FIRE Facilitating Innovation in Renewable Energies

D6 Technology Watch Report

Issue 2, covering period October 2007 – March 2008

Prepared by
ECN-EGON
Energy in the Built Environment
Petten, the Netherlands

April 2008

Table of Contents

1 Introduction

The overall aim of the FIRE project is to facilitate innovation of SMEs and SME Groupings from the renewable energy industry across Europe to participate in European RTD activities and programmes, including the framework programme seven. In recent years technological developments have brought down the cost of Renewable Energy Technologies, RETs. A number of them are now competitive with fossil fuel technologies in specific applications. Nonetheless, development has spread unevenly between different RETs and different countries and regions. Making these RETs fully competitive requires further research, technology development, market deployment and an increase in production capacities to mass production levels.

One of the objectives of the FIRE project is to prepare Technology/Innovation Audits. To this end a knowledge platform specific to the renewable energy sector is to be generated. It will consist of in-depth knowledge of innovation potential of SMEs (Innovation Audits); EU RTD Opportunities; and Technology and market trends (Technology Watch reports).

The aim of the Technology Watch to provide the FIRE project SMEs with a potential source of innovation identification by highlighting technology gaps in the renewable energy sector. Technology Watch reports are prepared and distributed to project partners every 6 months. This is the second issue covering period October 2007 to March 2008. In this issue we are concentrating on mapping the technology and market gaps within the present state of the art technologies in the Solar Energy, the Wind Energy and the Renewable Energy in the Build Environment. For this purpose several experts in these areas have been interviewed and their views presented here.

2 Solar Energy

Based on interview with Prof. Dr. Wim C. Sinke
Solar Energy Unit
ECN, Energy research Centre of the Netherlands

The interview with Prof. Dr. Wim C. Sinke took place on 29th February 2008 at the premises of ECN Solar Energy Unit in Petten, the Netherlands. The conversation covered views on identifying technology and market gaps within the solar electricity (PV) technology where Mr. Sinke is well known and established expert.

As a general statement, from the point of view of the potential for innovations from SMEs in the solar energy sector, there is no need for yet another solar module technology to be developed. Most of the production is by now in the hands of large companies and entering this arena in any case requires large investments. No gap can be identified in this area and potential involvement of SMEs.

However, where a technology gap can be identified is the availability semi-fabricates and final products for flexible use in a wide variety of applications. For modules to be applied, they need to be available (for instance) in different sizes, shapes and colours and with varying fixtures and wiring. They may be used as separate units or combined with building elements (roofing materials, façade cladding, etc.) to form multi-purpose solutions. In the latter case one may start with a rigid glass-based laminate or a flexible solar foil. At present solar products come in many different forms and are neither adapted to (sometimes country-specific) application requirements nor standardised on a European level. This hinders wide application in the built environment and increases the costs of use. Here is an opportunity for SMEs to be, for instance, solar module assembler for integration of systems in the built environment. The underlying idea is that solar modules have to become a building material, if possible even a standardised building material.

It is here that SMEs can be involved and work with PV manufacturers reducing the gap between producers and adapting solar products for the requirements of the building industry in terms of standardisation of BIPV (Building Integrated Photovoltaic) products as complete building materials (weather-tight, aesthetically pleasing, guaranteed performance and durability), rather than 'add-on' application of solar modules on roofs.

The problem also exists in articulation of requirements between the building sector and solar products manufacturers. It is here that SMEs can be involved bringing closer product manufacturers and requirements of the building industry. To illustrate this, in many cases architects have difficulty to provide specification for the solar products that are to be produced for application in buildings. The ideal future scenario would be to have an available 'library' of solar products that can be applied in buildings and PV systems well integrated in buildings as common practice. A parallel can be made with the way heating systems have become standard in buildings these days. Similarly, a building of the future would have a well integrated solar system as standard equipment.

Other identified gap is the quality of installers (whether they act as suppliers or not). There is need for after sales services to be developed. e.g. on procedures and schemes for maintenance, performance monitoring, and repair. Although the quality of the installations may differ between countries, the issue requires particularly attention in countries with emerging markets. An innovation is possible in offering services on the market. Typically SMEs can be involved in after sales services, insurance and financing of solar systems applications, acting as an interface to final customers.

Another area where SMEs could contribute is in the development of dedicated equipment for the production of solar modules. This for example could be in order to improve the speed or accuracy of an assembly in the manufacture processes leading to efficient automated process. Innovations could be made in equipment for specific handling of the production line assembly of solar modules.

The market for solar modules is divided between grid integrated systems and off-grid systems. The grid integrated systems typically includes applications on buildings and large power plants producing electricity. The off-grid systems consist of rural applications, telecommunications applications and consumer goods (small products such as battery charges, calculators, etc.). Although the last group has been present for quite some years now, there is a possibility for further development of high quality consumer products with the use of solar technology (for example using organic based solar modules as novel on the market). In this respect possibility is to team up SMEs with other start-up companies for work in market 'niches'. This collaboration requires doing market research and industrial design where 'solar' component in the product is an added value.

3 Wind Energy

Based on interview with Dr. Jos Beurskens
Wind Energy Unit
ECN, Energy research Centre of the Netherlands

The interview with Mr. Jos Beurskens took place on 11th March 2008 at the premises of ECN Wind Energy Unit in Petten, the Netherlands. The conversation covered views on identifying technology and market gaps within the wind energy sector.

At present in the wind energy sector there is a gap between supply and demand for wind turbines Delivery times can take even two year. As the demand is high, manufacturer capacities are lagging behind the demand from project developers. To this contributes the huge demand coming from the United States, China and India.

Within this state of the market large and well established companies (Siemens, GE, Suzlon, Shell, ABB, Alstohm, etc.), continue producing well tried and tested (low-risk) technologies. The opportunity for 'new comers' which are typically smaller companies, is therefore to enter the market offering novel products and technological advances. Recent market shows that each of these small companies has its own innovation or specific service which can enter the market, which at present is typically covered by more or less traditional wind technology. To name the few: Samtech, Mecal, Darwind, etc. This type of companies start with very small number of people, even as student-experts level, entering the market through innovations. Over time these small start-up companies grow and become more successful and they either become themselves large companies or are bought over by and integrated into existing large companies. Despite this, new companies are continuously coming on the market, which could be witnessed by their presence in large numbers on big wind technology exhibitions sometimes part of conferences and symposiums. Also, it is often the case that large wind technology manufacturing companies subcontract smaller specialised companies to do work they do not hold highly specialized expertise in.

The dynamics of these small companies is buoyant, quickly responding to new market requirements. To illustrate this, the demand to make wind technology manufacturing processes as sustainable as possible new companies started offering specialised services in oiling products for turbine machinery based on green sources. Other specialised areas are cleaning services of wind turbine blades and access technologies to perform regular maintenance of offshore wind farms at remote locations.

There is place on the market for new manufacturers of wind technology through innovations. The innovation seen here could be as providing specific expertise such as for example in: finite element calculations; meteorological measurement services; geotechnical engineering services in relation to site investigation; foundation and turbine installation; optimised electrical control solutions; consultancy services for visual impact assessment of off shore wind developments; design bureaus for off shore companies; aerodynamics; grid related issues and grid connection; condition monitoring systems (includes sensors and software development); and simulation software / lab testing systems to optimize dynamics, noise and vibration of wind turbines.

There is opportunity for SMEs within the small scale application of wind turbines such small turbines on buildings and in the rural sector. In the rural sector small scale wind turbine applications are suitable for providing electricity for lighting, electricity for water desalination, cooling, etc. As the market in rural areas is not capital intensive it has not grown as much as the large scale wind farm sector. Application in buildings is affected with issues of noise caused by the rotating wind blades, safety distance and vibrations. Due to this its success has been slowed down compared to PV technology application in the building sector where these issues are not present as the solar technology is static without movable parts.

Innovative aspects in small scale applications can be for example, in terms of improvement of the design, noise reduction and electrical conversion. However, the total potential of this segment of the wind energy market is minor compared to what is being achieved by large wind farms, in terms of electricity generation (in Denmark and Germany approx. 25% and 10% respectively of the energy comes from large wind farms). To even get closer to this scale of energy generation, small scale wind turbines would have to be installed on each house, for which there are constraints.

4 Renewable Energy in the Built Environment

Based on interview with Dr. Henk Kaan
Energy in the Built Environment Unit
ECN-EGON, Energy research Centre of the Netherlands

ECN Research Dwellings

The interview with Dr. Henk Kaan took place on 19th March 2008 at the premises of ECN – EGON, Energy in the Built Environment Unit in Petten, the Netherlands. Earlier on within the FIRE project, it was discussed whether renewable energy in the built environment includes passive solar design as it is more matter of design rather than technologies. It was decided to be included therefore, for example, when working with SMEs on development of building components for energy efficient buildings although it could be viewed as being on the edge between technology and building design, it is within the scope of the FIRE project.

At present achieving high energy conservation in buildings to the level of Passive House [1] performance or alike, is technologically possible. It has been shown in many parts of Europe that all technology exists to built buildings with low energy demand.

[1] http://www.europeanpassivehouse.org, PEP, Promotion of European Passive Houses definition: "The term Passive House refers to a specific building standard for residential buildings with good comfort conditions during winter and summer, without traditional heating systems and without active cooling. Typically this includes very good insulation levels, very good air tightness of the building, whilst a good indoor air quality is guaranteed by a mechanical ventilation system with highly efficient heat recovery. Thereby the design heat load is limited to the load that can be transported by the minimum required ventilation air. However space heating does not have to be carried through the ventilation system. For 40° - 60° Northern latitudes, under conditions specified in the PHPP calculation model:

- the total energy demand for space heating and cooling is limited to 15 kWh/m^2 treated floor area;
- the total primary energy use for all appliances, domestic hot water and space heating and cooling is limited to 120 kWh/m^2.

However, in small countries like the Netherlands, the building sector is very local. Buildings are built on the spot with some elements prefabricated nearby and brought to the building site. This is also true for small building components, windows alike. Windows are produced nearby, up to approx. 200km away from the site. Also, typically large quantities of buildings are built in one development. This differs compared for example with Belgium, where one-off buildings are often the case where it makes it much easier for a client to demand an energy-efficient (or Passive House) building. In case when large numbers of buildings are being built at one time, components and building products for energy-efficient performance have to be sourced further away. To illustrate this, triple glazed windows have to be transported from Germany and Austria rather than in the vicinity of the project. Having in mind that large quantity of components have to be transported for the building volume per development, it represents an increased risk (and cost) for any developer. Similar situation applies to other building components suitable for energy-efficient buildings. An opportunity for SMEs in this context is for manufacturing of appropriate components nearby, i.e. development and engineering of such components.
The way in which buildings are made in the Netherlands is to large extent very traditional. Despite the progress being made in past decades, the building technology is predominately with concrete foundations and brick walls. Compared to one hundred years ago, insulation is present, more machinery is used for building, modern scaffolding is present, etc. However, buildings are still typically made of brick or concrete (massive walls), and all building elements being put together as sum of parts, just as was in the past.
An example of different concept of building technology is the ECN Research Dwellings where the building is put together with integration of various technologies (including solar PV and thermal panels, mechanical ventilation system with heat recovery, thermal storage, etc.), rather than as sum up of windows, walls, heating system, etc.

ECN Research Dwelling close up

This is the area where technological gap exists. In real integrated design where various functions that building components have are integrated starting even from the manufacturing level of building components. Today there are very few available 'plug and play' elements in buildings. This is also true for integration of renewable energy in buildings. For example, the most common way of application of PVs in buildings is directly attaching it on the already completed roof construction as an add-on, in rather 'do it yourself' that does not look good and it is done in very unprofessional way.
An example of forward thinking for building components is the so called 'wire-free PV' module that is easy to install on a roof, easy to take it off for replacement with new one or maintenance. The main idea of PV-wirefree is to minimize costs of PV systems and costs of electricity generated by PV systems. The PV-wirefree system consists only of PV laminates, click-on-click-off dual purpose clamps, aluminum extrusions and an inverter. No diodes, no cables, no junction boxes, etc. The gap on the market for SMEs is to develop building components with similar way of thinking.
An integrated approach to PVs on buildings should result in visually successful integration. Projects that have done successful PV integration always use custom-made PV products, specifically designed, produced and installed for particular case rather than directly bought and integrated into a building. This is far from for example availability of window glazing and frames from different manufacturers, where wide choice is available for architects from catalogues. To this contributes lack of standardisation of PVs for building integration, (also mentioned previously by W. Sinke, p. 4).
If one looks at the traditional building material such as timber, in the Netherlands there is 30cm module standard that is widely accepted and used. Brick is another standardised element in size: 20cm x 10cm x 5cm with 1cm mortar for joining bricks. Typical Dutch roof tiles also come as standard sizes as well is the new Dutch tile and the newly improved Dutch tile. Consequently, what the built environment market needs for solar PV and thermal applications is wide European standardization. A parallel can be made as standardisation of bolts and other small parts in the car manufacture industry that are suitable in any car regardless of the car type or maker. This level of building elements standardisation is very distant from the situation with renewable energy in buildings. The priority lies in standards rather than new products.

Solar thermal and PV panels on the ECN Research Dwelling roof

Realistically, SMEs can not make great influence on the building industry. However, SMEs can offer products that will be accepted by the building industry, although these products will always represent a market niche. In terms of renewable energy in buildings it can be products for integration of PVs on façade or roof of buildings, or work on improved mechanical ventilation systems with high efficient heat recovery. An example is a type of a heat recovery system where the product performance is improved by utilizing extra heat from the condensation occurring in

the heat exchanger. Another example could be the Klimarad system with ventilation system integrated in radiators, or another type of product with wall integrated ventilation systems.
In case of existing buildings, any type of renovation means changes of the building, if externally applied insulation, changes to the appearance of the building façade, street view. If insulation is applied internally, the usable room space is reduced. SMEs work can be on, for example, advanced insulation products (such is the vacuum insulation with variable hydrogen gas which influences the thermal resistance of the insulation). An SMEs have an advantage in development of new products that they can run experiments and tests on small scale in laboratories. Once the new product performs well it can be offered to a larger company for large scale production.
Further opportunities for SMEs are in the area of engineering and consultancy as well as measuring and monitoring of energy-efficient building components and applied systems on buildings.

5 Sources of Information

ECN, Energy research Centre of the Netherlands. Solar Energy Unit. http://www.ecn.nl/en/zon/
ECN, Energy research Centre of the Netherlands. Wind Energy Unit. http://www.ecn.nl/en/wind/
ECN-EGON, Energy research Centre of the Netherlands. Renewable Energy in the Built Environment
Unit. http://www.ecn.nl/en/egon/.
De Boer et all. PV-Wirefree: bringing pv-systems back to their essentials. Paper presented at the 3rd World Conference on Photovoltaic Energy Convention, Osaka, Japan, May 2003.

6 Acknowledgement

This issue of the FIRE, Technology Watch Report was realised based on interviews with Prof. Dr. Wim C. Sinke from the ECN Solar Energy Unit, Dr. Jos Beurskens from the ECN Wind Energy Unit, and Dr. Henk Kaan from the ECN Energy in the Built Environment Unit. We would like to thank to all for shearing knowledge and views in their area of expertise.