Public debate on 28th June 2018 at the conference Sustainable Places at Le Bourget du Lac

SUSTAINABLE PLACES 2018 June 27-29,2018 Aix-les Bains, France

list cea tech

1/ Présentation de l'initiative

Organisateur(s) : CEA-LIST

Intitulé de l'événement: Putting residential flexibility management into action with pilot sites in Europe: Feedback from MAS2TERING, BEEST and DRIvE European projects

Date et Lieu : Conférence Sustainable Places 2018, INES, Le Bourget du Lac, 28 juin 2018

Forme de l'initiative : atelier avec des présentations, suivi par un débat public

2/ Déroulement

Programme :

- "Mas2tering project: Multi-Agent Systems and Secured coupling of Telecom and Energy grids for next generation smartgrid services", Marie-France Robbe (CEA)
- "Building Energy Efficiency Management & Smart Grid Integration Tools", Stefan Lodeweyckx (ENERVALIS)
- "DRIvE project: unlocking the demand response potential in the distribution grid", Stefan Lodeweyck (ENERVALIS)
- "Business Model Opportunities for local flexibility aggregation", Juan Manuel Espeche (R2M)
- "Streaming Data-based Forecasting for Demand Response: from Mas2tering to DRIvE", Monjur Mourshed (Cardiff University)
- "Multi-agent system optimization for local energy communities: from Mas2tering to DRIvE", (Meritxell Vinyals, CEA)
- "Authentication, Authorization & Accounting: from Multi-Agent System to grid security", Paul-Emmanuel Brun (AIRBUS)
- "Regulatory Frameworks Affecting Demand Response Solutions", Sergio Valentino Costa (COMSA)

- “Real-time Controller Hardware in the Loop (CHIL) as the key enabling technology for next generation Fast DR”, Nikola Stojkov (TYPHOON)
- Débat public

Qualité des intervenants : 8 intervenants scientifiques pour présenter les résultats des projets Mas2tering, BEEST et DRIvE.

L’Etat avait-il des représentants dans la salle et ont-ils répondu à des questions ? Aucun représentant de l’état n’était présent dans la salle. Nous avions invité les élus des conseils municipaux de Aix-les-Bains, Le Bourget du Lac, Chambéry, La Motte-Servolex. Certains élus ont répondu qu’ils étaient intéressés mais ne pouvaient se libérer. Ils vont recevoir le compte rendu du débat public.

Combien de personnes étaient présentes : élus, entreprises, associations, grand public, etc.) ? 32 participants, y compris les orateurs.

Comment la salle était-elle disposée ? Il s’agissait d’une salle de classe de l’IUT avec vidéo-projection des diapositives des présentations sur un écran, puis débat avec la salle.

Combien de participants se sont exprimés ? 8 personnes ont posé des questions à l’oral.

Ambiance générale : Certains participants sont venus pour faire passer des messages et orienter le débat vers leurs centres d’intérêt, ce qui n’a pas permis d’avoir un débat neutre sur l’ensemble des énergies et a freiné l’intervention d’autres participants.

3/ Résumés des présentations

- “Mas2tering project: Multi-Agent Systems and Secured coupling of Telecom and Energy grids for next generation smartgrid services”, Marie-France Robbe (CEA)

The main goal of Mas2tering (2014-2017, FP7 project) is to develop an automatic system that enables to adapt the residential consumption to the local production. Domestic final users will be progressively equipped with technologies able to provide flexibility: programmable smart appliances, local storage systems and local generation systems. Flexibility is the capacity of the controllable smart technologies to modify consumption/generation day-profiles based on external and internal conditions. The Mas2tering software platform uses this flexibility to perform a multi-level optimization of electric grid management from the user level to the district level, by way of a local community of prosumers.

The home-level optimization uses the user’s flexibility to reduce his energy bill by shifting electric loads when local generation is available to maximise self-consumption or when electricity tariffs are cheaper, whereas respecting the user’s preferences. The local community optimization enables to balance the local grid by trading local generation surplus of some prosumers to other local community’s consumers at tariffs more interesting than those proposed by the corresponding prosumer`s supplier. At the low/medium grid level, the optimization enables to smoothen the electric consumption during the day, to avoid peaks requiring to build additional production units little used during the year and very expensive to manage, and to reduce congestions (peaks of demand that may overcome the transformer limits and cause a district electric black-out).

The Mas2tering platform is protected by several security components to ensure the security and the robustness of the platform against vulnerabilities and potential cyber-attacks. The performance aspects of the platform were validated and assessed using quantified objectives to demonstrate the conditions under which Mas2tering has the potential to perform profitably. The Mas2tering solution has demonstrated potential self-consumption of 99% at the community level, peak reduction up to 18%, reduction of grid losses between 5% and 8%, and potential for substantial energy and carbon savings across the European Union.

- “Building Energy Efficiency Management & Smart Grid Integration Tools”, Stefan Lodeweyckx (ENERVALIS)

The main objective of BEEST (2014-2016, InnoEnergy project) is to develop a suite of applications (“apps”) aiming at reducing the energy costs in tertiary buildings by reducing energy consumption on the one hand, and unit cost of kWh on the other hand. Energy cost in hotels and office buildings constitute a significant part (20-30 %) of the total operating expenditures and the foreseen trend is for it to increase, thus threatening profits. Energy’s intangible nature and the complexity of its price components make it difficult to modulate exploitation practices in order to ensure that its associated cost is kept as low as possible. The BEEST suite of apps addresses the optimization of exploitation practices in 3 different dimensions.

In the Facility Management dimension, energy consumption is minimized by automatically optimizing working parameters in the Heating, Ventilation and Air Conditioning System through the existing Building Management Software. In the Energy Procurement dimension, assistance is provided to optimize price-sensitive contract parameters, such as contract demand. Finally, access to benefits of energy market deregulation, such as Demand Response programs and direct purchase in the wholesale market, are also explored.

The performance aspects of the suite were assessed and validated using quantitative indicators and Measurement & Verification techniques. Evidences were gathered that savings up to 20-25 % of the total yearly energy cost in the building can be achieved. Additionally, BEEST has demonstrated that a wide range of Building Management Software modules are susceptible of being connected to the suite for automatic cloud-driven operation of the Heating, Ventilation and Air Conditioning system.

- “DRIvE project: unlocking the demand response potential in the distribution grid”, Stefan Lodeweyck (ENERVALIS)

DRIvE (2017-2020, H2020 project) links together cutting edge science in Multi-Agent Systems, forecasting and cyber security with emerging innovative SMEs making first market penetration in European Demand-Response markets. Near-market solutions are strengthened with lower TRL, higher risk functionalities that support a vision of an “internet of energy” and “collaborative energy network.” From the research side, Multi-Agent Systems will move closer to real time operations and progress from a limited number of assets toward decentralized management of a larger number of assets providing Demand-Response services to prosumers, grid stakeholders and Distribution System Operators (DSO).

The research will deliver a fully-integrated, interoperable and secure Demand-Response Management Platform for Aggregators with advanced hybrid forecasting, optimization, fast-response capabilities and enhanced user participation components in a standard-compliant market-regulated manner, empowering a true cost-effective mass-market (100's millions of heterogeneous assets).

The project features 5 pilots across 3 countries consisting of a stadium, wind farm, 7-floor office, tertiary & residential buildings within medium-large districts, resulting in over 25 MW of potential flexible capacity. Direct engagement of 100 households and 2 tertiary buildings (over 1,000 persons) is attained and replication to over 75,000 persons is possible. The pilots will be running in real DSO environment with real engagement of grid players.

Overall, DRIvE will make available average 20% of load in residential and tertiary buildings for use in Demand-Response, resulting in up to 30% cost-saving (price-based Demand-Response) and also maximizing revenue for prosumers (incentive-based Demand-Response). DRIvE will also allow a minimum 25% increase of renewable hosting capacity and up to 30% of overall reduction of CAPEX (capital expenditure) and OPEX (operational expenditure) costs for DSOs.

- “Business Model Opportunities for local flexibility aggregation”, Juan Manuel Espeche (R2M)

The Local Flexibility Market is presented as a multi-sided platform where the Local Flexibility Aggregator is positioned as the ‘match-maker’ between energy actors who need flexibility for efficiencies and Prosumers who have engaged in demand response initiatives. The multi-sided business model provides opportunities for numerous stakeholders to exploit through potential business strategies and collaboration opportunities that evolve with transitional phases of the market’s maturity. How the Mas2tering products can facilitate and penetrate this new market is presented and a business rationale and linkage is made for the project use cases. This led to the Mas2tering project storyline, use-cases and associated business cases (BC):

- **BC1**: Use of the Local Flexibility Aggregator business model opportunity by a **Supplier** to increase competitiveness, expand its value-added services, retain or grow its client base and answer the call to empower consumers from either Prosumers themselves, regulation or market pressures

- **BC2**: Use of the Local Flexibility Aggregator business model opportunity by an **existing Wholesale Market Aggregator (WMA)** to provide flexibility management services to Prosumers within a Local Energy Community to increase their flexibility portfolio and to facilitate the formation and goals of Local Energy Communities;

- **BC3**: **Partnering between a Supplier and WMA** to exploit the Local Flexibility Aggregator business model opportunity in a fully functioning flexibility marketplace where the Distribution System Operator is a flexibility buyer.

Conceptualizing and developing the Local Flexibility Aggregator business model opportunity as a multi-sided platform, is relatively new. How to structure it, ignite it, and fully deploy is not yet commonplace. Applied to flexibility management, it allows to move beyond the question of “is load shifting a viable business?” to a broader view of the value brought to multiple actors in an electricity market redesign and how that can be made into a viable business at the Low-Voltage grid level.

- “Streaming Data-based Forecasting for Demand Response: from Mas2tering to DRIvE”, Monjur Mourshed (Cardiff University)

Accurate forecasting of energy consumption and generation profiles is critical in smart grid management, especially as the electricity grid is expected to host a larger share of variable renewable energy resources such as solar and wind. This workshop presentation at Sustainable Places 2018 communicated our experience in developing forecasting algorithms for low-voltage grid management the EU FP7 project Mas^{2}tering and the proposed approaches for tackling the challenges of uncertainties in predicted profiles in the recently started Horizon 2020 project, DRIvE.

Our research indicates that the effectiveness of the forecasting algorithms relies on the methods applied and the timeframe/horizon of forecasting. For short-term forecasting, data-driven machine learning algorithms and detailed based simulations are more appropriate than simplified simulations and regression-based models that are more suitable for long-term predictions of energy profiles or single quantity. Occupant behaviour of energy affects the predicted profiles; therefore, further research needs to be carried out to identify ways to integrate the variable in large-scale forecasting. Prediction in intermediate seasons such as Autumn and Spring are more challenging due to their intermittent nature. The other key finding from Mas^{2}tering is that most, if not all forecasting models are static and do not account for drift, changes and adaptations in the use of a facility.

Our approach in DRIvE is to develop a streaming-data based forecasting solution that is able better able to consider changes in energy consumption and generation at different time scales.

- “Multi-agent system optimization for local energy communities: from Mas2tering to DRIvE”, (Meritxell Vinyals, CEA)

DRIVE and MAS2TERING projects aim to unlock the Demand-Response potential of residential and tertiary buildings in the distribution grid by empowering the role of a local aggregator via a decentralised solution based on multi-agent systems. Under a Multi-Agent System approach, each stakeholder (prosumers, aggregator, etc.) is modelled by a different autonomous agent that takes its own decisions based on its own internal business model and objectives. The coordination of Demand-Response actions (i.e. trading of flexibility) takes place via decentralised negotiation, avoiding in this way the privacy and interoperability issues caused by centralised approaches.

Moreover, the scalable architecture of agent-based technology makes it particularly suitable for Demand-Response solutions, which involve multiple optimisation levels: at the building, at the local community and at low-voltage grid level. At building level, the Customer Energy Management System agent optimises the use of flexible assets to minimise the corresponding prosumer’s energy bill and enables bi-directional communication with the energy network to participate in Demand-Response operations (making flexibility available to the aggregator or other grid users). At the community level, the so-called Aggregator agent enables a local decentralised flexibility market (via bi-directional negotiations with each Customer Energy Management System agent, member of its portfolio) with the objective of maximising the self-consumption of local (green) energy and the revenue of all prosumers. Finally, to prevent occurrence of local congestion at the distribution grid level, a Distribution System Operator agent can make an incentive-based flexibility request to the local aggregators, that in turn negotiate the provision of flexibility with their local markets in order to reduce the import/export of communities for the congested time-periods.

Results obtained on real-data simulation of local communities showed how Multi-Agent Systems can effectively integrate distributed generation (self-consumption at community level close to 100%) whereas maintaining energy security (peak-load and grid losses reduction) and keeping costs down for prosumers (12-15% savings in the bill). Moreover, for congestion management, results showed that - in all cases - the investment of Distribution System Operator is relatively small in comparison with the indicative capital cost of a transformer upgrade.

- “Authentication, Authorization & Accounting: from Multi-Agent System to grid security”, Paul-Emmanuel Brun (AIRBUS)

In order to build Flexible Demand Response (DR), connectivity of a growing number of assets is a key enabler. However, increasing asset connectivity, and building cyber physical systems brings cyber threats into the real world. Recent Cyber-Attack consequences, such as the blackout in Kiev in Christmas 2016, show that cybersecurity is a key function to guarantee the resilience of Cyber Physical System (CPS). Indeed, cyber-attack could have critical impact in terms of safety, cost and even reputation.

Within the MAS²TERING project, the cybersecurity challenge has been tackle by building a secure-by-design technical architecture, taking into account the main threats of Cyber Physical System. This have been done by a 3-step security analysis: Identification of relevant threats regarding use cases (based on threats databases and ISO 27002); Risk analysis based on ISO/IEC 27005 methodology; Identification of security requirements to implement. Based on this analysis, two main security measures were implemented: An early warning system, able to raise alarms based on outdated or vulnerable software; Security components to secure the Multi-Agent System platform.

Within DRIvE project, we are targeting to go a step further in security measures implementation by providing :

- An end-to-end security layer within the Demand-Response system
- An anomaly detection framework to detect any abnormal cyber or physical behavior
- An investigation capacity to reduce the reaction time

- “Regulatory Frameworks Affecting Demand Response Solutions”, Sergio Valentino Costa (COMSA)

Regulatory challenges are critical to the implementation of business cases, and the legislative circumstances surrounding Demand Response are rapidly evolving. Many of these changes are expected to take place before 2020 through the proposed implementation of the Market Design Initiative within the 2016 "Clean Energy for All Europeans" Package (aka the Winter Package). The Market Design Initiative's proposed directives and regulations focus on supporting prosumers, aggregators and active consumers by facilitating access to Demand Response markets and promoting more market standardization across EU Member States. The DRIvE solution is perfectly positioned to take full advantage of these changes by giving aggregators the tools necessary to enable Demand Response actions in residential and tertiary buildings.

- “Real-time Controller Hardware in the Loop (CHIL) as the key enabling technology for next generation Fast DR”, Nikola Stojkov (TYPHOON)

The main goal of the presentation was to propose a solution for bridging the chasm which exists between, on the one hand, a universally acknowledged understanding that decarbonization, decentralization and digitalization of the grid hinges on embedded control software at the very edge of the distribution networks (including e.g. smart home appliances) which makes demand response (DR) possible, and, on the other hand, an apparent lack of technologies which make it possible to quickly and efficiently develop, fully test, optimize and pre-certify embedded software which operates at the very edge of the grid. More specifically, if we, as a civilization, are to make the vision of Smart Grid reality, whereby the grid is comprised of millions of controllable consumption/presumption agents interconnected into multi-agent systems which can be reconfigured into virtual power plants (VPPs) that make grid reinforcement unnecessary, the controllable agents of relevant assets (primarily inverters, batteries, electric vehicle chargers, and heating and air conditioning units) must be capable of not only shifting loads: they should be capable of providing ancillary services to distribution system operators (DSOs) and balance responsible parties (BRPs) such as voltage control (VC), frequency restoration reserve (FRR), frequency containment reserve (FCR), and, in general, power quality support (PQS). In order to be able to provide those capabilities, which can be termed Fast or Real-time Demand-Response, the embedded software must feature local control loops at operate at microsecond time steps i.e. at the time steps at which switching elements in these assets (e.g. inverters and battery chargers) are operating.

The solution proposed by Typhoon HIL, which is going to be implemented in the demonstration and validation activities of the DRIvE project, is to use the hardware-in-the-loop (HIL) methodology, which is already used for component development and testing of power electronics devices. In short, by embracing HIL to develop, test and optimize Demand-Response systems, engineers can interface real local energy gateways to high-fidelity real-time models (i.e. digital twins) of pilot sites comprising models of battery storage systems, Photovoltaic panels, inverters, diesel generators, heaters, etc. – which all run with a 1 µs time step necessary to assess dynamic grid support provided by Demand-Response systems. This way, HIL is the key enabling technology which makes it possible to develop, test and optimize next-generation Demand-Response systems in a hybrid environment, where the control software is real but is interfaced to real-time models of the assets being controlled, thus ensuring that control software and its algorithms will perform exactly as expected once they are deployed in the grid. Moreover, the HIL methodology enables Distribution System Operators, balance responsible parties and possibly transmission system operators to qualify Demand-Response equipment at both the component and system level for all relevant power quality supports and communication functionalities. Finally, HIL enables Demand-Response system manufacturers a means to simplify regression testing and to easily upgrade their products to meet new and emerging standards and grid codes.

Within the scope of the DRIvE project, Typhoon HIL will develop four digital twins of pilot sites which will be interfaced to real LEGs. The digital twin running on real-time simulators and real local energy gateways will comprise a single HIL testbed which will make it possible for DRIvE partners to develop, test and validate Demand-Response functionalities and for stakeholders and decision makers to see the positive effects of Demand-Response.

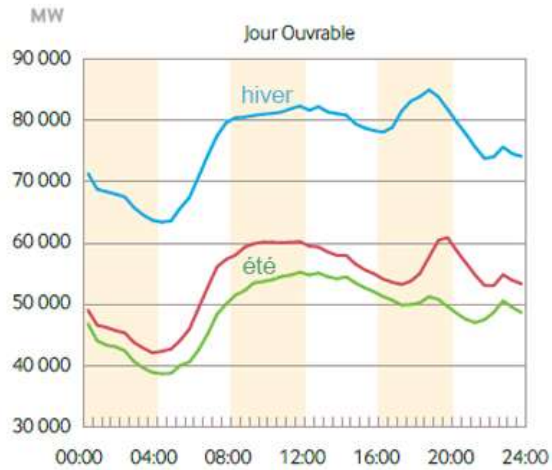
4/ Contenu des échanges

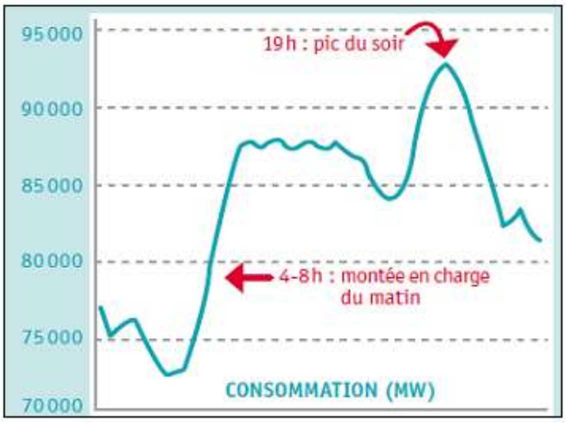
Ci-joint le contenu des questions et réponses. Les réponses apportées par les experts ont été étayées par des recherches sur internet, et les figures ayant permis de vérifier les réponses figurent dans ce document.

Participants from the conference: CEA, CIT, Concordia, LTU, , NUI Galway, UTRC, Université de Grenoble
Participants for the public debate: Cythelia, EDF-CIH, Vivre le nucléaire heureux

Question 1: What is the link between the workshop about residential flexibility management in Europe and the national public debate?
Answer 1: The workshop about Residential flexibility is both part of the Sustainable Places conference and the French public debate about the Multiannual Energy Program in France. Moreover, problems that arise in Europe are the same that those encountered in France and solutions developed in other European countries may be applied in France.

Question 2: Due to the intermittency of renewable energies, we will need to store energy. Why do you focus your studies on flexibility and not on the storage?
Answer 2.1: The flexibility is the solution to adapt the consumption to the production at the level of the day or the week. The storage is a mean to solve the difficulty of intermittent energy production. If you can adjust the demand to the production, the storage is not necessary.

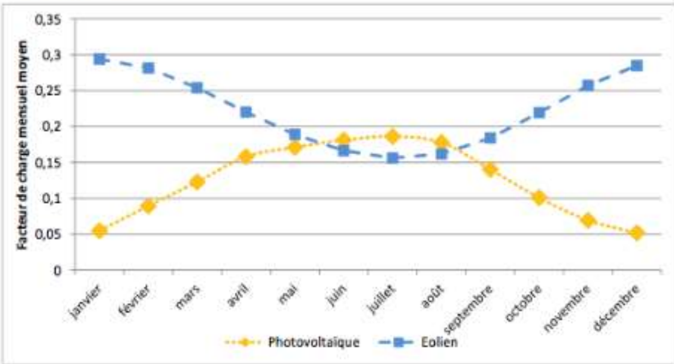




Answer 2.2: The RENNOVATES project renovated the houses of the Devo district in the Netherlands. The project will end in August 2018. The renovated buildings are equipped with smart controls and connected to a smart grid that controls the consumption of the building based on the available energy supply. The buildings create their own renewable energy through solar panels and generate heat with heat pumps. A smart grid, which controls the heat pumps when needed and stores surplus energy in batteries, matches supply to demand.

Question 3: For solar energy, we will need to store the energy produced in summer in order to consume it in winter. What is the best place for the storage: central storage at the district level or local storage at home?
Answer 3.1: This subject is currently under study and in discussion.
Answer 3.2: The best location for storage should be at local community’s level as users can partially charge the battery at different times.

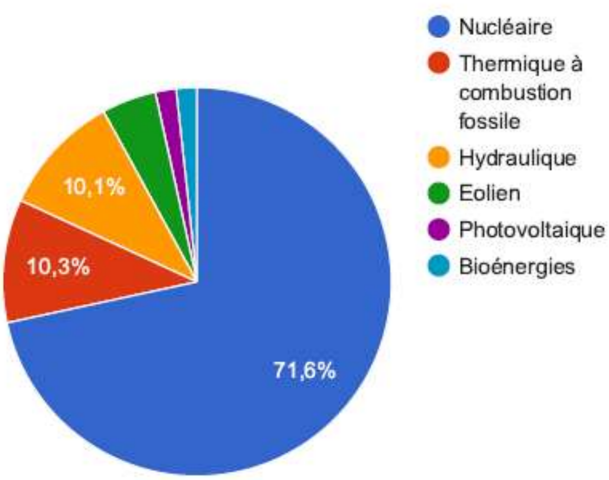
• Variabilité saisonnière



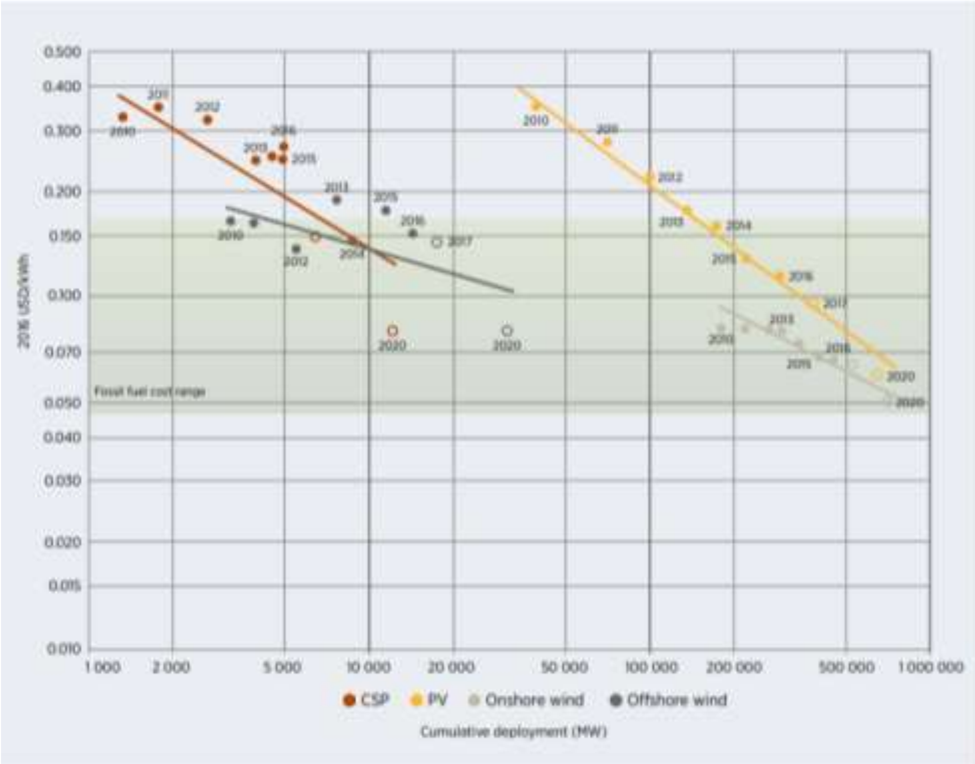
Question 4: Does the flexibility use need to know the social behavior of families?
Answer 4: For the pilot sites, we have defined several types of consumers with average consumption profiles. It is necessary to understand the consumers' behavior.

Question 5: You work on flexibility because of intermittent renewables, especially wind turbines and photovoltaic panels. In France, flexibility is today ensured by hydraulics which is cheap. About 90% of our electricity production is CO2-free and low-cost thanks mainly to nuclear power and hydro. We export around 50 TWh per year of electricity to neighboring countries that have no or few nuclear power plants. So why are we spending so much money in other intermittent ways of generating electricity?

Mix de production électrique en France en 2017 (en TWh)



Answer 5: The cost of renewable energies considerably decreased during the last ten years, so that renewable energies (solar and wind) are becoming cheaper than nuclear energy.



Based on IRENA Renewable Cost Database and Auctions Database; GWEC, 2017; WindEurope, 2017; MAKE Consulting, 2017a; and SolarPower Europe, 2017a.

Note: Each circle represents an individual project, or, in some cases, auction result where there was a single clearing price at auction. The centre of the circle is the value for the cost of each project on the Y axis. The thick lines are the global weighted average LCOE or auction values by year. For the LCOE data, the real WACC is 7.5% for OECD countries and China, and 10% for the rest of the world. The band represents the fossil fuel-fired power generation cost range.

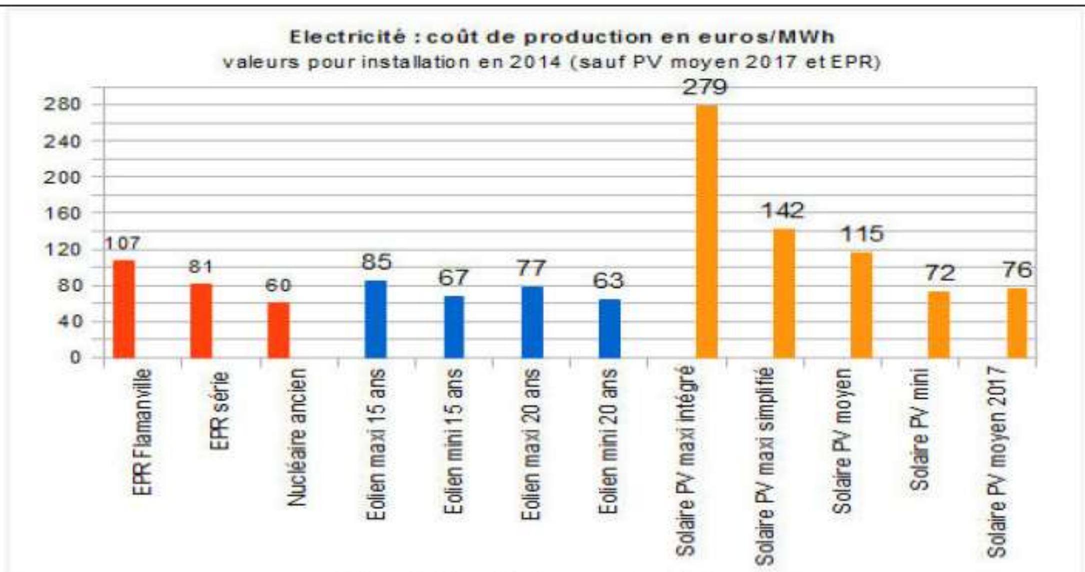


Figure 1.3 Exemple de comparaison déviante

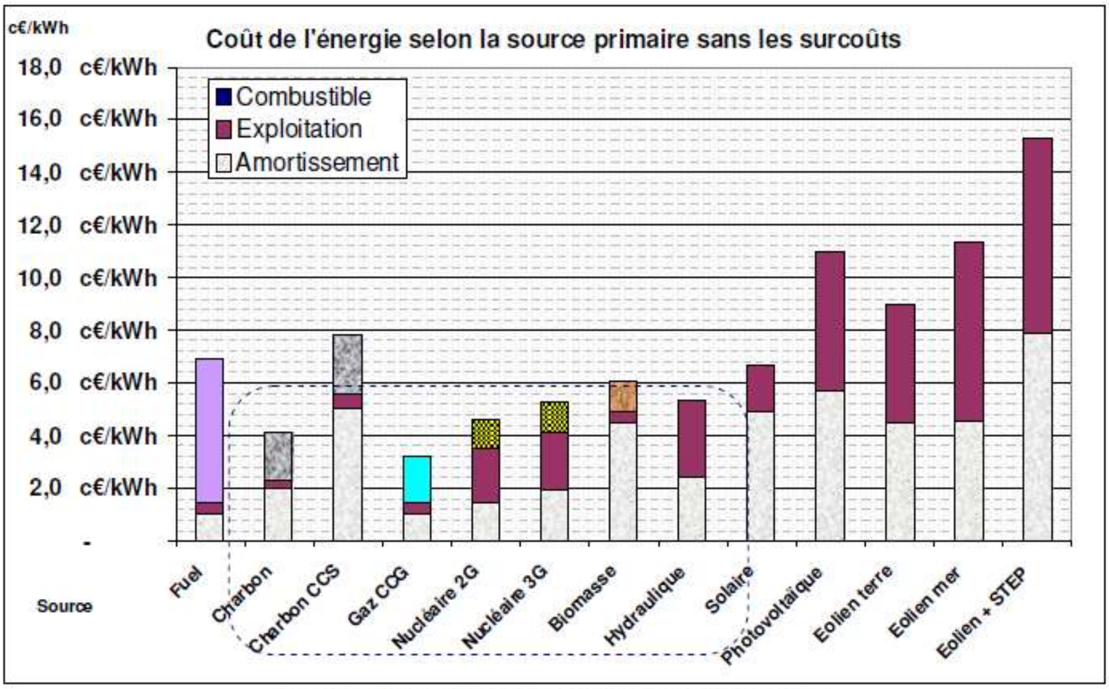
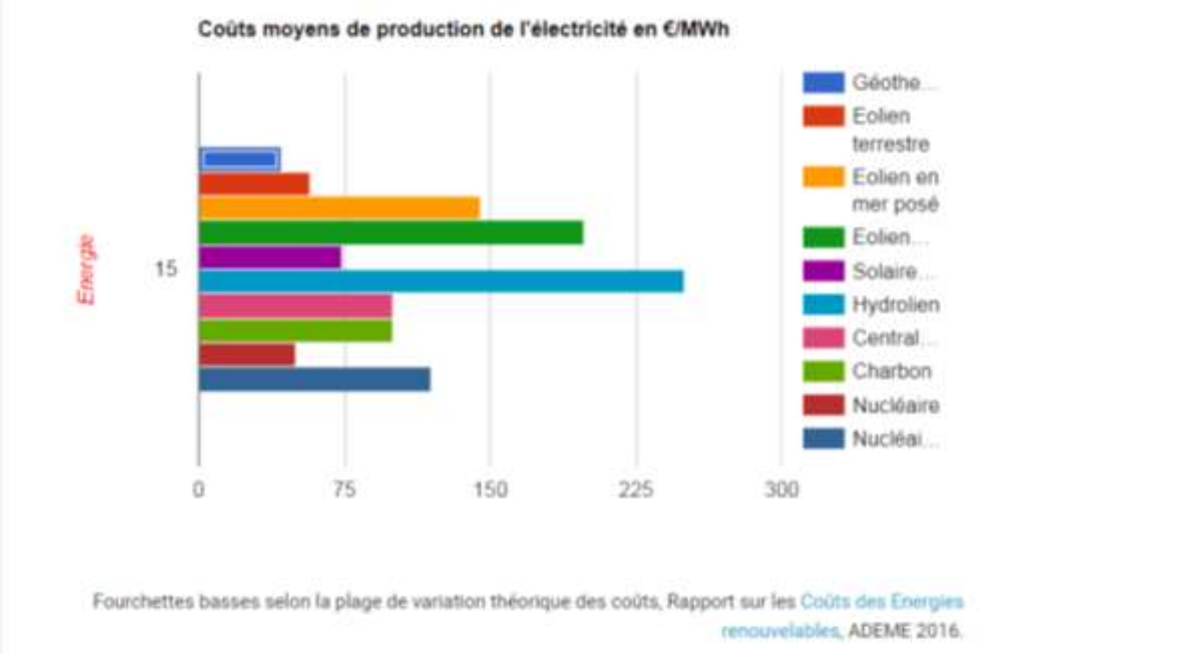


Figure 1.4 Comparaison des coûts des filières énergétiques

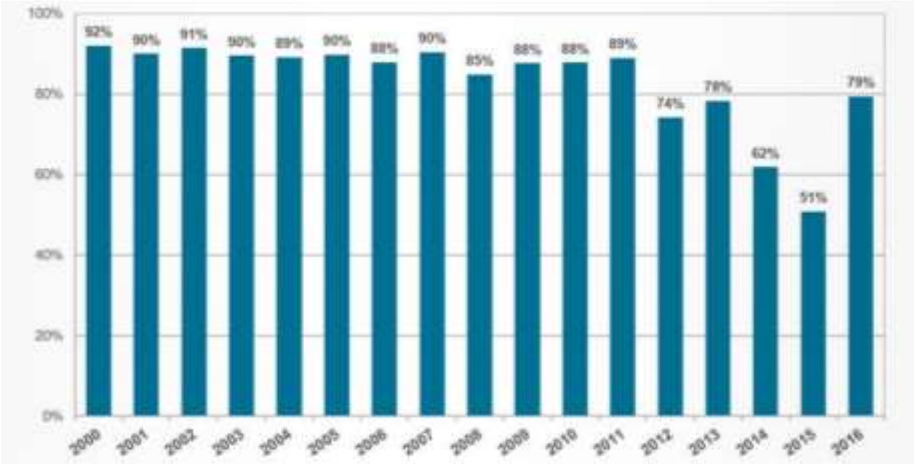


	Investissement initial	Durée annuelle moyenne de charge	Durée de vie	Coût production moyen
Hydraulique	de 1 500 à 2700 €/kW	4 000 heures	> 100 ans	de 33 à 53 €/MWh
Eolien	785 €/kW	2 300 heures	20 ans	43 €/MWh
Solaire photo.	de 6500 à 7500 €/kW	> 2000 heures	30 ans	De 300 à 500 €/MWh
CCCG	453 €/kW	3 000 heures	25 ans	32 €/MWh
Nucléaire (EPR)	1 660 €/kW	8 000 heures	60 ans	28,4 €/MWh

Question 6: Is the goal to orchestrate voluntarily a shortage to insert renewable energies randomly variable whatever the price?
Answer 6: In Belgium, there is no longer subvention for the installation of photovoltaic panels as this energy is considered as cost-effective.

Question 7: Clean and sustainable energies include nuclear energy in China and India. Why is this not the case in Europe which would facilitate the management of the "flexibility" necessary for renewable energy?

Answer 7: Nuclear energy is not the best energy for the future as solar and wind are becoming cheaper than nuclear. The availability of Belgian nuclear plants decreased from 90% down to about 60 % in 2014 and 2015, due to unplanned stops (sabotage of Doel 4 turbine, breakdown of Doel 1 alternator, and microcracks in the vessels of Doel 1 and Doel 2), before recovering availability rates of about 80 % in 2016 and 2017.



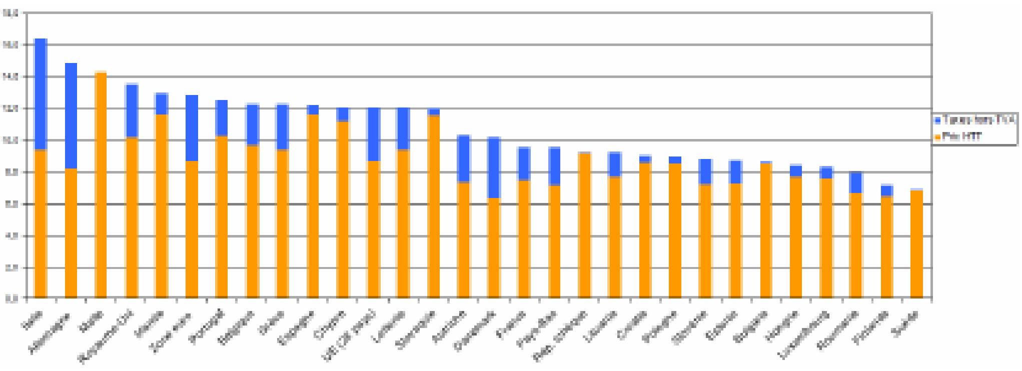
Performance des centrales nucléaires belges entre 2014 et 2016 (source : ENGIE Electrabel)

Question 8 : Why electricity in Germany is twice the price of electricity in France ?

Answer 8: In Germany, the government strongly subsidizes green energy investments. Germany supports the development of green energies trough a law called Erneuerbare-Energien-Gesetzt (EEG). This law integrates a tax included in the electricity bill of residential consumers and SMEs, paid to the German producers of renewable energies. Large companies are not concerned by this tax for competitiveness reasons. This tax increased until reaching 6.88 cents/kWh, so that electricity price reached 30 cents/kWh in Germany versus 13,7 cents in France.

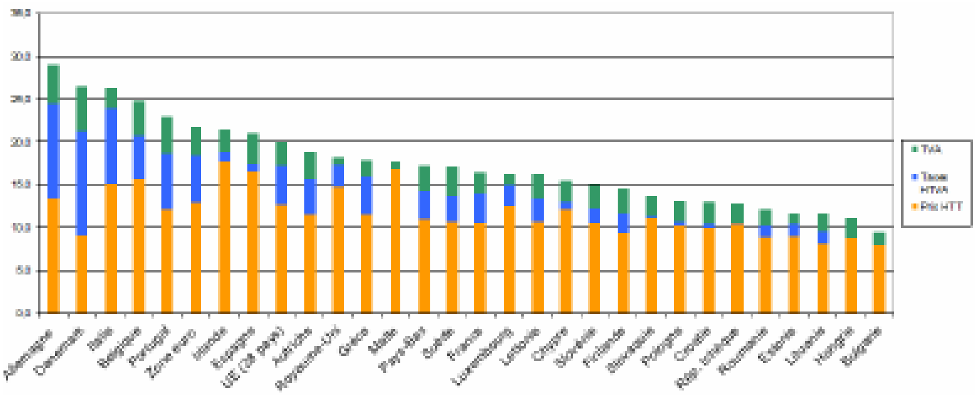
Prix moyen du kWh pour un foyer de trois personnes en centimes d'euros (conso annuelle de 3500kWh) – Source : BDEW, février 2015

Graphique 1 : prix de l'électricité pour les entreprises, hors TVA, en 2016
En c€/kWh



Champ : entreprises consommant moins de 150 GWh.
Sources : données Eurostat, enquête sur les prix du gaz et de l'électricité ; calculs SDES

Graphique 3 : prix de l'électricité pour les ménages, TTC, en 2016
En c€/kWh

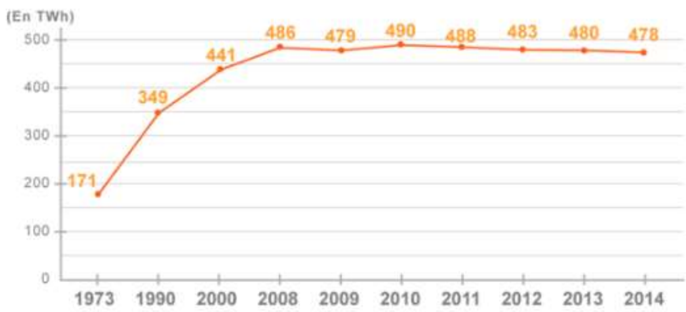


Sources : données Eurostat, enquête sur les prix du gaz et de l'électricité ; calculs SDES

Question 9: Why do you consider only solar and wind renewable energies among the low-carbon energies, which are intermittent energies and need storage and flexibility management and not the hydraulic production?

Answer 9.1: In France, 60% of the needs are covered by the nuclear power plants which provide a reliable and stable production of electricity. The wind is becoming more reliable with variations at the level of the week. The solar energy is variable at the level of the day. In France, the law about energy transition aims at reducing the nuclear production from 75% to 50% of the energy mix by 2025, and to divide by 2 the energy consumption by 2050. To reach this goal, France should need to shut down 20 GW of power plants, as the French consumption of electricity is relatively stable. The goal is not reachable by 2025 and a period of transition will be necessary.

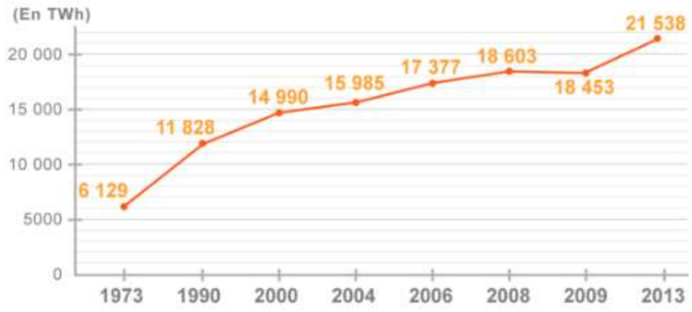
Évolution de la consommation d'électricité



Évolution de la consommation française d'électricité de 1973 à 2014
corrigée des aléas météorologiques d'hiver et d'été
(Statistiques de l'énergie électrique 2014 RTE - chiffres de consommation 2014) © EDF

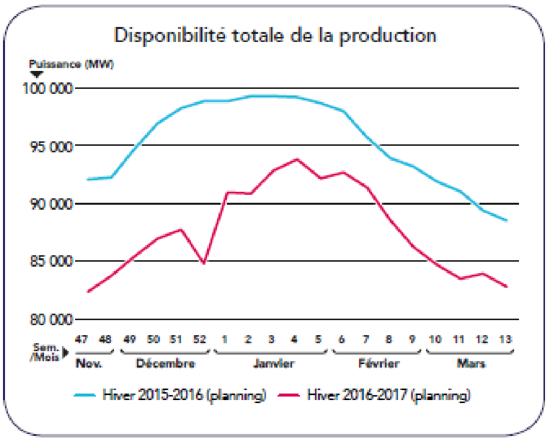
France

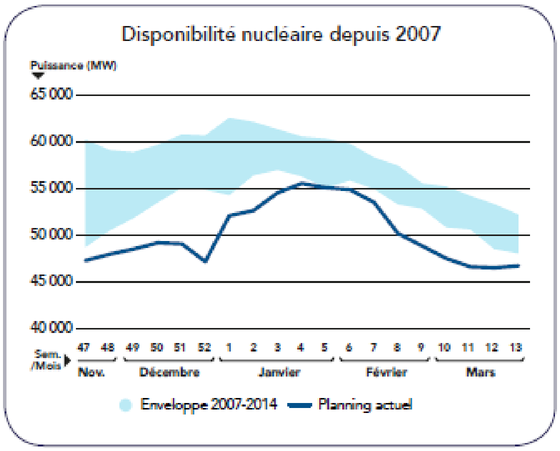
Évolution de la consommation d'électricité



Évolution de la consommation mondiale d'électricité de 1973 à 2013
(Observatoire de l'énergie, CEA, Air Liquide, IEA) © EDF

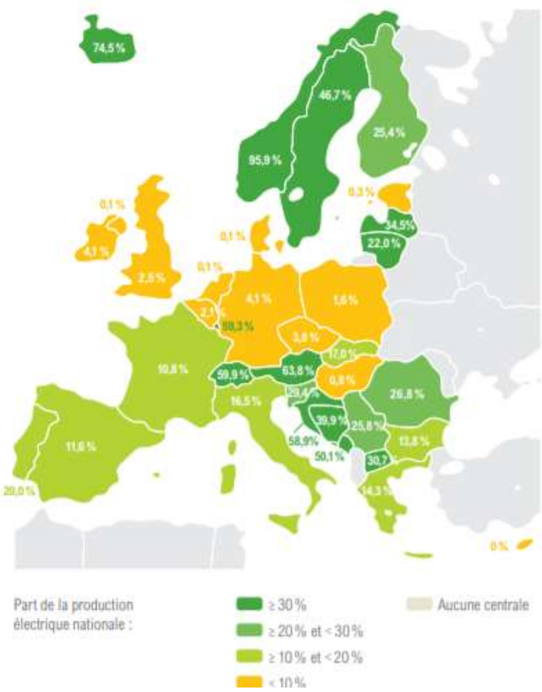
World



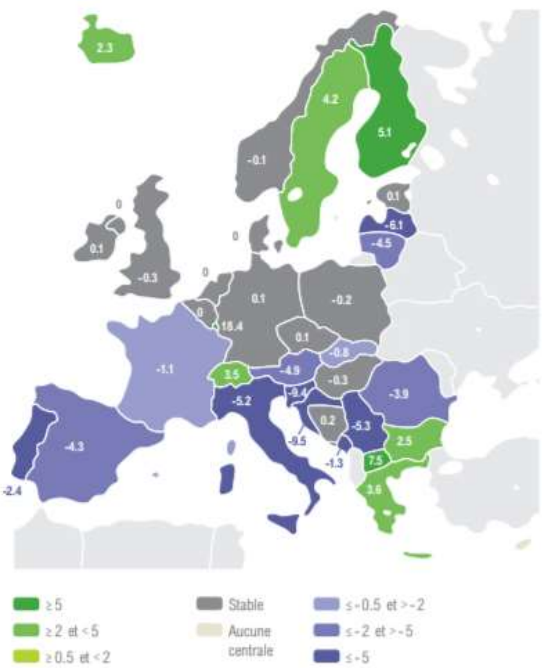


Answer 9.2: In France, an extra-capacity of 20 GW of hydraulic electricity production still exists. In the years 1985, EDF-CIH (Center for Hydraulic Engineering) studied the construction of several dams in the Pyrénées (10 GW) and the Alpes (5 GW) to create pumping energy transfer plants for daily and seasonal storage of extra-energy produced by nuclear plants. Hydraulic energy is able to answer instantaneously to quick fluctuations of demand, as current hydraulic plants are able to start and achieve full power in less than 5 mn, with a follow-up of consumption by tele-adjustment. The STEP (pumping energy transfer plants) consist in a lower reservoir and an upper reservoir separated by a big vertical drop. Water from the lower reservoir is pumped up to fill up the upper reservoir using the MW in excess, and then the water turbine is activated when needed. Currently the MW in excess produced by French nuclear plants are sold at very low price to Swiss pumping energy transfer plants that sell them again to France, Italy or Germany at a very high price during winter consumption peaks. It is time for France to revive the projects of big hydroelectric plants, which are huge green batteries, 10 times cheaper than chemical batteries and with a very long lifetime (more than one century). In Norway, 31 GW of hydroelectric plants were installed at the end of 2017 and 10 to 20 GW of supplementary hydroelectric plants are already planned to store the renewable energies produced in Northern Europe. In France, the projects for more than 10 GW of hydroelectric plants are available in the archives of EDF-CIH at Chambéry. More than 150 millions euros were already invested for geological and preparatory studies for the hydroelectric plants in la Haute Tarentaise (le Clou, la Combe, Viclaire, Moutiers) and la Haute Romanche (Goléon, Plan de l'Alpe, Rof Tort), le Vénéon. The building of the dam at Le Clou was stopped in 1985 by EDF due to the massive investments necessary at the time for the development of the nuclear plants with the building of 4 plants per year. Rather than massively investing on intermittent renewable energies like solar and wind, it would be more cost-efficient to invest on additional dams and hydroelectric plants, which are more reliable.

PART DE L'HYDROÉLECTRICITÉ DANS LA PRODUCTION TOTALE EN 2015



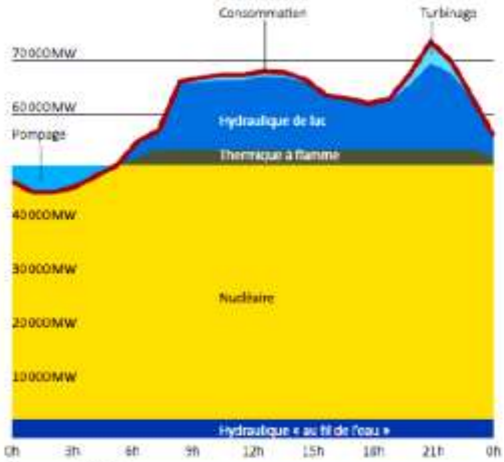
ÉVOLUTION DU TAUX DE COUVERTURE HYDRAULIQUE, EN POINT DE POURCENTAGE



Evolution de la production hydroélectrique (en TWh) en France métropolitaine sur 2007 – 2014

Source RTE et SOeS

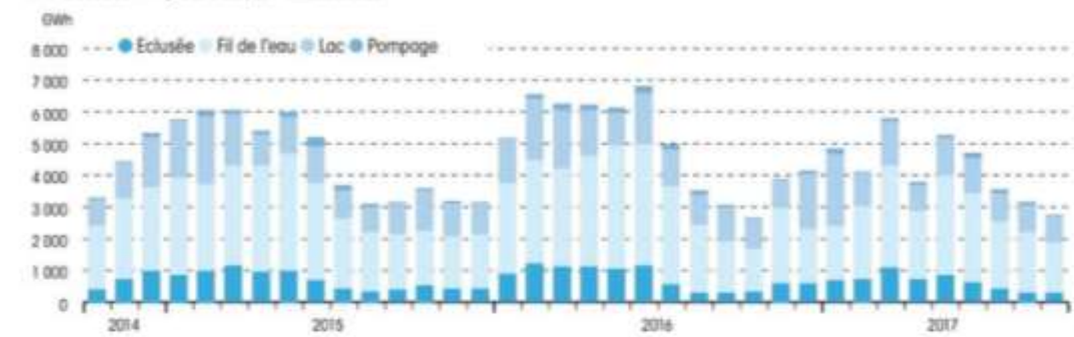
Production électrique schématisée d'une journée d'hiver en France



Source : SER

Composition du parc hydroélectrique français

Production hydraulique mensuelle



Le parc hydraulique français compte plus de 2 500 installations, dont plus de 90 % sont des centrales au fil de l'eau.

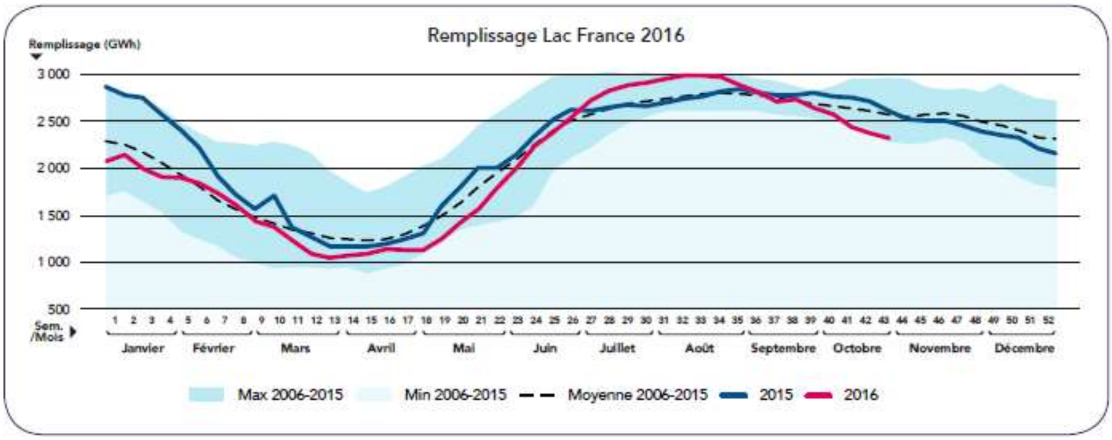
La puissance totale des installations est de 25,5 GW en France continentale fin 2017 et se décompose comme suit :

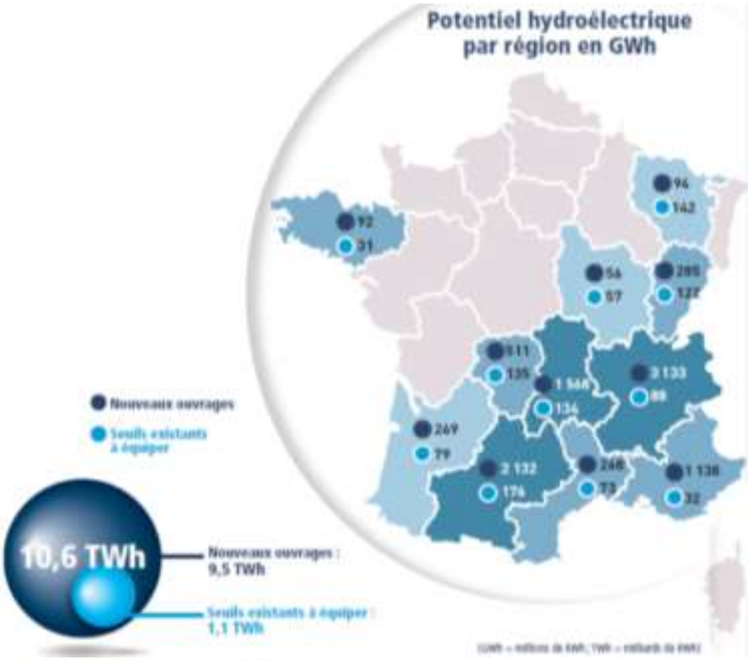
> Centrales au « fil de l'eau » : 26 %

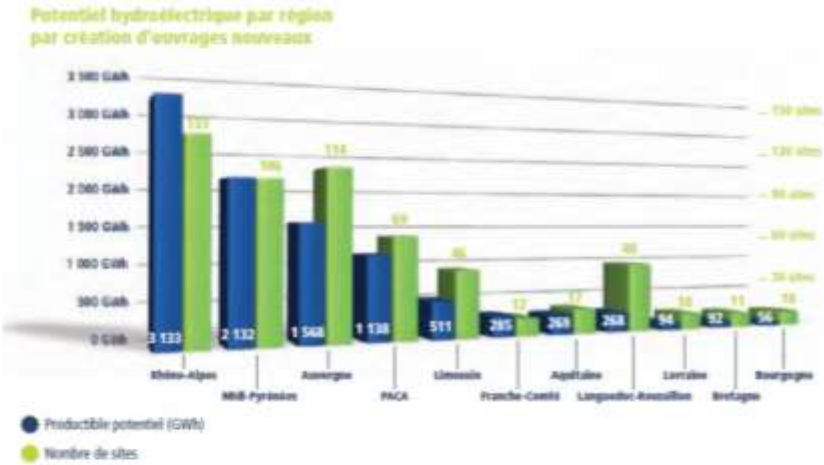
> Centrales de type « éclusée » : 16 %

> Centrales de « lac » : 40 %

> STEP (Stations de Transfert d'Énergie par Pompage) : 18 %





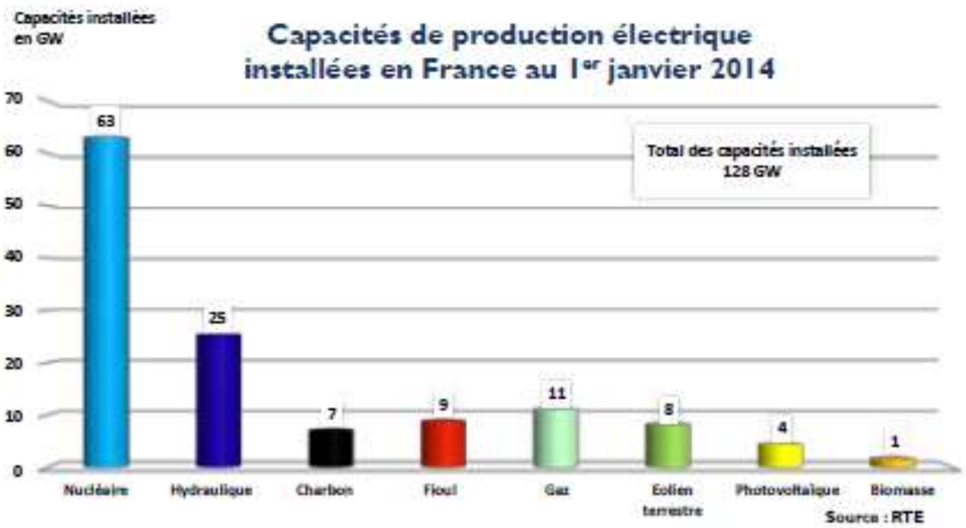


Question 10: For managing demand-response residential flexibility, do you produce weather forecasting data on site?
Answer 10: The forecasting services are located in Met offices, which provide forecasting services for specialized industry (airport, PV plants) from Met Office Weather stations data measured on site, using models to forecast the weather in the following days. Now the forecasting is better. However there are errors induced by downscaling as variations in solar radiations and wind occur at 10 km from the place of forecast.

Question 11: How do you obtain the weather data for forecasting?
Answer 11: It is necessary to buy forecasting data. The subscription to forecasting services costs

100€/month what is a return on investments manageable for a company selling flexibility optimization services.

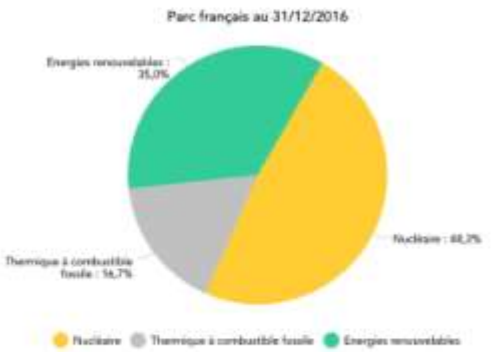
Question 12: What is the interest of managing residential flexibility for the consumers? Answer 12.1: The residential consumption is not constant during the day. In particular, there are peaks of consumption in the morning and the evening. The management of flexibility enables to reduce peak heights by curtailing some loads or shifting them at a more favorable time. As the capacity of both the electricity production plants and the distribution network are sized according to the maximum peak to manage in the year, some gas and coal plants are very little used during the year as there are only present to manage peaks. By reducing the peaks, utilities can defer investments for extending the capacity of the production plants and both Transmission System Operators and Distribution System Operators can also defer investments for extending the capacity of the distribution networks. Deferring investments will contribute to lower the price of electricity for consumers. In consequence, the benefits of managing flexibility for the consumers will be savings in the energy bill.
Answer 12.2: In France, the nuclear energy production is stable at about 50 GW, whereas the demand in winter is about 95 GW. Peaks last generally less than 40 hours per year and reached 102 GW in 2012 and 101 GW in 2017. The French production capacity installed is about 130 GW, however the full capacity is not available at a given time due to maintenance, breakdowns, lack of wind or sun, etc. The use of flexibility by curtailing some volunteer high electricity-consumer industrial plants enables to save some capacity for many: residential and tertiary consumers. It avoid black-out or importing electricity from abroad at very expensive tariffs.



Le parc électrique installé

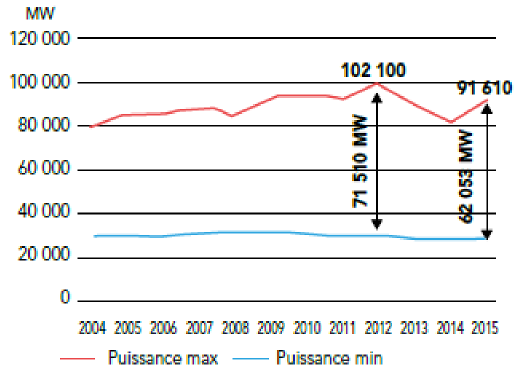
La puissance totale installée des installations de production d'électricité en France métropolitaine s'élève à près de 130 GW au 1[er] janvier 2017.

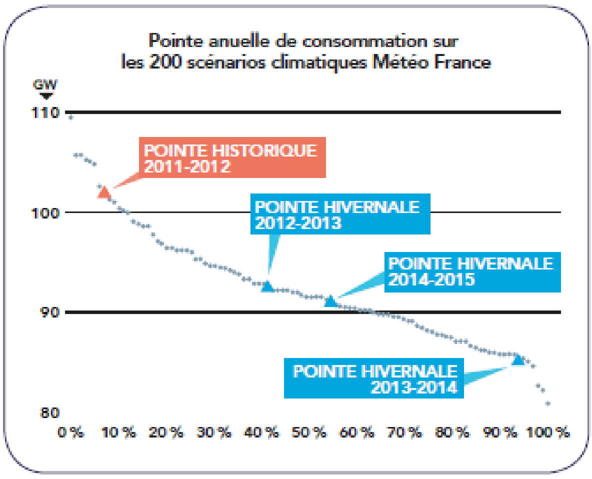
Le parc électrique français, du fait de la prédominance des technologies bas-carbone, présente des niveaux d'émissions de CO2 très bas par rapport aux autres pays européens.



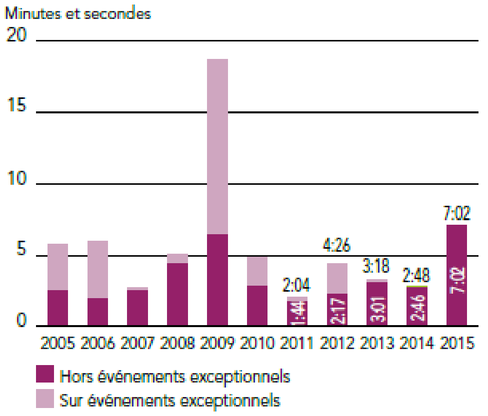
Source : RTE

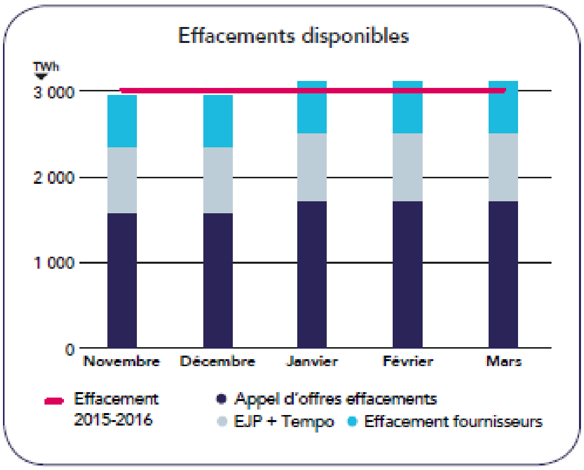
Évolution des extrema annuels de consommation





Temps de coupure équivalent





4/ Evaluation de la portée et des résultats de l'évènement

Pensez-vous que les participants sortent de l'événement avec une vision plus claire des enjeux centraux de la PPE ? Sur quels points ? Vos commentaires :

Les participants ont pris conscience que le développement des énergies renouvelables n'est possible à grande échelle qu'en faisant évoluer la demande de façon plus flexible de façon à l'adapter autant que possible à la production d'électricité.

Pensez-vous que des arguments échangés ont permis de faire évoluer les participants ? Sur quels points ? Vos commentaires : Certains participants étant arrivés avec des points de vue très tranchés, ceux-ci n'ont pas évolué. Par contre, d'autres participants ont obtenu des compléments d'information qui leur ont permis de mieux appréhender les enjeux, limites et possibilités du mix-énergétique.

D'après vous quels sont les différents messages envoyés par les participants au gouvernement dans le cadre de l'élaboration de la PPE ? Lister et détailler ces points.

- Besoin d'adapter la consommation à la production via des tarifs dynamiques pour pouvoir développer les énergies renouvelables sans déséquilibrer le réseau électrique
- Développer un marché pour gérer la flexibilité des petits consommateurs (ménages, tertiaire) via le développement de communautés locales gérées par des agrégateurs (actuellement seul le marché de la flexibilité pour les gros clients a été mis en place)
- La gestion de la flexibilité permet de lisser les gros pics, ce qui permet de différer les investissements sur le réseau électrique et la création de nouvelles unités de production sous-utilisées pour répondre aux périodes de pointe uniquement
- Avantage de produire et consommer localement pour ne pas transporter l'énergie sur de grandes distances : favoriser l'autoconsommation et la création de communautés énergétiques locales, 5% à 8 % d'économies sur les pertes du réseau possibles grâce à la consommation locale
- Besoin de stocker l'énergie de façon journalière (solaire), hebdomadaire (éolien), saisonnière (surproduction en été/production insuffisante durant les pics de consommation en hiver)
- Possibilité de stockage de l'ordre de 15 GW grâce au développement de nouvelles stations de transfert d'énergie par pompage en France (plusieurs projets dans les archives de EDF-CIH)
- Consommation électrique moyenne en France stable, mais augmentation du niveau des pics en hiver obligeant à importer de l'énergie à prix fort
- Actuellement vente des surplus de production électrique française à bas prix en été et rachat en hiver à prix fort, notamment auprès des STEP suisses
- Besoin du nucléaire pour assurer une période transitoire vers les énergies renouvelables
- Besoin de toutes les énergies disponibles pour assurer la consommation d'énergie en période hivernale
- Prendre en compte le coût total des énergies depuis la fabrication jusqu'au recyclage, y compris pour les énergies renouvelables
- Prendre en compte la disponibilité des énergies pour estimer une capacité de production haute et basse du parc électrique français

5/ Espace complémentaire d'expression