Discussion paper
No. 2010–8

Renewable Energy as a Rural Development Opportunity

John Bryden
Research Professor II, NILF

Norwegian Agricultural Economics Research Institute
P.O. Box 8024 Dep,
NO-0030 Oslo, Norway
Corresponding author: john.bryden@nilf.no

This version: September 2010

Preface

1. The following background paper was prepared by John Bryden[1] for the OECD Workshop on Renewable Energy as a Regional Development Policy for Rural Regions, Montreal, September 15-17 2010. The workshop launched a new two-year international action research project with participation from Norway, Sweden, Denmark, Finland, the Netherlands, Spain, Italy, Scotland, the USA and Canada.

2. Global Investment in Renewable Energy currently amounts to US$162 billion, and most of this investment is in rural regions. Astonishingly, and according to FAO estimates, this sum is nearly five times the current levels of investment in agriculture (US$33 billion in 2007). Wind, solar, bioenergy, and small hydro have been growth areas, and Bloomberg (Business Week) reports expect geothermal energy to increase by over 40%, and biomass by over 33% by 2013.

3. The paper argues that huge potential that renewable energy offers to rural regions, including farming families, can only produce real long term benefits if farmers, other rural residents, and communities are fully engaged in it as citizens, investors, and users. This requires appropriate policy and support structures, in which the Nordic countries have special experience in designing.

4. John Bryden is a member of the OECD expert group for the project, and both he and Karen Refsgaard, senior researcher at NILF, teach on this topic in the International Comparative Rural Policy Summer Institute in which NILF and UMB are joint partners.

[1] Research Professor, Norwegian Agricultural Economics Research Institute, Oslo; Emeritus Professor of Human Geography, University of Aberdeen; President of the International Rural Network.

Background Paper:

Framework Conditions for Renewable Energy to become a force for Territorial Development in Rural Regions

1 Introduction: The Particular Economics of Renewable Energy and its relevance for Territorial Development

The first point to note about renewable energy is that most of the processes involved take place in rural places and environments which is where most of the water, wind, waves, tides, biomass production, and solar radiation occur, and where there is greatest access to geothermal resources. The sole exception relates to anaerobic digestion of human waste in the form of sewage or other urban waste, which at present accounts for a very small proportion of total renewable energy production, a situation which, despite further potential, is not likely to change significantly in the future. This reinforces the evident fact that renewable energy is a present and future opportunity in rural regions

The second point is that renewable energy technologies typically involve the exploitation of public goods and/or the mitigation of public 'bads'. Public goods can be – and often are - 'captured' for economic gain. For example, fishery resources were (and in some circumstances still are) common property, also captured by the fishing industry for economic gain. More generally, the 'global commons' or ecosystem which is required to absorb the non-market 'bads' of human resource exploitation, manufacturing, transportation and consumption is raising contemporary challenges for humanity through overburden and impacts on water, air and the climate. In this case economic gain is achieved because the 'bads' are not paid for by producers or consumers. The gainers do not – and probably in most cases would be unable to - compensate the losers. Like land, with which many public goods are associated, their place-specific nature, and limited supply, means that much of the 'value-added' from the commercialisation of public goods takes the form of 'rent', and rent accrues to those who have the rights to use the asset in question[2].

The economics of renewable energy are such that, with the main exception of bio-energy used for heat and gas, the principal components of value-added or GDP in the sector are rent, interest and profit. While private costs per unit of energy are usually higher for renewables than those for non-renewables, a key issue is the value of the negative (or positive) externalities involved in each case, and how producers may be compensated for/ levied for/ the value of these externalities. This is a classic problem (a) of the valuation of public goods and (b) of payment levels and systems related to such valuation. Public policy and governance issues are thus central.

It follows that the value added mainly accrues to owners of land and capital involved in renewable energy production, and in most cases these owners - most especially of capital - are usually not resident in the regions of production. For the question of whether renewable energy production (and technology development) can be a new territorial development opportunity for rural regions, then this question of ownership becomes a central rather than a peripheral question. The wage costs may be less than 20% of value-added (good data is unfortunately lacking), and the benefits to regions from wages alone may be insufficient to compensate for negative externalities (environment and landscape, social displacement and conflict). This focuses our attention on the frameworks needed to ensure that local entrepreneurs, communities and sources of finance have an important role in the development of renewable energy technology and production

In the case of Scotland, Land reform legislation in 2003 was intended to give local communities the opportunity to capture the gains from public goods as well as private

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[2] See also the discussion in my 1996 John McEwen lecture (Bryden, J M (1996) Land Tenure and Rural Development. The 1996 John McEwen Lecture on Land Tenure in Scotland, September 1996. Rural Forum Scotland and AK Bell Library, Perth) and in my later paper on land taxation (John Bryden: Radical Land Reform for Scotland? Political Perspectives. Session Introduction: International Union for Land Value Taxation 23rd Biennial Conference. One day conference on Land Reform - Getting to the Root: Scotland, Russia and Land Value Taxation. Edinburgh University, Monday 9th July 2001).

assets, and to combine these in ways that would improve the prospects for livelihoods and quality of life, especially in remoter rural areas (Bryden & Geisler, 2010). However, Scotland has not been alone in such efforts even if it is somewhat unique. In particular, we may note that the land reforms were a reflection of the historical forces which gave rise to the extreme inequality of land ownership in Scotland compared with most other countries of Europe and North America. It was and is this inequality which means that the gains from land-based public goods are also, inevitably, so unequal. In these circumstances, without land reform, communities would be unable to capture the gains from opportunities such as renewable energy, as the islanders of Gigha succeeded in doing after community acquisition. In those countries where land is more evenly distributed and/or municipalities (local government) own and manage land on behalf of local communities, then the benefits from development based on public goods - whether this be landscapes, renewable energy assets such as wind, or others – are more widely distributed and largely accrue to local people as opposed to absentee landowners or external corporations. Scandinavia is notable in having such patterns of land ownership, and this explains why, for example, local communities were able to benefit to such an extent from wind generation, and also why there is a very high level of support for renewable energy development in rural Denmark.

There are three other aspects of renewable energy production which are significant for the present OECD action research project on “The Production of Renewable Energy as a Regional Development Policy in Rural Areas”. First, the geography of renewable energy resources does not necessarily match the geography of need for territorial development, although such matches can and do exist. Second, neither the availability of renewable energy resources nor the need for territorial development overlap with the existing concentrations of population, meaning that energy needs to be moved across space, sometimes for long distances, and with considerable actual or potential transmission losses. These points imply that the choice of technology and associated renewable may differ as between national and territorial energy interests and objectives, and that issues such as grid losses or costs of energy (or energy resource) transport can loom large.

The third point, linked to the previous point about benefit to territorial inhabitants (‘locals’), is that without such benefits, local inhabitants may - and often do - oppose the development of renewable energy production in the form of wind and solar parks, for example, and related infrastructure developments (power lines). For this important reason, community energy production in various forms is a popular cause in rural regions, and has been shown to alter local attitudes to renewable energy projects (see, for example, Breukers & Wolsink, 2007; Warren & McFadyen, 2010).

2 The new interest in Renewable Energy and its relationship to discussions on Public Goods

As a consequence of increasing scarcity and cost of non-renewable energy, as well as the efforts to mitigate climate change (requiring reduction of greenhouse – GHG - emissions), renewable energy has become a more attractive option, giving rise to attempts to capture ownership of relevant assets, especially those with access to energy transmission lines. The United Nations Environment Programme’s (UNEP) definition of ‘renewable energy’ includes the following:-

Geothermal
Marine & small-hydro
Biomass & waste-to-energy
Biofuels
Solar
Wind

Of these, the most important in terms of current contribution to overall energy supplies are hydro power, wind, biomass, geothermal and solar, in that order.

It is noted that UNEP excludes large hydro generation from renewable energy technologies. In this paper I follow the International Energy Agency (IEA) and include large hydro where possible.

Wind, water, solar and tide – all of which involve public goods - can be, and in some cases already are, captured for economic gain, and large scale international enterprises have not been slow in seeking to capture this gain, including the large energy companies. The latter have also in some cases made large windfall financial gains from the introduction of carbon trading mechanisms[3]. However, in several notable cases the projects proposed by these large corporations have been extremely controversial and ultimately rejected by local people and planning authorities. Although some small economic benefits may accrue to locals from such projects (mainly in the form of wages, although employment is very limited), the rents and benefits of GHG emission savings are mainly captured by non-local interests, sometimes international financial interests. Although such rents will increase Gross Domestic Product (GDP), they do not significantly increase income-to-locals. Local people therefore have no great economic interest in promoting such enterprises, and often believe that the benefits to them will be more than offset by negative externalities (visual, noise, bird-damage) created.

3 The role of rural communities in renewable energy

Scandinavia and Germany have been at the forefront of efforts to capture such rents for local people and communities. For example the strong role played by farmers and local cooperatives in the development of the wind-farm industry in Denmark means that greater benefits have accrued locally from this technology[4] (Midttun & Koefoed, 2003[5]). Many local people, including farmers, invested their pension funds in shares, for which they had preference up to a certain level of holding. Moreover, the strong development of wind generation all over Denmark, especially since the early 1970's, together with close

[3] Under the EU ETS, Europe's largest emitter, the German power company RWE, is estimated to have received a windfall of $US6.4 billion in the first three years of the system (Kantner, 2008), and made €1.8 billion in one year by charging customers for permits it received for free (Lohmann, 2006a: 91), both citations from Spash, C L(2010). The Brave New World of Carbon Trading. Norwegian University of Life Sciences, December Online at http://mpra.ub.uni-muenchen.de/19114/ MPRA Paper No. 19114, posted 09. December 2009 / 20:25

[4] *Danish wind power* now provides more than 7% of the total electricity supply in Denmark; Danish windmill industry has supplied 50% of the worlds windmill capacity; Danish wind industry has 10.000 employees, and is Denmark's 3rd largest export-industry. Total sales amounted to 5 billion DKK in 1997 d 12.5 billion DKK in 1999.

[5] Atle Midttun and Anne Louise Koefoed Green Innovation in Nordic Energy Industry: Dynamic Patterns and Institutional Trajectories: Paper for the Conference: Innovation in Europe: Dynamics, Institutions and Values" Roskilde University, Denmark, 8th -9th May, 2003

cooperation between local communities and manufacturing companies such as Vestas, gave Denmark a lead in wind technology which led to it becoming the lead supplier of windmills for electricity generation in the world[6].

In the Norwegian case, rents from hydro power often accrue either to locals (in the case of small scale or micro hydro power plants, sometimes shared by a group of small farmers, for example) or to local communities (especially Municipalities). Moreover, under the pioneering Concession Laws of the early 20th C, industries utilising hydro power were located close to the production sites, usually in remote areas, so bringing much needed employment there. It is a point of now mainly historical interest that Scotland also sought to achieve a similar pattern through the then public Scottish Hydro Electric Authority, which also had rural development goals and activities.

In Scotland, the Community land ownership stimulated by the pioneering cases of Eigg and Assynt in particular, and supported by the Community Land Unit at Highlands and Islands Enterprise (HIE)[7], the establishment of the Scottish Land Fund in 2000, and subsequent Scottish Land Reform has led to some very important changes in community land ownership, some pioneering efforts in community energy (for example in the case of Gigha), and the establishment of the not-for-profit Scottish Community Energy Company to support communities interested in this option with technological, financial and other advice. However, large challenges remain in securing the level of local and community investment in large scale renewable energy schemes that will be needed to ensure both high levels of local support for renewable energy projects, and economic development gains for local people in areas like the Highlands and Islands. Most of these challenges relate to the conception, planning and financing of renewable energy schemes, the provision of adequate and geographically balanced transmission capacity, and related regulatory issues (for example, the implicit or explicit costs of using transmission lines for energy produced).

[6] Other factors were also important including the fact that windmill technologies were classed as ‘agricultural’ and so were not subject to copyright laws, encouraging cooperation between producers as well as between producers and users.

[7] The Regional Development Agency for the North and West of Scotland, established as the Highlands and Islands Development Board in 1965.

The stakes for rural regions such as the Highlands and Islands are very large. There is clearly an enormous potential for the production of renewable energy from water, wind and tides in and around the region, and some potential from biomass and waste conversion. On the other hand, if the benefits are not captured by and for rural people, the latter run the risk of being displaced and impoverished. Moreover, conflicts with project promoters will increase. To compound matters, Government regional policies and priorities, based as they are on GDP per head, will mistakenly give less attention to the Highlands and Islands[8]. It is therefore vital that the region aspires for much more than becoming the 'hewers of wood and drawers of water' of the post-oil era, and focuses clearly on the means of achieving this, in the present case through renewable energy.

4 Global Investment in Renewable Energy

Investment in renewable energies other than large hydro power grew from $22bn in 2002 to $173bn by 2008. Although there was a setback due to the global recession in 2009, when investment fell to some $162bn, this was earlier expected to rise again to $175 to $200bn in 2010 partly as a result of clean energy linked stimulus money, and especially in the US, China, and Europe. However, there have been unexpected declines in the investment in wind energy in Spain and US which now make this recovery doubtful, although investment remains at high levels in China.[9]

It is relevant and interesting to note that global investment in renewable energy, which largely takes place in rural regions, substantially exceeds that in agriculture[10].

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[8] Mistakenly because Income to Locals is typically less than GDP per head, and the larger the external ownership of land and capital, the more this is the case.

[9] See Fiona Harvey in the Financial Times supplement on Modern Energy, 13 September 2010.

[10] "The UN Food & Agriculture Organisation (FAO) expects a gap of $22 billion (constant 2009 prices) per annum between what needs to be invested in agriculture in developing countries to meet the increased need for food by 2050 ($55 billion) and what was invested on average from 1997–2007 ($33 billion)". See Carnegie Endowment for International Peace. Article on "World Food Security and Investment in Agriculture" by Hafez Ghanem in the International Economic Bulletin, September 2009. See http://www.carnegieendowment.org/publications/index.cfm?fa=view&id=23850 (accessed 26 September 2010).

The most rapidly growing sectors in terms of investment in both capacity and research & development (R&D) have been wind (56% of total investment), Solar (20%), and Bioenergy (biofuels, biomass and waste) (11%). With the exception of 2009, Solar has been a rapidly growing sector in recent years, increasing by 172% between 2004 and 2008. Biofuel investments, formerly growing rapidly, have also declined in importance since 2001. Marine and Small Hydro power investment grew by 53% between 2004 and 2008, while investment in wind power increased by 51% over the same period[11]. Wind power remained strong in 2009. According to various recent reports in Bloomberg (Business Week), it is expected that geothermal energy will increase by over 40%, and biomass by over 33% by 2013. Marine based energy is also expected to grow rapidly as new technology is proven.

Europe and Asia (mainly China and India) each accounted for around $40bn of new financial investments, and North America around $21bn in 2009, while nearly all of the $12bn in South America is accounted for by Brazil. The rise in the relative importance of Asia was partly caused by the differential impacts of the financial crisis, but the check in energy prices also had an impact.

Of the total investment in renewable energy of $216bn in 2009, $24.6bn was in public and private R&D, mainly in energy smart technologies (energy efficiency, hydrogen fuel cells etc), followed by Solar, carbon capture (CCS) and low carbon services, wind and biofuels. R&D in biofuels expanded by 58% between 2008 and 2009, and was concentrated on second generation biofuels that do not compete with food production.

[11] The data used here are from the data table supplied with 'Global Trends in Sustainable Energy Investment 2009: Analysis of Trend and issues in the Financing of Renewable Energy and Energy Efficiency. UNEP & new Energy Finance, 2009, and from the report 'Global Trends in Sustainable Energy Investment 2010', also by UNEP and New Energy Finance.

5 Energy demand and sources

At present almost all fuel for transportation needs (air, sea, road, rail) is carbon-based, and with the widely anticipated decline in availability of liquid fossil fuels which currently supply the bulk of this need, new sources are urgently needed[12]. Heyerdahl (2010) argues that this will be the priority for biologically based materials, which are also carbon based, but that it will take many years to achieve the switch. Heyerdahl's point is that global demand for personal and goods transportation is such that diminishing stocks of liquid fossil fuels will need to be focused on this sector for the time being, and that in future priority should be given to the use of biological resources for this purpose[13]. Technological advances, especially in relation to cellulosic conversion of biomass, will also be needed. This forces attention on other sources of renewable energy for electricity production, heating and cooling. Wind, water, waves and tides (and in sunnier climes, solar) represent the most obvious alternative renewable energy resources for electricity production, while geothermal energy represents a major, and as yet largely untapped, potential source for both heating and electricity production. With respect to heating, those countries which have developed community based district heating systems (as in Finland and Sweden) will be well positioned to convert to geothermal sources as (mainly deep drilling) technology improves and costs decline.

6 Institutional and Policy issues

Some of the key issues arising in the literature relate to the following

1. Favourable treatment of different groups of investors (power utilities, large companies, cooperatives, communities, farmers etc)
2. Feed-in rights and tariffs
3. Taxation provisions, favourable and unfavourable
4. Innovation and the Patenting of technology
5. State partnership or investment in early stage technology

[12] In Norway, to take one example, about half of energy use is accounted for by electricity production. Petroleum based products account for a further 35% and are mainly used for air, sea and land transportation.

[13] See also the article by Ed Crooks on Biofuels in the Financial Times supplement on Modern Energy, 13 September 2010.

6. State grants for investment and/ or renewable production
7. Operation of carbon markets and renewable energy certificates (RECs)
8. Conflicts or potential conflicts between regional/ State policies and national policies.
9. The creation of 'legitimacy' for innovative technologies and production, especially renewables.

Government regulation plays a major part in the development and location of renewable energy production, its growth path and rate, the creation of popular legitimacy and the type of technologies prioritised and the type of beneficiaries from them. As already discussed, Scandinavia has been at the forefront of efforts to capture the rents associated with renewable energy for local people and communities. The preference given to local cooperatives in Denmark, the Concession Laws in Norway, and the support given to District Heating Schemes in Sweden and Finland, all gave popular legitimacy to renewable energy production[14], thus easing the path for its development and making investment politically secure.

The issue of popular legitimacy at regional level has often been underemphasised. A recent comparative study of North-Rhine Westphalia in Germany, and England found that "*Whereas policies in NRW 'invited' citizens to invest in wind power, wind power development in England remained the prerogative of the energy companies and some independent companies. Because the early wind projects in NRW were locally based and locally owned, early local resistance was forestalled and capacity for mobilization emerged. Even in the early 1990s – the analyses of the three cases applies to the period early 1970s-2005 – Dutch and English residents felt that 'big companies' were the main ones making profits. A remarkable finding is that the collaborative practices in NRW haven't been institutionalized in (local) planning ... policymakers and wind project developers do not sufficiently recognize the nature of tensions at the local level. Facilitating local ownership and institutionalizing participation in project planning can help to arrive at a better recognition and involvement of the multiple interests*

[14] For the case of Norway, see Brox, 1993.

(environmental, economic and landscape) that are relevant at the local level of implementation"... (Breukers & Wolsink, 2007: cited in Boon, 2008).

The recent study in Scotland by Warren & McFadyen (2010) also lends empirical weight to the notion that local ownership and involvement smoothes the path for renewable energy projects. They conclude that *"the promotion of a more locally embedded approach to wind energy projects (whether through community ownership or energy cooperatives) could help to reduce the incidence of damaging and divisive controversies which currently afflict wind power development in Scotland. In turn, this could help to facilitate the achievement of renewable energy targets."*

(a) Favourable treatment of classes of investors

In some countries (e.g. Netherlands, UK, USA) large corporate investors and/or very wealthy individuals have been favoured by public subsidies and especially tax incentives, while in others (e.g. Denmark, Sweden, Finland, Germany) Breukers & Wolsink (2007) farmers and other smaller investors, or communities have been favoured. Whether by accident or design, policies that favour large corporate or private investors do not help projects to gain local legitimacy, and they can therefore be counter-productive.

(b) Feed in rights and tariffs (FITs)

FITs are the most important policy tool for encouraging the development of solar, wind, and are also important for small scale hydro and bio-energy. The literature on the rapid development of renewable energy technology and production in Germany, Denmark, and Finland emphasises their role in this process. In the Danish case, the Government legislated in 1984 to obligate utilities to buy wind power at 85% of the retail price, a move that was crucial for the rapid development of the wind industry. According to Deutsche Bank (2010) FITs are responsible for approximately 75% of global photo-voltaic (PV) and 45% of global wind deployment.

FITs can be and often are tailored to meet a range of policy goals including territorial development, location and choice of technology. They typically include three key elements

- guaranteed grid access;
- stable, long-term purchase agreements (15-20 years);
- payment levels based on the costs of renewable generation (Mendonça 2007).

In some countries, such as Germany, they include streamlined administrative procedures that reduce transactions costs for producers and speed up implementation.

Many European countries have committed to using FIT policies to achieve their long-term RE targets out to and beyond 2020, which indicates a long-term commitment. In addition, European policies typically extend eligibility to anyone with the ability to invest, including – but not limited to – homeowners; business owners; federal, state, and local government agencies; private investors; utilities and non-profit organizations (Germany BMU 2007, Lipp 2007, Mendonça et al. 2009b).

(c) Taxation provisions

Tax provisions are very important in several countries, including the USA, where Federal support for wind power has come mainly from the production tax credit (PTC), and 5-year accelerated depreciation. The PTC provides a 10-year inflation adjusted tax credit, which in 2003 stood at 1.8¢/kWh, while accelerated depreciation provides a tax deduction equal to the capital cost of the project spread over a 6-year period. Tax-based incentives such as the PTC and accelerated depreciation are largely available to project owners with tax liability, which effectively limits them to wealthy individuals and corporations. A report on community wind power in Oregon (Bolinger et al, 2004) argues that this "handicaps ownership structures involving non-taxable entities such as cooperatives or non-profits (as well as publicly owned utilities)" and of course the majority private individuals who have tax liabilities far lower than the estimated $100,000 per annum which Bolinger and his colleagues say is needed to benefit fully from this subsidy. Although another federal incentive – the Renewable Energy Production Incentive (REPI) – was "intended to provide a similar amount of value as the PTC to non-taxable entities, funding for the REPI is limited and subject to annual congressional appropriations (as opposed to the PTC, which requires no budgetary line items and is guaranteed for 10 years), rendering it of significantly less worth than the PTC. Furthermore, even if non-taxable entities are able to capture the REPI, they still cannot benefit from accelerated depreciation, for which there is no cash equivalent." Both the REPI and PTC expired in late 2003.

(d) Investment subsidies

Investment subsidies are commonly used to stimulate higher investment in renewable energy capacity and/or production. Thus Denmark introduced a 30% investment subsidy for new wind turbines in 1979, although this was gradually reduced over time and finally abandoned ten years later (Kristinsson & Rao, 2007). However, studies have demonstrated the importance of the detail of investment subsidy schemes for their success on the ground. *"Investment subsidies for turbine owners were based on installed kilowatts, and not on produced kilowatts-hours like in Denmark (Snel; Hooft, 2007), which would streamline better with the interest of wind cooperatives for instance (Langenbach, 2007). At a certain point in time during the 1990s, policy makers offered six different instruments for the exploitation of wind energy which you could choose from as an organization. Well, then you really need to be on top of things to decide which one of the six you can choose for best (Beurskens, 2007) – you needed a 'financial engineer' to sort this out (Van Kuik, 2007). And those very same instruments were normally replaced about every two years as well, which made the challenge for organizations who wanted to invest in wind energy even more difficult. This inconsistency quite simply scared off financiers, as they normally found the institutional risk to invest too high (Beurskens; Vorrink, 2007)."*

Moreover, Boon leads evidence to support Agterbosch in the contention that in the Netherlands – in polar contrast with Denmark - the large power utilities were favoured over farmers and communities in terms of both investment subsidies and municipal fees and subsidies.

(e) Innovation and Patenting

Kamp (2002) used a regional innovation systems approach to compare the technical lead established by the Danish over the Dutch in windmill technology. Key issues in regional innovation systems are the learning processes within any system, and these depend on "producers, users, and on the interaction between the two types of actors", as well as the geographical milieux involved (and related policy and institutional frameworks)". Kamp found that while the Dutch relied more on 'learning by searching', thanks to larger R&D subsidies, learning by doing was far more important in Denmark. This in turn was stimulated by the spread of windmills on the ground, again through sound policies, the growing Californian market, and the popular legitimacy of wind power in Denmark. Denmark was also noted for much stronger interaction between users and producers of turbines in developing the turbines technology, and this probably goes back to the Grundtvigian traditions[15] including the Folk High Schools, and the absence of patenting for agriculturally related technologies (which included wind power)[16] which encouraged open exchange in solving technical problems. Kamp argues that "it was learning by interacting however that has made the biggest difference between the performance of the Dutch and the Danish wind turbine industry. The Dutch industry was science-driven: the interaction between researchers and producers was very strong. However, the interaction between these two groups of actors and the users was problematic. In the Danish industry on the other hand, the different actors kept up on the same level of technology development. In this development, they also gradually replaced their hands-on knowledge

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[15] NFS Grudtvig was the most important 19th Century radical (and liberal) Pastor/ Philosopher/ Educationist/ Politician in Danish history, responsible for the creation of the Folk High Schools.

[16] Poul de Cour, the Danish 19th century meteorologist and recognised windpower pioneer the Association of Danish Wind Power Engineers which offered training courses for wind electricians. He particularly focused on the farm and rural population, clearly drawing on the folk high school tradition established by Grundtvig. Le Cour also developed a new wind turbine he called the Lykkegard wind turbine, with a power output of approximately 30kW at 12 m/s wind speed. By 1908, 72 Lykkegard turbines had been sold (Maltha, 2005) and Denmark was leading in rural electrification (Heymann, 1995:71). The 1895 law laid down that processes and techniques in agriculture could not be patented, and wind power was regarded as an agricultural technology. The Folkcentre in northern Jutland continues this tradition today.

of the early phase with more science-based mathematical knowledge, required to produce the large-scale and complex wind turbines of today".

Kamp does not mention the absence of patenting in processes relating to agriculture in Denmark since the law of 1895, compared with other countries, and the role this played in their technological lead, not only in Europe, but also in North America and indeed globally. This stimulated exchange of ideas and knowledge on both turbines and blades, areas where the Danes established their leading position.

However a forthcoming paper by Popp et al (2010) and based on econometric analysis of (ironically in terms of the Danish case) patent data attempts to link the stock of knowledge, relevant patent data, and investment in renewable energy. Using patent data to construct stocks of knowledge for 4 different renewable energy technologies, they estimate the effect of increased knowledge on renewable energy investment to be "robust … but small". They indicate that *"a 10% increase in the knowledge stock increases investment in biomass by 2.6%, and investment in wind by 0.6%."*

(f) Human skills & R&D in relation to renewables

What human skills are needed for the successful development of both R&D, production capacity, and among users as well as designers of appropriate policies?

The human skills required for the installation, operation and maintenance of renewable energy production plants vary according to the type of technology and the energy source. It is noted that many courses in wind, solar, and geothermal energy are now available at college and university level in many countries, at both undergraduate and post graduate level. Thus Judy Stallman writes that wind power creates *"Good paying maintenance jobs in rural areas. Community colleges in (US) areas with larger wind installations are setting up training programs for maintenance workers--these are very skilled jobs. They are also dangerous because they are working high in the air"* (ICRPS Summer School, Oregon, USA, 2010). It is also noted that in some cases the skills are the same as – or very similar to – those needed for non-renewable energy production, and will often be transferable as the switch from non-renewable to renewable sources takes place. A good example is geothermal power, where deep drilling techniques are similar to those needed for offshore oil. In many cases too, the need for such things as practical mechanics and people with a head for heights (e.g. windmill maintenance) can draw on a plentiful supply of such skills in rural regions, even if some updating and retraining may be needed.

R& D needs are plentiful in all areas, and especially perhaps in relation to wave and tidal power, wind, bio fuels, solar and geothermal power all of which are likely to be crucial in almost any future energy scenario. There is a need, already reflected in some courses (such as those at Minnesota University), for cross-disciplinary skills and training for researchers who have to deal with the often complex problems involved in renewables, but it seems that considerable progress has been made. The priority R&D needs from a rural development point of view will vary from region to region are likely to relate to:

- small scale, decentralised production systems in all areas, and hence to efficient distribution systems;
- biofuels and especially more efficient conversion (and cleaning through membrane technology), and methods avoiding conflict with food production) at a small scale;
- geothermal power (drilling technology, power conversion, reservoir technology);
- wave and tide power (conversion and capture technologies);
- wind power;
- and institutional and policy frameworks that
    - encourage local investor and entrepreneur involvement and higher local value added;
    - avoid planning conflicts
    - stimulate long term R&D and pilot investments in key areas of biofuels, geothermal, wind, solar, tide and wave.

As a general observation from a rapid and cursory review of some of the tertiary level courses on renewable energy, one can observe that the focus is overwhelmingly on the technical issues, and hardly at all on institutional and policy frameworks. Given that it is the latter that crucially explain why some countries have developed one or other renewable energy technology and production – and stimulated local involvement - far faster and more effectively than others, this seems to be a major gap. In addition, the general provision does not seems to adequately recognise the important role that social and informal learning has played in both gaining rapid acceptance to new technology among the public, and securing the necessary local investment resources to back its development. The case of Denmark discussed in several comparative studies seems to be worth noting in this regard (see the studies by Johnson & Jacobbsson who compared Germany with the Netherlands; Kamp, who studied the Danish and Dutch cases; Garud & Karnoe who compared the US and Denmark; Midtun & Koefed, 2003, who studied the Scandinavian countries; and Boon, 2008, among others). Favourable policies were also important.

Key policy issue here is whether the market needs to be stimulated in some way, and the regional answer may in some cases differ from that at national level. At present, the issue barely arises in the literature except in relation to research effort, where there appear to be gaps. It is also relevant to note that the training of rural windpower engineers - pioneered by le Cour in Denmark - also has a present day counterpart in the form of the Barefoot College in India, established by Bunker Roy. The Barefoot College trains illiterate rural men and women in the installation and maintenance of solar power systems for rural households and villages in India, Pakistan, Afghanistan, and a range of other countries in Africa and elsewhere.

8 An overview

In the writer's opinion, community involvement in renewable energy is essential if rural regions are to benefit in a decisive way from the very considerable (and growing) investment in, and production of, the various forms of renewable energy. In its absence, rural people will either oppose renewable energy development successfully, or they will become the post-oil age equivalent of Joseph's Gideonites, doomed to be 'hewers of wood and drawers of water'. The countries of Scandinavia, together with Germany, demonstrate that the development of renewable energy where there is such community involvement brings significant benefit, both directly and indirectly, as well as securing legitimacy and support for the industry. Policies, including both incentives and regulations, have had a considerable impact on the nature, pace and location of renewable energy production and innovation, including community participation and involvement. The Scandinavian countries and Germany are notable for their success in securing positive attitudes towards renewable energy development as well as considerable community investment and benefit to rural regions. The following table gives a summary of the historical policy drivers in different countries.

Table 2: Historical Drivers of Community Wind Power Development

Policy category	**Denmark**	**Sweden**	**Germany**	**UK**
Feed-In Laws	√	√	√	
Standardized Interconnection	√	√	√	
Tax-Free Production Income	√	√		
Energy/CO2 Tax Refund	√	√		√
Flow-Through Depreciation			√	
Wind Turbine Manufacturing Industry	√		√	
Ownership Restrictions	√			
Permitting Denials				√

Source: Bolinger *et al* 2004. Table 2.

Investment in R&D and Development in Renewable Energy now exceeds that in Agriculture at global level, indeed significantly so. Yet renewable energy continues to be largely ignored as a regional development option for rural areas. This is both curious and damaging. Much more work is needed to ensure that the investment brings benefits to rural communities, and not merely negative externalities. This work includes research to establish the policy and other conditions under which such success emerges in different institutional contexts, and with different types of renewable energy.

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Annexe: Some key success stories in renewable energy taken from Atle Midttun and Anne Louise Koefoed: 'Green Innovation in Nordic Energy Industry: Dynamic Patterns and Institutional Trajectories': Paper for the Conference: Innovation in Europe: Dynamics, Institutions and Values" Roskilde University, Denmark, 8th -9th May, 2003

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1. Finlands bio-energy industry. This supplies a quarter of all energy used in Finland, making it the highest user of bio energy in the industrialised world. Together with Sweden, Finland is in a world-leading position in combustion, harvesting and logistics/ transport techniques related to bio-energy industry. Together with CHP related technology, bio-energy production and consumption technology provided Finland with 12 billion FIM in export value in 1998.

2. Swedish bio-energy industry had a market share of 19% of total Swedish energy consumption in 1997. The industry consumes more than half of the 87 TWh of bio-energy used in energy production. 50% of district heating in Sweden is based on bio-energy, equivalent to 25 TWh. Since CHP is still not extensively applied in Sweden, only a small share of the electricity production is based on bioenergy. Like Finland, Sweden is a major exporter of various biofuel-handling technologies.

3. Danish bio-industry supplies 6% of total energy supply (1997); if incineration of waste is included, we are talking about 10%. Sales from bio-related industry and bio-related product categories are the second largest renewable export area after wind power. The value of bio-related technology exports was 750-1000 million DKr in the early 1990s. When direct energy- and heat producing companies are excluded, some 160 Danish firms have been indicated to be somewhat linked to the energy sector's use of bio-fuels.

4. Finnish CHP ranks as the primary technology choice for electricity production, accounting for 1/3 of total Finnish electricity production. District heating related

CHP furthermore provides 1/3 of the Finnish heating market. Developments in the Finnish CHP-sector have also appended a broad supply industry from valves, boilers and piping to advanced combustion technologies. Technology-export of energy related products, where CHP-related products constitute the major part, provided Finland with 12 billion FIM in 1998.