ETIP SNET
Western Region Workshop
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IMDEA

Parque Tecnológico de Móstoles
Avda. Ramón de la Sagra, 3
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Madrid, Spain

Project session 3
(Projects addressing topics within the scope of ETIP SNET's Working Group 3 (WG3): "Flexible Generation")

Presentation of Intermittence Plus project (France)

Project « INTERMITTENCE PLUS »

A project supervised by the French Environment & Energy Management Agency in the frame of the national program Smart Electric Networks, co-financed by the Program of Investments for the Future

Duration: 3 years, 2016-2019, Budget: 5,1 M€

Project overarching objectives :

Provide innovative solutions to increase the renewable share in the generation mix, possibly up to 100%, safely, by controlling appropriate massive amounts of power loads, simultaneously and in real time for adjusting the balance dynamically by shedding, forcing consumption or storing energy at the right moment at demand side.

These solutions aiming to be:

- suitable for balancing unpredictable variations of production and network failures
- virtual primary and secondary reserve
- durable, reliable and energy efficient
- easy and inexpensive to deploy and operate
- acceptable by users
- exploitable in the context of numerous present and future business models
- low requirements for interoperability
- compliant with European regulations

The consortium in its national ecosystem

Co-financer

Supervisor

Labels of project quality

Coordinator

ARMINES
Academic
Modelisations & simulations

cotherm
SME
Smart control of water heater

degetel
SME
Project design & mgt & software provider

eqinov
SME
FR & EU regulations & business models

ERGYLINK
SME
Electronics & software provider

SCIENCES PO GRENOBLE
Academic
Sociology of energy

SCLE SFE
Large enterprise (ENGIE)
Long range PLC techno provider

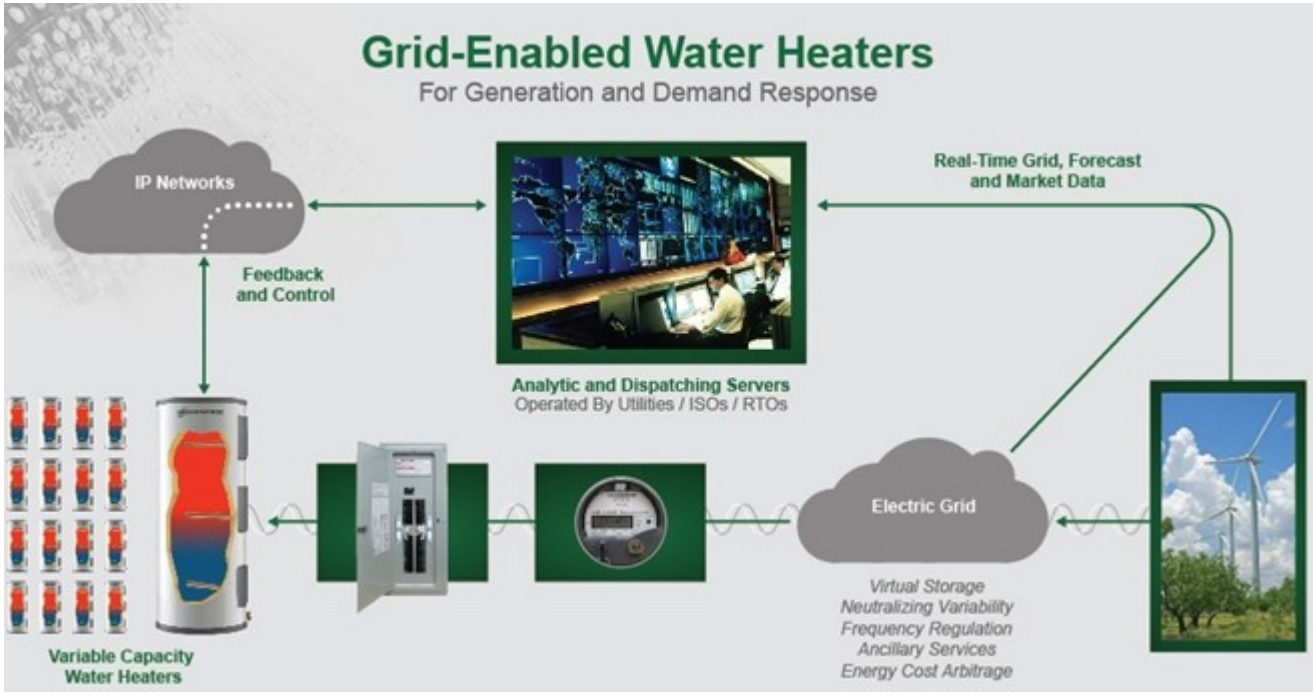
SIGFOX One network A billion dreams
SME
Long range radio techno provider

VIESMANN
Large enterprise
Thermodynamic water heater techno provider

The genesis of the project

At the beginning, our ambition was to find smarter solutions, and more suitable to Europe, than those of the American company Sequentric, who was aiming in 2015 to control 100 million water heaters in North America and planned to come in Europe.

France was the best place to start this project because of its track record in the domain, the presence of industrial leaders and the size of its park of electric water heaters (15 million having an average capacity of 200 L).



Sequentric corp. in 2015, aiming 100 million water heaters controlled in the USA and Canada

So we did… Some key technical principles of the project

A system architecture based on the subsidiarity principle:

Three complementary sources of information are combined for controlling the **smart loads**:

- **Local detection** of events at the delivery point (F, dF/dt, V) - [ultra fast, OK even if RX is KO]
- Receipt of remote controls **broadcast**ed to all points (embedding post-addressing) – [fast]
- Receipt of remote settings in **unicast** – [not time critical at all, any robust datacom can suit]

A return path is added in unicast – [not time critical at all, any robust datacom can suit]

Implicit aggregation of the right power loads to be controlled for achieving the right global effect on the electrical network by selection of the right values of the post-addressing criteria which are broadcasted simultaneously to all receivers controlling the power loads (e.g. type of client, type of building, type of use, line number, transformer number, operator defined number…), each criterion having an escape code allowing any relevant combination.

Sophisticated remote control scheme for limiting the need of bandwidth in the transmission subsystem, and **for minimizing requirements regarding interoperability** (e.g. the controller doesn't need to know the characteristics of the smart power loads it has to control).

Most remote controls are of « fire and forget » type (transmission of an objective which is fully managed locally by the receiver), e.g. objectives regarding shedding and storage which are transmitted directly under the form of a quantity of energy to be saved or consumed).

Project Key exploitable results

- improvement of the management of the grid by offering a safe, efficient and affordable solution to unpredictable causes of unbalancing of the electricity network
- allows renewable production up to 100% (in complement to known solutions addressing predictable)
- decrease of CO2 emissions (e.g. by decreasing or stopping production based on fossil fuels)
- decrease of fine particles pollution (e.g. by decreasing or stopping production based on coal)
- allows the offer of a minimum service of electricity to final customers (light, telecom, Internet, audio, video, computing, electronic payment at points of sales, food cold chain and all other low power uses are always supplied, only the power loads are managed and can have their supply stopped or limited)
- improvement of network resilience (reduction of the risk of blackout)
- allows reduction or avoidance of new investments for strengthening the distribution network
- compliance with European regulations
- usable in the frame of capacity mechanisms and system services
- compliance with numerous present and future business models
- can be implemented separately or as a complement to existing smart grid and smart metering programs
- main final beneficiaries are the citizens and the small businesses through a better quality of service of the electricity they can get while the overall level of pollutions will decrease (and also the industry because simulatnaeous flexibility actions on massive quantities of spread power loads become an alternative to actions on big consumers)

Needs for future R&I

INTERMITTENCE PLUS project has proven the validity of some universal concepts through specific technical choices of implementation which were relevant for an exploitation of the results mostly in France as it was a national project (only Sigfox low power long range radio communication can be used worldwide as is).

Additional R&I involving local partners is needed for adjusting the implementation choices to the specificities and needs of other European countries, for minimizing the impact on existing infrastructures and for reducing the costs of implementation.

Themes for further R&I works based on the results of INTERMITTENCE PLUS project

- different types of communication channels for transmitting remote controls in broadcast/multicast (other standards of long range PLC, ripple control, long range radio, even FM RDS or digital radio which works well in deep indoor could be used for broadcasting the few amount of data that is needed…)
- different types of bidirectional communication standards for transmitting remote configuration and data needed for operations in unicast (e.g. PLC G3 or PRIME directly, or better, through the smart meter used as a gateway, other low power long range radio standards…)
- implementing the load manager functionalities directly in the power apparatuses for eliminating the need of a specific installation and its cost
- implementing the load manager functionalities in adapters suitable for use with standard power apparatuses (classical Joule water heaters, electric heaters, air conditioner…) for eliminating the need of specific installation and its cost
- control of battery based reversible storage solutions for storage instead of water heaters
- control of unidirectional and bidirectional chargers for electrical vehicles
- modelisation / simulation / machine learning for helping to operate or for operating automatically the load control system
- combination with self-consumption… *Other ideas opening on other use cases and needs are welcome!*

Deployment prospects of the most promising solutions

- All the countries, in Europe and in the rest of the world, which have committed to increase their share of electricity production based on renewable energy at an ambitious level, for reducing both nuclear share and CO2 emission, will need such solutions.

  Moreover, the need will increase with the increase of the ratio because the last 40% are difficult to reach safely with only traditional solutions needing predictability and which have a significant latency.

- In France, the first deployments target the French islands where high operational needs exist, for improving the Quality Of Service of electricity (reduction of risk of blackout) and for substituting ready to start additional generators by virtual primary and secondary reserve based on the solutions of the project Intermittence Plus.

Needs for further testing

Each new R&I work (pls. see the page « Needs for future R&I» will need appropriate field testing in the countries they target for evaluation and validation.

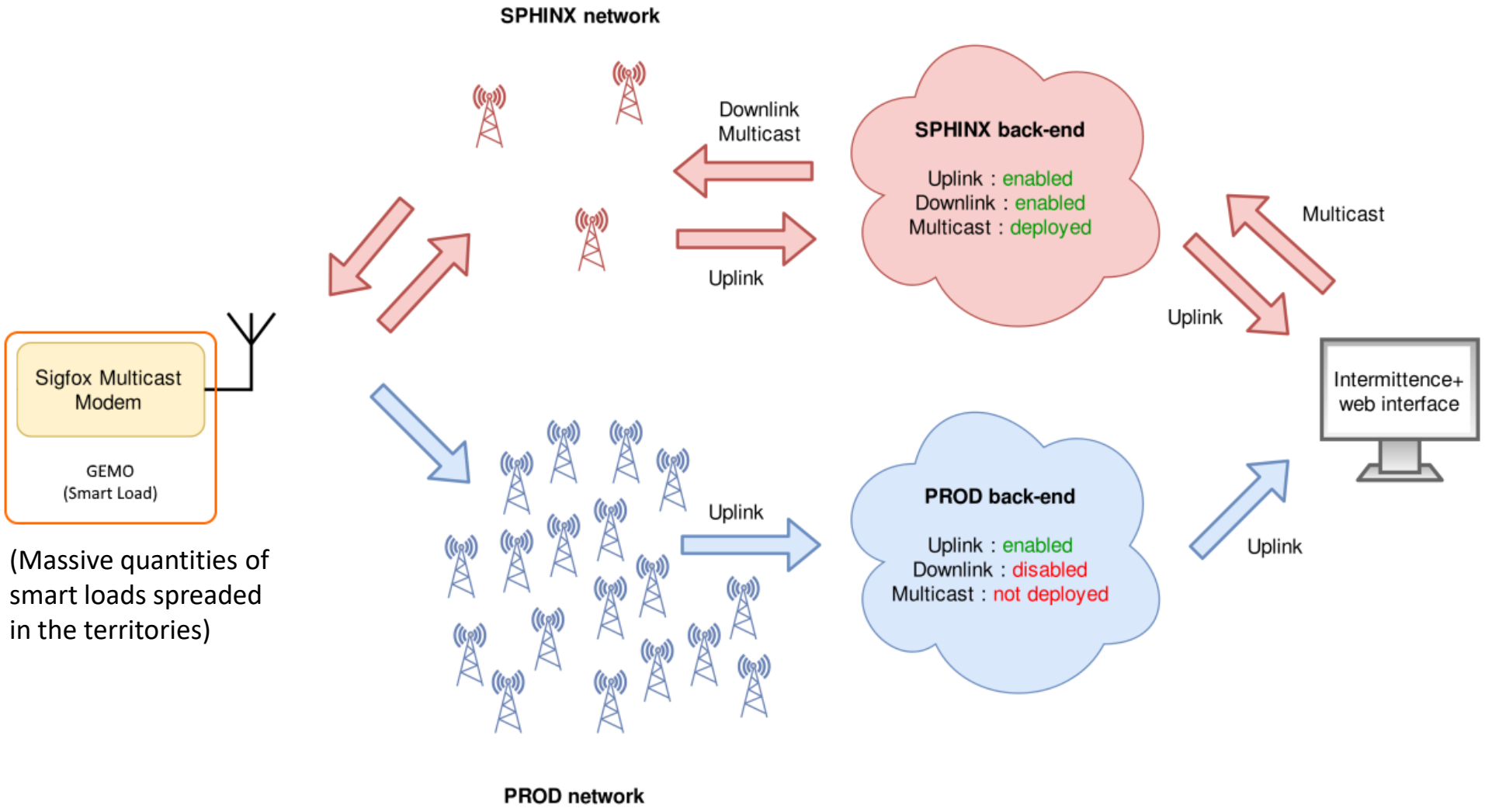
Large field tests are welcome for transforming technical solutions which work into innovations widely adopted in Europe.

Need of an inter-regional cooperation

Part or all of partners of Intermittence Plus project are open to any relevant cooperations everywhere in Europe! (in the four Regions),

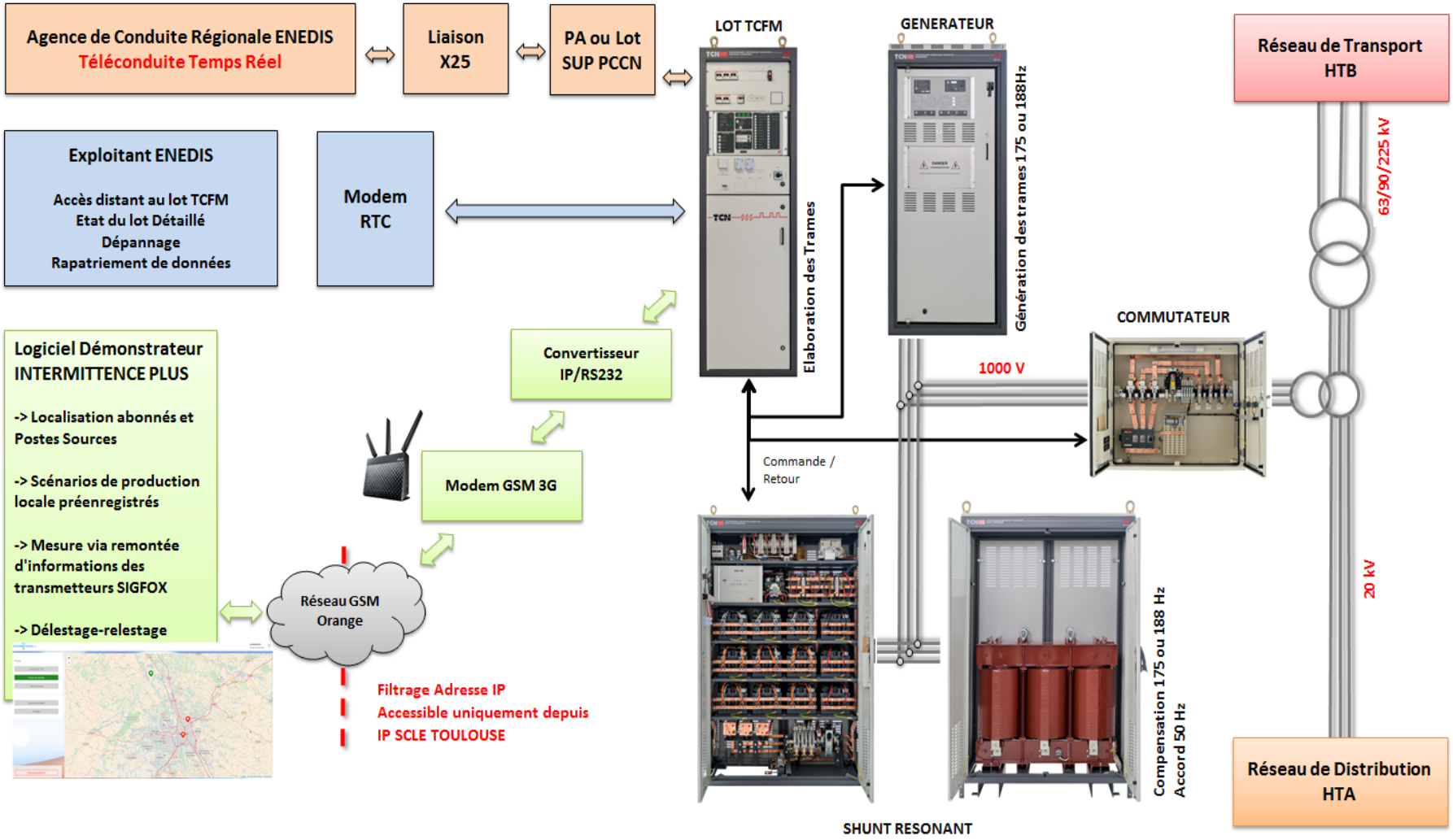
For example in Central Region, we believe that our solutions could help Germany to shut nuclear production without using coal based production in the same time (reduction of CO_2 and fine particle emissions).

Image gallery of the project INTERMITTENCE PLUS



(Massive quantities of smart loads spreaded in the territories)

Architecture of the long range-radio broadcast + unicast solution, compliant with Sigfox infrastructure



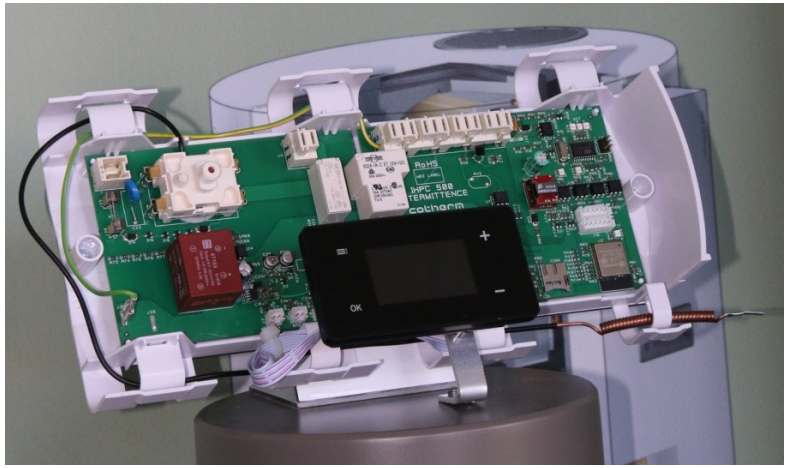
Architecture of the long range-PLC broadcast channel which is based on reuse of existing infrastructures

The « GEMO », the ultimate smart load controller:

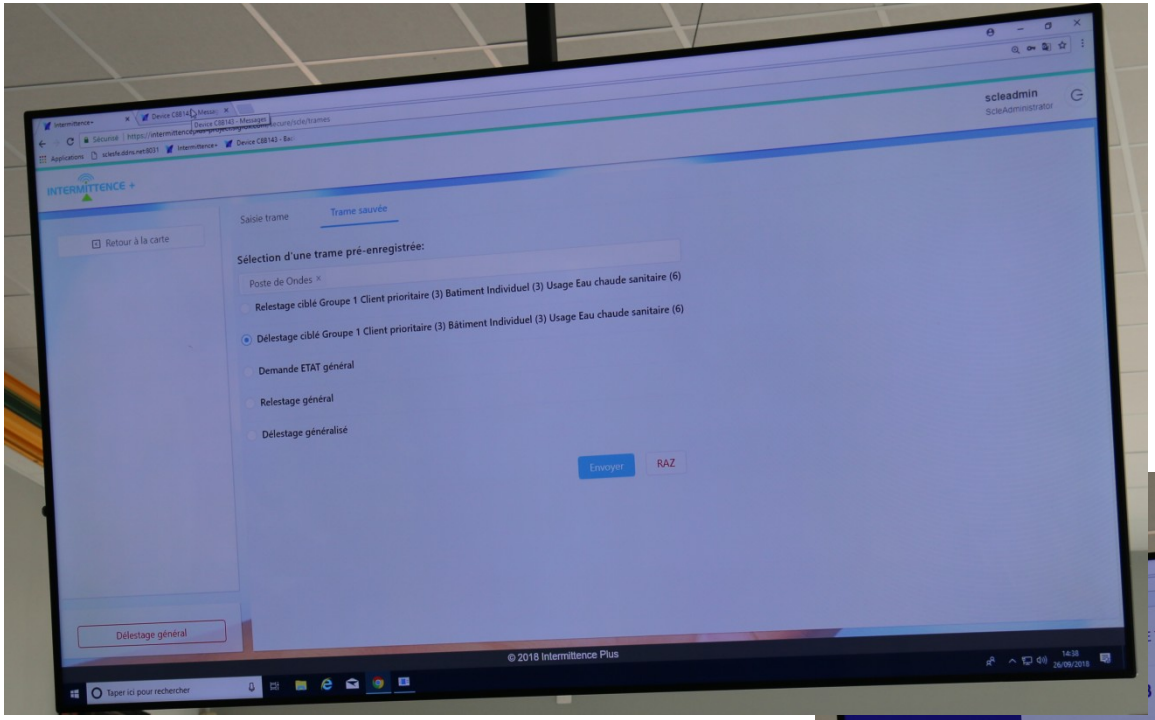
- *allows simultaneous aggregation from hundreds of KW to hundreds of MW of loads with a short latency for flexibility actions*
- *manages all communication channels used for remote operations (radio broadcast RX + radio unicast RX/TX and PLC broadcast RX)*
- *monitors mains frequency, derivate of mains frequency and voltage*
- *controls the loads according to the algorithm through two outputs for external power relays and one bidirectional bus (1 wire 230V)*
- *implements its own smart meter dedicated to the energy management of the controlled load(s) (up to 60A)*
- *can be connected to an external smart meter (e.g. Linky in France)*
- *allows « subscribe, install and forget » type of services*
- *a compact design in a standard 3U DIN module which achieves a MTBF of 20 years, a self consumption < 1W in operation and which can be manufactured in volume at a unit price < 40 €*

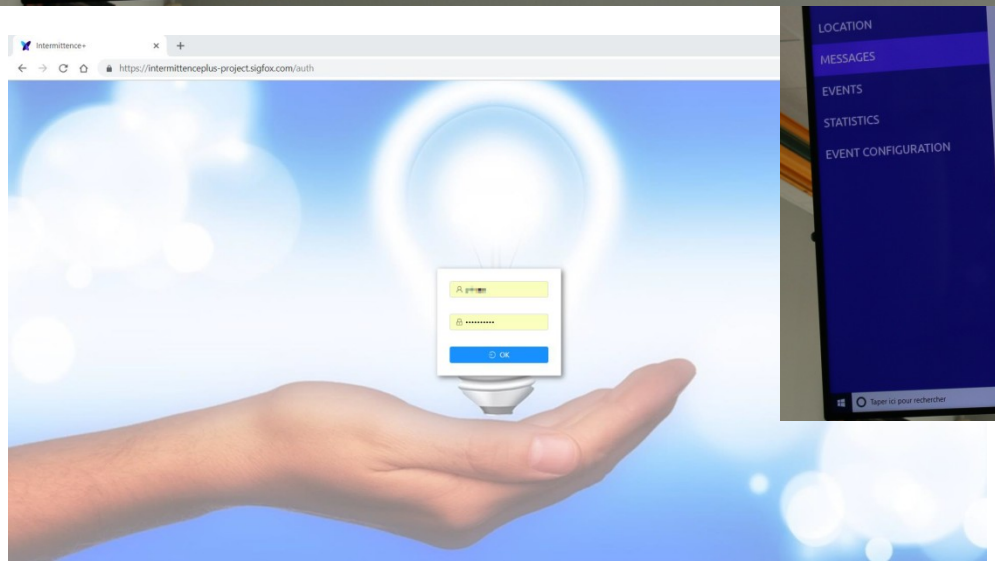
The smart thermodynamic water heater controller:

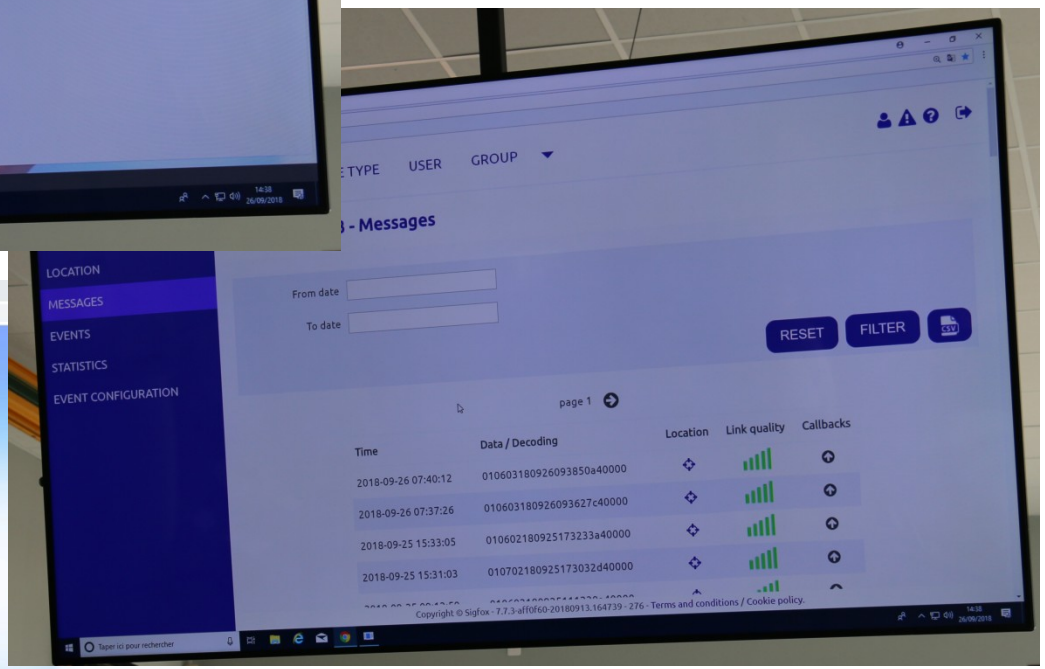
- *manage the thermodynamic and the Joule heating sources*
- *implement a machine learning algorithm which predicts user needs in order to always satisfy them first*
- *virtual additional storage capacity for being able to respond to electrical network needs at any time (all system services)*
- *continuous monitoring the remaining storage capacity*
- *(e.g. remaining storage capacity in KWh, time needed to reach 100% capacity, water temperature…)*
- *fully compliant with all relevant EU safety standards*



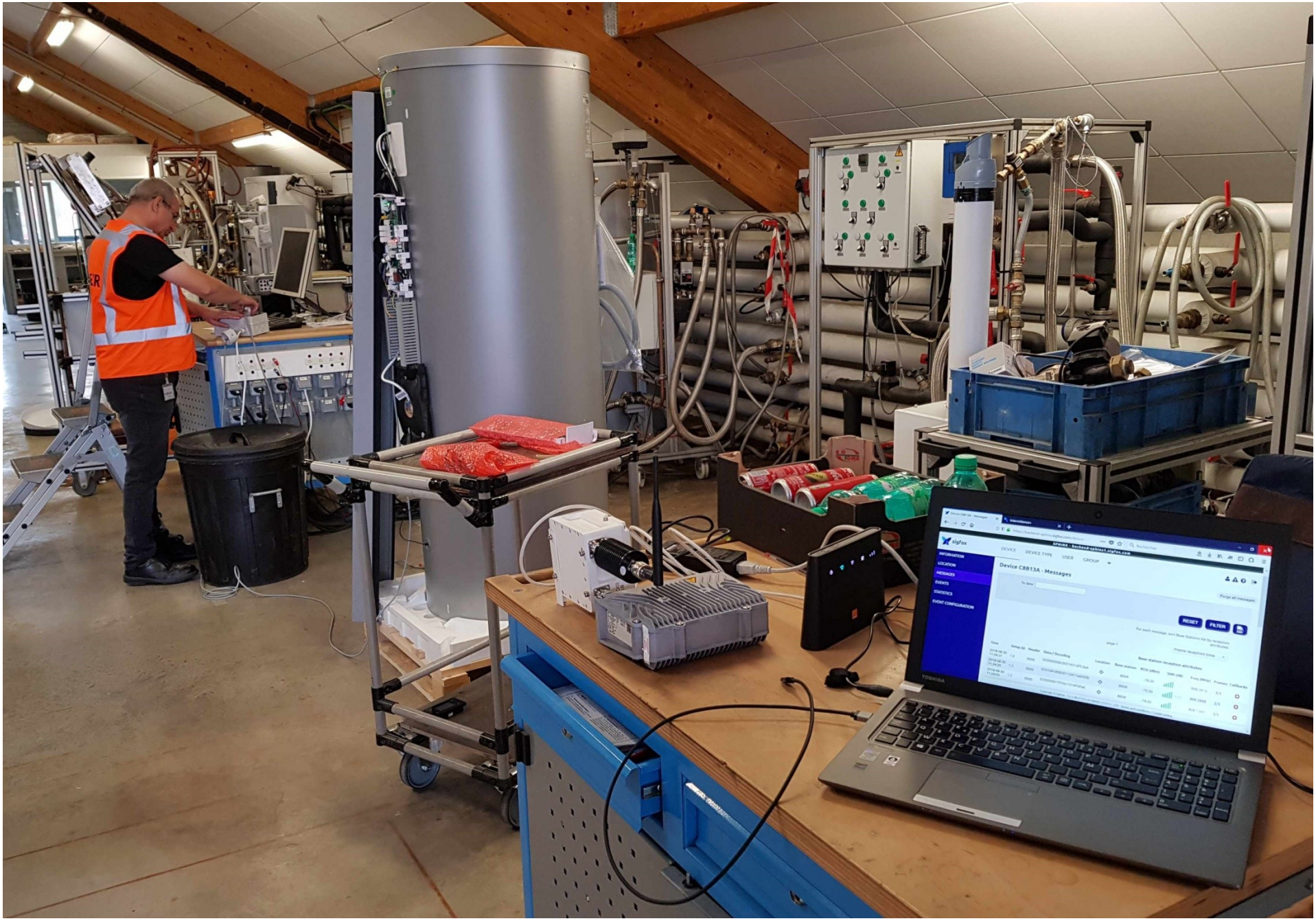
Prototypes of the objects which have been designed for the field tests of the project







Some user interfaces based on the latest technologies of the web for managing the field tests of the project



Test of integration of the thermodynamic water heater in VIESSMANN's laboratory in Faulquemont

The showroom of the project, including a space for real demonstrations, at SCLE-SFE in Toulouse

Thank you for your attention

Contact for any further inquiry about the project INTERMITTENCE PLUS:

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