

The trailblazers of the universal energy revolution

by

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Overview

Discussion about energy transition is no longer based on ideological issues, but has become economically focused. Renewable energies are now more competitive than fossil fuels and have less negative impact on the environment. Despite this unquestionable observation, there are still obstacles to the development and distribution of environmentally-friendly energy because a centralised and dominant method of functioning still seems to pervade our country. In this area, experiments have proved that new 'green' solutions are viable and harmless. They involve making new partnerships with those concerned, putting an end to old-fashioned behaviour, and giving initiatives to those involved locally. We welcome three speakers who are resolutely committed to this energy transition to talk about their experiences.

Report by Sophie Jacolin • Translation by Rachel Marlin

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Michel Berry: People tend to adopt fixed positions and have unrealistic expectations regarding energy transition. Some people dream about a future where nuclear power plants are replaced by completely natural and decentralised energy production, whereas other people consider that renewable energies are too unpredictable and intermittent to provide a serious solution. These wide-ranging views seem to ignore the fact that in this area energy transition is already underway, and this can be seen in a large number of innovative approaches. Initiatives taking place in the town of Loos-en-Gohelle, Akuo Energy and ENGIE demonstrate this.

■ Talk: Jean-François Caron

A life-size model

The town of Loos-en-Gohelle embodies in its physical landscape the very nature of what is at stake with regard to energy transition. Its slag heaps are the proof of the mining area's deregulatory part in climate change. The closure of its nine coal mine shafts fundamentally destabilised the town economically, socially and environmentally. The mining areas of Loos-en-Gohelle had long been governed by Les Houillères mining concessions. Today the town must gain its autonomy, change its method of governance, and demonstrate its ambition and creativity. In the past we were used to extracting coal from 1,000 metres underground. Today we have to show that we are able to adapt, and are open to the world and also to produce good results. In the face of competition, we have started the race with a few handicaps.

Despite this, the town has committed itself to a sustainable transition, relying on a novel organisation of the elements present. Rather than resorting to the dominant management methods, we prefer processes which have their origins in this area and draw on support and help from local people. We are doing everything we can wherever there are issues concerned with energy, and the results are proof of this. Loos-en-Gohelle was named ADEME's (*Agence de l'environnement et de la maîtrise de l'énergie*: French Environment and Energy Management Agency) model 'demonstrator town' in its programme of energy change to create sustainable cities. A trip to Loos-en-Gohelle was the only organised visit scheduled by the participants of the 2015 United Nations Climate Change Conference, the COP 21.

Towards a third industrial revolution

How can a region drive an innovative energy policy and a decentralised production programme? Having drawn inspiration from the vision of the famous futurist and American militant Jeremy Rifkin, and benefitted from his direct support, the *Hauts-de-France* region was able to develop its strategic project entitled the 'Third Industrial Revolution'. Jeremy Rifkin managed to turn the discussion around by demonstrating to the economic actors in our region that they would deprive themselves of wonderful opportunities and even expose themselves to considerable losses if they did not take part in this energy transition.

The 'Third Industrial Revolution' cited by Jeremy Rifkin is characterised by two combined events, the adoption of renewable energies and the widespread deployment of the Internet. It comes at a time when the curb on fossil fuel sources certainly brings with it availability issues, but also cost issues because the CO₂ taxation system is still difficult. Rifkin predicts in concrete terms that in five or ten years' time, a private individual will be able to produce electricity because of the micro-wind machine installed on his roof. If there is a surplus of energy supplied by this machine, then it will be transferred to his neighbour's dish-washing machine which will automatically start functioning.

Rifkin thinks that this revolution relies on certain cornerstones, namely the development of renewable energies, energy-producing buildings, energy storage, intelligent networks ('smart grids') and mobility. I would add that

some elements which are necessary for renewable energy are in short supply such as cobalt in the constitution of solar panels. Regardless, all the companies and people concerned in our region are well aware of the project and are organising their activities around three areas: energy efficiency, the service economy, and the circular economy. Hundreds of projects have emerged, partly financed by a *livret d'épargne populaire* (a savings account for people on low incomes) which is dedicated to the Third Industrial Revolution.

One of our major symbolic successes was to have made this subject 'trendy'. Everyone from those working in the textile sector to those in the metalworking industry is convinced that it is trendy. This enthusiasm was started by Philippe Vasseur, who at the time was president of the Nord de France regional Chamber of Commerce, and who in turn was supported by political backing at the highest level from the *Nord-Pas-de-Calais* and then the *Hauts-de-France* regional councils.

Consuming less, producing better

As far as the region is concerned, the energy question has two major issues: to save energy, and to produce decentralised renewable energies.

The primary source of energy savings. Traditional productivist logic postulates that it is inevitable that energy consumption will increase. However, the opposite is true as the first source which we have is energy savings. According to ADEME, France spends 70 billion Euros on fossil energies (gas, oil, coal and uranium), and the construction sector accounts for 30 to 40 % of the total consumption. If a national plan for the renovation of buildings with a budget of 7 billion Euros per year existed, the benefits would be huge as would the side-effects such as energy independence with regard to producing countries, less energy insecurity, the creation of jobs, and so on.

At Loos-en-Gohelle, simply renewing street lighting has resulted in spectacular reductions in consumption. We are also investing in eco-construction and eco-regeneration, including for social housing projects. The annual cost of heating in this sector has fallen to less than 150 Euros for a 3-bedroom apartment compared to 1,500 to 2,000 Euros for accommodation using conventional electric heating. The same is true of spending power. We use building materials which come exclusively from the Hauts-de-France region, apart from the solar panels. Furthermore, the town has an eco-mobility policy notably with its bicycle plan and its 'Green Belt', a network of links favouring transportation on foot or by bicycle.

Additionally, we encourage the emergence of new economic models. When we commission public works, we systematically encourage the use of methods from the circular economy and the service economy. They also have a carbon footprint.

Additionally, our support for organic farming and short circuits is beneficial in terms of energy savings and CO₂ emissions. Using intensive farming techniques, a plot of wheat is ploughed by a tractor fourteen times every year, and is subject to inputs and plant health products. Five of our farmers have changed to organic farming methods and chosen short circuits. They have increased their revenues compared to their colleagues who have remained with the conventional farming model.

The production of renewable energies. Loos-en-Gohelle has an economic centre of excellence which handles energy questions. It includes the TEAM² (*Technologies de l'environnement appliquées aux matières et aux matériaux*) competitive cluster, a business incubator, and even a test platform for solar technology. Solar technologies are more efficient than expected in our region where the hours of sunshine are limited. In fact, the sensors work better when temperatures are low and they can be cleaned by frequent rain showers, unlike in Spain where the accumulation of dust limits the transfer of electrons.

We have one of the seven poles of excellence which the public authorities decided to finance in the *Hauts-de-France* region, alongside those which exist exclusively for the automobile and railway sectors. We are recognised as a source of employment as well as a support lever wherein other sectors will be able to reduce their energy dependence.

Our expertise in solar sensors has allowed us to develop many experiments in the town in co-operation with energy providers. The roof of the Saint-Vaast church is the first church in France to have been entirely covered with solar panels. Such a memorable operation on this scale is crucial in change management strategy. Incidentally, it represents an annual saving of 5,000 Euros for the town. We are gradually witnessing a breeding ground for innovation in terms of renewable energies and in initiatives taken by municipal employees. Our municipal 'solar plan' aims to equip all public roofs, followed by private roofs, and will be financed by the town's population in the form of a community-oriented cooperative enterprise. Symbolically, since 2018, because of this scheme, every new-born baby has been given one square metre's worth of solar sensors on our roofs.

It goes without saying that the fleet of the town's official cars has been running on natural gas for a number of years.

Finally, in collaboration with the regional council and the French government, we are demonstrating that the regions which suffered during the second industrial revolution can be revitalised thanks to energy and the Third Industrial Revolution. It will be the opportunity to show that discussions about energy can result in exemplary and successful approaches on a local level.

■ Talk: Éric Scotto

The virtues of long-term investment

Akuo Energy's experiences illustrate two dimensions whose importance Jean-François Caron has just underlined, namely the phenomenal acceleration in the energy transition because of the convergence of renewable resources and digital technology, and the role played by regions in this revolution.

'Agri-energy' on the island of Réunion

Akuo Energy develops, finances, builds and operates power plants using exclusively renewable energy sources (such as the sun, wind, hydropower and biomass). Over the past fifteen years, we have been working tirelessly on the development of a new, sustainable and decentralised energy model.

We installed our first solar equipment on Réunion where the problem of being an island and one which was not interconnected forced us to use our imagination, but with help from the local population, we were able to solve the issues of resilience. We came across fierce competition from many energy providers who were attracted by the island's tax incentives. Immediately we were faced with the problem of space. How could two activities which were essential for man – farming and the production of energy – coexist? Rather than pit them against each other, we combined them so that they were mutually beneficial. We invented anticyclonic greenhouses covered with solar sensors which provided the population with a guaranteed food source during the tropical storm period.

This concept of 'agrinerger' (a combination of agriculture and energy) which went against the established order, firstly ran into considerable opposition, because, without knowing it, we were inventing a new economic model. By paying for a tool which the farmers would not have been able to afford themselves, and by paying their salaries for three years (the length of time necessary for the soil to be replenished), we enabled them to change from extensive farming methods to organic cultivation and even permaculture. We must make it clear that these farmers do not repay us at all. They are developing their own economic model.

This is not a case of philanthropy as far as we are concerned, but well understood mutual interest. In fact, these solutions ensure that we are sustainably established on the island. The main characteristic of our private company is that it is based on the long-term. We have not drawn up a business plan for the next twenty years with a bank loan covering the lifespan of the solar panels, but we have worked towards a timeline of fifty or even seventy

years. This means that as shareholders we will be less 'greedy' in the very short term. On the flipside, we have to commit for at least half a century towards making life in this region dynamic and creating wealth there, and this is a guarantee that our energy bills will be paid off. We are building our profitability in the long term.

This strategy has been extremely successful on Réunion, to the point that very soon after it began, 40% of the island's energy mix came from renewable energy sources. However, this did not signal the end of all the technical problems. The passage of clouds in very sunny areas creates variation in energy supply which is hard for a network to manage. Six years ago, we decided to resolve this problem by storing energy as we thought that this would be a determining factor in accelerating the energy transition. Since then, the cost of storage has been reduced fivefold. I do not deny that these solutions give rise to new challenges, in particular the availability of rare earths. As a response, it is important to mobilise a broad spectrum of techniques: pumped storage plants, lithium-ion technology, and also techniques related to the production of hydrogen. Massive, stationary storage of hydrogen now is a viable solution. This was not the case until recently because half of its cost was taken up by its production. Now that this energy is abundant and not expensive, storage is possible, and a virtuous circle exists.

Spurred on by the results on Réunion, farmers in New Caledonia asked us to do the same in their region. After this operation, we have spread our activity to many islands around the world, in particular in Indonesia.

The first Akuo farm in mainland France

We are now investing in mainland France. An Akuo farm will soon be in operation in Piolenc (*Provence*). This is a project which we won by public tender, in other words, we were the lowest tender. Once again, we devised the project based on the specificities of the area, in this case, a quarry filled with water next to the river Rhône. We debated the possibility of transforming it into a leisure park, but that would have been expensive for the town. We decided instead to cover this wasted space with floating solar panels. This sort of project is financed thanks to banks which are confident that we will sell our energy over the long term. As far as Akuo is concerned, it reduces its short-term profitability as a shareholder in order to finance the permaculture in this quarry. There are obvious local benefits such as the creation of jobs and the provision of local school canteens with organic fruit and vegetables, all using short circuits. In these circumstances, energy providers can become partners in the 'rebirth' of a region by their ability to integrate the long-term into the assessment of the profitability of their project.

This regional project which boosts both an energy and agricultural transition is purely financed by the revenues generated from the production of energy.

The reason why renewable energy sources will be essential

We must put an end to the myth of renewable energy which has to be subsidised. Today it is fossil fuels which are able to exist thanks to public money. They account for two-thirds of all global energy subsidies¹.

Regardless, an operator like Akuo has no other choice than to be competitive in order to win bids for tender, including traditional operators. Yet, renewable energies have won the economic battle. A megawatt-hour of renewable energy costs less than 50 Euros in France, which cannot be compared with the cost of nuclear energy. As Al Gore said, nuclear energy is no longer an industry inasmuch as it is no longer able to cover its investment costs. Renewable energy is the most economically competitive and the least environmentally damaging source of energy. It is time that renewable energies occupy a place in a strong-willed energy policy. In a country like France which produces too much energy, there is no point in increasing its traditional energy capacities. However, one must make choices. If not, renewable energy providers will not be able to grow.

1. Source : International Energy Agency

A low-carbon, decentralised and digitalised future

ENGIE's vision of the energy transition is in line with the previous case studies. I would say it is rather complementary.

The future has not yet been determined. Our past has been marked by changes in direction. Let us not forget that energy was first produced in a decentralised way. Gas factories in the past were local and provided the needs of a town. The network was only unified during the 1960s and 1970s. Similarly, electricity was first supplied by local, urban and even rural companies. Electrical interconnection between towns is relatively recent and resulted in economies of scale, the choice of nuclear energy and a specific means of setting the tariffs. This movement brought with it a very centralised logic.

Are we heading towards a model which is completely decentralised? This is undoubtedly the case in some African countries which will remain without interconnected networks. Elsewhere the question is unresolved. Some countries advocate solutions which are entirely local and decentralised, but will they really be disconnected from the network? Others, like China, think that solar and wind energy will be produced where the climatic conditions are the most conducive, and then be relayed, by a global network, at high voltage and by direct current (so called HUVC). I do not know which of these models will prevail. I do not find the second very credible on a planetary scale, but it is plausible on a regional level.

We are therefore at a crossroads. In this sort of situation, one must have a few convictions in order to move forward/progress.

Using less, decarbonising, and then only electrifying

ENGIE strongly believes that it will be essential to play on the synergy of the energies. However, one factor must not be forgotten: the need for energy efficiency savings and to lower the level of peak demand for electricity. In winter, demand is so great that we have to import coal-produced electricity from Germany. This dispels the myth of decarbonised electrical heating. A natural gas condensation boiler is more efficient than the majority of heat pumps used in France when it is really very cold.

Having made energy savings, we need to decarbonise, in other words to systematically encourage solutions which involve less carbon content by playing with their synergy. In this case, the geothermal heat pump (which can be a substitute for fuel) makes perfect sense. Nuclear power also has a role to play. As long as existing nuclear power stations are safe and supervised by an independent authority, they should be operated because they do not give off carbon. On the other hand, ENGIE has decided not to invest as a shareholder in new nuclear equipment because this economic model cannot sustain a private company.

It is only after having made energy savings and decarbonised that one must electrify. ENGIE has chosen to offer only 'green' electricity to its new clients. In just one year this has enabled us to gain one million new clients in France. Similarly, we promote hydrogen as a means of storing energy. The reduction in the marginal cost of the production of renewable energy creates a virtuous circle where electrolysis, storage and fuel cells are involved. The hydrogen used by fuel cells may also be used towards mobility solutions or be transformed into methane.

Digitalising and, where appropriate, decentralising

In reality, the energy transition will take on very different forms depending on the regions and the initial energy mix, aspirations, and local specificities. Acceptance of wind turbines will vary from place to place, the availability of space in which one can make solar installations also varies, as does the potential for hydraulic, geothermal and biogas energy. At ENGIE, we have chosen to provide solutions based on a decarbonised, decentralised and

digitalised future. We intend to put the client at the heart of this focus, thereby breaking with the conventional centralised vision in which engineers decided on the correct source of energy to supply to consumers.

Digitalisation supports our energy innovations. We use it in our production processes. An example of this is Darwin, our data collection and optimised piloting tool used throughout our renewable energy parks (wind turbines, solar panels and, in the future, biogas). Digital applications also facilitate clients' lives. There is a website, www.manouvellechaudiere.com, where clients can post a photograph of their faulty boiler *in situ*, and, in less than two hours, we can send them a quote to replace it with a more efficient machine.

Finally, decentralisation helps to provide solutions to regions which do not have access to energy. In Africa, ENGIE and the Zenith company have developed domestic solar solutions for homes or groups of houses. In Papua New Guinea, we are working with Electric Vine Industries to provide solutions at the village level which consist of solar panels on pylons and batteries.

In France, GRDF has connected forty-eight biogas sites to the natural gas network. Some of these are powered by urban waste or sludge from water treatment plants. We should point out that ENGIE does not encourage the production of biogas produced from agriculture which is planted with the sole intention of producing biogas as it would be in direct competition with food crops. We also intend to produce gas which is 100 % renewable. If we succeed, the gas network will be powered from the distribution system, with "backwards" installations feeding the gas into the transmission or storage system : this is the exact opposite of the reasoning behind the construction of the network.

Will this vision become reality? We are working very hard for this to happen. All the same, the future is uncertain. Predictive models are not very reliable, and are sensitive to tiny variations in hypotheses. Changes in price differences between solar energy, wind-powered energy and hydraulic energy are likely to disrupt them severely.

When faced with a number of future possibilities, one must be pragmatic, choose decarbonised energy in all of its different forms, keep a maximum number of options open, experiment, observe the reaction of clients and those involved, develop solutions which work and disregard those which do not. This implies adopting more decisions which are taken locally so that potential solutions can be assessed locally. Needless to say, in a group like ENGIE which employs 155,000 people, this sort of decentralisation does not just happen overnight. We have to work towards it every single day.

Discussion



Renewable energy for everyone?

Question: *In the northern and southern hemispheres, how can we increase access of the world's poorest populations to renewable energy?*

Éric Scotto: Our governments and companies have a duty to encourage access to energy. In Africa, barely 40 % of the population has access, and yet decentralised electrification of a region, in particular the free clinics and schools, is a local development issue which limits rural exodus and migrations. Technologies exist which are less expensive. For example, ENGIE has just won a tender with Meridiam to provide solar energy at \$3.80 per kilowatt-hour in Senegal. Unfortunately, whenever the country involved is in Africa, money-lenders demand a very short return on investment for fear that they will not be reimbursed. If in the future they lend money

to industrialists at a fair price, we could equip these countries with energy at a very low cost. I do not mean subsidies, but financing at normal costs.

Didier Holleaux: In the northern hemisphere, the situation is more complicated. In France there are social tariffs which guarantee certain access to energy. The problem is that the systems which make it possible to finance energy efficiency improvement in housing efficiently in terms of energy are not powerful enough. The only solution to this problem is strong-willed political action.

Viable storage solutions

Q.: *The difficulty of storing wind and solar energy has been seen for a long time as an obstacle to the development of these energies. What innovative storage solutions exist today, coupled with the storage of gas?*

D. H.: In the future, first- and second-generation biogas as well as hydrogen will be able to provide the supplement which is essential to the method of storage by batteries in the short term which is currently used. We are particularly interested in biogas, not only for the biomethane which is produced when wet matter and agricultural waste is fermented, but also for the pyrogasification of wood or straw as a means of producing hydrogen or methane which can then be stored.

In the future, regions could have both factories to produce methane from forestry resources as well as a series of smaller installations regrouping one or several farms with a biogas plant connected to the distribution networks. We predict that in 2050, France will be able to use renewable gas exclusively. This should ensure inter-seasonal storage.

Jean-François Caron: Increased energy costs and taxation (which will continue to increase on fossil fuels) will make solutions viable, which until now seemed prohibitive. Energy providers, for example, have suggested interesting ideas such as taking advantage of our mining shafts and tunnels in order to store heat or compressed air. We need to experiment in these fields.

On a different topic, electric cars may be a significant way of storing energy. Currently, we have connected our church to two electric cars belonging to the neighbouring Beguin convent which welcomes elderly people. We are simultaneously testing the idea of sharing cars.

Q.: *You have discussed storage. What about transporting electricity? For example, how will the Baltic wind turbines provide populations in Bavaria with electricity?*

D. H.: We have not yet solved the problem of acceptability of electricity transmission lines over long distances. In Germany there is congestion between the north and the south, and there is no high-voltage line which could redress the network balance. Other solutions are being developed at the same time which remain quite expensive, but are inventive, and consist of producing hydrogen in northern Germany, transforming it into methane, and transporting it by pipeline.

Is Germany a counter-example?

Q.: *Germany is the country which has most invested proportionally in renewable energies, but also has the largest CO₂ emissions per kilowatt-hour in Europe. German electricity is coal-generated, and even more so nuclear electricity which still works at 77 % of its capacity. How do you explain this contradiction between your talk and the German example?*

É. S.: Germany has made a brave political choice by establishing the objective of using renewable energy for all of its energy needs. Since it had a cultural attachment to the principle of energy autonomy, it committed itself to energy transition before other countries. This pioneer approach was, by definition, costly. The Fukushima incident led to the harsh political decision to stop nuclear energy production, which disrupted the initial plan.

Germany will undoubtedly reach its objective because the technology is available. There are currently ninety building permits for the installation of offshore wind farms in the North Sea with record-breaking energy costs of less than 50 Euros per megawatt-hour. Because of Germany, the cost of wind power has fallen throughout the world.

France is building a nuclear power plant in Great Britain. Electricity will cost 120 Euros per megawatt-hour. France is faced with the important problem of how to manage nuclear waste which it does not know how to store safely for thousands of years to come. The countries which bought our nuclear power plants send their waste to France. France is in the process of becoming the world's nuclear dustbin.

Nuclear power will never be cheap again. Renewable energy has definitively won that economic battle. Since the COP 21, all the money-lenders in the world have measured their capacity to accelerate the energy transition, and reallocate funds from fossil energies to renewable energies. If Henri de Castries, who was once the CEO of Axa, promised to no longer invest one Euro in coal, it was because he realised that his portfolio included a toxic asset in both a figurative and literal sense. All these money-lenders still have shares in power plants which have not yet broken even. These assets do not have any value in the long term any more. Their brutal depreciation would have catastrophic effects, and so this movement must be progressive. It is also for this reason that the transition is moving forward slowly, but it is nevertheless relentless.

D. H.: Germany's plan for conversion to renewable energy was undermined by the decision after Fukushima to halt nuclear energy production. This places Germany temporarily in an incoherent situation. There are no grounds for concluding that every transition to renewable energy is doomed to fail.

Ingenious plans might be found which involve using the existing nuclear capacities in a certain number of countries including Belgium and France. However, it would be unreasonable to build new nuclear plants. The costs of the production of this energy would make such a plan pointless. No-one would pay this much for electricity.

Today, the real issue is how to replace the world's 1,900-gigawatt coal production capacity. The one hundred and fifty nuclear projects in the world represent 150 to 190 gigawatts, therefore they can only resolve 10 % of the problem. We ought to be more interested in the remaining 90 %. The solution in this case is not nuclear, especially since the energy needs exist in countries where nobody wants to build a power plant. Besides, such plants would take fifteen years to be built, and we do not have the luxury of time.

J.-F. C.: Wind power will not replace nuclear power. This is not in doubt. However, one must develop models which are less time-consuming and are based more on enriching the energy mix. Take the example of the hospital in Lens which is about to be totally rebuilt. With a capacity of seven hundred beds, it will be the largest hospital construction site for the next decade. 80 % of its energy needs will be provided by deep geothermal energy. I am not sure whether a few years ago one would have even considered this energy source. The transition will take place via a multitude of local responses which will reduce the demand and diversify the offer. Consequently, nuclear energy will slowly decrease.

Trust, the 'magic wand' associated with the transition

Q.: *Jean-François Caron, how do you encourage the inhabitants of your town to agree to initiatives which are likely to greatly change their way of life, and even cost them more? I am thinking in particular about the building renovation.*

J.-F. C.: The political thinking of the town is favourable to these sorts of building site projects because the population trusts our collaborative skills.

Michel Berry: I should point out that Jean-François Caron was elected mayor in 2001 as a member of the Green Party which was a major achievement in a region populated by mining cottages. He was re-elected for the first time with a majority of 82.1 %, and a second time with a majority of 100%.

J.-F. C.: Trust is gained with time, but once one has acquired trust, it is like a 'magic wand' when one wants to mobilise people. Take the example of our favourite topic, the renovation of existing buildings. The problem

is that investment does not generally benefit the person who finances it (the owner), but rather the third party (the tenant).

As well as the financing problem, there is a technical difficulty. I was contacted by the French Building Trades Association about the important lack of technical skill in this sector. To cite a specific example, an electrician who installs a plug with a bell saw will destroy the airtightness of an apartment and damage its energy efficiency. The Association considers that it is important for construction workers to receive training about new methods, and for different trades to learn to work together. This would require changing the labour organisation, but also allocating responsibilities in case energy efficiency is not adequate. We have a system whereby the performance of a building is officially evaluated.

We tested the processes of renovation in one of our many mining engineer's houses which are true energy pits, using exclusively eco-materials from local areas (including sheep's wool and hemp). It is possible for fifteen people to live in this 'test house' when the outside temperature is -7°C without having to turn on the boiler. The heat given off by the inhabitants is enough to heat the building.

This pilot study was extended to six other test houses. In 2017, the French prime minister Bernard Cazeneuve announced a contract to renovate this mining area, and the key measure was the renovation of 23,000 accommodation units for miners. This was made possible by the work we had already done in terms of research, the determination of costs and expected performances, and consequently the necessary length of time to secure a return on investment. We are currently creating a certification tool which ensures a link between the level of investment and the amount of energy savings. This reassures the bankers as well as the consumers. The entire profession became actively involved in the project.

Let us discuss the farmers. I did not preach to them about converting to organic farming as I might about changing religion. The intensive model was a constituent part of their identity and abandoning it would run the risk of being seen as a setback. I reassured them that they would have a local market, notably with schools by establishing a network of the thirty-six towns in our urban agglomeration. As a result of the trust we were able to create with the farmers, local consumers and school canteens in our meetings with the local MPs, we were able to make progress. It was also essential that this change should be carried out by a group of farmers rather than by a single person who could become some sort of martyr or become ostracised by his peers.

É. S.: Participatory or collective investment is also a means by which people can support innovative solutions. This is very popular. Citizens want to invest in sustainable models in their regions and support employment, and benefit from their investment. Subsequently, we have created the AkuoCoop platform which is in the process of becoming a real way of financing the transition.

Constant cultural obstacles in France

Q.: *It is surprising that in these discussions, politicians always evoke environmental issues and not economic ones. What about economic questions? What would be the most efficient way of spreading your experiences?*

J.-F. C.: This subject touches on a culture which was acquired by a certain number of professionals during their early years as engineers. Faced with a paradigm shift, they find it hard to ignore pre-conceived ideas.

I do not advocate that we should do without centralised energy. As well as solutions in the field, we need systems of security and guarantees. This is the reason why, even though I am an ecologist, I support RTE (the network of the transport of electricity) in many places. My heartfelt conviction is that the world of large-scale industry and engineers is in the process of disappearing. I see those hanging on to this old order standing in the way of the administration and politicians in order to limit the development of innovative models. I am convinced that we are moving towards collaborative and flexible schemes in which those involved – especially the regions and the economic circles – will find the solutions intelligently. The traditional French nuclear model has run its course. It is obviously difficult to abandon what was once a national flagship. From my point of view, this problem is largely cultural.

É. S.: The reason that Akuo almost immediately became international is that we recognised the cultural barriers we were facing in France. 83% of electricity in France is still nuclear. As long as the dominant way of thinking

leaves no place for innovations, we will not be able to move forward. We should leave it to SMEs, SMIs and large groups such as ENGIE to develop creative solutions! There are lots of them and they are very accessible. Take the example of data centres which in a few years will account for 12 % of the world's electricity consumption which is an intolerable prospect. A solution was perfected which consisted of submerging the computer servers in thermal oil: this would avoid having to cool them down and would make it possible to recover the heat that they give off which can then be used to heat buildings. This system works and is competitive.

Q.: *Is it not a bit foolish to oppose the 'goodies' (who are in favour of 'everything renewable') with the 'baddies' (who are engineers who have not totally turned their backs on nuclear energy)?*

É. S.: There are no 'baddies', but simply decisions made at a time when the country had to become autonomous in energy terms. Times have changed. Today most of the world agrees that we should encourage renewable energies. France is one of the last countries where this cultural discussion is still on-going. However, ENGIE's perspective or Jean-Bernard Lévy's announcement (EDF's CEO) to invest in 6 gigawatt-hours of storage would suggest that the transition is progressing.

J.-F. C.: Far from me to stigmatise large groups in principle. The proof is that we are implementing our solar plan with EDF and that we are operating our solar energy plant with ENGIE. We should set aside the *status quo* and think up new, collective schemes with help from those in the field.

■ Presentation of the speakers ■

Jean-François Caron: health executive, physiotherapist, mayor of Loos-en-Gohelle and vice president of the Lens-Liévin conurbation in charge of innovation and transition towards the Third Industrial Revolution. He is the president of the *Centre de développement des éco-entreprises* and the Lumiwatt Association on solar energy.

Didier Holleaux: after a career in the French administration culminating in the position of principal private secretary to the Energy Minister between 1992 and 1993, he joined Gaz de France (which later became GDF SUEZ, and then ENGIE) in 1993 where he had various jobs in the fields of transport, liquified natural gas, exploration and production, and distribution. He has been the deputy director general of ENGIE since July 2015.

Éric Scotto: president and co-founder of Akuo Energy, having been an Internet pioneer. Akuo Energy, the leading independent producer of renewable energy, develops, finances, builds and operates energy production plants, and also suggests solutions in areas where the company has sites.

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