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The Economic and Policy Setting of Renewable Energy

Where Do Things Stand?

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RESOURCES FOR THE FUTURE

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Abstract

This paper looks at the status and prospects of renewables—with particular emphasis on windpower—in the electric power sector. Although renewables account for a steadily rising share of electricity generation in various countries, their role remains small in absolute terms. In part, this is because of technological progress of and successful competition from fossil-fueled generation—notably, combined cycle gas turbines. While diminishing, subsidies continue to be indispensable to the use of renewables in most places. Viability of renewables-based electricity is undermined by the cost of externalities for which fossil energy combustion is only partially charged. A number of countries (and states in the U.S.) have launched obligatory requirements for renewables-based electricity in the years ahead. This so-called "renewable portfolio standard," while technology-forcing, offers an opportunity for an economically efficient way of promoting greater market penetration of renewables.

Key Words: Renewable energy, electricity, windpower, externalities

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The state of renewable energy for generating electricity is for the most part widely understood: the relative contribution of nonhydro renewables to electricity capacity remains generally very low. At the same time, their importance in some places has been rising fairly steadily, even if the starting point is so low that annual growth rates can be somewhat misleading.

In this paper I first review of the state of play of renewables in major regions, with special emphasis on windpower. I then look at the economic and noneconomic constraints that have impeded greater market penetration of renewables and consider how the playing field might be leveled to enhance the prospects for alternative energy systems. Next, in what is mostly a sifting exercise, I take a selective look at trends, policy initiatives, and problems in specific countries. Finally, I present a brief set of conclusions and list the broad challenges facing the renewable energy sector.

The Status of Renewable Energy Systems: A Quantitative Review

Let us start with the numbers. In Table 1, we see that for the three groupings of countries used by the Organisation for Economic Co-operation and Development (OECD)—North America, the Pacific region, and Europe—renewables hover at around 2% of total electricity production. Predictably, some countries depart markedly from that share, such as Iceland and

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New Zealand, where geothermal energy is tapped; Finland, which grows biomass; and Denmark, which uses windpower. Germany, the United Kingdom, and the United States are close to the OECD-wide average of 2%, although rapid change could make such numbers only a point-in-time snapshot.

Table 1. Nonhydro renewables, percentage share of electricity production, 2000.

By regional grouping	
OECD total	2.0%
North America	2.0
Europe	2.1
Pacific	1.6
Selected countries	
Iceland	17.2%
Denmark	16.7
Finland	12.3
New Zealand	8.9
Germany	2.5
United Kingdom	1.3
United States	2.1

Source: IEA, *Renewables Information 2002* (Paris: OECD/IEA 2002).

Table 2 provides OECD-wide data on specific types of renewably generated electricity, expressed as both shares of generation and shares of installed capacity. Biomass and industrial-municipal waste resources are still the dominant players here, though as relatively mature contributors, their growth rates have been very modest. Growth in windpower generation, by contrast, has proceeded at a 22%-per-year clip, and its 14% share of renewables generation puts it in at least respectable company. But note: windpower's installed capacity share is more than twice its electricity production share.

Table 2. Distribution of nonhydro renewable electric systems, OECD, 2000.

By generation	*GWH*	*Percentage*
Geothermal	32,878	5.7
Solar	1,128	0.5
Tidal	605	0.3
Windpower	28,897	13.8
Biomass	95,292	45.6
Industrial and municipal waste	49,969	23.9
Total	208,769	100.0
By capacity	*MW*	*Percentage*
Geothermal	5,644	11.3
Solar	777	1.6
Tidal	258	0.5
Windpower	16,110	32.2
Biomass	16,173	32.3
Industrial and municipal waste	8,499	17.0
Combined sources and unspecified	2,653	5.3

Source: IEA, *Renewables Information 2002* (Paris: OECD/IEA 2002). GWH = gigawatt hours or million kilowatt hours; MW = megawatts or million watts.

That leads us to Table 3, which highlights the technological and economic challenge posed by renewables with their intermittency and low rates of capacity utilization. The table shows that recorded annual operating hours for different technologies range from a high of close to 7,000 hours (i.e., nearly 80% of theoretical maximum availability) for a nuclear power station down to rates of 17% to 20% for solar and wind systems.

Table 3. Annual hours in operation, different energy systems, OECD, 2000.

Energy source	*Hours per year*
Nonrenewable: nuclear	6,947
Nonrenewable: fossil fuels	4,171
Hydro	3,336
Geothermal	5,825
Solar	1,425
Tidal	2,345
Windpower	1,794
Biomass	5,892
Industrial and municipal waste	5,879
Theoretical maximum operation (hours in a year)	8,760

Source: IEA, *Renewables Information 2002* (Paris: OECD/IEA 2002).

A stylized but more complete representation of typical renewable capacity factors appears in Figure 1. Of course, the capital-intensive outlays required by a nuclear facility would never be undertaken if the plant could not be expected, at least *ex ante,* to be deployed as a baseload—that is, with more or less year-round operation. (The table, incidentally, reveals a decidedly lower capacity utilization rate for fossil-fueled plants because even though many are, like nuclear plants, of the baseload variety, periodic recourse to peak-load and auxiliary capacity provided by older and inefficient sites reduces the overall utilization rate.)

Factors Shaping Market Penetration of Renewables

Aside from successes in a small handful of countries, then, market penetration of renewables has remained very low. What's the explanation? The insights I've managed to acquire are based mainly on U.S. experience, though there are numerous aspects of the story that are more widely applicable.

At its core, the decision of how to expand electricity-generating capacity rests on the comparative marginal costs of renewable versus conventional systems. To be sure, such a comparison can be tilted in one direction or another in a variety of ways: the differential imposition or neglect of external costs, the use of subsidies favoring a particular technology, or policy dictates that the market is forced to absorb. Examples of such policies in the United States include ethanol requirements for transportation fuels and, in some states, renewable portfolio standards (requiring that some percentage of power come from nonhydro renewable sources). But the fact remains that during much of the past decade, dominant market forces have not been kind to renewable energy.

A study conducted at Resources for the Future (RFF) in 1999 [1] found that although both advocates and more agnostic analysts had expected the costs of renewable-based electricity generation to fall during the 1980s and 1990s, the declines were greater than either group expected—in some cases, markedly so. A quarter-century ago, the cost of windpower generation, then estimated at around 60 cents per kWh, was not expected to fall much below 8.5 to 11 cents per kWh by the year 2000. In fact, recent bids for some new windpower facilities appear to be in the range of 3 to 5.5 cents per kWh, depending on location (in constant-dollar costs, expressed in 2002 price levels). The cost of solar applications remains substantially higher.

Given the sharp decrease in costs, why has the market share of renewables remained so low in the United States? Because, to an important degree, the costs of conventionally fueled electricity generation also fell sharply. Those costs had been expected to head in only one direction—upward—during the final two decades of the 20th century. The U.S. Department of Energy, for example, had projected that the overall cost of generating electricity would rise about 5% between the early 1980s and the mid-1990s; in fact, it fell 40%. That decline, it is true, was triggered mainly by an unexpectedly large drop in the cost of fuels used for conventional power generation. But even apart from future trends in fuel costs, it stands to reason that technological improvements in power production will apply not just to renewables but to their nonrenewable competitors as well, thus hampering renewables' success in gaining market share.

The technology of choice for power generation in the foreseeable future is the highly efficient combined-cycle gas turbine (CCGT). An advanced version of this turbine may well be able, within the next decade or two, to produce power below today's nationwide average generation cost of around 4 cents per kWh. CCGT may thus constitute a formidable challenge to windpower and other renewables, most of which, unlike a CCGT baseload plant, bear the economic burden of intermittency, which limits their ability to dispatch power on demand. Still, a more recent RFF study, comparing the costs of renewables-based and conventional electric power facilities coming on line in the United States over the next 20 years, sees windpower emerging as the most promising renewable [2]. But not surprisingly, windpower's competitive attractiveness turns out to be highly sensitive to assumptions about continued progress in CCGT technology.

Although the specific circumstances have varied, the experience of the United States has been mirrored elsewhere. In the 1990s, for example, the United Kingdom also began to exploit the economic benefits of combined-cycle natural gas turbines. In the British case, that development was stimulated by the forced closure of many inefficient coalmines, whose production declined by half between 1989 and 1995, and by the coincident availability of North Sea gas, whose price to electricity generators trailed the overall rate of inflation. All this was coupled with environmental concerns and pollution abatement laws (which did not go so far as to make renewables the route to greater environmental integrity). Indeed, the continued subsidies (until recently) for nuclear power in the United Kingdom have been another deterrent to greater market penetration of renewables [3].

In contrast to the United Kingdom's cold-turkey approach, Germany's continued subsidization of the coal industry has complicated rather than eased the economic viability of renewables. Nevertheless, the country's windpower capacity now stands at an impressive 12,000 megawatts. Even in Denmark, the leading country in terms of the share of generation accounted for by wind, costs of conventional electricity are still substantially below those of windpower.

Indeed, that sort of spread, with minor deviation, appears to characterize a large group of diverse economies. Table 4, derived from estimates developed in 2001 by the International Energy Agency, shows the average electricity-generating costs for various generating modes for the 15-member European Union [4].

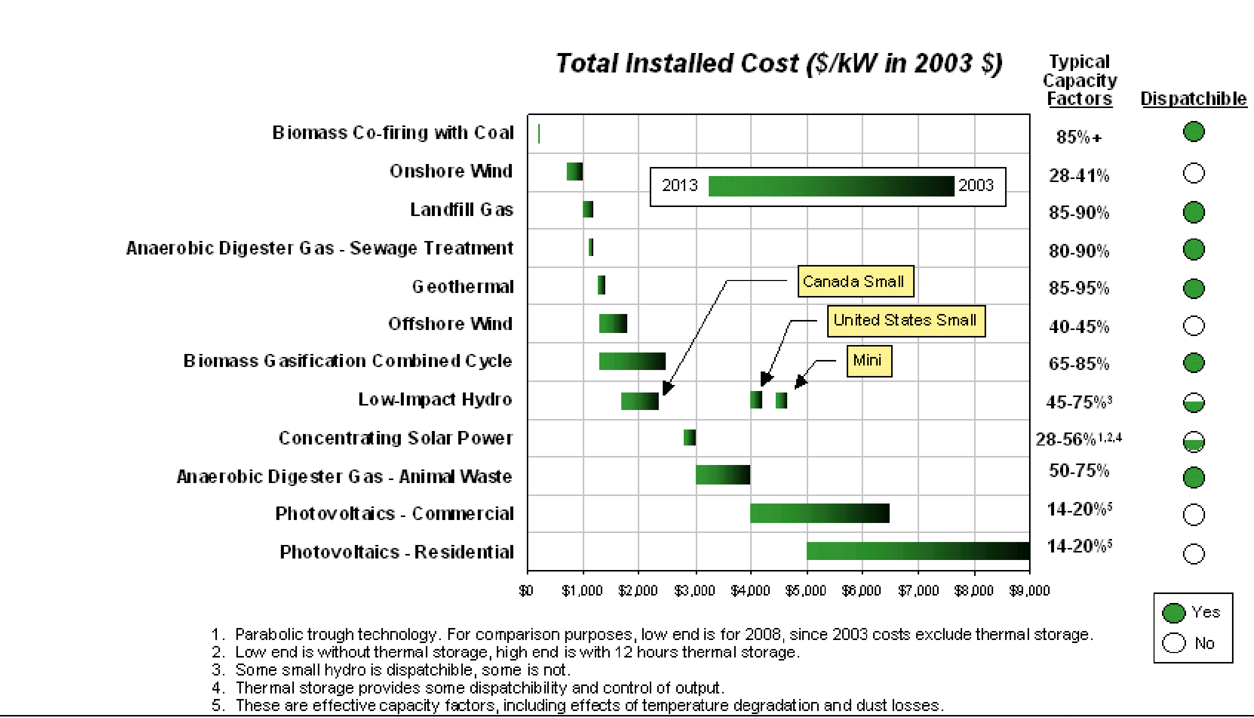
Table 4. Recent generating costs, EU.

Energy source	*Cents/kWh, 2002 prices*
Coal	4.4
Combined-cycle gas	4.0
Bioenergy	5.1
Windpower	9.1
Solar PV	84.3
Nuclear	6.2

Source: IEA, *World Energy Outlook: 2001 Insights* (Paris: OECD/IEA 2001); IEA figures adjusted to 2002 price level.

In noting that windpower, for now, remains more than twice the cost of combined-cycle gas, the International Energy Agency nevertheless expresses the view that "windpower could be in close competition with fossil fuels within the next decade in locations with very good wind conditions and under the assumption that current capital costs are reduced." Under one such assumption, shown in Figure 1, onshore windpower capital costs decline from around $1,000 per kW to $750 per kW over the next decade. To be sure, any sharp rise in natural gas prices would lower that cost-competitive hurdle for windpower investment. Although its scope for significant expansion may be more limited, bioenergy might also achieve greater cost-effectiveness. Still, the agency says, growth in renewables "over the next twenty years will rely on the continuation of government intervention." But that somewhat bland prediction involves intricate conceptual, measurement, and policy issues.

Figure 1. Capital cost and capacity factors of different renewable systems.



Source: Presentation by Lisa Frantzis, Navigant Consulting, NREL Third Energy Analysis Forum, June 11–12, 2003. http://www.nrel.gov/analysis/presentations_03.html. Accessed Sept. 12, 2003.

The Conceptual Issue: A Level Playing Field

Society is best served by market transactions that reflect both the private and the external costs of producing goods and services. But this principle of promoting socially efficient outcomes is undermined in numerous ways. Fossil fuel combustion, for example, releases harmful by-products not reflected in existing policies. Even some renewable energy systems create externalities—Cape Cod residents confronting the prospect of wind farms need no reminder. Ignoring the full costs of different energy systems distorts allocational decisions by both consumers and producers. The former are induced to overuse an underpriced commodity, and the latter, unhampered by the need to face up to the costs of external impacts, make suboptimal investment decisions.

The issue of externalities is related to that of subsidies. Indeed, it is just a matter of semantics whether one regards the subsidy to, say, a German coal producer as different from an externality produced by burning coal; in either case, the industry is spared the burden of confronting its real costs. And just to preserve the symmetry, one could argue that the U.S. windpower producer tax credit of nearly 2 cents per kWh has an equally—some would say egregiously—distorting effect on electricity market decisions.

Talking about the problem in principle doesn't do us much good, however, if we can't get a handle on the comparative magnitudes of the distortions arising from externalities and subsidies. And yet that comparison, and the corrective policies needed to deal with it, is at the core of the argument about the role and prospects of alternative energy systems. It is all well and good for Glenn Schleede, a perceptive analyst of renewable energy economics, to alert us to the policy bias extended to wind and other systems [5]. But his virtual silence on favoritism to conventional energy leaves us with very little basis for judgment. Hence we reach the subject of leveling the playing field.

Let me start by suggesting how, at least in principle, *not* to level the playing field:

- Recognizing that since the unpaid cost of coal combustion includes damage from carbon dioxide and mercury emissions, we cannot right the balance with an offsetting subsidy to wind or other renewables. All that does is stimulate extra demand for electricity from both sources.
- Acknowledging that nuclear power has been the beneficiary of government largesse in the past, we cannot belatedly offset that favoritism through handouts to renewables. What's done, however misguidedly, is done; a sunk cost is a sunk cost. To favor windpower or biomass now would merely compound a historic misjudgment by adding a questionable new one.

It is beyond the scope of this brief paper to provide even "guesstimates" of the distorting effects of subsidies and externalities in various countries' energy markets. That said, for the United States I have some feel for the extent to which externalities imposed on fossil-fueled electricity generation would narrow the competitive disadvantage of windpower. My sense is that requiring, say, coal-fired power plants to absorb added costs for emission-related damage would still leave wind with an inability to compete, absent the production tax credit I mentioned a few moments ago. To be sure, so little is certain about the value of damages caused by long-term global warming that one can plausibly, if not probabilistically, assign a carbon charge so high as to make wind an uncontested winner. On the other hand, the middling $50-per-ton carbon tax simulated in a recent report, shown in the bottom panel of Table 5, translates into increments of 0.6 and 1.2 cents per kWh (for gas- and coal-fired plants, respectively) that only barely provide a competitive opening for wind [6].

Table 5. Comparative nuclear and fossil fuel generating costs under different assumptions ($2002).

Case	*Real levelized cost (cents per Kwe-hr)*
Nuclear (LWR)	6.7
Reduce construction cost by 25%	5.5
Reduce construction time by 4 to 5 years	5.3
Further reduce operation and maintenance costs to 13 mill per Kwe-hr	5.1
Reduce cost of capital to that of gas or coal	4.2
Pulverized coal	4.2
CCGT* (low gas prices, $3.77 per mcf)	3.8
CCGT (moderate gas prices, $ 4.42 per mcf)	4.1
CCGT (high gas prices, $ 6.72 per mcf)	5.6

* Gas costs reflect real, levelized acquisition cost per thousand cubic feet (mcf) over the economic life of the project.

Power costs with carbon taxes

Carbon tax cases, levelized electricity costs (cents per kWe-hr)	*$50 per tonne C*	*$100 per tonne C*	*$200 per tonne C*
Coal	5.4	6.6	9.0
Gas (low)	4.3	4.8	5.9
Gas (moderate)	4.7	5.2	6.2
Gas (high)	6.1	6.7	7.7

Notes: LWR = light water reactor; Kwe-hr = kilowatt hours electric; CCGT = combined-cycle gas turbine; mcf = thousand cubic feet.

Source: Massachusetts Institute of Technology, 2003, *The Future of Nuclear Power: An Interdisciplinary Study,* 7.

The upper panel of Table 5 indicates possible reductions in nuclear generating costs compared with coal and combined-cycle gas turbine generating costs under varied natural gas price assumptions. It shows the baseline cost of various technologies, including hypothesized ways of reducing the cost of nuclear power. The lower panel shows the additional effect of different levels of carbon taxes.

Of course, to greater or lesser extents, externalities are associated with all energy sources and forms—even windpower, as some wind farms' neighbors are only too eager to remind us. Thomas Sundqvist [7] has scoured the literature to ascertain the ranges of externality estimates for different energy systems in different countries, summarized in Table 6.

Table 6. Survey of externality estimates.

		Cost of externalities (U.S. cents per kWh)			
Fuel source	*Number of observations*	*Minimum*	*Maximum*	*Median*	*Mean*
Coal	28	0.31 (U.S.)	58.04 (Be)	8.3	12.52
Oil	13	0.32 (U.S.)	31.99 (Fr.)	12.35	11.96
Gas	21	0.10 (U.K.)	8.97 (Dk)	6.15	4.49
Nuclear	14	0.01 (Fr., U.S.)	64.45 (U.S.)	0.82	10.09
Hydro	10	0.02 (U.S.)	26.26 (No)	0.35	4.44
Wind	14	0.001 (U.S.)	2.53 (De)	0.27	0.43
Solar	7	0.15 (U.K.)	1.11 (De)	0.76	0.68

Source: Thomas Sundqvist, 2001, Regulating Externalities in the Power Sector: Some Lessons from Previous Valuation Studies, *Minerals and Energy* 16(1): 21. Abbreviations: Fr = France; Be = Belgium; Dk =Denmark; De = Germany.

Quite apart from the effect of different methodologies employed in their derivation, the estimates are decidedly not comparable in terms of their scholarly fastidiousness. Advocacy positions clearly enter into some of the numbers, such as charging coal and oil 10 or more cents per kWh.

Still, Sundqvist's reconnaissance suggests that agreement on both the size of externalities and their likelihood of adoption may be a futile expectation. This is therefore the juncture at which to abandon one's purist trappings and, in fashionable economic policy jargon, allow the best to be the enemy of the good. Some reasonable degree of government financial support for struggling yet promising renewable energy systems requires no apologetic rationale. Call it support for basic research, cite historic instant-industry arguments, demonstrate investment risks and long-term time horizons, and note the social value (including both domestic and international security dimensions) of a diversified energy portfolio. If these are objectives that private investors will pursue only reluctantly, the case for a visible public sector role in renewable energy policy emerges.

One can debate the magnitude of such support and the form it should take—direct or indirect financial assistance, mandated renewable portfolio standards, demonstration programs—as long as it leads to a test of an entrepreneur's willingness to actually gear up for an output run. Unfortunately, the more insidious prospect, amply borne out by past government initiatives, is that such programs routinely become captive to special interests and are reenacted with little, if any, information on how well they have met the criteria for success.

We all have our favorite examples of the institutional inertia that resists dilution of subsidies once adopted. The canonical example may be ethanol mandates for gasoline blending. In electricity, nuclear power (whose eventual revival in acceptable fashion we cannot dismiss) doesn't lack for boosterism, either. In mid-2003, Sen. Pete Dominici sought to restore proposed Senate legislation requiring federal loan guarantees, purchase guarantees, and several tax breaks for new nuclear power generation if "the plant is necessary to contribute to energy security, fuel or technology diversity, or clean air attainment goals" [8]. You can bet that meeting such vague conditions would not prove insuperable. I might add that the MIT study summarized in Table 5 provides a thoughtful argument favoring some limited and transitional public support (specifically, a $200 per kW tax credit) to sustain and significantly enhance the integrity of a future nuclear option…but there's that spooky word, *transitional.* Not surprisingly, the pursuit of federal energy dollars is a race the wind industry doesn't want to miss—hence the understandably frenetic effort by the American Wind Energy Association to ensure extension of the federal production tax credit beyond 2003.

When we seek to level the playing field, then, we find that sensible comparisons among energy systems are hampered by the difficulty of divining the extent of externalities and subsidies. Subsidies, if transparent, aren't inherently objectionable. But their goals must be clearly articulated, and progress toward meeting them, periodically evaluated. That task for energy policy applies equally to renewable and conventional systems.

Policies and Trends in Different Countries

I now turn to particular examples, and here we find, first, that however haltingly, renewables are beginning to emerge from their coddled and privileged status and seek viability in the market; and second, that even when support continues, it is more likely to encourage marketlike and economically efficient character. Of course, impediments to renewables penetration persist and deserve to be flagged.

Although trends are hard to document, in at least some significant instances, subsidies for renewables are shrinking. Denmark, where wind constitutes 13% of electricity-generating capacity, has announced that subsidies for new wind turbines will cease beginning in 2004. The government still facilitates windpower market penetration, however, by shielding industry from wind-led price increases, which are shifted to other consumers. Spain, another leading windpower country, is said to be "considering removal of its renewable energy subsidies" [9]. Nevertheless, substantial continued support of the country's coal miners—estimated at EUR

60,000 per worker in 1999—would hold wind at a greater disadvantage than might otherwise be the case and may make elimination of renewables support politically tricky.

Sustained support to the coal industry is even more contentious an issue in Germany, which pumped $1.5 billion into the industry last year and has won from the European Union the right to continue subsidies at least until 2009. And if harmonizing subsidies among the current 15 EU members remains an elusive goal, the imminent accession of two major coal-producing members, Poland and the Czech Republic, will scarcely simplify the task.

In the United Kingdom, the problem for renewables-powered electricity hasn't been coal—former Prime Minister Thatcher saw to that with forced privatization (and therefore large-scale retrenchment) of the industry in the 1980s. Rather, it has been the continued subsidization of nuclear power that has distorted electric power markets. But that support is now expiring.

Of course, when we learn that one country or another is scaling back support for windpower or other renewable energy systems, we don't necessarily know what subsidies remain. For each of the countries I've cited, various types of benefits will persist for some years, and others are introduced as circumstances are deemed to warrant. For example, the United Kingdom has instituted a hefty "climate change levy" (amounting to 0.43 pence per kWh in 2003–2004), which, along with several other measures, is said in a recent U.K. white paper "to provide the renewable industry with support worth around [$1.6 billion] a year. This is designed to deliver the required expansion in renewables [10% of electricity generation]" by 2010 [10]. A different study by a royal commission assesses the magnitude and cost of various renewable resources in the year 2025 [11]. As Table 7 shows, windpower (both offshore and land-based) comes in at a range equivalent to 5 to 5.5 U.S. cents per kWh in today's prices—a less ebullient outlook than some other predictions, but maybe more realistic.

Table 7: Electricity from renewable energy, U.K.: Assessment of cost-effective resources in 2025.

Source	*Accessible resource (annual average rate of supply, GW)*	*Total cost-effective resource* (annual average rate of supply, GW)*	*Cost below which at least 90% of cost effective resource is available (p/kWh)*
Noncarbon-based sources			
Onshore windpower	36.0	6.5	3.5
Offshore windpower	468**	11.4	3.0
Photovoltaics	30***	<0.1	7.0
Small hydro	n/a	0.3	7.0
Alternative carbon-based sources			
Energy crops	n/a	3.7	4.0
Agricultural and forestry waste	n/a	2.4	5.0
Municipal solid waste	1.5 ss	0.8	5.0
Landfill gas	n/a	0.9	3.0
Technologies being developed			
Wave power	95.0	3.7	4.0
Tidal steam	4.1	0.3	6.5

ETSU = Energy Technology Support Unit, part of AEA Technology plc, under contract to U.K. Department of Trade and Industry. Costs are expressed at the 2000 price level (personal communication).

*ETSU's estimate of the rate at which electricity could be generated at a cost of less than 7 pence per kWh in 2025, assuming a discount rate of 8%.

** Assumes a load factor of 0.43

*** In the absence of an estimate for the accessible resource, the figure for maximum practicable resource is given.

SS = total potential at current rates of waste production.

n/a = ETSU did not estimate the accessible resource.

Source: Royal Commission on Environmental Pollution, *Energy—The Changing Climate*, June 2000, 124

In the United States, the federal production tax credit for windpower, which had widely been expected to be extended, lapsed at the end of 2003, due to Congress' failure to enact an omnibus energy bill. Conceivably, the credit will be restored as stand-alone legislation in the second session of the 108th Congress. The head of the American Wind Energy Association has called continuation of the credit as justified by, among other things, the utility industry's unfamiliarity with wind farm technology [12]. Exactly how a producer tax credit will provide the tutorial to overcome such ignorance is unspecified.

Any effort to provide a systematic rundown of the renewables subsidy picture across countries quickly devolves into the suggestive and anecdotal. But one multicountry development strikes me as distinct: initiatives requiring that by some specified date, some minimum share of electricity generation be furnished by nonhydro renewables. The renewable portfolio standard (RPS) has eluded efforts as a federally legislated mandate in the United States, though it is on the statute books in several states.

Free-market purists, not surprisingly, look askance at such dictates. Rather than join that debate, I will here suggest only that if kept modest, such technology-forcing measures, though admittedly somewhat arbitrary, provide the opportunity to inject a degree of economic efficiency and transparency into electricity market transactions.

Texas, second only to California in installed windpower capacity in this country, is among the states with an RPS. Retail utilities are required to deliver 2,000 megawatts (in stages) of renewably generated electricity by 2009, a target that would constitute around 3% of the state's electricity supply [13]. Interestingly, the RPS legislation also tightened emissions standards on fossil fuel combustion—underscoring the fact that the outlook for renewables is part and parcel a function of having competitors assessed for externalities for which they bear responsibility. Without that provision, the purpose of the Texas RPS would have been attenuated by coal's competitive advantage.

The Texas RPS regime incorporates a tradable credit system among utilities (as is the case in several other U.S. jurisdictions). The trading scheme seems admirable and helpful as far as it goes. For example, it prevents runaway escalation of credit costs through provisions that, in effect, cap credit prices at 5 cents per kWh—a level far above prices at which credit transactions have taken place. But the problem in Texas, as in other states, is that trades can occur only within the state's electricity network, limiting the scope and efficiency of the trading system. Politically, Texas legislators found it more attractive to have, say, a Corpus Christi utility buy credits from (i.e., reward) an El Paso utility rather than one in Nevada. And within Texas alone, the market, currently not very liquid, needs substantial growth in transactions.

With variations among individual countries, Europe appears to be moving in the same direction. Britain has mandated a 10% renewables share in electricity production by 2010—a target whose realization is to be facilitated by a system of open certificate trading, allowing generators that overcomply in meeting their renewables requirement to sell excess certificates to those that do not. However, the fate of wind or other renewables is not yet entirely at the mercy of the market; the British government is expected to support the renewables industry with some $1.5 billion annually. Presumably, as renewables become viable contenders in the electric power market, the need for significant government assistance—in the United Kingdom and elsewhere—will be reassessed.

One impediment to the integration of renewably generated electricity, not merely within a given country but across national borders, is the limited nature of efficient, pan-European electricity markets enabling producers and retailers to hedge against fluctuations in demand and energy costs, which in turn might lead to lower retail prices. As *The Economist* observes, the effort "to make the market more transparent and less volatile…is some challenge, for storing electricity is next to impossible. Delivering it to the right place at the right time is a precise science. Producing consistently is a special problem for wind farms, which might produce only 30% of their capacity in a year" [14]. Yet as the article points out, "traders remain innovative. They have ideas that will help even wind farms to hedge against uncertainty. Entergy-Koch, one of the few American energy traders still in Europe, offers bets against a monthly wind index for ten locations. The owner of a wind farm would be paid when wind speeds were low and not much power is produced and would pay money out when winds were unseasonably strong. Entergy-Koch has done a few deals—mostly, not surprisingly, with financiers of wind farms."

Conclusions and Broad Challenges

So where do things stand? The short answer is, as we have seen, "not still." The renewables picture in general, and windpower conspicuously, is one of constant and rapid change, with rates of growth not particularly meaningful and policy initiatives in a state of flux across countries. Under the circumstances, no crisp summary is possible. Still, five points deserve emphasis:

- Although subsidization of renewables remains, for now, essential to market success, stand-alone viability seems no longer remote, particularly for windpower.
- Projections of renewables targets also no longer seem Panglossian, some countries having stipulated mandated outcomes rather than merely goals. (Of course, what governments dictate, governments can repeal.)
- No excuse is needed to justify continued public support, particularly in the area of basic research, for slowly maturing renewables systems.
- Economically enlightened policies and supportive institutional changes are finding their way into renewables transactions. Examples include tradable credits to meet RPS requirements; the establishment of trading mechanisms to hedge against price

volatility; and the specification of standby rates and net metering for distributed electricity systems, at least some of which include renewables.

- Leveling the playing field remains an issue. Critics who fault windpower subsidies and externalities have an obligation to consider the distortions arising from fossil and nuclear subsidies and externalities.

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Note: In addition to the foregoing documents cited or considered in the text, several additional references may prove useful:

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