Integrating renewable energy technologies in buildings – Photovoltaics in the UK

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Abstract

Buildings account for nearly 50% of energy use in the UK. Measures to make them more energy efficient and where practicable generate their own energy are required to help the UK meet its stated carbon emission reduction targets.

The UK government has adopted market transformation programmes to pump-prime the market for small-scale micro-generation technologies in buildings where the market mechanisms fail to facilitate their development. The EST runs one of the programmes aimed at stimulating the micro-generation market. This programme provides grants to install Photovoltaics on homes in conjunction with energy efficiency improvements for these homes.

Introduction

This paper examines the impact that the Department for Trade & Industry's (DTI) Major Photovoltaic (PV) Demonstration programme has had on increasing awareness levels of PV as a building integrated renewable technology to reduce carbon emissions from buildings. It seeks to examine the barriers to take-up and proposes a viable solution.

GLOBAL PERSPECTIVE OF PV

The global market for PV is growing at 30-40% per year and is expected to continue growing at this rate for the next 5-10 years. Prices are coming down due to worldwide scale-up. Increased innovation has led to greater efficiencies. The UK launched the DTI Major PV demonstration programme in 2002 with £20M funding to support PV installations on both domestic and non-domestic buildings. EST won the contract to manage this programme and in 2004 a further £11M was made available due to the increased demand for the technology.

THE UK PV MARKET

The PV market in the UK has grown from a very small baseline of less than 1 MW installed capacity in 1998 to nearly 6 MW in 2003[1], with an additional 6 MW expected by 2005. The industry has grown from a relatively small number of around 10 established specialist companies in 1998 to over 50 companies operating in the UK in 2004. Awareness levels of the technology amongst consumers and the specialist construciton trades has typically been low with very little opportunity to offer PV as an 'off the shelf' product, though this is improving as media coverage grows.

The UK renewables industry[2] is very fragmented and is made up of numerous stakeholders vying for attention and market share. In some cases the renewables industry competes with itself to secure capital investment in the different markets. However there are a few indigenous PV manufac-

1. IEA Co-operative programme on Photovoltaic Power systems, National survey report of PV power applications in the United Kingdom 2003.
2. http://www.est.org.uk/solar/how/finding.cfm

turing and/or assembly facilities operating in the UK, with ICP Solar technologies Ltd being the biggest manufacturer of thin film modules in the UK. Crystallox is the UK's largest employer in the PV market and produced 120 MW of multi-crystalline silicon ingots in 2003.

BP Solar & Romag Ltd have entered into an affiliation to set-up a glass/glass assembly plant in the North East of the UK. Sharp has also set-up a new manufacturing facility at its Wrexham (North Wales) plant in the UK to supply PV to Europe. Marley Roofing has developed a solar tile system designed to be integrated with UK roofing systems.

What opportunity for micro-generation in the UK?

POLICY INSTRUMENTS AND LEGAL FRAMEWORKS

The UK Climate Change Programme set out the Government's proposals for meeting the UK's target under the Kyoto Protocol of 20 per cent reduction in carbon dioxide emissions by 2010. The Energy Act 2004 includes a clause that commits the government to producing a strategy to promote micro-generation in Great Britain[3]. The Renewables Obligation requires licensed electricity suppliers to source electricity they supply from renewable sources.

The Climate Change Levy is a tax on the use of non-renewable energy used in industry, commerce and the public sector. The 2003 Energy White Paper[4] encourages local planning authorities (LPAs) to promote renewables[5] through the planning system. Under the Department for Environment, Food & Rural Affairs'(DEFRA)[6] Energy Efficiency Commitment for 2002 to 2005 (EEC), electricity and gas suppliers are required to achieve targets for the promotion of improvements in domestic energy efficiency.

STANDARDS & CODES OF PRACTICE

Changes to Part L[7] (Conservation of fuel and power) of the Building Regulations are being introduced to reduce carbon dioxide emissions from buildings. From 2005, developers can meet the new Part L carbon emission standards through a combination of energy efficiency, micro CHP and renewables. Independent research carried out for the Office of the Deputy Prime Minister's Part L Industry Advisory Groups earlier this year demonstrated that the amount of solar PV required to reduce carbon emissions by 10% in a new three-bed semi built to 2002 Building Regulations standards is just under 0.5 kWp[8].

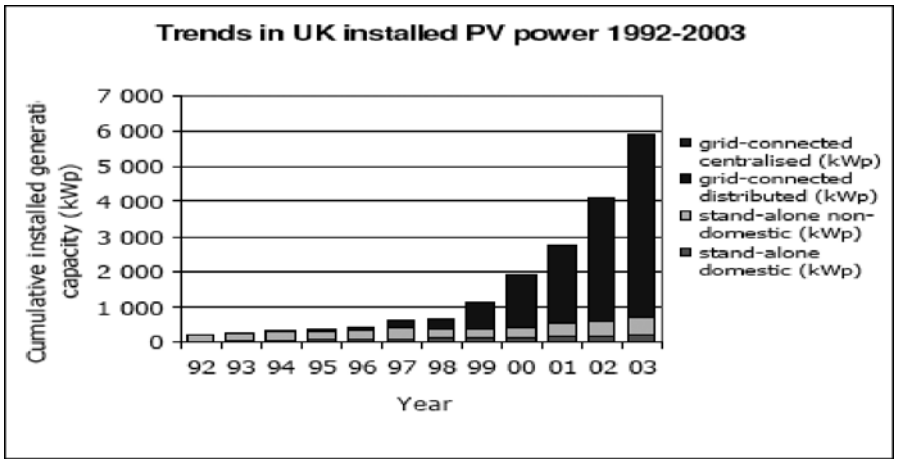
The recommendations[9] for connection of small-scale embedded generators to low voltage distribution networks provided a simple mechanism for connecting PV systems to the local grid network. The removal of the requirement for half hourly metering[10] on Third Party Generators at Domestic Premises removed the requirement for micro-generators to install costly half-hourly meters to measure generation, which presented a large cost barrier to installing micro-generation.

The electricity market has been liberalised in the UK and all licensed suppliers of electricity (and gas) can now supply heat and power to anyone in the UK. Consumers can change their supplier every 28 days where practicable. As a result the competition for domestic customers is very intense with prices remaining very competitive for over 10 years.

The case for PV in the UK

Economics of PV in the UK

The capital costs of PV arrays in the UK (excluding inverters, grid connections and VAT) range between £160/m² to



*Installed PV power in the UK – 1992 to 2003**

** IEA Co-operative programme on Photovoltaic Power systems, National survey report of PV power applications in the United Kingdom 2003*

3. Micro-generation strategy – Energy Act 2004: http://www.dti.gov.uk/energy/environment/jwgee/0423.pdf
4. The energy White Paper - http://www.dti.gov.uk/energy/whitepaper/index.shtml
5. Planning Policy Statement 22 - http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_030334.hcsp
6. DEFRA EEC - http://www.defra.gov.uk/environment/energy/eec/
7. Changes to Part L of the building regulations proposals - http://www.odpm.gov.uk/stellent/groups/odpm_buildreg/documents/downloadable/odpm_breg_030371.pdf
8. PV-UK press release - http://www.pv-uk.org.uk/reference/prpartlbuildingregulations23-07-04.pdf
9. G83/1 engineering recommendation - http://www.energynetworks.org/whatsnew.asp
10. P81 Alternative: Removal of Half-hourly metering - http://www.elexon.co.uk/documents/Consultations/Open_Consultations/77_013a.pdf

£450/m². The experience from the DTI PV programme has shown that installed costs of complete PV systems vary from £5 000 to £10 000 per kWp, or from about £400 to £800 per square metre of solar PV modules[11].

Typical solar fraction levels in the UK assume an average of 750 kWh/kWp/yr. Households installing 2 kWp, delivering approximately 1 500 kWh/yr will generate roughly £100 saving in displaced electricity costs per year[12]. With grants of 50% of the capital costs available under the DTI programme, the householder will pay between £5 000 and £10 000 for a 2 kWp system. At this level of expenditure the return on their investment is longer than 50 years.

Under the Renewables obligation, generators of renewable electricity are entitled to a Renewable Obligation Certificate (ROC) for every MWh of electricity they supply[13]. These green certificates are tradable and are currently valued at approx. £47/MWh. In theory a householder with a high performing 2kWp PV system could generate 2 ROCs per year, which would provide a return of £94/yr on top of the savings made in displaced electricity costs. This would ensure that the payback of the capital costs for the PV system would be recovered within the life of the PV system and certainly within the life of the building. This payback mechanism compares favourably with the German Feed-in tariff where the feed-in tariffs range from 40-50 Euro/MWH for PV generation.

Other fiscal incentives could be introduced to further support the take-up of PV in the UK. This might include Value Added tax (VAT) exemptions on use of the technology; enhanced capital allowances (ECAs)[14] for manufacture of the technology; rebates on Stamp Duty[15] when buying & selling homes with PV systems on the roof; energy services contracts with energy suppliers.

BARRIERS TO THE TAKE-UP OF MICRO-GENERATION IN THE UK

There are significant barriers to the early development of a market for small scale renewable energy. Consumers still have a poor grasp of the meaning of "renewable energy" and insufficient knowledge of small scale renewables services to make informed choices[16]. The supply chain is equally immature. The emphasis of government intervention so far has been mainly on capital grants towards the installation of the technologies. The rapid establishment of new small scale renewables markets, to achieve longer term carbon emissions aspirations, will require a broader range of interventions to increase demand and capacity in the supply chain.

The single biggest barrier to mass take-up of PV as a building integrated energy generator is the cost of the manufactured materials and the lack of a relevant revenue stream for the electricity generated in the UK. The cost of modules is high, particularly in the UK where most of the PV used on buildings is imported from Europe, the US or Japan.

Institutional Barriers

Although the Renewables Obligation is one of the most attractive economical mechanisms for supporting the development of renewable energy technologies, it does not encourage the development of small-scale embedded generation, due to difficulties redeeming the green certificates (ROCs) by small scale generators. Whilst ofgem (Office for Gas and Electricity Markets), the energy regulator in the UK) are seeking to provide a solution to enable small-scale generators to redeem their ROCs, the absence of an equitable economic mechanism for both small and large scale renewables is preventing further investment in micro-generation. Also distribution and transmission companies have large vested interests in maintaining the current electricity trading arrangements since their income stream is likely to decrease under the plans to adopt more distributed generation of electricity (and heat).

Inadequate Partnerships

There is a lack at present of any national support for the development of local renewables strategies. There is no structured, inclusive forum for addressing issues in a co-ordinated, effective way. The Government has embarked on a major partnership strategy in relation to large scale renewables, through the Renewables UK programme, working with RDAs, other regional bodies, agencies and business. So far, this has not been very effective in developing small scale renewables. Many regional and local agencies need to be involved in developing supportive policy frameworks and facilitating small scale projects.

Immature Supply Chain

Even for those consumers who may want to pursue small scale renewable energy generation in their homes, their perceptions of the quality of the products or of installers' services is acting as a barrier. Consumers are waiting for the products to be proven and for the installers to be experienced. At best, there is a fledgling market with insufficient numbers of either suppliers or informed buyers. A complete supply chain needs to be developed and this will require a variety of incentives and infrastructure development including market standards, quality audit and training.

An intensive campaign of education by suppliers and other interested stakeholders is needed to create an interest and to establish regular demand for energy services. The 28-Day rule[17] has partly inhibited this uptake. Under pressure from EST and others, Ofgem has now agreed to a trial suspension of this rule to test whether this increases the take up of energy services. Lack of suitable finance (and advice

11. MDP annual report - http://www.est.org.uk/solar/resources/pvannual.cfm
12. This assume the retail cost of displaced electricity is £0.067/kWh or £6.7/MWh
13. rounded up from 0.5MWh
14. ECAs - http://www.eca.gov.uk/etl/
15. Stamp duty rates for conveyancing - http://www.inlandrevenue.gov.uk/rates/stamprates.htm
16. Attitudes and Knowledge of Renewable Energy Amongst The General Public – Reports and Findings - http://www.dti.gov.uk/energy/renewables/policy/attitudes.shtml
17. The 28 day rule amendment to promote energy services - Requires all energy supply contracts to be terminable on 28 days' notice. http://www.dti.gov.uk/energy/environment/jwgee/0428.pdf

about sources of finance) is another obstacle to early take up of consumers.

Lack of consumer awareness

The proposed low carbon economy for the UK will require major changes in consumer behaviour but these are unlikely to happen without a significant improvement in general understanding of the role of consumers in such an economy where the widespread dissemination of information about products and services is necessary.

To date consumers have mainly encountered the issues of renewable energy, in the planning proposals for large scale wind turbines. Many such proposals are opposed partly out of a sense of mistrust and lack of understanding. A small scale renewables programme would help familiarise communities with this technology, and facilitate longer-term acceptability of larger sale projects, where these may be appropriate.

It is unlikely that consumers are ready for the switch from an infrastructure whereby large generators feed into the national electricity grid to one of small local generation in the home and community. Wide scale marketing activities are necessary to make the potential benefits of small scale renewable energy known to householders. A trusted independent body could offer reassurance about the reliability of novel products and services. The rules for distributed generation are also daunting and guidance is needed on technical, commercial and regulatory issues.

In addition to the domestic market, there is potential for small scale collaboration projects such as community owned wind turbines and biomass-fired Combined Heat and Power (CHP). This market is also inhibited by lack of information and insufficient established suppliers and installers.

LESSONS LEARNED

A number of obstacles still exist to mass take-up of PV in the UK. Various legislative changes will be required, not least in the metering requirements for distributed generation so that equitable export tariffs can be negotiated with energy suppliers. The building regulations should be utilised to require housing developers to consider building integrated renewable energy technologies by setting higher standards for new-build housing.

The key to the success of both the Japanese and German PV programmes has been consistency and predictability of Government support. PV customers in Germany are now guaranteed approximately 40p (~58 eurocents) per kWh for exported electricity for the next twenty years. In the absence of any consideration of a feed-in tariff scheme in the UK it is essential therefore that the Government now allow small-scale renewable generators to access the ROCs under the Renewables Obligation in the same way that large-scale renewables can currently.

UK Government programmes have been effective in stimulating some expansion of the renewables sector in these areas, as well as some cost reduction for the technologies in question. However both the cost and carbon reduction impact of these programmes has arguably been limited by; the provision of support for a large number of relatively small schemes , many of which are at the household level – has limited the impact of economies of scale in securing cost reductions; Neither scheme has yet been successful in attracting major construction industry players & housebuilders etc into this area in a meaningful way. Small niche players are responsible for the very large proportion of installations; There is no clear link between the installation of building integrated renewables and wider energy efficiency measures.

A solution for generation from small renewable sites

The current administrative procedures of the ROC system effectively bar small installations from generating ROCs. Amending the administrative procedures to integrate these types of installations would impose high transaction costs. If a ROC is worth £30-£50, and a typical solar PV installation can be expected to generate approx. 2 ROCs/yr, the transaction cost for metering, auditing, and handling the ROCs can not exceed £6-10/a, or 10% of the value of the ROC. An alternative would be to adapt the EEC solution for small-scale renewable ROC generation, by allowing an installation to receive full ROC credit over its life-time at the time of commissioning.

The Energy Efficiency Commitment (EEC) allows energy suppliers to claim the discounted value of the life-time energy savings of a measure that they install at the time of installation. Suppliers are currently looking at energy efficiency schemes that will cost them 0.8 p/kWh saved. The value of EEC is therefore lower than the value of ROCs, which have a approx. 3 p/KWh buy-out price, and currently come out at 4.7 p/kWh in the market. This conclusion does not rule out a move towards an EEC type solution for these installations though.

AN EEC STYLE SOLUTION

Under this solution, suppliers would receive credits for renewable installation for their lifetimes or until 2027 (end of the ROC system), whichever is shorter. The credit they receive is the number of ROCs generated in this period. For every 1 kWp installed of solar PV, this would come out at 1 ROC/a.

Case 1 Solar PV

Installation size 3 kWp; Load factor 10%; Installation year 2004; Lifetime 40 years; Installation cost £5/Wp – total £15 000; ROCs generated 23 (2004-2027) years x 3 ROCs = 69; ROC value in 2004 £55/ROC

Total value of ROCs from installation = £3 800. This represents the absolute maximum funding by the supplier. Realistically, this would probably be approx. £1 700-£2 200.

As this example shows, adopting an EEC style system for ROCs has a number of distinct advantages. It is very simple, and easy to understand for the consumer. It is fair, because it allows small-scale renewable operators to benefit from the renewable value of their installation. It is market based, because it reflects the higher value of one form of generation over another, and suppliers will compete with each other, ensuring that consumers can get a good deal on renewable installations. It delivers support at the time it is needed, when capital expenditure occurs. It is fully compatible with the ROC system for larger generators, because the ROCs

produced are identical. It uses a system that suppliers are familiar with, and that allows them to integrate support for domestic renewables into their marketing system. Suppliers can, through their purchasing power, bring down prices for renewables installation and ensure that the work is undertaken to good quality standards.

Such a system will have the potential to significantly grow the market for domestic renewables in the UK by involving the energy suppliers. The system can be refined by introducing discount rates for future ROCs, if that is seen to be fair compared to large-scale installations. It has advantages for installations up to 200 kWp for solar and 50 kW for micro-wind, because of the reduction of transaction cost.

Government grants should be allowed to co-fund installations funded by suppliers – e.g. through the proposed Low Carbon Building programme. The ROC output should be reduced proportionately. Suppliers could use this system in conjunction with offers for a feed-in tariff for the renewable energy that the installation may export into the grid, under P81 metering arrangements. This would increase the attractiveness of the offer and increase supplier's marketing appeal.

Conclusion

- PV in UK is very embryonic, but has a large potential when integrated into buildings.
- There is a mixture of institutional, supply chain and consumer awareness barriers which must be overcome.
- A potential solution exists in the form of an ESCo type arrangement delivered through energy suppliers combined with continued and consistent government market transformation support.