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DEMAND RESPONSE GENERATION : ENERGY SAVINGS FOR MILLIONS OF HOMES

by

Pierre Bivas
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Translation by Rachel Marlin

Overview

Voltalis produces energy savings for consumers without asking them to spend any money or forgo their comfort. Electricity supply to their radiators is interrupted for just a few minutes during which time the consumer hardly notices any drop in temperature. When this operation is performed simultaneously in thousands of homes, significant energy savings are made. Voltalis derives its income from the sale of these 'demand response productions' for instance to RTE, a transmission system operator, who uses this as a means to balance in real time the electrical system, thus replacing expensive methods of power generation which cause pollution. Stemming from the work and knowledge of a team with diversified competence in mathematics, technologies and economic models derived from the Internet, and a long experience of energy issues, Voltalis is the only operator in Europe which is qualified to carry out this energy-balancing mechanism based on distributed load shedding production. Although Voltalis' activity has been recognised as being in the public interest, it has encountered strong resistance among some of those involved in the field of electricity.

TALK : Pierre Bivas

Voltalis is a new company which launched in Europe a new activity, the production of 'distributed electricity load shedding' (an advanced type of which is often called *demand response*). This business helps to improve the management of the electricity system usually regulated by electricity production. We suggest that this system be managed in real time by monitoring and modifying energy consumption (and performing subsequent 'load shedding') on a large number of sites.

How it works

Our solution includes the installation of boxes in electrically-heated homes or businesses. Initially a box is placed in the electrical panel, downstream from the circuit breakers which regulate the electricity flow to the radiators. This box includes several electricity meters and switches through which the electricity is supplied to various appliances (such as for a radiator or a group of radiators). This box is equipped with a PLC (Power Line Communication) chip which enables it to communicate with a second box equipped with a GPRS (General Packet Radio Service) modem, similar to that used in mobile telephones. This second box communicates data to our servers about the energy consumption of each radiator in real time via the Internet. In turn, it receives orders either to stop or to start one or a group of radiators connected to the box. It also receives a certain amount of information, for example on programming elements to upgrade the software.

Interrupting the electricity supply to a radiator reduces electric power needed by 1 kilowatt (kW). If there were five radiators in a house, this would represent 5 kW, and with 10,000 houses, the saving would be 50 megawatts (MW). Actually, we work in rotation, so that the same radiator is not switched off for an hour, but momentarily for a few minutes or for half an hour, so that the temperature will only be lowered by one-tenth or two-tenths of a degree which is hardly felt by the consumer. When load shedding takes place and a radiator is turned off, energy is instantly saved. However, once the radiator is turned back on, one might argue the thermostat has to compensate for the lowering of the temperature and has to use more energy, the net result of which would be the energy saving. To discover what really takes place, we made a systematic study of this situation by carrying out a project with support from the ADEME (Agence de l'environnement et de la maîtrise de l'énergie : French Environment and Energy Management Agency). We observed that when one turns off a radiator which consumes 1kW for thirty minutes, 77 % of the corresponding energy is saved : the delayed consumption will be spread out and will be only 23 % of the demand response. This can be explained because thermostats are not precise enough to be able to react to a drop in temperature as small as one-tenth of a degree. Furthermore, homes are not static systems : they are in a state of constant flux and subject to many other changes.

Better management of the electrical system

The ability to reduce electricity consumption instantly is of great interest to transmission system operators, who are responsible for ensuring real time balance in the electrical system. Electricity cannot be stored, at least not on a grid. It is therefore imperative to ensure that there is a perfect balance between the inflow and outflow of energy in the grid at any time, and consequently the balance between consumption and generation of electricity. If not, one runs the risks of sharp falls in frequency or even important damage, which can be best avoided by automatic systems causing general blackouts.

Electricity operators forecast energy consumption for every minute of every day, and use this information as the basis for their production programme. These forecasts are extremely precise and the margin of error is generally less than 1 %. A discrepancy of 1 % between supply and demand is enough to completely disrupt the network.

When the transmission system operator notices that consumption tends to exceed the production level, he makes the necessary adjustment by injecting additional power, e.g. by starting up or accelerating electricity production at a power station to produce the necessary 30, 50 or 200 MW to maintain global equilibrium. The alternative that we offer consists of reducing consumption.

This is not a new idea as such : historically, important industrialists were asked to interrupt production at their factories in order to reduce their power consumption by 10 or 20 MW. Even though this method is very simple, unfortunately it disrupts the industrial process and therefore, from an economic point of view, it has little value for the company or the community.

To overcome this difficulty, we produce *distributed* load shedding, in other words, a given reduction of consumption spread over a large number of sites and installations without inconvenience to customers. Interrupting the electricity supply to several thousand radiators for fifteen minutes amounts to the same reduction in consumption as stopping a factory, but causes no disturbance. Furthermore, customers can always refuse the reductions by pressing a button on the box. Therefore, load shedding produced always meets customers' agreement.

Peak demand

The service we offer is useful all the time and not just for peak periods. At every moment, one must ensure the balance between electricity production and consumption, even when consumption is not in its higher level.

Yet, energy reduction provides an additional bonus at times of peak consumption. The sizes of all infrastructure and grids are determined in relation to peak times. This is true for all areas, but is particularly important for electricity because it is impossible to stockpile it. This is dealt with much more easily in water management : even if all the consumers took their shower at the same time of the day, the water towers would still provide reserves of water to satisfy demand.

In France, the peak of electricity consumption is very sharp. For approximately 30 to 50 hours every year, we use between 15 and 20 gigawatts (GW) more than during the rest of the year, an additional capacity of 20 %. In other words, 20 % of production and transport investments (and investments costs) are necessary only to cover these peak times of between 30 and 50 hours per year. Naturally, this investment is reflected in everyone's electricity bill.

The question of peak consumption has become increasingly problematic since the market for electricity was opened up. When EDF had a monopoly, it coped with its obligation to satisfy customer demand and to construct additional power stations. When its monopoly ended, the market would not lead any company to build power stations to generate only 30 hours of electricity every year. In order for such infrastructures to be profitable, the electricity produced for these 30 working hours should be sold at prices thousands of times higher than electricity sold on a regular basis : this is not politically feasible. This is why every country which has decided to open up its electricity market is currently wondering how operators can make the investments necessary to meet peak demand.

The solution which we provide constitutes a key element of the answer because it lessens the effect of this peak period, making it less of a challenge. It greatly reduces the investments necessary to avoid blackouts. Once again, demand response avoids unnecessary production.

Savings for consumers

Load shedding has a direct impact on consumers because it makes energy savings for them. By accumulating a large number of small heating reductions, annual savings may amount to 10 % to 15 % of consumption, corresponding to a lowering of one's electricity bill by

between around 150 to 250 Euros per year. This is substantial, especially because this saving requires no investment or effort from the consumer.

We are currently developing new solutions that will provide more interaction with the consumer and make even greater savings.

Apart from the energy savings as a result of load sheddings, we offer clients very detailed information about their electricity consumption. Energy providers usually send their customers a bill based on an estimate of their energy consumption every two months. At Voltalis, every member can log on to our Internet site and follow in real time the changes in his consumption. Numerous studies have shown that providing this sort of information to consumers is to enable them to make energy savings of approximately 10 % simply because they become aware of the factors which actually determine their consumption. For example, they can instantly know the cost differential depending on whether they set their thermostat to 19°C or 23°C.

Economic and ecological advantages

The investment necessary to build a capacity of load shedding of 1 MW costs twenty times less than creating the infrastructure necessary to generate and carry an additional 1 MW. Furthermore, as opposed to the 1 MW of electricity injected, 1 MW of load shedding does not require any transport and is therefore not affected by energy losses on the grid. The economic value of load shedding a MW is therefore greater than that of producing a MW.

From an environmental point of view, by not resorting to power stations which run on hydrocarbons (gas, oil, and even carbon in cases where electricity is imported from Germany for example), load shedding contributes in a particularly efficient way to reduce carbon emissions.

Economically speaking, this electricity system management is also much more attractive than any other renewable energies. Photovoltaic energy, in particular, is heavily subsidised in France, and has led to significant increases in electricity prices (again recently via an additional tax of 7.5 Euros/MWh). Only one half of this cost was billed to clients, and the rest was covered provisionally by EDF. EDF is forced to buy photovoltaic energy from the providers up to a maximum of 580 Euros/MWh ; consumers then pay EDF approximately 30 Euros/MWh for this energy, which means that EDF buys this energy 19 times more than the price at which EDF sells it ! One should add that photovoltaic electricity production (which by definition is very irregular) can greatly upset the grids and requires costly infrastructure work.

Load shedding technology is the cleanest renewable energy which exists, and it is profitable at market price without the need for subsidies.

The story of the company

The idea for Voltalis came from Jean-Marc Oury and Bruno Heintz. They run an innovative business employing several engineering graduates from the prestigious Corps des Mines of the Ecole des Mines in Paris. Before creating the company, we met companies whose skills we thought might be useful for our project, and we suggested forming partnerships with them. The only answers we got with regards to innovation were the usual ‘you haven’t grasped the fundamental aspects of the technology and the business, and in any case you will not be able to do it without us.’

For instance, we realised that the business model of electrical goods companies consisted of selling their boxes worldwide at a price which was five times the production cost, whereas we needed a very specific box which had to be manufactured as cheaply as possible because in our model, we pay for the box, not the customer. Therefore, we designed the boxes ourselves and had them made directly by the manufacturing subcontractors of these groups.

The company was created at the end of 2006. Potential clients were very interested, especially RTE (which manages the French electricity grid) and its Italian equivalent.

At the end of 2007, the French Energy Regulatory Commission allowed us to test our system subject to obtaining a technical qualification which RTE gave us once the tests had been carried out at the end of 2008. In January 2009, we signed a contract with RTE which made us 'distributive load shedders' and enabled us to sell our production as balancing means to RTE. We are currently the only company in Europe qualified to carry out this activity.

Fifty thousand members already

We would now like to develop our system as widely as possible in France. Consumers who are interested in reducing their electricity consumption are our source of demand response. They are not our clients but members : we do not ask them for money nor do we give them any. The advantage for them is that they make energy savings ; the advantage for us is selling our load shedding production. In the next twelve months, the number of our members should increase from tens of thousands to hundreds of thousands, and, in the long term, millions in France and abroad.

In France, we have a potential market of 8 million homes (and businesses too) which are heated electrically. If four or five million of these were equipped with our box, assessing 3 or 4 kW of electricity per site, this would represent about 15 GW, equivalent to the capacity of 10 EPR (European pressurized reactors – new generation nuclear plants).

In January 2010, we carried out a distributive load shedding experiment in Brittany, a region where the electricity supply is particularly at risk. A month ago, we signed an agreement with the Prefect of Brittany and the president of the Brittany regional council who have asked us to develop our system extensively in this region. The objective is to install our technology in 300,000 homes in the long-term, amounting to an equivalent of 900 to 1,000 MW, which is significant.

We are also preparing development abroad. The difficulty in grid balancing exists everywhere in the world, but is particularly important in developing countries which lack the infrastructure in both production and transportation of electricity. In China, for example, sometimes production in industrial zones can be halted for several days in order to deal with electricity shortages, whereas, during this time, air-conditioners are on full-power, wasting huge amounts of energy and causing consumption peaks which are difficult to manage. Our system would be very useful in this country.

Voltalis' economic model

Voltalis pays for all consumer manufacturing and installation costs. Boxes are installed by Voltalis employees or local electricians. We also pay for communication costs between our hub and the boxes, and, of course, management of the hub and R&D.

We do not ask for subsidies (nor generate costs but savings for our members, who do not have to buy our systems) unlike other companies which use other renewable energies, despite the fact that (i) we sell the cleanest energy that exists, (ii) production from such other sources is intermittent and entails additional grid costs.

Our revenues come from electrical markets, such as sales to RTE of demand response production in order to balance the electrical system without additional electricity production. To demonstrate how this works consider this example : RTE warns that in the next thirty minutes there will be a discrepancy between energy production and consumption of 50 MW. RTE must reduce this difference and therefore calls on electricity producers to shed this load. Since RTE is a monopoly, these calls are precisely regulated. Every day, producers make very

detailed tenders to RTE, informing them of the quantity, the price and the time at which they can supply RTE with electricity. When the need arises, RTE looks at all the tenders it has received and chooses the one which most suits its need, starting with the least expensive. Voltalis also tenders to RTE and we are chosen if our tender is the most attractive.

Even though electricity is quite cheap in France, our business model is sound particularly because our expenses are principally in electronics and telecommunications, and these costs are much lower that those of other sectors in electricity production.

Because our activity does not rely on obsolete regulation or on subsidies, but on solid fundamentals of the management of electrical systems, we received the backing of our shareholders who are interested in the long-term prospects of our company. This encourages us to be optimistic about our national and international development.

Opposition from those in the market

Our economic model does not please everyone. This is normal because, like any innovation, our new solution 'pushes the boundaries' and upsets the economic model of some of our partners and other producers who are our competitors.

Energy thieves ?

In the summer of 2007, there was a rumour that we were 'energy thieves'. It was claimed that we 'harnessed' energy produced by EDF and then sold it. This rumour was totally unfounded because we do not sell energy – we sell load shedding production. It is true, however, that our objective is to reduce electricity consumption, which means that we indirectly reduce EDF's turnover. To compensate for what EDF saw as a negative effect, EDF requested that Voltalis pay them part of their income so that their revenues would be the same, regardless of whether their clients consumed electricity or whether their consumption was reduced. This logic is strange. It is like claiming that the income of a shopkeeper should always be the same, regardless of whether his clients buy from his shop or not. For example, bakers have no compensation if they do not sell all their bread, nor if they have not made enough to satisfy all their customers.

Nevertheless, this request by EDF appealed to the French Energy Regulation Commission (CRE) which decided we should compensate the suppliers for energy which is not produced, and therefore not sold. We have contested this decision before the French Council of State and we are awaiting a verdict which is imminent[1]. In our opinion, the CRE's aim is not to protect suppliers, but consumers, thus to encourage the opening up of the market, innovation and energy savings. The American Federal Energy Regulatory Commission (FERC) held the opposite point of view to that of the CRE and defended consumers, concluding that one MWh of electricity which was either produced and injected or generated as load shedding should be paid at the same price – the market price – because it provides the same service.

Demand response : for the public good

In France, a recent law dealing with being able to respond to peak energy demands calls for the option of 'demand response or production'. Demand response is therefore recognized as being in the public interest in order to manage peak consumption. It avoids investments which would only serve for thirty hours of additional electricity production per year. On a broader basis, if one wants to optimise the electrical system, it is preferable to use both levers (energy production and reduction) rather than just one. All year round, saving energy avoids wasting energy, a large part of which is billed regardless it has no value. Such circumstances would not benefit the energy suppliers themselves.

[1] Since the conference, the French Council of State cancelled the CRE's decision, arguing there is no basis for such a compensation.

Our only bone of contention is the demands made to Voltalis to compensate the suppliers for their lower turnover. In the beginning, the CRE organised talks between those involved (i.e. electricity providers) to ask them under what conditions they would allow us to develop our activity. The answer was predictable : 'so long as nothing changes for us.' The process was absurd. It would have been fairer to say that our project ought to exist because it is in the public interest from both an economic and an environmental point of view, and then to attempt to redistribute the roles in order to allow our activity to proceed.

In the United States for example, Congress established a National Action Plan for Demand Response. This plan has been implemented since 2007 by the FERC which made it one of its main strategies. Studies they carried out showed that the management of demand may represent as much as 15 % of available electrical power within the electrical system. In France, this would represent a saving in capacity of approximately 15 GW. But we are not yet there : for the time being, in France, the powers that be have so long prefered to subsidize extremely costly photovoltaic equipment rather than to encourage the development of demand response.

A new economic model ?

In spite of being innovative, many of those involved oppose it by claiming that it cannot or should not be implemented, rather than by trying to realise how this innovation might be either a threat or an opportunity for their own economic models.

If this were the case, the development of distributive load shedding should encourage electricity providers to change their models and to take into account the possibilities of optimising electrical consumption so that customers get better value and use less energy. Therefore, EDF could have tried to take advantage of the energy savings in order to improve its margins. For the time being, EDF demands compensation for the value created by demand response, and this is not a reasonable position.

DISCUSSION

Deregulating the prices ?

Question : *Most of EDF costs are fixed, whereas its revenues vary considerably and its tariffs are regulated. This is even more so for RTE and ERDF (Électricité réseau de distribution de France). Your demand response system appears to be a threat both to the electricity producer and the company which transports the electricity. Would your system not work better if prices were deregulated ?*

Pierre Bivas : Our activity does not depend at all on the price paid by the consumer. A consumer is delighted to make savings, whatever prices of electricity are, because he has no expenses for our equipment. On the other hand, one could argue that as the tariffs are not an immediate reflection of the cost of electricity, they do not encourage the consumer to make electricity savings. However, it would be crazy to think that a consumer would keep his eyes fixed on the radiator all day because the tariff might fluctuate. There is a potential energy saving beyond the tariff scale and this is what makes our activity useful.

It is appropriate that the ERDF and RTE tariffs for distribution and transport are regulated because they have a monopoly on these activities. In return, the CRE regularly analyses their costs and fixes a tariff in order to cover these costs. The absence of an energy incentive programme does not come from the tariff regulations, but from the fact that the greater the consumption, the greater the revenues for the suppliers and transporters.

Other methods of load shedding

Q. : *Some time ago, EDF created tariffs which were meant to encourage consumers to avoid consumption during peak hours. What are the advantages of your solution in comparison with these tariffs ?*

P. B. : EDF developed energy incentive programmes (such as off-peak and peak tariff bands) : many electrical water-heaters in particular are regulated according to such hourly tariffs. On the other hand, apart from a few storage heating systems, most electrical radiators work night and day at the same level, without any programming.

When we started investigating the 'new-build' housing market, one of our partners, a property developer, explained to us that he systematically installed heating programming systems during the building phase because their contribution to the reduction of electricity consumption was taken into account in the thermal regulations which apply to the construction of 'new-builds'. To achieve the energy performance according to the regulations, it is, in fact, a great deal cheaper to install these systems rather than to build thicker walls. Unfortunately, these programming systems seldom achieve the performance intended, because they are not used as they are seen to be too complicated.

Property developers agree about this difficulty and say that even their sales teams do not know how to make the programming systems work. Nowadays, when ergonomic objects such as iPhones (which are very easy to use) exist, it is hard to believe that these thermal programming systems are so difficult to programme. Clearly these programming systems are installed primarily in order to conform to thermal regulations and not for use by consumers...

I asked management executives at EDF, a company which is supposed to have encouraged energy savings for years, how they could possibly be satisfied with the fact that their customers waste energy, for instance by heating rooms when they are not at home. I received some surprising replies : one executive said that if people programmed their own heating, this would create a huge surge in consumption when they returned home from work resulting not only in a lower turnover for EDF but in higher costs…

EDF thought about improving the system of off-peak and peak hours a few years ago with specific tariffs (called EJP – Peak Day Savings – and Tempo). EJP customers pay a low tariff all year round, apart from 21 'red' days in the year, chosen by EDF, during which the prices are much higher. This encourages customers to reduce their consumption on these days significantly. I have several friends who have told me that on certain days, at their

grandmother's house, they have to wrap themselves up warmly because it is a 'red' day and she has to turn her heating off. This system, which is a bit basic, requires the consumer to be watchful. They are warned the day before, and then have to remember to turn off their appliances and radiators. At Voltalis, we do not disturb our consumers and they do not have any special action to take, and the energy reduction is barely felt.

Initially, these EDF tariffs worked well : EDF announced that there were 6 GW of savings in French consumption on peak days. However, over the years, this figure has fallen to 3 GW, particularly because this tariff is no longer on offer, and also because industrialists, who used back-up generators on 'red' days, now have to conform to environmental norms which are more restrictive.

Smart electricity meters

Q. : *Do you see competition from ERDF's recently installed 'smart meters' ?*

P. B. : 'Smart meters' are now called 'advanced meters' which would appear to suggest that they are not as smart as all that ! Actually, they simply measure consumption globally, and send out consumption indexes every week or every month, instead of a manual statement sent out once or twice a year, as is the case today.

In the configuration of the French electrical system, the ERDF monopoly stops at the meters, whereas demand response necessarily takes place further down the chain, in other words, in the private domain. Therefore, ERDF cannot carry out load shedding.

More generally speaking, wanting to make the meters 'smart' leads to problems about how long they are meant to last. Meters are designed to last about thirty years, whereas 'smart services' should be able to change very quickly. Having 'smart meters' would mean having to change the meters much more often than is currently the case, which incurs additional costs of equipment and labour.

Competition

Q. : *Do you have any competition ?*

P. B. : We do not have any competition, but some companies in the United States are developing a system which is in competition with one of our sectors, namely shedding peak time consumption. Their technology is inferior to ours, but their backing enables them to develop very quickly and their development is supported by local authorities and other bodies. However, because of the high quality of French engineering, we already have the best EDF, the best Areva, the best Alstom, and the best Schneider Electric. So why not have the best Voltalis in the world ? To achieve this, we need help to develop this new branch, not only in the interest of French consumers, but also to ease EDF's debt.

Q. : *I thought that a system which is quite similar to yours was being developed in an EDF subsidiary.*

P. B. : EDF's 'commercial' branch is in fact in the process of testing a similar device, and is very ambitious since it intends to equip 600 homes this year. Some managers in the company told me that EDF is capable of handling large infrastructures, but less able to manage small, dispersed systems like this. Each company has its own unique composition. Today, one thing is certain : a comprehensive international census presented by the French Environment and Energy Management Agency (ADEME) last year showed that with 50,000 members, we are the largest company in the world in the field of energy demand response. It is not EDF or any of its subsidiaries…

Marketing

Q. : *How do you manage to find new members ?*

P. B. : Our aim is to regroup as many electrical boxes as possible to be installed in a defined geographical location. Because the service we offer is completely free, our principal target is partners who want to offer their clients this as a sort of present. These partners may be property developers, local authorities, council housing bodies, and so on. They can tell their clients about the system's ecological benefits, or that it is free and clever. We have also signed an agreement with the Brittany regional authorities whose aim is to encourage members to put distributive load shedding technology in place, targeting up to 60,000 members this year, and we are committed to equipping them by providing, installing and operating the boxes. This enables us to make economies of scale by organising a local network of installers for these customers. Publicity which we have received from articles written about us in the press has also resulted in a great number of individual requests by telephone or from our website.

Q. : *Do you let members choose the number of blackouts in a year (ten, twenty or fifty), or do you have a standard offer ?*

P. B. : In the beginning, we wanted to offer a service where we indicated the number of hours during which we would turn off appliances every year. This was difficult to convey because people thought that their heating would be stopped for several hours *at a time*. So this led us to invent a system where the consumer can press a button to reactivate control of his heating whenever he wants. Actually, people use it very little.

International

Q. : *Is your innovation protected by a patent ?*

P. B. : We have registered patents and we are preparing others. Our innovation is not just our BluePod boxes, but also the software and the algorithms whose distribution is easier to control. Having said that, every successful innovation ends up by being copied after a certain length of time.

Q. : *In view of the way electrical systems in other countries are organised, will you be able to develop your company abroad ?*

P. B. : In Europe, all the models of electricity markets are relatively similar. Elsewhere, they can be different, but the costs of electricity production are comparable and demand response always adds value.

Presentation of the speaker :

Pierre Bivas is an engineering graduate from the Corps des Mines and is CEO of Voltalis since its inception in 2006.

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