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RENEWABLE ENERGIES - The wild card of distributed production

The effective liberalisation of electricity production, distribution and marketing, formerly protected by centralised and monopolistic systems, is completely changing the European energy market. Provided it can succeed in offering kilowatt-hours at increasingly competitive rates, renewable energy has an excellent opportunity to win a share of the market as an inherent part of the innovative approach known as 'distributed production'. Over the past five years, the consortium of 32 partners working on the *Dispower* (1) European project has been engaged in research that is today making it possible to propose technological solutions and management tools for the opening up of networks, as well as the economic models needed to rise to this challenge.

Europeans must succeed in producing at least 21% of their electricity by harnessing renewable energy sources during the decade 2010-2020. Pictured here are photovoltaic panels in Austria.

It is a recurrent theme that has been gaining acceptance over a number of years now and that today – in the context of global warming and the inevitable increase in global energy demand – is more pertinent than ever: the need for clean and renewable energy sources to contribute more to global energy supplies. For Europe, this is now an established priority.

Technologically, the conditions have been largely met. Energy today can be generated increasingly efficiently by a growing range of clean and renewable sources – wind power, photovoltaic solar energy, biomass and ocean energy being just some examples that are already operational. Other solutions are also being developed, thanks to the prospects offered by fuel cells, for example.

Restated priority

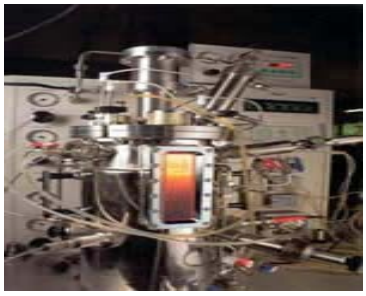
In the 1990s, the EU reiterated the need to double the renewable energy contribution to European energy production by 2010, to the point where it would meet at least 10% of total energy needs. With just five years to go before the deadline, the conclusion must be that the target is proving difficult to meet.

Paradoxically, the ambition not only remains but is being restated with more conviction than ever. "Europeans must succeed in producing at least 21% of their electricity by recourse to renewable energy sources during the decade 2010-2020," insists Manuel Sanchez Jimenez, Project Manager for energy production and distribution at the Research DG. "And ultimately, we must aim to arrive at an even bigger share."

But how can this reaffirmation of intent be justified? "Such an increase in renewable energy ceases to be unrealistic the moment the switch is made to what is known as the 'distributed production' system, which is now perfectly possible in the context of the new liberalised electricity market," continues Manuel Sanchez Jimenez. "Over the past five years, the results of the European Dispower project, in which the sector's industrial players have been very closely involved, have provided the operational means with which we can now rise to the challenge. It is perfectly possible to arrive at a situation in which renewable energy sources supply the equivalent to the expected growth in electricity demand, which is just over 2% a year."

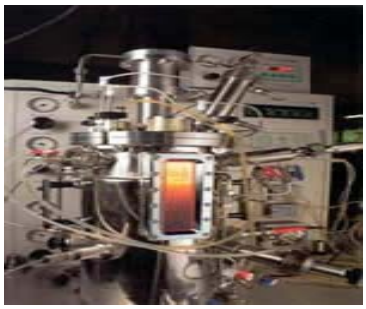
The old pyramid model

The centralised system which has prevailed until now on the European electricity market is based on a pyramid vision which focuses on the need to distribute this essential energy vector.



The present priority is to ensure that the electricity generated arrives 'downstream'. First it must be generated in huge production plants, predominantly nuclear power plants – at reactors with average generating capacities of 1 300 MW – or thermal power stations that burn massive quantities of combustible fuels. Very high

tension lines come out of these plants, via interconnected networks with progressively lower voltages, to arrive at a myriad of consumption points distributed over vast national (or cross-border) geographical areas. Although these consumption points differ widely depending on whether they are industrial, tertiary or private users, the needs to be met are united in a single entity that is seen as a 'global' demand.



Use of biomass, a renewable energy source included in the implementation of the distributed production concept.

Such a structure, which is based on gigantic proportions has, to date, proved a virtually insurmountable obstacle to developing renewable energy sources that, by their very nature, can only supply electricity across small or very moderate power ranges. The biggest wind power plants, for example, have individual capacities of between 3 and 5 MW. Their production is therefore only deemed worthy of integration in a public grid if it is harnessed within large wind farms(2).

Small is beautiful

The opening up of the electricity market is today encouraging an approach that is loosening the straightjacket of traditional technological and economic models. It is opening the door to a reasoning that does not view electricity solely as an energy vector that must be carried to a 'distributed consumption' but as one that also takes into account the need to network all the many potential feed-in sources.

At the basis of the Dispower project is the desire to show that it is possible to promote, with a view to distributed production, a dynamic and efficient policy of multiple generators of moderate or even modest size – as low as a few KW in capacity – that can meet local or temporary needs. In addition to the benefits of decentralised production in terms of lower energy transport costs, the huge advantage of such an approach lies in the potential to optimise a great variety of primary energy sources. What is more, this approach is not intended for the benefit of renewable energy sources alone, even if they are the priority. Small units based on diesel or gas turbine generators for the combined generation of heat and electricity, a practice that doubles energy efficiency, also stand to benefit.

But for their contribution to be of real significance to energy supply, there is an essential precondition: the effective and guaranteed linking up of these units to the traditional grids. This is essential to guarantee a continuous supply of sufficient and stable electricity for the consumers in question. For this, there must be the 'umbrella' in the form of a grid that is able to cope with peak demand that the decentralised sources are unable to meet.

Crucial counterflow

If it is to succeed, this new framework of distributed and connected production also has a much more difficult technological challenge to face, that of profitability. To achieve this, it must be possible for decentralised units to be able to capitalise on their temporary energy surpluses by 'selling' them to traditional networks or grids. This problem is particularly acute for the two principal renewable energy sources, namely wind and solar. These have the disadvantage of being variable and intermittent because of their dependency on weather conditions – which poses complex questions regarding acceptability of their integration in 'host' grids.

"The connection of distributed systems of electricity production produces a genuine change in the direction of the energy flow. This 'counterflow' operation must be taken into account and the network protection system adapted. If there is a growing number of interconnected decentralised generators, we must be careful to ensure current stability, the balance between the current produced centrally and the decentralised contribution," explains Philipp Strauß, Dispower coordinator at the *Institut für Solare Energieversorgunstechnik (ISET)* at the University of Kassel (DE).

Taking stock

The large scale co-operative research conducted by Dispower has laid the foundations for many viable and promising technological solutions in meeting these challenges of integrating a growing share of distributed production in interconnected European networks. The

The EuroDish generator at Milan's *Centro Elettrotecnico Sperimentale* is linked to the local low-voltage network. The dish concentrates solar radiation to heat the helium that fuels a Stirling engine.

Kassel meeting in November 2005 took stock of progress to date, with participants presenting concrete results of a nature to lead to many innovative developments.

The manufacture of storage systems for electrical energy is becoming a reality, for example, with the innovative generator known as EuroDish, which consists of a parabolic concentrator that absorbs the sun's rays which are then used to heat the helium that drives the Stirling engine. EuroDish has been in place at the Centro Elettrotecnico Sperimentale (CESI) in Milan since July 2002 where it is linked to a local low-voltage network. Another example is the adaptation of grid control and management tools to allow for the intermittent production of renewable energy sources, such as the Windpro software developed by the Danish company EMD, that can model the effects of connecting up wind power systems. The partners also looked at the various regulations in force in the different European countries, set up laboratory pilot installations and conducted real-size tests on the use of wind power on a number of French, British and Greek islands (see box).

Pursuing common research

Dispower included over a dozen mutually complementary sub-projects. "Most of the results were the fruit of transverse discussions," explains Philipp Strauß. "The working groups were organised so that several partners pooled diverse expertise on common subjects. This experience of a multifaceted research community really is very important, even if it is not a scientific result in the true sense of the term. It allowed distributed electricity production to acquire a high profile among all the European stakeholders."

Although Dispower ended at the end of 2005, the partners will be collaborating on new projects, such as the DER-LAB Network of Excellence that will continue the inter-laboratory co-operation. That is not the least of the results achieved.

(1) Distributed Generation with High Penetration of Renewable Energy sources. Launched in 2001 as a consortium of around 32 partners with a budget of almost €17 million (half of which coming from the EU), Dispower is the pioneering element of a wider cluster known as IRED, members of which also include six other research centres involved in promoting the production of distributed electricity using renewable energy.
(2) A number of countries (notably Germany, Denmark, Spain and, to a lesser extent, the Netherlands and Italy) are implementing a policy of developing vast 'wind farms', often offshore. The energy produced by these plants is now integrated in centralised production systems. In this respect, they have overcome the obstacles of the distributed 'micro' production that lies at the heart of the Dispower research.

The consumer players

Although Dispower was concerned primarily with technical matters, the project nevertheless posed a number of socio-economic questions linked to the opening up of a new electricity market. "The new technologies cannot be implemented without considering questions of how they are to be regulated and their social acceptance," stresses Manuel Sanchez. The Dutch Foundation for Energy Research (ECN) headed the working group on the socio-economic questions of regulation, the market and their interaction. "How can the new technologies be rendered economically profitable? How, for example, can ancillary services be included in a distributor's business model?" asks Philipp Strauss with regard to the services that clients could offer the distributor. These services include drawing on electricity reserves built up by cogeneration systems at times of peak demand as a means of guaranteeing the quality and security of supply, which implies a managerial responsibility that is spread increasingly between the players, including decentralised electricity producers. New types of contract will have to be drawn up for this.

Another issue is that of variable electricity tariffs depending on the time of day. The project coordinator takes the view that "there is no point having variable tariffs if the consumer is unable to react to the variations and has no means of being informed in real time". Within Dispower, a team including MVV Energie AG, a German electricity distributor from the Mannheim region, and the Fraunhofer Institut für

Solare Energie, checked the social acceptability of variable electricity tariffs among a population of 400 residents of the Stutense residential district, just outside Karlsruhe, as part of the project entitled 'Washing with the sun'. The inhabitants were informed by text messages of times when electricity rates were at their lowest so as to prompt them to use the most energy-thirsty household appliances at those times. This helped alleviate peak consumption. "It is vital for the consumer to become increasingly involved and become a real market player," believes Philipp Strauss. "Domestic meters could be fitted with an interface that manages energy production and consumption in a way that optimises expenditure. This electronic manager would respond automatically to variations in distribution rates and would adapt energy consumption. We can imagine perfectly well such devices existing in the future."

Kythnos, an island in the wind

"We can learn a great deal by studying experiences with distributed production in the particular situations found on islands," stresses the Dispower coordinator. Unlike on continents, their traditional thermal grids cannot rely on interconnections with the outside and are therefore isolated. With ideal wind and sun conditions, the island of Kythnos, in the Greek Cyclades, is something of a pioneer. The first 'mini wind farm', consisting of three generators with a total nominal production of 100 kW, was set up there in 1982 and interconnected with the diesel generators that supply the central grid. Since then, other wind and solar systems have been added.

Within Dispower, studies entrusted to the Greek National Centre for Renewable Energy have made it possible to carry out a full-scale analysis on grid control devices so as to assimilate, as harmoniously as possible, the fluctuations in current that occur with renewable energy sources. It seems, for example, that electrochemical batteries are the best solution for constituting electricity reserves to stabilise and guarantee continuity of supply.

TO FIND OUT MORE

- Dispower [http://dispower.org/]
- Energy research [http://europa.eu.int/comm/research/energy/index_en.htm]
- IRED [http://ired.iset.uni-kassel.de/]
- DERlab [http://www.der-lab.net/]
- International Journal of Distributed Energy Resources [http://www.der-journal.org/]

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