

National Innovation, Industrial Policy and Renewable Energy Technology

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Abstract: This paper notes that different nation's approaches to innovation and industrial policy impact on the range of renewable energy policy options available, the choices that are made and the aims that underlie them. It considers those policies which have been most successful in stimulating installed wind energy capacity and industrial growth in wind turbine manufacturing in Denmark, Germany and Spain with a view to the instruments employed and the context of their employ, that is, within more coordinated economies. This is compared with the greater constraints on nations with more liberal economies, specifically the UK, and the less impressive results achieved therein. The range, flexibility and impacts of central support mechanisms and of additional policy instruments operating alongside them are also considered with a view to achieving the full range of RE policy goals.

Introduction

Alongside the environmental goals which attach to renewable energy policy, there are a number of other goals set within national policy frameworks. Besides the desire for greater economy and energy security is the wish to see the stimulus of new industrial opportunity. It is clear that different policy instruments have the potential to engender different impacts on manufacturing industries and their potential for accessing competitive international marketplaces.

This paper discusses the factors impacting on industrial growth of RET manufacturing from the perspective of applied policy. It has specific regard for the wind turbine manufacturing industry as the most mature of the new RET industries. It considers the context in which national policies relating to renewable energy are developed and the significance given to the potential to stimulate RET manufacturing within the context of that policy. Relevant aspects of National Innovation Systems (NIS) as they have applied to the development of wind turbine manufacturing are discussed, both with regard to the limits they place on available policy options and to the advantages that may arise in some NISs which are not available in others, most specifically where they have implications for industrial policy. The potential for more liberal economies to adopt more aggressive industrial policies relating to RET is discussed.

Industrial Development as a Goal and Shaper of Renewable Energy Policy

The stated aims of different national renewable energy policies are manifold. The common central aims tend to be the capture of environmental benefits; the capture of other social and economic benefits such as increased employment opportunities; increased manufacturing and export capability and increased energy security, as well as a number of more nationally specific goals.

Whilst most nations do not apply any form of explicit ranking with regard to these goals it is apparent that different political actors give greater emphasise to some goals than to others. The policies instruments they apply reflect the level of priority they give to the whole basket of goals. This paper concerns itself with the emphasis given to the creation of new industrial opportunities by the various national political actors in providing support for renewable energy development. Given that wind energy technology can be regarded as the technology which has seen the most

significant moves towards becoming a mature technology, emphasis is placed on the historical development of the wind turbine manufacturing industry and of policies which have both failed and succeeded in nurturing it. A number of nations have subsidised wind energy with the professed aim of this leading to the creation of a thriving and internationally competitive industry. The most successful historically have been Denmark, Germany and Spain, though the US-owned GE Wind, formerly Enron Wind, has also enjoyed some success. It should be noted that as Enron Wind, the company absorbed a German company, Tacke Windtechnik, which is responsible for a significant fraction of the companies historic production, and notably in the context of this paper had been the subject of significant industrial policy benefits in Germany (Johnson and Jacobsson 2003). GE Wind is also vulnerable to fluctuations in the unstable US market. The top ten turbine manufacturers in 2001 are shown in Table 1, along with the historical capacity they have produced. Each of Denmark, Germany and Spain has employed a tariff based mechanism as their central policy instrument.

TABLE 1. Top ten suppliers, 2001

	Total MW 2000	Sold MW 2001	Share 2001	Total MW 2001	Share of total
Vestas (Denmark)	3335	1648	24.1%	4983	20.0%
Enercon (Germany)	2170	1036	15.2%	3206	12.9%
NEG Micon (Denmark)	3636	874	12.8%	4510	18.1%
Enron (US)	1423	865	12.7%	2288	9.2%
Gamesa (Spain)	1476	648	9.5%	2125	8.5%
Bonus (Denmark)	1713	593	8.7%	2306	9.3%
Nordex (Germany)	1013	461	6.7%	1473	5.9%
MADE (Spain)	592	191	2.8%	783	3.1%
Mitsubishi (Japan)	379	178	2.6%	558	2.2%
REpower (Germany)	246	133	1.9%	379	1.5%
Others	3034	448	6.6%	3482	14.0%
Total	19,017	7075		26,092	

Source: (Gipe 2002)/(BTM Consult ApS 2002)

Danish companies remain dominant, though their share of the world market has steadily reduced through the late 1990's and into the 21st century. Danish companies have historically dominated their domestic market with 100% of sales, and non-Danish companies have tended to avoid even trying to compete. It is also important to note that figures for the world market tend to be somewhat skewed by the strong performance of German companies in their own home market, where they have typically captured 55-65% of demand in recent years. The size of the German market – typically around 35-40% of the total world market – means that German companies thus enjoy a significant share of the world market which perhaps does not reflect in their performance outside Germany. This has significance in respect of the long term industrial goals of German RE policy.

One interpretation of the situation is that there is a direct link between the greater industrial success noted for the industries of those nations where a tariff mechanism has been employed, and that the mechanism is intrinsically superior. This paper notes there are a number of

characteristics that make a tariff mechanism more appropriate to the particular policy strand of stimulation of new industrial development, most importantly, the stability that a tariff mechanism creates that is not apparent with a quota mechanism. However, it also suggests that the use of the tariff mechanism can be regarded as being indicative of a particular cultural approach to the support of new technology and industry. Those countries which are unwilling to entertain the use of a mechanism with so little foundation in the market may be limiting their options with the result that they are less able to access particular policy outcomes. For example, they may prove less able to stimulate their own industrial sectors to capture international market opportunities or be competitively disadvantaged in comparison with companies emerging from states which are more flexible. Further, the same cultural foundations which allow governments greater access to a choice between tariff and quota mechanisms also provide greater scope for the use of additional supporting mechanisms which in themselves may provide additional support to achieving the full range of political goals. More specifically, national industrial cultures which are more amenable to the use of tariff mechanisms – which in themselves may offer advantages in terms of providing stable domestic markets – seem more likely to be open to a wider range of supporting policy instruments which specifically address the growth of competitive domestic industry.

There are effectively two issues relating to the use of policy instruments to stimulate increased use of particular RETs. The first is the degree to which a particular mechanism stimulates a demand for technology within a country drives a capacity increase; doing this successfully works towards achieving the environmental goals of RE policy as well as providing increased security and diversity. The second issue is the nature of the driver in terms of stimulating a domestic industry relating to that increased demand. One does not lead to the other as demonstrated in both the UK and Sweden (Mitchell 1995; Johnson and Jacobsson 2003). Providing sufficient funding from the public purse through either tariffs or quotas leads to increased capacity. Simply stimulating demand does not create a domestic industry nor does a particular mechanism offer greater advantage with regard to capture of markets by domestic companies. Some policies clearly offer the potential to be manipulated at the national level to offer advantage to domestic companies. Underlying this however is the context in which policies are created, and which can act to limit the availability of policy options, both with regard to the central mechanisms and support mechanisms. Those countries adhering more closely to market mechanisms – liberal market economies – will interfere less in the markets, may have more barriers to doing so, or may not have the institutions in place which allow this to be carried out with more ease. Co-ordinated market economies may be at an advantage.

As has been noted, there are a range of motivations for nations and regions in developing renewable energy policy. Fundamentally, the basis for policy stems from the environmental benefits that accrue from using renewable energy sources as an alternative to fossil fuel. Whilst this justifies the desire to see increased RE use, the capture of environmental benefits is a general issue; it leaves the question of how it can best be met to political actors. Thus, whilst this factor is the underlying justification of policy, the creation of policy may also take into account other potential benefits that may accrue from more or less aggressive policies in the area; be they financial or regulatory in nature. Increased security of supply through exploitation of increased diversity of indigenous energy sources is desirable and positively influences balance of payments. Other potential policy goals include aiding rural regeneration, as in the UK (DTI 2000), and the potential for stimulating community involvement through the use of co-operatives, as occurred in Denmark (Tranæs 1997).

Fundamentally however, the exemptions to international trade rules that allow the provision of state aid to assist the development of new environmentally beneficial technology may also prove

more amenable in advantaging domestic industry to the detriment of non-domestic, and the application of instruments that allow this may be more easily applied in some nations than others.

Industrial development of Wind Energy Technology

A significant number of factors impinge on the development of new industries, and this remains true for wind energy generating technology. The success of a new industrial sector can be judged in two contexts; the domestic marketplace and the international marketplace.

Success in the domestic marketplace has been demonstrated to be an essential foundation for the development of an internationally competitive industry; this is also the area where a nation can most easily act to support its own economic and social interests. Further to this, fundamental to the growth of a domestic industry is the formation of a stable domestic market, which inevitably means a stable demand (Porter 1990; Johnson and Jacobsson 2003). Thus to be serious about trying to stimulate a new internationally competitive industry, a nation must provide policy which delivers a stable demand for the goods provided by the new industry, should such a demand not already exist.

With regard to the establishment of wind turbine manufacturing it is apparent that some nations have adopted policies which lend themselves ably to the creation of a more stable demand. Notably, the nations whose companies which currently dominate the wind turbine manufacturing sector have been careful to provide regulatory and fiscal assistance to ensure a continuing demand for turbine production, this is perhaps particularly notable where circumstances have meant the industry has faced leaner demand.

A tariff mechanism, as has already been noted provides a much more stable financing environment for the development and operation of wind turbines. There are various examples of other policies which have also helped with stabilising demand both alongside a tariff mechanism or prior to its adoption. Danish examples include the 1988 agreement between the Danish Government and utilities which saw the utilities agree to purchase 100MW of turbine capacity and effectively prevented the total disintegration of the Danish sector following the collapse of the California market which had been created through federal and state tax breaks. Essentially, the creation of a Californian market in the 1980's acted to draw existing wind turbine companies from around the world and to expand the sector with new entrants. Danish manufacturers, with superior technology resulting from the particular characteristics that had driven the small home market quickly came to dominate a large portion of the market, in Karnøe's interpretation, because of superior technical knowledge gained as a result of servicing a more sophisticated marketplace (Karnøe 1990). When tax breaks were repealed and the market collapsed, many of the non-Danish companies went out of business and the danger was that most of the Danish companies would follow, with a concomitant loss of the knowledge and expertise gained both before and as a result of the Californian experience. Essentially the government acted to stabilise demand until it could put into place a more permanent mechanism for driving demand. Detailed accounts of the California situation and of the early history of the Danish wind turbine manufacturing industry with regard to contributing political, social and economic factors have been provided by a number of authors (Karnøe 1990; Gipe 1995; Jørgensen and Karnøe 1995). A detailed account of the development of both wind turbine technology and of industrial growth internationally can be found in Heymann (Heymann 1998).

Denmark has recently seen a similar agreement for purchases of five 150-160MW offshore wind farms was agreed between the government and utilities with construction to take place between 2002 and 2008. Two of these projects will act as pilot projects, and further development will rest on their performance. The first, a 160MW farm at Horns Rev has been completed, whilst the

second, a 158MW farm will be constructed at Rodsand. This demand may well have helped to stabilise Danish domestic demand following the initial – and eventually postponed introduction – of a quota mechanism which had undermined security relating to investment, and thus financial viability of development and thus seriously destabilised domestic sales.

The status of Danish turbine manufacturers as first movers meant that Denmark had not had to interfere with the market with large-scale instruments which offer preference to domestic customers. The initial advantage in technology meant that non-Danish companies were incapable of competing effectively in Denmark, and the advantage has been maintained through an intensely competitive environment, though it is possible that some advantage is garnered through the application of safety regulations which cause costs to fall disproportionately on non-domestic companies. It is possible that the rapid expansion of offshore wind in Denmark might open up the market, with implications for the future development of the Danish turbine industry.

What is apparent from the historical development of the Danish wind sector have been the close ties between industry, the Government, and its agents, and which has existed since the early days of the industry. Close consideration allowed the easy transfer of results from government R&D to commercial usage as well as aiding in providing the new industry with legitimacy.

Mechanisms to aid transfer were specifically put in place, and these drew in the involvement of both the Ministries of Energy and of Industry. These R&D efforts were carried out by both public and private sectors and backed with public funds to try to ensure commercial products. This close collaboration, beginning as long ago as the late 1970's, has continued to the present, though the form of the support has changed considerably in that period (Øster and Jacobsen 1990; Pedersen 1990).

Whilst Danish wind turbine manufacturers have clearly benefited from the country's status as first movers within the industry, entrants to the sector from other nations have required more support domestically to overcome in order to be able to combat Danish dominance.

Germany can be regarded as being the major success story of the renewables sector with an installed capacity of 12GW of wind power out of the world total of 31.2GW at the beginning of 2003 (WPM 2003). German installed capacity at the beginning of 1990 was less than 20MW and the rate of expansion necessary to the present has dwarfed that in other nations. However, German companies have experienced problems in achieving significant penetration into international markets, where Denmark continues to dominate, though this is slowly beginning to change. If Germany is to recoup some of its investment in wind technology through capture of significant portions of the turbine manufacturing sector – and the concomitant economic and social benefits this would imply – it is forced into a position where it must continue to provide subsidy, preferably in an environment which directs advantage towards domestic manufacturers, rather than fuelling purchases from overseas suppliers. The central problems with this are twofold. Firstly, Germany may run out of economically viable sites to exploit before its companies have made sufficient inroads into the international market. The German Wind Energy Institute has suggested that German installation rates peaked in 2002 and are likely to fall annually until 2008, when it is hoped that increased offshore sales will push figures back up (Molly 2002). They note that BTM Consult, the leading wind industry consultant suggest figures will begin to rise again from 2004. Secondly, each year Germany, or more precisely German electricity consumers, must meet both the costs of current commitments of those turbines already installed, plus the new turbines installed that year. The rapid rate of expansion has applied both to capacity and costs and thus will eventually render the tariff mechanism economically and politically insupportable, despite the changes that were made in the restructuring of the tariff mechanism in 2000. Key to Germany seeing a long-term return on its investment other than with regard to reduced emissions, is being able to maintain both a stable domestic market and one that

is more amenable to its own companies, at least until they have become more established outside the German market.

That Germany has industrial ambitions in the sector is clear. German companies dominate their domestic market and have done so since Germany began to develop its wind resources in 1990. Alongside both incarnations of its tariff mechanism, Germany has employed a number of additional instruments, ostensibly aimed at aiding the growth and penetration of capacity. Johnson and Jacobsson detail how many of these instruments have also been to the specific benefit of German turbine manufacturing companies, allowing them to remain in business and to develop their technologies in the face of superior Danish technology and more experienced manufacturers.

An example of German industrial policy at work is the 100MW/250MW programme. Introduced in 1990 to support the original German tariff mechanism, this provided an additional 6pfg/kWh to the 16.52pfg/kWh of the tariff. Gipe records Uwe Cartensen of the German Wind Energy Association as suggesting that the subsidy from the BMFT was directed to projects such that German turbine manufacturers were favoured, pointing out that over two-thirds of the subsidy funding went to projects using German built turbines. Johnson and Jacobsson's research highlights how the application procedure allowed manipulation of awards to favour German industry (Johnson and Jacobsson 2003). They also provide evidence of further support for German industrial efforts provided at the regional level where schemes again ostensibly aimed at stimulating capacity displayed notable bias towards local manufacturers.

A further German policy of note is the large-scale provision of 'soft' loans, that is, loans which are available significantly below market rates. These are available both through national and regional institutions. Lindley (Lindley 1996) has suggested that the Deutsche Ausgleichsbank DtA had had one of the most dramatic influences of any single institution on renewable energy. Its 2003 merger with Kreditanstalt für Wiederaufbau (KfW), another significant source of funds for RE seems unlikely to herald a significant change in the support it provides to wind energy projects¹. The result of the merger, the KfW-Mittelstandsbank (or SME bank) remains under the control of the state and the regions. This form of support is typical of the German system of industrial control, wherein the state acts – as Weiss has it – as the co-ordinator of 'last resort' (Weiss 1998) pp70). Weiss also notes that the German State has historically acted to compete internationally through the mobilisation of large amounts of capital by creating publicly funded financial institutions (Weiss 1998) pp120). Whilst it is not possible to provide data which clearly demonstrates that funding goes preferentially to German manufactured turbines, this would be in line with German industrial policy historically. Further to this point, the domination of a majority of the German market by German manufacturers - who struggle to compete outside the German market - would suggest that some advantage is being provided to German companies that is not available to non-domestic companies.

Effectively, German industrial policy has, at its base, significant interdependence between financing, industrial and government institutions. This interconnection allows government to focus on sectors where it wishes to see stimulation of industrial development. This gives a closer working relationship and allows greater responsiveness from government to aid the sector should circumstance cause it to be stymied.

Spanish policy at the national level has been founded on the twin bulwarks of a national tariff mechanism and generous capital subsidies. However, regional policies have also played an important in both making wind energy projects economic and in encouraging the growth of new turbine manufacturers. Spain's hierarchical system of governance, with considerable power

¹ See <http://www.kfw-mittelstandsbank.de/mportal/English/English.jsp>

devolved to relatively low levels has meant that regions have been able to act to remove barriers to wind turbine deployment where opportunity for resource exploitation has existed. The result has been that Spanish capacity has increased from 7MW in 1990 to 115MW in 1995, and on to 4830MW by the start of 2003 (WPM 2003).

Spanish policy on capturing the industrial benefits of investing in increasing wind turbine generating capacity has been more straightforward than in Denmark and Germany. Effectively acting to stimulate an industry in competition with both Denmark and Germany has required policies which encourage entrants and allow them access to markets. Spanish efforts have been aided by the existence of small manufacturers in existence prior to the big Spanish push on capacity, but also by the degree of legitimacy that has been brought to the industry by the commitment of all relevant actors including national, regional and municipal government, utilities keen to develop their own manufacturing and development arms and local investors and farmers keen for a new source of income.

Particular regions have allowed applications for licenses only from companies committing to develop production within their boundaries. Galicia, for example, required the submission of a 'strategic wind power plan', detailing the commitment that the manufacturers would make in supporting the regional growth of manufacturing of turbines. Commitments could be fulfilled either through the establishment of factories through the developers associated manufacturing arms, or by purchasing equipment from other manufacturers within the region. A minimum of seventy percent of turbines had to be manufactured locally. The scale of the capacity available through the licences on offer ensured that a large amount of bids were attracted, and the initial undertaking of 2550MW was oversubscribed. By 2000, twelve plants were producing equipment in the region, providing 650 jobs. Similar schemes have been employed in other Spanish regions. It seems clear that replication of this licensing policy, used in a number of Spanish regions, would not be an easy task in a number of political constituencies, where it will likely prove antithetical to those favouring an open a market as possible. Certainly, its adoption was not considered within the UK consultation process which led to the current UK mechanism, the Renewables Obligation. Support mechanisms in the UK have been notable for the advantages they have failed to create. The initial introduction of the NFFO came too early in the UK's efforts to support renewables, effectively preceding any stimulation of companies to exploit the markets it created. The result was to provide a market for turbine manufacturers from Denmark and elsewhere (Mitchell 1995). The attitude of the UK to development of competitive RE industries might be best summed up with a 1995 statement by the then Energy Minister, that "the NFFO process does not provide a privileged position for UK equipment suppliers, but the Government believes that this is as it should be. Suppliers must be able to compete in world markets if they are to succeed so, ultimately, it does not help to protect them at home" (Welsh Affairs Committee 1995). The UK has tended to remain true to this statement, with public funds being made available to support technology development at minimum short-term cost to the consumer. It is possible however, that some of the policy instruments introduced alongside the RO have the potential to be used to support UK industry preferentially, though this remains to be seen in practice.

Discussion

The choice of RE support mechanism reflects the particular nation that produces it, and the national innovation system and style of economic governance of its society. Nations which refuse to consider a tariff mechanism do so through a commitment to addressing market failures through the use of instruments which are as near-market as possible in the belief that this entails the least costs to the market and the consumer. Nations which thus reject the use of a tariff

mechanism in the belief it is likely to prove too costly, and on the basis that it interferes too greatly with the efficient operating of the market are also more likely to reject other mechanisms which also create greater market interference where another option is open to them. Whilst Menanteau *et al* (Menanteau, Finon et al. 2003) present evidence that the tariff mechanism is anyway more efficiency owing to the uncertainties that persist in quota mechanisms, it is possible that the ability to choose a tariff mechanism is indicative of a more flexible approach to achieving policy goals. It is suggested here that those nations which have adopted the tariff option, do so at least in part for reasons relating to the potential for securing advantage in the manufacturing sector. They desire to see social as well as economic return on investment at the national level, tend to have a culture more historically rooted in government interference with the development of new technology and industries, and are more likely to consider the wider range of options. Systems which allow the consideration of tariff mechanisms also allow the greatest range of potential for additional mechanisms to be used alongside them to address disadvantages in their use or to make their use more specific to additional policy goals. Those that adhere to market mechanisms may not allow themselves to access the full range of policy benefits. This can be seen as a function of systems which have the scope to consider policy instruments which are both market and non-market based.

The greater range of options thus available allows greater flexibility in choosing from more policies which are more amenable to stimulating RE policy goals other than that of capacity increase. It can be noted particularly that this extended range of policy options may offer greater opportunity for the manipulation of markets to favour domestic manufacturers.

To sum up, the domination of the turbine manufacturing industry by companies coming from those countries which have primarily relied on tariff mechanisms may more specifically represent a link between industrial domination of the turbine industry and countries which allow the possibility of using a tariff mechanism, that is to say, it is a product of the industrial policy of the nation in question. The industrial policy is a product of the form of the economy in question. The conclusion that there is a link may have important implications. These implications may include, but are not necessarily limited to;

- The applicability of policy instruments for stimulating further new technologies and new industries to produce those technologies;
- The potential for countries whose industrial policies suggest less flexibility to capture the market for new technologies;
- The potential for less flexible countries to become more flexible with regard to the range of policy instruments they are willing to consider.

Clearly, tariff mechanisms can be easily applied to the development of further new RE technologies, as can many of the policies which currently accompany them in the nations that enjoy enough flexibility to adopt them. The use of quota mechanisms to stimulate technologies which are not near market when the mechanism is adopted is more complex. There is some potential for the use of ‘banding’ – having separate quotas for different technologies – though this can be seen to be at odds with the central justifications that the mechanism is closest to market conditions and ensures least cost to the consumer. In the UK at least, this was grounds for the rejection of banding during the adoption of the Renewables Obligation quota mechanism. Providing a stable market with a quota mechanism as the central focus could thus prove to be more difficult for newer technologies than is the case for currently competitive technologies, leaving significant problems for their stimulation market readiness and, more particularly, for supporting the development of national competitive advantage in the market for those new

technologies. Countries which accept tariff mechanisms can simply add a new rate for a new technology.

Germany has tended to use the additional mechanisms to provide domestic companies with an advantage, whilst the tariff mechanism merely provided the stimulus for a stable demand. Quota mechanisms such as the RO provide both a less stable market and are too transparent to be easily turned to being used preferentially. The liberal economic preferences of the UK also mean that there is less inclination to apply additional support mechanisms to providing advantage to domestic companies. The provision of grants for specific technologies, as in the UK seems unlikely to create a long term stable market for these technologies, returns the Government to a position of having to pick winners and is likely to be politically unacceptable in some constituencies. At least one new policy in the UK, the Carbon Trust's Low Carbon Innovation Programme offers the potential to support UK companies preferentially, though currently its typical available funds are only £25-30 million p.a. Most existing UK policies seem likely to be unable to be applied on a preferential basis due to the level of transparency associated with them.

So what options are available for less flexible countries, with less coordinated economies, to achieve competitive advantage in markets for renewable energy technologies? It would certainly appear that they are at some disadvantages; nevertheless this does not imply that they are fated to be subordinate to more flexible countries. Firstly, it must be noted that whilst a nation may apply elements of industrial policy to one RE technology does not imply it will do the same for another technology. Johnson and Jacobsson emphasise that before industrial policy can be applied other factors impinge on the potential for growth. Entrants to a new industrial sector must be induced, for example, and Johnson and Jacobsson highlight the importance of the early legitimacy that political consensus gave to wind turbine technology which stimulated a variety of entrants to the sector in Germany and the Netherlands. No assumption can be made regarding the conditions that will apply to further new RE technologies in any of the nations which might or might not wish to develop them.

Further factors also apply; the necessity for a stable domestic market in ensuring international competitiveness places geographical limitations on countries to develop technologies only where they have relevant national RE resources, thus competition for new industry to meet policy driven demand will differ between technologies. Additionally, the costs of using a tariff mechanism are substantial, the returns are not guaranteed, and even where returns are made, the initial investment may not always be politically supportable, and may grow less so with each new technology supported concurrently.

We have seen in the wind turbine manufacturing sector that acting as the first mover on a national basis may provide a significant baulk for domestic companies against future entry to the market by companies from other nations buoyed by national market creation programmes. Thus, being the first nation to stimulate a domestic industry may prove to be even more important to those countries with less policy flexibility. This is of course not straightforward. Such a course could require additional commitments to supporting a wide range of technologies and perhaps a return to trying to pick winners which may prove to be anathema to policymakers in more liberal economies.

The alternative is the potential for more co-ordinated economies to adopt instruments which provide industrial policy advantages to domestic industry. Again however, there are cultural and institutional barriers to such an adoption that may prove difficult to overcome.

A key issue identified within the German and Dutch wind turbine R&D programmes was a greater emphasis on diversity of effort, that is, of working to acquire knowledge of different forms of the technology, rather than focussing too early on one aspect as was the case in a

number of territories with regard to the development only of MW sized turbines (Johnson and Jacobsson 2003). This may be a useful lesson with regard to other new RETs. Johnson and Jacobsson underline repeatedly the importance that establishing the legitimacy of a technology played in helping to support the growth of virtuous circles of resource supply, market development and growth. Political support which aims to assist the growth of such legitimacy for new technologies should thus be a key aspect of policy in the early stages of technological development, and beyond. One key factor common to development in Denmark, Germany and Spain has been the close ties between government, industry and other national institutions such as banks or other sources of finance. In each country this allowed and continues to allow greater responsiveness in policy creation. Developing closer ties between these actors in other countries may aid in overcoming disadvantages created by less flexibility in policy choices.

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