THE CASE FOR RENEWABLE FEED-IN TARIFFS

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ABSTRACT

The development of renewable power generation in the United States is hampered by policy incoherency between federal, state, and local governments that results in insufficient overall investment incentives. By contrast, unprecedented levels of renewable energy deployment have been achieved in several European countries using guaranteed national tariffs for feeding electricity into the transmission grid by private operators on a priority basis. Despite far less sunshine, 55% of the world's solar capacity is presently installed in Germany with a feed-in policy that promotes technical innovation, climate protection, and job creation. Operator reimbursement is guaranteed for 20 years to insure payback of capital-intensive generation equipment and to stimulate new investment. Renewable energies already provide one seventh of total generated power in Germany, higher than the level predicted by EPRI for the United States by 2030. The corresponding discrepancy between implementation potential and deployment could be overcome through the adoption of a national feed-in system for renewable power generation.

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Renewable generating technologies produce electrical power from physical forces in the natural environment. The absence of contaminating effluents and waste allows generation to be established near areas of human habitation, thus avoiding the energy efficiency losses incurred by long-distance transmission to points of consumption.

Localized generation is the mainstay of renewable energy policy in many European countries. Solar plants, wind turbines, hydroelectric generators, and biogenic (biomass and biogas) generators feed electrical power into the transmission grid on a priority basis. Since this decentralized generation infrastructure requires proportionally greater capital expenditures than large-scale plants, renewable electricity feed-in rates generally exceed normal trading prices for grid power. These fixed tariffs insure payback of capital-intensive generating equipment within a few years' time while also stimulating investments in additional production capacities.

Germany has attained unparalleled penetration levels of renewable power generation using legally guaranteed feed-in tariffs. In the ongoing phase of international market development, however, countries with greater geographical expanses, accelerated energy demand, and intensified political awareness constitute more favorable locations for new investments. The financial advisory corporation Ernst & Young Global Limited now ranks the United States as the most attractive country for renewable energy projects in the world, with India, Spain, and the United Kingdom likewise surpassing Germany in aggregate long-term prospects for wind, solar, and biomass generation.

These ratings, however, do not consider the hypothetical case of more effective legislation being enacted in emerging renewable energy markets. Under the plausible assumption that Germany would have received an even lower investment rating without its present feed-in law, the adoption of comparable regulations in other countries should correspondingly accelerate renewable power usage.

IMPEDIMENTS TO RENEWABLE ENERGY UTILIZATION

Due to its physical relationship with the natural environment, renewable power generation contributes to meeting weather-dependent electricity demand. On stormy days, buildings cool out more rapidly and require additional energy that may be supplied by wind turbines and ocean wave generators. Photovoltaic arrays on rooftops predictably reduce the grid loads imposed by air conditioning equipment during periods of intense sunshine.

Weather extremes alone, however, cannot overcome the enduring impediments to renewable power utilization. In the United States, for instance, solar home retrofits continue to be forestalled for a number of tangible reasons.

1. Photovoltaic building panels can generally supply only a fraction of the energy required for indoor living spaces.
2. Improved wall and ceiling insulation reduces heating and cooling requirements at lower cost than by generating renewable power to compensate for excessive thermal dissipation.
3. Some 40 million Americans change their address each year. The repayment time of a solar installation thus often exceeds the period of occupancy. Renewable energy investments will be lost if subsequent home buyers are unwilling to reimburse them.

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4. Solar equipment purchases may be deferred in anticipation of future price reductions.
5. In the absence of climate protection mandates, no economic motivation exists to lower carbon dioxide (CO_2) emissions.

Moreover, diffuse renewable energy strategies rarely include adequate investment incentives, even when mandatory implementation targets have been imposed. In the United Kingdom, a Renewables Obligation requires suppliers to provide an annually increasing percentage of electrical power from renewable sources (Reform of the Renewables Obligation, 2006, p.10). The Obligation introduced in 2002 rises annually from 6.7% in 2006/07 to 15.4% in 2015/16. Renewables Obligation Certificates (ROCs) verifying renewable generation may be presented by suppliers or substituted by a buyout charge. Since the contribution of renewable power in 2006 barely exceeded 4%, however, the timely adherence to the Obligation appears doubtful. The United Kingdom and numerous other countries are thus confronted with either intensifying existing bureaucratic procedures or enacting alternative feed-in legislation in order to expand the generation of renewable power.

SUCCESSFUL RENEWABLE POWER DEPLOYMENT IN EUROPE

Renewable energies are used effectively in many parts of Europe owing to energy efficient buildings, little domestic air conditioning, and low housing turnover rates. The EU Emissions Trading Scheme (ETS) as well as national climate protection programs are also increasing the net cost of fossil fuel power generation, virtually subsidizing all non-carbon energy resources.

Germany is already well ahead of its national renewable commitments using feed-in tariffs. At the end of 2007, renewable energies were supplying over 14% of the electricity used in Germany, exceeding the goal of 12.5% set for 2010 (Erneuerbare erreichen, 2007).

The ability for solar power to moderate summer peak loads may appear superfluous north of the Alps, where most buildings are not equipped with air conditioning. Yet the output of particular power stations is routinely reduced during extremely warm weather to avoid overheating local rivers. The coincidence of intense solar irradiation with the highest ambient temperatures and power trading prices on early summer afternoons allows the diminished output of overheated nuclear plants to be substituted by over 2,500 megawatts (MW) of solar-electric grid capacity in Germany alone (Stromerzeugung, 2007).

GERMAN RENEWABLE POWER LEGISLATION

Despite having considerably less sunlight and only about one fourth the population, Germany far exceeds the United States in most categories of renewable power generation. In 2006, renewable energies provided 73 terawatt-hours (TWh), or 12% of the country's total electricity production. Almost half this amount (30.5 TWh) was contributed by 18,685 wind turbines (www.wind-energie.de/de/statistiken), followed by hydroelectric generation at 21.6 TWh. Solar electricity from 300,000 photovoltaic arrays (Statistische Zahlen, 2007) accounted for 2 TWh, the majority of which was generated near points of usage with minimal transmission losses.

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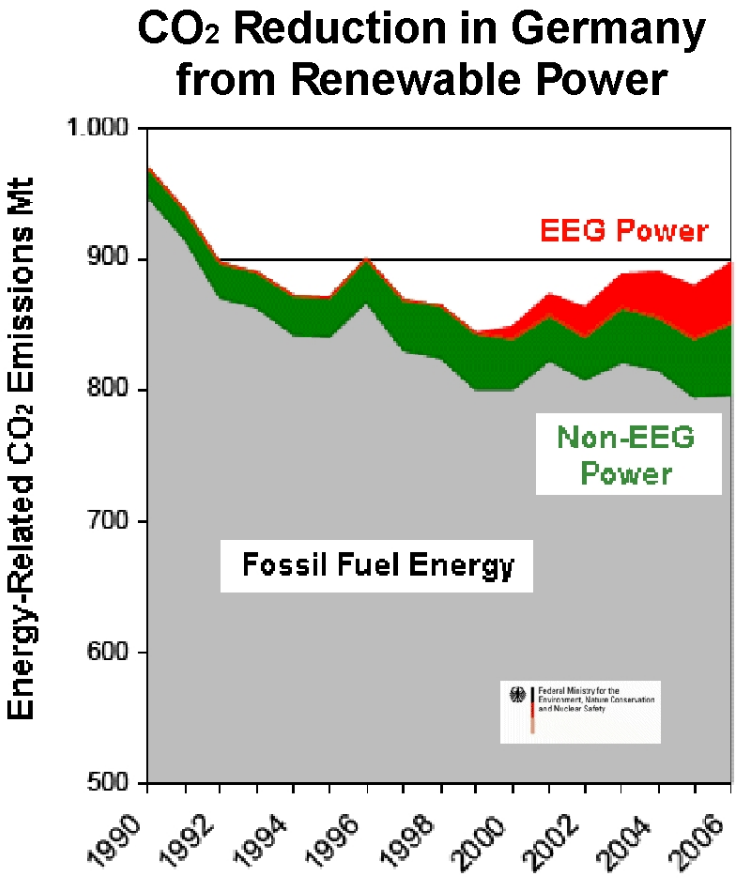
This increased deployment of non-nuclear, CO_2-neutral power sources has been necessitated by Germany's self-imposed commitment to phase out its 19 atomic reactors within two decades (Act on the structured phase-out, 2002), while also eliminating 21% of all greenhouse gas (GHG) emissions by 2012 (referred to 1990) under the Kyoto Protocol. Carbon dioxide emissions (comprising 87% of the GHG total in Germany) have not increased in proportion to rising power consumption owing to renewable power legislation that was first introduced in 2000.



The generation technologies contributing to the dual objective of nuclear retirement and CO_2 reduction can be financed at low risk under power feed-in guarantees of the federal Renewable Energy Sources Act (*EEG*, or *Erneuerbare-Energien-Gesetz*), enacted in its present form in 2004 (Act revising the legislation, 2004). Under *EEG* regulations, utility companies are required to buy electricity fed into the grid at specified tariffs from any newly contracted, independently operated solar, wind, biomass/biogas, geothermal, or hydropower installation (up to 150 MW). The law likewise supports wind turbine upgrading ("repowering") to at least threefold capacity and any expansion or modernization of hydropower plants that increases rated power by 15%. In most cases, a fixed incentive payment per kilowatt-hour is guaranteed for 20 years. For installations commissioned after August 8, 2004, the following grid feed-in tariffs in euro cents (ct) apply.

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Table I. Guaranteed Prices for Renewable Power Generation in Germany Beginning in 2004 per Renewable Energy Sources Act (EEG)			
Energy Source	**Grid Feed-In Tariff Ct/kWh**	**Degression Factor for New Contracts**	**Qualifications**
Hydro	3.7 – 9.67	1%/a for plants exceeding 5 MW	Up to 150 MW Upgrading until 2012
Wind	5.5 – 9.1	2%/a	Differentiated by wind intensity of site
Biomass & Biogas	3. 9 – 21.5	1.5 %/a	
Landfill-, Sewage- & Mine Gas	6.65 – 9.67	1.5 %/a	
Photovoltaic & Solar Thermal	45.7 – 62.4	5 – 6.5%/a	Differentiated by mounting & location
Geothermal	7.16 –15.0	1%/a	Degression beginning in 2010

The degression factor reduces the tariffs each year for new installations to reflect ongoing technological improvements and increased manufacturing efficiency. For instance, roof-mounted photovoltaic arrays of up to 30 kW peak capacity (kWp) contracted in 2007 receive 49.21 cents (about $0.70 US) per kWh, 5% less than the 51.80 cents provided in 2006. Lower reimbursements apply to wind turbines, solar farms, and other large installations owing to more moderate equipment costs per installed kilowatt capacity. Increased rates are provided for solar façade cladding of buildings and roadway noise barriers to compensate for the reduced output of vertically mounted panels. The highest tariffs for biomass generation are paid when combined heat and power (CHP) or innovative technologies such as Stirling motors are employed.

The price difference between feed-in tariffs and regular utility rates requires that renewable power supplied to the grid be measured independently of customer demand. The technique of bidirectional (net) power metering widely employed in North America can therefore not be employed. Instead, two conventional power meters or alternatively one electronic meter with two independent measurement circuits are used to distinguish feed-in from consumption.

PRICE SUPPORTS INSTEAD OF SUBSIDIES

Since no government payments are made to system operators, German feed-in incentives do not constitute public subsidies. The guaranteed tariffs instead combine regular grid power charges enhanced by mandatory utility price supports. This practice is not unique in Germany to renewable energies. Price fixing (*Preisbindung*) is employed for the sale of books, sheet music, maps, cigarettes, taxi services, and prescription medicines to prevent commercial corporations from undercutting small retailers. These regulated prices allow sufficient returns on investment to be achieved.

Earlier federal and state monetary incentives for renewable energies in Germany were often truncated by budgetary limitations. As shown in the graph, the number of wind turbines, biomass generators, and solar-electric installations has increased significantly

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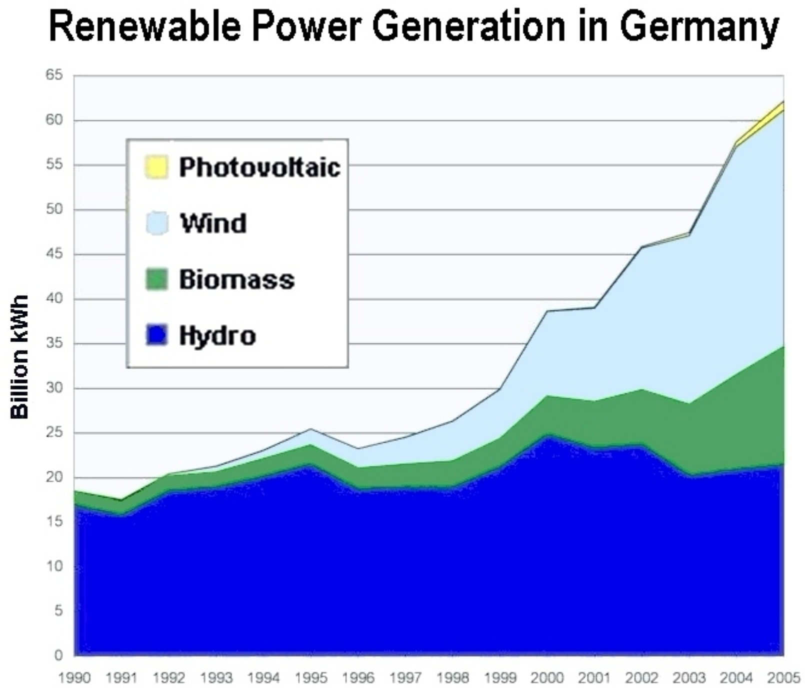
since guaranteed feed-in payments were first introduced in the year 2000. Financial constraints have been eliminated by this practice, since all costs are passed on to ratepayers. Grid operators are obligated to accept renewable power on a priority basis, thereby insuring operator income even if conventional generating plants are forced to reduce operation in consequence.



INCURRED AND AVOIDED COSTS OF THE *EEG*

By imposing mandatory long-term payback for any new installation with no allowable intervention by either government or the power industry, Germany has created the world's most effective system for increasing renewable energy usage. The average reimbursement paid by utilities for a kilowatt-hour of power fed into the grid in 2005 was 9.5 ct, or $014 (Energieversorgung, 2006, p. 32). The incurred costs are redistributed equitably to all customers at 0.63 ct/kWh (2006), raising electricity bills in private households by an average of 3% (What electricity, 2007, pp. 3–4). In return, every wall socket in the country is supplied with one seventh green power. Green power customers pay for 100% renewable electricity generated for their account.

The small feed-in surcharge imposed for renewable energy is compensated many times over by the avoided ecological detriments of conventional power production. The German Federal Environmental Agency places the indirect financial burdens of fossil fuel generation on human health, manmade structures, and agriculture at 7 ct/kWh, compared with hydropower at 0.4 cents and wind energy at 0.1 cent (Externe Kosten, 2007, pp. 5–6).

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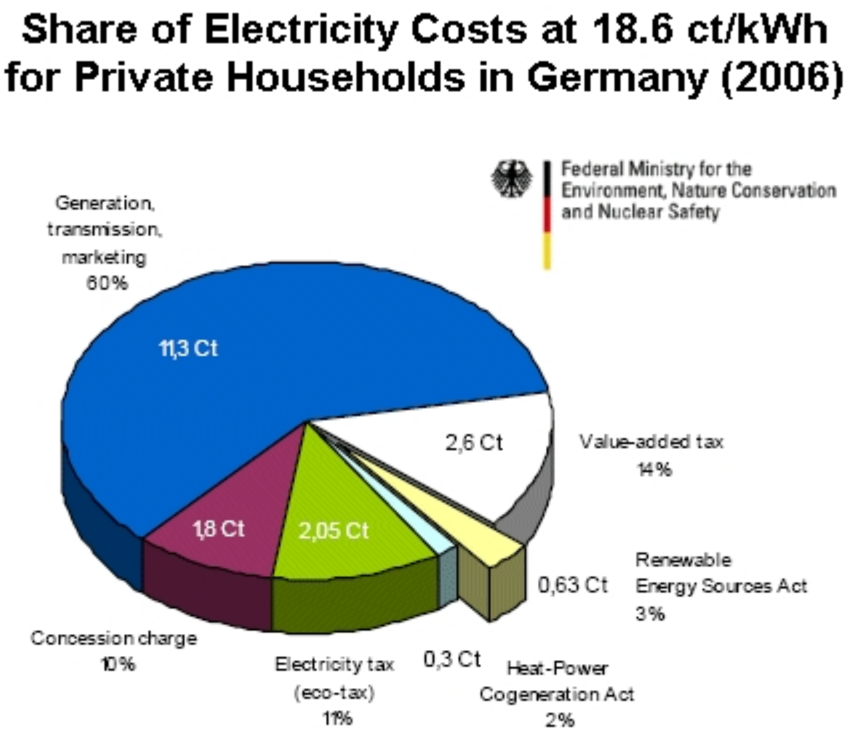


Even after the feed-in tariff of 0.63 ct/kWh has been added, electricity from coal and gas imposes more than eight times the environmental and societal costs of renewable power. This discrepancy is concealed in utility billing rates, which exclude the effects of global warming, air pollution, landscape destruction, and groundwater depletion that are inherent to fossil fuel usage, as well as the safety risks of nuclear generation and waste storage. With solar and wind power, by contrast, what you see is largely what you get.

The solar industry organization *Bundesverband Solarwirtschaft* estimates that 750 megawatts of peak photovoltaic capacity was added to the German grid infrastructure in 2006 alone (Körnig, 2007, pp. 1, 4). A website showing the real-time generated output and *EEG* income achieved by small solar arrays throughout Germany is maintained by Walter Grotkasten at *www.grotkasten.de*. The achieved payback time may be estimated with reference to typical realization costs between 4,700 and 6,200 euro/kWp (about $6,700 to $8,800), generally in inverse proportion to scale. Germany's largest solar park rated at 40 MWp is currently being erected near the city of Leipzig at a cost of approximately 3,250 euro/kWp ($4,600) (Hinsch, 2007, p. 117).

German feed-in legislation has demonstrated that a strategy occasionally criticized as overpriced is capable of delivering unparalleled economic benefits. The federal environmental ministry has reported 235,000 employees in the renewables industry, while projecting over 400,000 jobs by 2020 (Gabriel, 2007). The workforce already exceeds that of the conventional power sector.[1] The avoided costs of electricity purchases, fuel imports, and environmental degradation greatly outweigh both ongoing feed-in payments and the reserve generating capacities necessary for maintaining grid stability under conditions of

[1] The lignite industry, which provides about one fourth of German electrical power production, had 22,909 employees in mining and generation in 2006. See www.kohlenstatistik.de.

fluctuating renewable supply. The government findings summarized in Table II do not include the demographic and economic benefits of increased employment.

Table II. Incurred and Avoided Costs of the German Renewable Energy Sources Act (EEG) in 2006			
Incurred Costs		**Avoided Costs**	
Feed-in payments	3.2 billion euro	Power purchases	5 billion euro
Reserve generating capacities	0.1 billion euro	Fuel imports	0.9 billion euro
		Climate, air pollution	3.4 billion euro
Source: *Erfahrungsbericht 2007 zum Erneuerbaren-Energien-Gesetz (EEG) gemäß § 20 EEG. BMU-Entwurf. Zusammenfassung* (Berlin: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, July 5, 2007), p. 5			

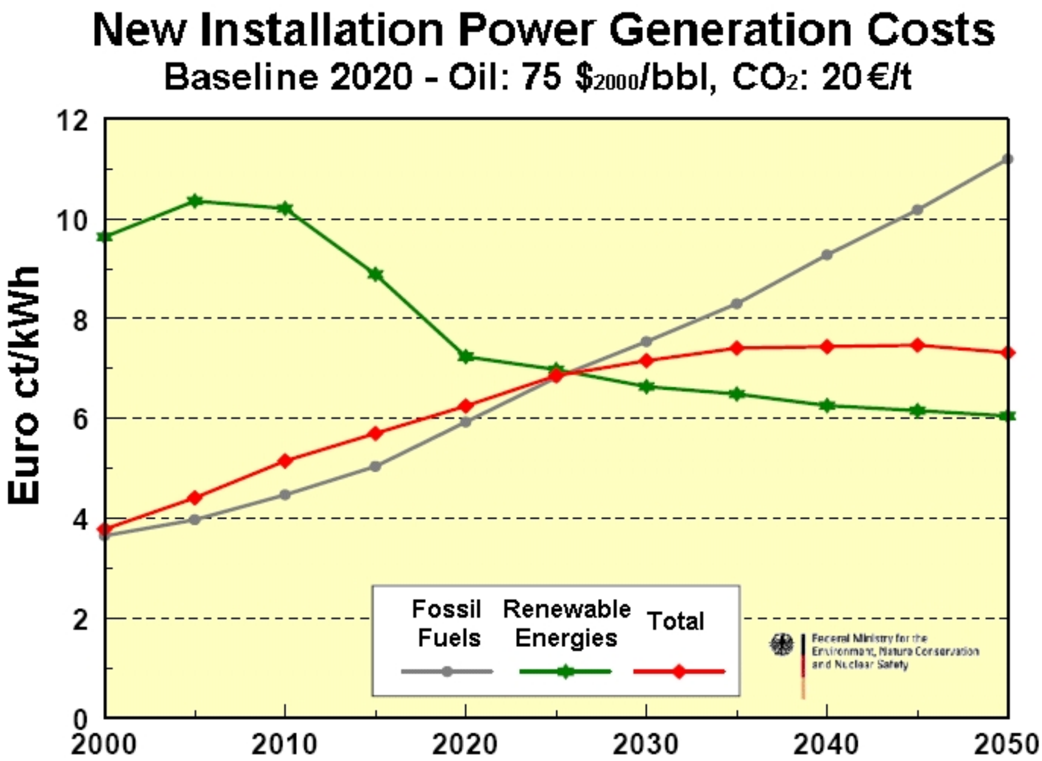
ACCELERATED COST CONVERGENCE

The yearly degression of payments made for newly installed renewable energy equipment in Germany has consistently stimulated manufacturer price reductions. The *EEG* was originally formulated under conservative estimates of future energy price increases. Fossil fuel usage has since become decidedly expensive and risk prone due to both global supply limitations and greenhouse gas ceilings imposed by the Kyoto Protocol. In view of the unexpected rapid growth of renewable equipment sales under these conditions, the German environmental ministry has now proposed increasing the annual degression factor for solar installations to 8% in an amended *EEG* to become effective on January 1, 2009 (Entwurf eines Gesetzes, 2007, § 24).

A recent study commissioned by the ministry has predicted that the costs of new fossil fuel and renewable power generation would converge in 2025 if an oil price of $75 per barrel (dollar valuation referred to the year 2000) and a CO_2 emissions trading level of 20 euro per metric ton had been attained by 2020 (Nitsch, 2007, p. 63). This is likewise a cautious assumption based on current technologies. The future employment of carbon capture and storage (CCS) for eliminating greenhouse gas emissions from fossil fuel usage could already impose CO_2 avoidance costs exceeding 20 euro per ton (Forschungs– und Entwicklungskonzept, 2003), giving renewable energies an additional price advantage.

CCS effectively buries a portion of energy expenditures in underground repositories, resulting in “welfare-economic losses” similar to those caused by emissions trading. A one-sided deficit of nearly 4 billion euro has been calculated by Danish researchers for new ETS entrants in Germany alone using a CO_2 baseline of 20 euro per ton (Lindboe, Werling, Kofoed-Wiuff, and Bregnbæk, 2007, p. 42). This figure would rise disproportionately to 15 billion euro at a trading price of 30 euro/ton, and thus commensurately for CCS.

The insensitivity of renewable energies to CO_2 pricing diminishes the financial risks of their implementation. The rising costs of fossil fuels and emissions trading certificates should eventually render investment incentives superfluous. The separate metering of renewable generation would remain necessary, however, to enable feed-in power to be measured for comparison with grid requirements.



New wind turbine placement is declining in Germany due to the growing scarcity of land-based sites with both adequate wind resources and close proximity to transmission lines. For this reason, wind generator repowering at existing locations materially contributed to the capacity attained in 2006 of 21,621 MW. An increase to over double that amount (48.2 GW) is now anticipated by the end of the coming decade with the construction of offshore wind farms in the North Sea and Baltic Sea (Planning of the grid, 2005, pp. 7, 16). To promote this development, improved feed-in tariffs for offshore wind turbines are foreseen in the proposed amended version of the *EEG* (Entwurf eines Gesetzes, 2007, § 35).

The perspectives for biomass and biogas deployment are difficult to quantify due to the dependency of fuel availability on changing market conditions and agricultural or forestry policy. The 3,500 biogas generators in operation in 2006 delivered 5 TWh of electricity from less than 2% of total German farmland (Biogas, 2007). The 550 MW of new biogas equipment installed that year is capable of supplying the same amount of grid energy as the 2,280 MW of wind capacity realized during the same period.

The deployment of renewable energies is being pursued in many European countries to promote electricity price stability, Kyoto compliance, and the increased use of domestic resources. According to the most recent data available, non-hydro renewable electricity generation in the European Union approached 150 TWh/a at the end of 2005 (Renewable energy, 2007), equivalent to one fourth of total electrical power usage in Germany. Feed-in laws have since been enacted in 19 of the 25 European Union member states and 47 countries worldwide (Germany, 2007), including Brazil and Turkey.

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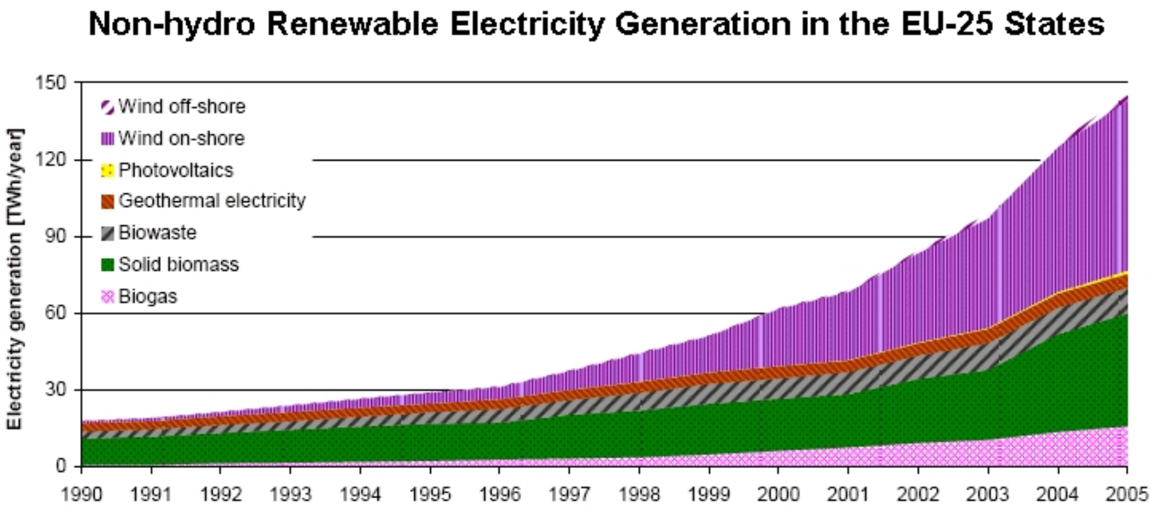

Compensation that is fully independent of power trading prices and weather conditions may lead either to underpayment or to excessive profits on capital investment. Standard feed-in tariffs can alternatively be subdivided into a fixed rate and a market variable component to reduce these divergences. Stepped tariffs may also be employed to lessen payments beyond the number of full-load generating hours that are necessary for investment amortization. In Slovenia, variable feed-in rates ranging from 0.7 to 1.4 times the base feed-in tariff are offered to producers according to the time of day and the season of the year (Held and Ragwitz, 2006).

PREREQUISITES FOR FEED-IN LEGISLATION IN THE USA

In North America, feed-in tariffs are endorsed by numerous non-governmental organizations.[2] House Bill no. 5128 introduced in Michigan by Assemblywoman Kathleen Law in September 2007 is patterned closely after the German EEG with tariffs set at comparable levels. An appropriate ministerial directive has also been adopted in Ontario.

Although implementation lags behind much of Europe, the United States has taken exemplary steps in increasing the use of CO_2-free energy. More wind turbines are now being installed annually (2,454 MW in 2006) than in any other country (New world record, 2007). Several commercial retail chains are committed to providing 100% renewable power to their sales outlets. Renewable Portfolio Standards (RPS), Renewable Energy Certificates (REC) or green tags, public benefit funds, and purchasing rules for government agencies are widely employed in support of CO_2-free energy usage.

The DSIRE Database of State Incentives for Renewables and Efficiency (www.dsireusa.org) compiles state, local, utility, and federal incentives for promoting renewable energy and energy efficiency. The provocative variety of these measures, however, reflects the absence of a coherent national policy for flanking conventional power generation. Since electricity is sold across state lines, federal legislation would be justified in correcting this deficiency. Particular consideration should be accorded to mechanisms suitable for making renewable energy technologies more cost effective.

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1. **Degression Adjustments.** The consumer price for electricity in most U.S. states is less than half the current German tariff of over 20 ct/kWh ($0.29), so that lower feed-in payments for renewables could appear necessary to preclude disproportionate utility rate increases. However, the chronological degression of reimbursements in other countries has already delivered the price reductions necessary to justify feed-in tariffs in the United States based on current equipment costs. Individual adjustments of degression rates could be warranted to reflect technology learning curves differing from those in other parts of the world.

2. **Metering Policies.** The technique of net metering currently employed in North America employs a bidirectional power meter to deduct the amount of renewable power supplied to the grid from regular customer consumption. Since only power differences are measured, however, the specific contribution of renewable energies to reducing grid demand cannot be determined. The Advanced Metering Infrastructures (AMI) now being realized by many utility companies to implement Demand-Side Management (DSM) programs should therefore include a second meter at those customer locations supplying renewable energy. Tariff schedules could be structured to promote the most cost-effective reduction of conventional power generation. A solar array, for instance, would qualify for feed-in incentives only in conjunction with DSM participation, thereby excluding profits accrued in disregard of avoidable power wastage. Feed-in legislation in Europe does not yet account for such complex interrelationships in reducing grid loads, since appropriate metering technologies have yet to be introduced.

3. **On-Site Storage.** The future availability of plug-in hybrid electric vehicles (PHEV) will make multiple tariffs necessary to distinguish three modes of energy transfer between the vehicle and the grid: a) recharging, b) storage of grid energy that can be recalled by the utility on demand, and c) motor-electric generation for supplying additional grid power. Automobiles employing biofuels or electrolytic hydrogen from wind or solar power would qualify as renewable energy sources. Comparable tariff structures could be used for flywheels and other in-home storage devices that similarly contributed to grid load stability. Since hybrid vehicles may travel across state lines before recharging, federal rate structures would be indispensable to providing billing consistency independent of location, embodying an essential attribute of a national renewables feed-in law.

4. **Grid Storage.** Although aggregate power demand greatly exceeds the scale of renewable energy production, continuing efficiency improvements of both consumption and generation can reduce the grid dependency of individual sites. Some ratepayers already produce as much electricity as they use in the course of a year with wind and solar power, or from agricultural biogas. Since the times of production and demand do not always coincide, however, the grid effectively becomes a storage device that returns electricity previously generated. Conventional supply billing could be replaced in these cases by storage invoicing. Time-dependent rates would account for renewable power delivered under conditions of peak demand, but returned off-hours to the customer at lower prices.

[2] A running list of endorsements is maintained at www.wind-works.org.

5. **Renewable Energy Mapping.** If an Advanced Metering Infrastructure tracks the metered power of all feed-in sources geographically, a renewable energy map can be compiled for real-time Internet presentation. It then becomes possible to visualize local power generation in comparison with metered consumption. The productivity of each type of renewable energy may be classified according to region, assisting the selection of technologies for new installations.

ANCILLARY FACTORS OF IMPLEMENTATION

The principle of renewable energy mapping is inherent to Renewables Portfolio Standards (RPS) that are based on local prerequisites for generating technologies. If such an approach had been employed in Europe, however, solar power would likely be most widely employed in the Mediterranean regions instead of Germany, where half of the world's photovoltaic capacity is currently installed.

European renewables usage actually depends not only on geographic location and meteorological conditions, but also on factors having little relevance to solar irradiation. Among these are the enduring trauma of the Chernobyl catastrophe, record unemployment in parts of Central Europe, environmental degradation caused by coal power generation, rising prices for imported fossil fuels, and the perceived effects of global climate change. The benefits of alternative energies have been secured by responding to these conditions with mass production strategies more effective than any regionalized incentive system. In 2001, the European Community issued a corresponding directive aimed at achieving a 22.1% share of electricity produced from renewable energy sources within ten years (Directive 2001/77/EC, 2001).

Federal feed-in legislation in the United States could likewise supplant state and local programs, providing administrative uniformity independent of generating site. In analyzing Renewable Portfolio Standards in a 2002 study, the Center for Resource Solutions noted that from "a contractual and transaction cost perspective, fixed feed-in tariffs with standardized interconnection requirements, contract terms, and conditions can … simplify negotiations and speed the development and contracting process for renewable generators relative to an RPS strategy" (Wiser, Hamrin, and Wingate, 2002, p. 13).

The transition to universal feed-in tariffs may be resisted by utilities and grid operators confronted with the necessity of transmission system upgrades, particularly for accommodating immense wind or solar farm capacities in thinly populated regions. Net metering of renewable power is already restricted or unavailable in some areas for the same reason. To alleviate this difficulty, feed-in payments in Germany are shared equitably by all customers on the grid. Localities that have rejected renewable energy projects on aesthetic or economic grounds nevertheless assume proportionate costs for alternative power development elsewhere.

EMBRACING NATIONAL ENERGY SECURITY

The Center for Energy Efficiency and Renewable Technologies (CEERT) estimated in 2002 that renewable energies could be capable of providing 20% of total power generation in the United States within two decades (Ferguson, 2002, p. 13). The required investment

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of 20 billion dollars per year would be diverted from purchasing natural gas to produce the same quantity of electricity. Gas price increases and technological efficiency have since improved this prospect. As is the case of Germany, the costs of equipment and transmission could be defrayed among all utility subscribers, simultaneously alleviating pressure on the foreign trade balance.

According to the National Energy Policy issued in 2002, U.S. reliance on oil imports may be rising from 52% at the beginning of the present decade to 64% by the year 2020 (National energy policy, 2002, pp. 1–13). An anticipated 50% increase of domestic natural gas production could also "not be high enough to meet projected demand" (National energy policy, 2002, pp. 1–8). These estimates have already taken all economic measures of energy conservation into account. The only remaining possibility for diminishing import dependency is therefore the increased use of renewable energies.

Wind turbines and photovoltaic installations impose no demands on local aquifers, eliminating supplementary energy expenditures for water management. In contrast to coal and gas power plants, furthermore, additional equipment and resources are not required for meeting climate protection obligations.

The Earth's biosphere must accommodate increasing quantities of effluents from fossil fuel combustion and industrial processes. A 42.7% rise in national greenhouse gas emissions, from 5,773 million CO_2 equivalent tons in the year 2000 to 8,237 million tons by 2020, was predicted at the beginning of the decade by the U.S. Climate Action Report (U.S. Climate Action, 2002, p. 73). Without suitable decarbonization technologies for moderating that trend, the United States could suffer a competitive disadvantage under future climate protection agreements. Federal feed-in legislation for renewable generation would provide nationwide incentives for reducing fossil fuel dependency while simultaneously addressing global warming.

In analyzing the prospects for carbon-constrained electricity production, the Electric Power Research Institute (EPRI) has formulated "advanced technology targets" for the year 2030 in which 4.9% of generation would be delivered by conventional hydropower and 6.7% by non-hydro renewables (Electricity technology, 2007, pp. 14–15). The percentage contribution considered attainable in two decades is therefore less than what Germany has already achieved. Conventional power generation would have increased during the same period by 36% due to load growth.

The EPRI figures have been derived without presupposing a national feed-in law. They are reminiscent of European analyses in the 1990s, when renewable generation was considered only an "additive" power source. A significant physical divergence prevails between EPRI expectations and both solar intensities in the American Southwest and wind availabilities in the Northern Plains states. The economic case for feed-in legislation should be examined under the premise that such resources will be too significant to be neglected in the pursuit of national energy security.

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