10 Clean Energy and New Ventures

Online student resources

Additional materials

Secondary clean technology sources

Secondary clean technologies can be categorised in different ways. Some materialise in novel amalgamations of existing know-how– one example being efforts by climate change innovators working out of India to retrofit plug-in electric cars with rooftop-loaded longer-life batteries enabling 150km journeys following a a single six-hour charge. (Friedman 2009) Others are close to green chemistry solutions: the distillation of oil from marine algae; the use of garlic as a pesticide or worms as a fertiliser, etc. The crossover between nature and science that is a core principle in ecological business applies first and foremost in the field of green innovation.

In general, secondary clean technologies refer to solutions whose economic viability has yet to be proven and/or whose locational specificity prevents any broad diffusion. Geothermal energy, for instance, where thermodynamic entropy drives heat from the Earth's warmer inner core towards its cooler surface, is largely limited to the geyser spouts where the flows surface. Such energy could be carried further afield, of course, but the intensity will dissipate with distance. Thus, despite recent investment in this field – with the Geothermal Energy Association (www.geo-energy.org/) predicting, for instance, an additional 7,000 megawatts of new baseload geothermal energy in the US over the next few years – capacities in this one area are necessarily limited.

Note that the underlying principle of using temperature differentials to generate energy has long been implemented via 'heat pumps'. The basis for a number of well-known appliances such as refrigerators or air condition, this technology is increasingly being used for general building heating purposes. Indeed, the comparative inefficiency of many modern CHP 'combined heat and power' units (see glossary) has sparked a general search for viable alternatives, with attention often falling on electricity-powered heat pump units. The best examples (recently developed in Japan) have proven capable of transforming 1 kWh of electricity into the delivery of 4.9 kWh of heat in the form of hot air or hot water (MacKay 2009). Still, like their natural counterparts - or more mechanical solutions such as 'pumped storage' (hydroelectricity projects where water is shifted between low and high altitude reservoirs) - energy transportation constraints mean that these kinds of technology are rarely useful over a longer distance.

Hence the growing interest in 'fuel cells' capable of simultaneously storing input energies such as oxygen or hydrogen and converting them into electric current. Much research in this area has focused on the concept of storable hydrogen. The problem is that current solutions rely on processes that are too costly and technically difficult (i.e. electrolysis) or on feedstocks that do not correspond to clean energy specifications (i.e. natural gas). A technological breakthrough may have been achieved in recent years following experiments with abundant and non-toxic catalysts such as cobalt and phosphate that are capable of sparking hydrogen electrolysis (Luoma 2009). If the new technology pans out (see http://www.suncatalytix.com/), it would herald an era during which electricity might become as readily available as water (Luoma 2009). For the moment, however, this cornucopian vision is more dream than reality.

On the other hand, there is a fuel cell design that an increasing number of companies would already consider operational. Called the 'Bloom Box', the technology has been described as a "mini power stations... that can run on anything from natural gas to the more renewable stuff" (Jha 2010). Whereas most fuel cells have relied so far on expensive materials such as platinum (or corrosive chemicals that subsequently shorten their lifespan), more recently the market has seen cheaper sand-based Bloom boxes that are effective enough so that a stack no bigger than a brick has become capable of powering the average sized house. A number of well-known companies including Google and E-Bay are adopting this technology, which allows users to function off-grid if they can source input fuels independently (and are steady in their power drawdowns, i.e. if they avoid intensive peak demands). Bloom boxes are still very expensive (ca. $750,000 per uni) but prices should fall as producers achieve economies of scale (Wheeland 2010). Operational costs of ca. 8 to 10 cents per kilowatt-hour are already extremely competitive, with some analysts calculating that this enables payback horizons of as short as five years.

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Clean energy patents

A New York law firm called Heslin Rothenberg Farley & Mesiti (HRFM) has carved out a strong identity for itself with its publication of the Clean Energy Patent Growth Index (http://cepgi.typepad.com). This offers an excellent picture of green innovation intensity by tracking patents granted by the United States Patent and Trademark Office (PTO) and categorising these registrations by industrial category and by inventors' sector of activity and place of origin (including foreign interests registering their discoveries in the United States). Note that the process for receiving a patent is arduous and expensive, meaning that inventors will only embark on this path if they have confidence in their innovation's potential commercial viability.

The results from the index that HRFM published in September 2010 covering the year's second quarter showed a strong and even accelerating rise in registrations for total clean energy patents, which reached 437 in total. Note that this was highest quarterly result since HRFM began tracking patents back in 2002. There had been a rise of 15 percent (58 patents) from 1Q 2010, and almost 60 percent from the total of 274 registered twelve months previous.

Regarding patent categories, the leader by far was fuel cells (248), followed by solar (76) and wind (33). The renewed interest in solar applications - almost entirely dominated by photovoltaic technologies – means that this category has led wind for three quarters consecutively, reversing a previous trend towards greater innovation in wind. Indeed, there are some indications that innovation in the wind sector is starting to stabilise after strong rise in patent numbers for the seven years previous. Photovoltaic solar patents, on the other hand, rose sharply to surpass the 150 annual mark that they had averaged in 2002-2003, before a five year slowdown during which annual totals stayed between 80 and 100 (or 20 and 25 on a quarterly basis). Lastly, patents for hybrid/electric vehicle applications (also 33 in 2Q 2010) were down from the previous quarter's high of 50. Note that the remaining categories - biofuel (12), tidal wave and geothermal – came in at much lower levels.

In terms of applicants, the automobile industry was the leader by far, as it has been for a while. Indeed, the same names could be found at or near the top of table for number of applications: Honda, which registered 28 fuel cell patents along with a few solar and hybrid electric ones; GM, with its 24 registrations (almost all fuel cell-related); with the next automobile company, Toyota, coming in fourth place with 17 registrations during the period in question (12 fuel cell, 5 hybrid/electric). Interestingly, the highest ranking of a non-automobile cmpany was Koren electronics giant, Samsung, with 22 fuel cell and one solar patent. The names rounding out the top ten were, in order, General Electric (mainly wind), Panasonic, Nissan, Hitachi, Dupont and finally Bloom Energy and electric carmaker Telsa.

It is also interesting to note the hierarchy of solar photovoltaic applicants. Over the period 2002 through 2009, the Japanese Canon was well ahead of the pack with 94, followed by two fellow nationals, Sharp (40) and Kanegafuchi Chemicals (21). The first American (Boeing) came in fourth place with 18, followed by the Japanese Sanyo (16) and a second American, Sunpower (16). Otherwise, it is also worth nothing that the Korean Samsung came on strongly in late 2009/early 2010, with five new solar photovoltaic patents. It is one thing to indicate which companies are the historical innovators in a particular field of technology – it is another to determine whether they maintain their momentum. To some extent, updating this dynamic picture requires knowledge of future patent applications in the pipeline.

All in all, in terms of inventors' region of origin, Japan came top with a total of 121 clean energy patents in 2Q 2010, followed by California (50), Korea (37), Michigan (35), Germany (29) and New York (22). The US as a whole (all states combined) accounted for 188 out of the total 437 clean energy patents registered in the United States in 2Q 2010. This leadership should be adjusted to account for the country's relatively larger population size (and the fact that this survey covered US patents, which should assumedly be dominated by domestic innovators). On a per-capita basis, the Asian powers are clearly ahead of all rivals.

Finally, it is worth stating that the reason why the United States PTO remains a barometer for clean energy innovation is because of the relative convenience with which companies can register in that country. As of April 2010, for instance, the European Union still required 33 months to process renewable patents. An effort was being made to shorten this to 12 months, but for the moment the speed of the PTO, the strength of US intellectual property right protecgtions – and probably even more crucially, the size of the American market – meant that EU innovation institutions still lag somewhat behind their US counterparts.

Revision tips

- Since organisations' limited capacities force them to prioritise their workload, managers operating under severe financial constraints pay most attention to issues with the greatest effect on the bottom line. In the field of Ecology and Management, this often means energy. Hence the rise of the renewable clean energy generation/distribution industry, which current acccounts globally for ca. $600 billion in revenues and employs 2.3 million people . This will explode when the energy crunch hits. For student readers, the issue here is career timing and whether it is better to work in a large company's new division or be an entrepreneur.

- Economic efficiency is often strongly determined by the energy density of inputs driving transformation processes. Electricity constituted a quantum leap from manual power. The development of national grids enables energy consumption far from where it was being produced. This also causes problems, as does 'intermittency', which refers to the difficulty of matching supply capacities to demand variations. Hence the general interest in energy storage and portability (battery technology).
- Renewables face similar constraints. One further complication is the determination of the dominant technology in an infant industry. Post-Copenhagen, the framework is conducive to experimentations in many countries, with the advent of renewables obligations creating a real incentive to invest. The best prospects are solar and wind (biofuels are more controversial). National endowments in natural resources vary, as do downstream installation capabilities. There is a discussion whether energy MNEs should integrate vertically.
- Solar is divided into PV cells converting sunlight into electric current and thermal captors producing heat. It remains expensive (i.e. it is still far from 'grid parity) and oil prices will either have to rise or else heat storage/electric conversion must become more efficient (either through science like nanotechnology or else by achieving scale, possibly with the help of public subsidies).
- Wind turbines (blades turning generators that convert mechanical into electrical energy) offer a more established technology. Despite improvements, the potential is limited. Wind speeds tend to vary and turbines' distance from consumption centres means much energy is lost in transmission.
- Infant solar or wind companies are hampered by start-up costs, lack of scale and immature technology. There is a significant need for funding (public or private sources). Most renewables firms qualify for socially responsible investment (SRI) funding. The problem is the riskiness of this sector until its relative expensiveness abates. Share prices in the renewables sector can be volatile and cause bubbles. Hence the growing number of joint public-private investments. Banks' favourite funding vehicle is far and away asset financing (reflecting their desire for collateral). Venture capital funding is high profile but in reality relatively inconsequential. The preference for different kinds of funding vehicle varies internationally.
- The international outlook at yearend 2010 is hard to ascertain given the overlap between clean energy and clean technology patent registrations. Certain trends are clear, i.e. rising number of Chinese clean energy ventures, with twice as many total 2009 investments in this country as in the US and thrice as many as in the EU. In terms of total clean energy stock, however, the EU is world leader. The future depends on different governments' stimulus packages, policy commitments – and the price of conventional energy. There was a slowdown in new ventures in early 2009 during the

credit crunch but growth renewed in 2010, especially when oil prices began to jump again. Future prospects depend on economic agents' evolving conceptions of acceptable payback horizons. Ecology and Management may well be a subset of investment theory/

Case study: The UK and its marine renewables

As this book has demonstrated throughout, localism constitutes a key aspect of environmental economics. In the energy sector, for instance, localism refers to a community being able to mobilise readily available natural resources instead of having to rely on imports coming from afar. Most analyses on this topic limit their scope to conventional fuels or the leading renewable alternatives, such as solar or wind power. The problem with this narrow focus is that it neglects a number of secondary renewable energy sources. Reports have discovered, for instance, that global wave energy amounts to between 2,000 and 4,000 Terawatt hours (TW) annually and that tidal energy resources can add a further 800 TW (Madigan 2009). Theoretically, this is equivalent to 25 percent of the world's total electricity use. Clearly, countries with local access to the sea have an interest in harnessing its power.

In the main, there are two ways that maritime environments produce energy: through tidal and wave movements; and because offshore wind speeds are often higher than onshore. For businesses seeking to capture marine energy, there are synergies between these two categories, not only because both create electricity via turbine mechanisms but also since they have to overcome the same hostile environment, exemplified by sea water's corrosive effect on equipment and cables. In addition, both require significant expertise in cable laying and grid connections. This means that research and capital investment in one area can benefit the other – a crossover best achieved when a mechanism exists to enhance sectorial learning. This function can be assumed by governments (BWEA 2009) and/or by research consortiums such as the ETI (www.energytechnologies.co.uk) that specialise in performance assessment programmes analysing different technologies' cost/output ratios and evolutionary possibilities. Small engineering companies such as Osiris Marine Services or MojoMaritime in the UK can also provide technical knowledge about activities like underwater platform foundations. The sum total of this body of knowledge is a factor that - alongside finance – creates the enabling conditions that can give birth to the new sector.

Many countries are interested in marine renewables, with Danish firms, leveraging state sector investments, widely recognised as having been the first to ramp up the offshore wind sector on an industrial scale. At the same time, Great Britain, which features heavy seas, a dense population and an extensive electricity grid, is currently experiencing the fastest growth in offshore installations. With North Sea oil running out, the UK government has recognised the strategic nature of developing its tidal and offshore wind capabilities and called for a total installed capacity of 14 Gigawatt hours (GW) of marine energy in 2020, vs. 3 Gwh at present (Boettcher *et al* 2008). The question is what is being done to achieve this.

The first condition, as always with an infant industry, is to ensure that ventures in this field have sufficient funds to tide them through their early cash-burning investment phase, In the UK, lobbying groups such Renewable UK have called for £200 million in government monies to launch the British wave and tidal industry (Macalister 2010a). The problem is severe competition for state funds at a time when a new government's number one priority is to cut spending. Otherwise, there is the possibility of large capital injections from the private sector, like the £80 million that German multinational (MNE) Siemens agreed to invest in 2009 to build an offshore wind turbine manufacturing plant in Northeast England. Here the issue is that the announcement had been made in response to the previous government's commitment to offer robust incentives to parties investing in this new sector. Siemens' enthusiasm might abate in the absence of consistent governmental engagement – as evidenced by the decision taken by Danish wind turbine manufacturer Vestas to close its Isle of Wight facilities in 2007. Entering a new sector is always a leap of faith requiring companies to juggle tomorrow's growth predictions against the amount of capital available today. Lastly, there is the ancillary question of whether authorities are seeking to support domestic equipment manufacturers or the maritime energy projects themselves. It is noteworthy than a mere 20 percent of the £900 million Thanet wind farm that opened up off the Kent shore in summer 2010 – the world's largest installation – went to British firms (Macalister 2010b). This is hardly reassuring in terms of UK companies' ability to compete in a sector widely predicted to generate hundreds of billions of pounds in revenues as mega-installations dwarfing current projects begin to proliferate worldwide.

The new sector's takeoff will also depend on the choices made in regards to marine turbine and blade designs. Some standards may be set by small start-ups, including British ventures like Wavegen or Pelamis in the wave sector or Marine Current Turbines or OpenHydro in the tidal area. Normally, the implementation of one technology versus another should be rooted in an objective assessment of performance. Yet there is every chance that large MNEs (such as Siemens or Sweden's Vattenfall) currently acquiring equity stakes in UK start-ups will want to amortise their investments by imposing their own standards through market power. In turn, this would bias the sector's launch trajectory.

Lastly, there are the host country's overall attitudes towards a new sector. Some UK constituencies have their expressed opposition to offshore energy devices, accusing it of hampering military radars, impeding fishing or damaging seaviews. In general, however, the public supports energy sources that are not only clean and renewable but also domestic hence secure. How the government juggles these conflicting views – for instance when allocating planning permits – will go a long way towards determining the new ventures' chances of success.

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Case study questions

A. What potential does the marine sector have to become a major component of the global energy market or, conversely, to what extent is it condemned to remain a purely local factor in certain national contexts?

B. What technological problems do companies need to resolve before they can hope to enter this new industry?

C. What are the long-term prospects for the marine energy sector?

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