pdf

There are a few other states in the US that are pursuing similar programs.

Green Building legislation of the New York variety integrates the key components necessary for the acceleration of renewable energy sources in buildings. The program has green financing through low interest loans, regulatory action through green building certification (e.g., using the LEED program as a standard for buildings), green alliances between community development organizations and real estate developers (who lobbied together for New York's legislation).

EFFICACY OF ECONOMIC INCENTIVES

The effectiveness of individual economic incentives is partly a function of the renewable technology and purpose for this technology. It has been demonstrated that an investment tax credit (ITC) in the US of between 35-45% is sufficient to generate benefit cost ratios greater than one for a roof-mounted grid connected PV system providing energy savings (kWh) and peak shaving (kW) (see Byrne et al, 1994 and 1997). If the facility of emergency power is added to the configuration, the economics for the system greatly improves and a lower ITC is required (see Byrne et al, 1997, 1998 and 2000). When the potential architectural value of BIPV systems is taken into consideration as demonstrated in CEEP's analysis of the use of thin film technology for design material on buildings in China (Byrne et al, 2001), an ITC of 15% or less is sufficient to meet typical investment criteria. By adding the replacement cost of material to the economic value of a peak shaving PV system with an emergency power function, an ITC of only 15% can produce benefit cost ratios of nearly 2.0 and payback periods of less than 4 years.

Wenger and Herig (1997) have shown that rebates can produce favorable economic outcomes for BIPV, but typically additional policy incentives will be needed to attract commercial investment. Positive consumer cash flows were realized for rooftop PV residential systems in 20 states of the US when net metering, a 5% interest loan and a $3/watt rebate were collectively present. Under a scenario when net metering and 5% loans were available but rebates were not, all 19 of the 20 states in the Wenger and Herig study were projected to have negative cash flows (the one exception was Hawaii, whose electricity rates are among the highest in the US). However the addition of the $3/watt rebate, produced positive cash flows in all cases (including Austin, Texas, despite relatively modest electricity prices). It should be noted that the favorable results from Hawaii were a function of a high PV capacity factor and a state investment tax credit of $1,750, as well as the 3 other policy incentives.

Production incentives are also effective in accelerating renewable energy technology with their greatest effect being realized for centralized energy supply configurations, for example, wind farms. Bulk power technologies do not require an energy services configuration to be competitive. The experiences of Germany, Spain and Denmark (see, e.g., Erge et al, 2001) suggest that moderate to significant production incentives can produce favorable economic outcomes and rapidly attract wind capacity additions. However, this technology may be less relevant to urban settings where green building initiatives are being pursued.

One of the most promising policy directions that can positively impact the economics of renewables is the recent adoption of the Renewable Portfolio Standards (RPS) and the System Benefits Charge (SBC) as elements of electricity market reform strategies. In the US, 13 states have implemented an RPS facility, which can require utilities to provide as much as 30% of generation from renewables (e.g. Maine[5]). In the case of the SBC, the market potential is sizeable as 15 US states are stockpiling significant amounts of funds for renewables, efficiency and conservation projects. The four leading states in SBC initiatives are investing nearly US $0.75 billion per year (i.e., 6.2 billion Yuan per year) in SBC funds for projects (California: US $359 million ~ 2.9 billion Yuan; Connecticut: US $109 million ~ 905 million Yuan; Massachusetts US $150 million ~ 1.2 billion Yuan; New Jersey US $125 million ~ 1.04 billion Yuan).

CONCLUSION

Broadly, the lesson learned from two decades of policy experience is that a variety of tools can spur the use of renewable energy in new and

[5] http://www.dcs.ncsu.edu/solar/dsire/regulatory.html

existing buildings. But if green buildings are to become commonplace, an integration of economic incentives is needed. The building sector's commercial interests, financing needs, legal obligations and stakes in the community and environment must be treated together so that a common economic signal reinforces market and societal support for creating a green buildings future.

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