PREMIO
The Smart Grid Demonstration Project supported by EDF

PREMIO: (Production Répartie, Enr et MDE, Intégrées et Optimisées)

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Agenda

- Smart Grid Demonstration project overview
  - Organization of the project
  - PACA Region, Electrical power system
  - What is PREMIO?
- Project Progress
  - Installation of equipment
  - Modeling
  - Social Assessment
  - Use Cases
- Lessons learned

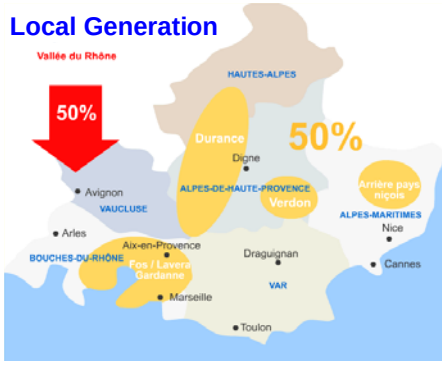
Smart Grid Demonstration project overview

Organization of the Project

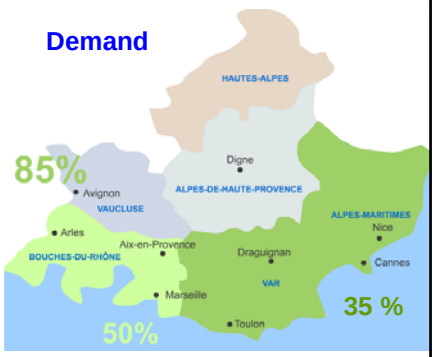
- The PREMIO demonstration project is led by CAPENERGIES
- Budget: 4,3M€: 50% funded by the PACA Region, 50% by the project partners
- EDF R&D is a major partner, contributing 20% of the total budget (i.e. 40% of the partners' financing)
- Phase I – Study Phase: 2008- 2009 PREMIO is located at Lambesc
- Phase II – Experimental Phase: 2010 to 2011
- An extension of 2 years is being examined
- http://www.projetpremio.fr/

Logo lambesc

PACA Region
Electrical Power System



Source: RTE (French TSO)



Source: RTE (French TSO)

- 85% of demand is concentrated in the Mediterranean coast
- Local generation covers less than half the regional demand
- Long distance between generation and consumption sites
- The region is supplied by a unique 400kV transmission line

What is PREMIO?

PREMIO is primarily a technical proposal created to address the following goals in the PACA region:

- to develop a dynamic demand-response at local level,
- to integrate Distributed Generation and especially renewable energies,
- to reduce greenhouse gas emissions from polluting peak power plants
- to manage regional electrical energy from a wide range of local actors
- to increase the flexibility of the power system,
- to promote a new energy culture which encourages energy efficiency

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Objectives of the demonstration project

- To develop and test a VPP at the distribution system level
  - use of existing Distributed Resource technologies
  - communication with a control unit
  - requests for load reduction are based on local load peak and national CO2 emissions
- To identify weakness and strengths of the existing distributed resource technologies and requirements when integrated into this VPP
- To learn lessons during the:
  - Development of the architecture
  - Installation of equipment
  - Assessment of results
  - Recruitment of customers
  - Improvement of demand response acceptance

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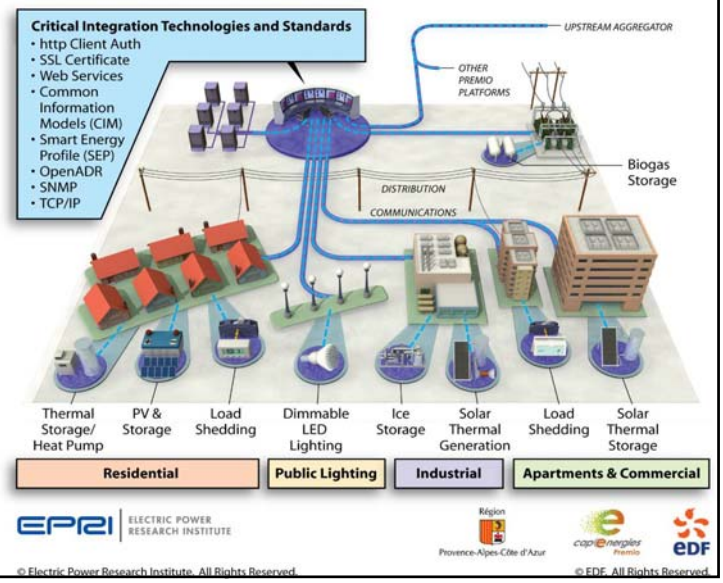
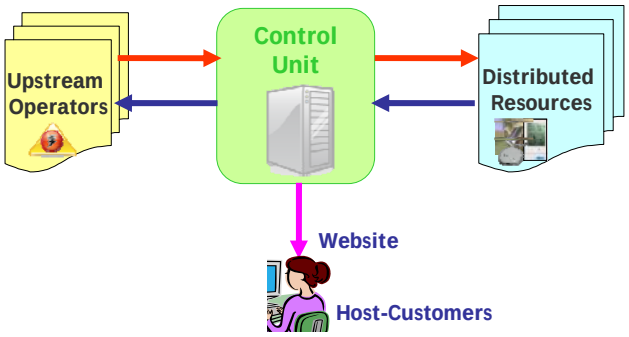
- 9 types of Distributed Resources
  - Curtailable loads
  - Distributed Generation
  - Electrical and thermal Storage



Services offered by the PREMIO Platform



- The Control Unit optimizes the use of host-customers' Distributed Resources: two types of load reduction services, 'day-ahead' or 'day-of', are offered to an upstream operator
- day-ahead' service: one day prior to its implementation (17h00)
- 'day-of' service: the same day to its application (up to 5-10 min before)

Characteristics

- PREMIO is a tool located at the end of the supply chain
- Distributed Resources are aggregated by an energy third part or service company in the power system
  - Not “one upstream aggregator” oriented
  - Covers various configurations of actors, originating from the residential and small commercial sectors

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Project Progress

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Project Progress – Equipment installation

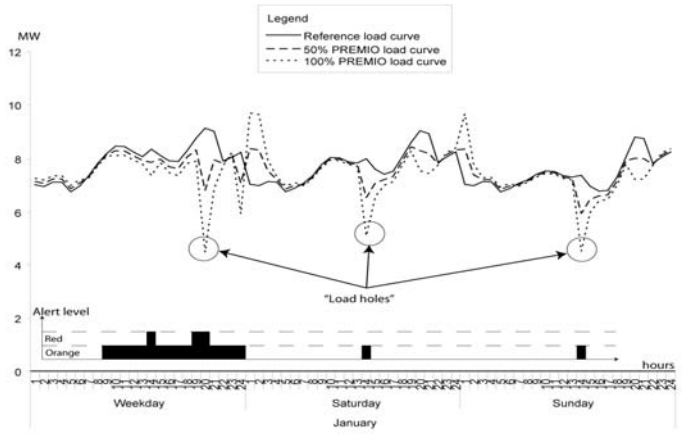
- Control unit is installed
- Most of Distributed Resources are also installed
- "PREMIO compatibility" : tests to guarantee the compatibility of resources with the functioning of the whole platform
  - Communications between the Control Unit and Distributed Resources
  - Verification of functions and information: time, frequency, content…
- Test of the Control Unit functions are carried out
- Starting date - T0 - planed to end June 2010

Project Progress – Simulation

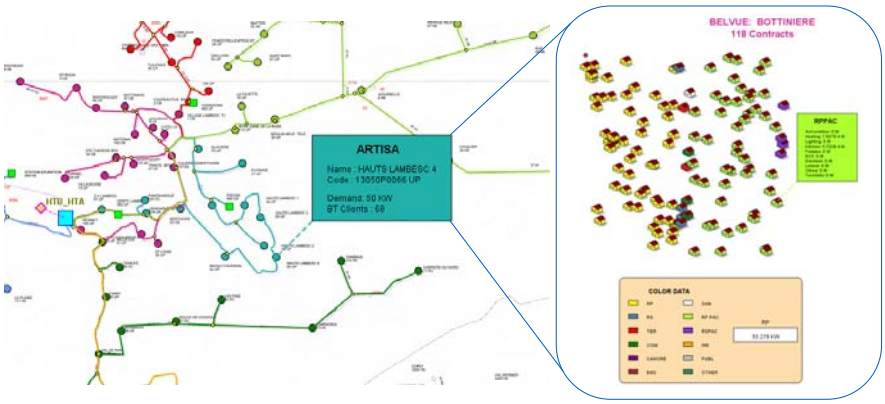
- **Simulation is a key task** taking into account the number of customers and the capacity for load reduction of PREMIO
- Two bottom-up approaches:
- First approach:
  - Static approach used to obtain approximated results of load reduction and CO2 emission savings
  - Aggregated load profiles (France level) per consumption uses are applied for local load curve modelling by modifying quantity of energy.
  - Impacts of Direct Load Control are assessed by re-shaping these load profiles of traditional uses
- Second approach
  - Agent-Based Model which presents a three level bottom-up approach and uses data provided by statistical sources that has been geographically located

First modeling approach

Bougnol P., Imbert P., Chartres S. Normand O., « Modélisation énergétique de la plateforme PREMIO, une architecture dédiée à la gestion dynamique de la charge sur le réseau électrique », REE - Revue de l'électricité et de l'électronique, N° 1, janvier 2010, p. 111-118.



Modeling of the PREMIO platform / Lambesc



-Modeling and simulation of the whole commune of Lambesc by ABM

-Modeling of smart grid platform

-Scenarios with a high penetration of Distributed Resources

Social Assessment

- Customer acceptance will be monitored and assessed during the experimental phase
- A methodology for monitoring data communicated by the Upstream Operators (critical periods, requests) and by Distributed Resources (facility's consumption, temperature and overrides) has been established
- Follow-up interviews with host-customers will be conducted to assess and to understand the impact of the remote control in their homes
- Lambesc's inhabitants who do not participate directly in the project will also be surveyed to measure awareness and perception of the project
- Interviews of project partners were carried out to study their own vision of the project

Project Progress
PREMIO Use Cases
Pierre Bougnol

Introduction to Use Cases (UC)

- Use Cases (UC) are used in the computing industry as a common methodology to define a system's requirements (e.g. Smart Grid)
- As soon as project objectives are sat, naming different UC will define the scope of the system to be developed.
- UC are a list of goals or functions attributed to each sub-system

- Decided with high-level management

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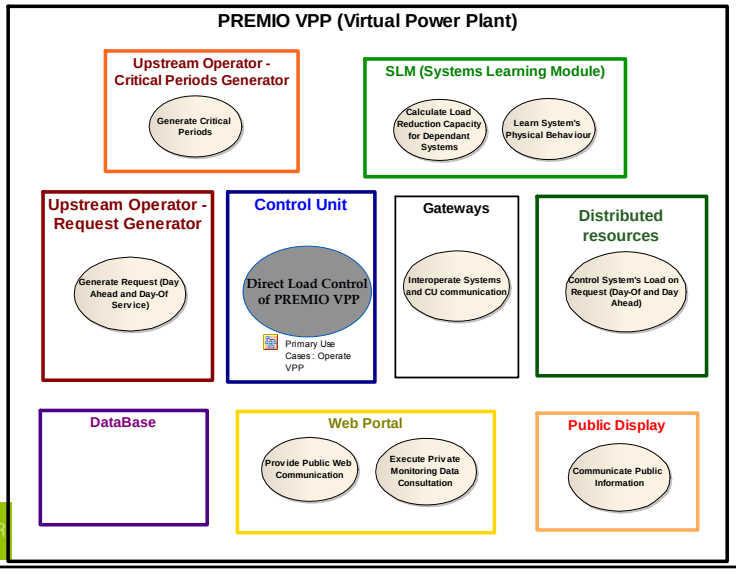
PREMIO Use Cases (UC)

- What do you want each system to do?



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List of PREMIO Use Cases (14)

Function Name	Performed by	Brief description (Scope, Objectives, Rationale)
Direct Load Control of PREMIO VPP	**Control Unit**	***The central function assigned to the PREMIO Virtual Power Plant (VPP) is to perform direct load control through a portfolio of distributed resources, called Systems. The Control Unit drives this operation by communicating between the Upstream Operators and the distributed resources. The load control is one mean to address European, national and regional concerns about electricity supply and CO2 emissions.***
Critical Periods Generation	Upstream Operator - Critical Periods Generator	*This function generates day ahead critical periods corresponding to the concerns of an Upstream Operator: load peaks or CO2 emissions. The Critical Periods are decisive in the process of aggregating individual load reduction capacities.*
Request Generation	Upstream Operator – Request Generator	*This function simulates the formulation of day ahead and day-of requests by an Upstream Operator. These requests correspond to the whole or a part of the aggregated load reduction capacity.*
Load Reduction Capacity Calculation for Dependant Distributed Resources	System Learning Module (SLM)	*This first function of the SLM aims at calculating the Individual Load Reduction Capacity of dependant distributed resources, i.e. the distributed resources that do not have the ability to do it on their own.*
Distributed resources' physical behaviour learning	System Learning Module (SLM)	*The second function of the SLM is to periodically upgrade the model simulating the Individual Load Reduction Capacities of the distributed resources. The upgrade is based on an analysis of the distributed resources' physical behaviour observed in the monitoring data.*
Individual load control of the distributed resources	EDF PV & Storages	*This function focuses on the individual load control of the EDF PV & Storage technology, in response to the Request of the Control Unit.*

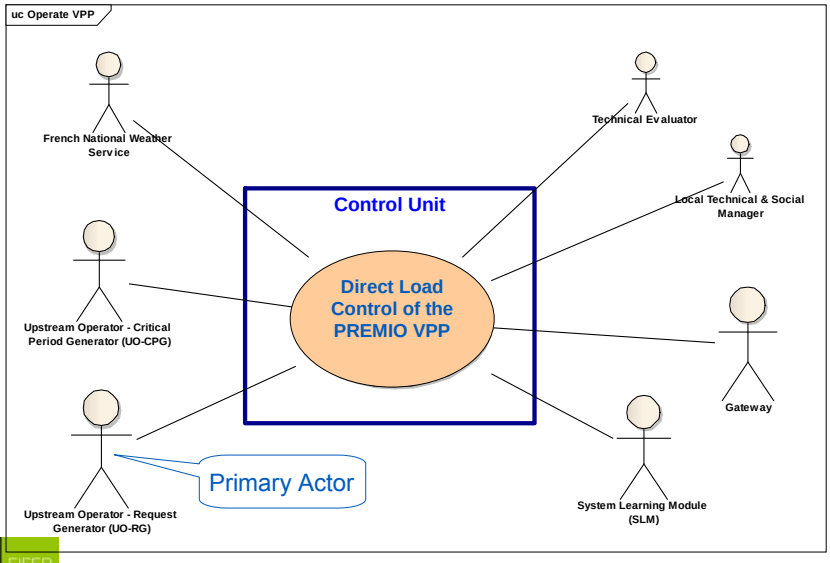
List of PREMIO Use Cases (14)

Function Name	Performed by	Brief description (Scope, Objectives, Rationale)
Individual load control of the distributed resources	EDF Heat Pumps &Thermal Storages	*This function focuses on the individual load control of the EDF Heat Pump & Thermal Storage technology, in response to the Request of the Control Unit.*
Individual load control of the distributed resources	EDF Load shedding appliances	*This function focuses on the individual load control of the EDF Load shedding appliances, in response to the Request of the Control Unit.*
Individual load control of the distributed resources	WATTECO Pulssi devices	*This function focuses on the individual load control of the WATTECO Pulssi devices, in response to the Request of the Control Unit.*
Individual load control of the distributed resources	WATTECO Public Lighting devices	*This function focuses on the individual load control of the WATTECO Public Lighting devices, in response to the Request of the Control Unit.*
Interoperation of Distributed resources and CU communications	Gateways	*This function describes how the Gateways interoperate the distributed resources and CU communication.*
Public information communication	Public Display	*This function is based on the public display that will be sat up within the municipality. It aims at communicating to the residents about the coming critical periods to come and relevant results of PREMIO Platform.*
Provide Public Web Communication	Web Portal	*This function is based on the project web portal. It consists in communicating to the public about critical periods to come and relevant results of PREMIO Platform.*
Execute Private Monitoring Data Consultation	Web portal	*The purpose of this function is for the host customer to consult through a private access, the monitoring data of the distributed resource(s) located within his facility.*

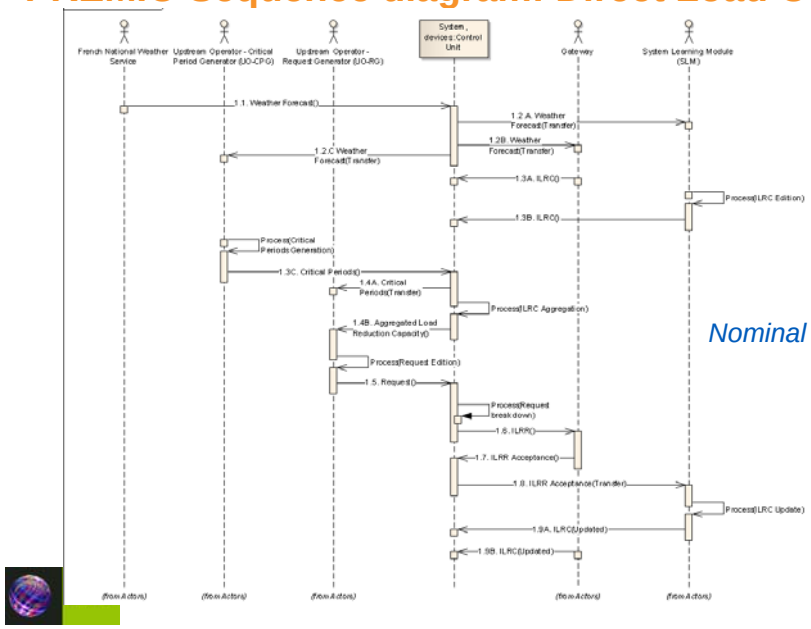
PREMIO Use Cases (UC)

- To represent UC → UML (Unified Modeling Language) description:
  - UC diagram,
  - Sequence diagram
  - Activity diagram,
  - Many others…
- UC implementation for PREMIO during implementation phase
- First UC: *« Direct Load Control of PREMIO VPP »*
  - ***The central function assigned to the PREMIO Virtual Power Plant (VPP) is to perform direct load control through a portfolio of distributed resources. The Control Unit drives this operation by communicating between the Upstream Operators and the distributed resources.***
- Software used for UML description: Enterprise Architect

PREMIO Use Case diagram: Direct Load Control

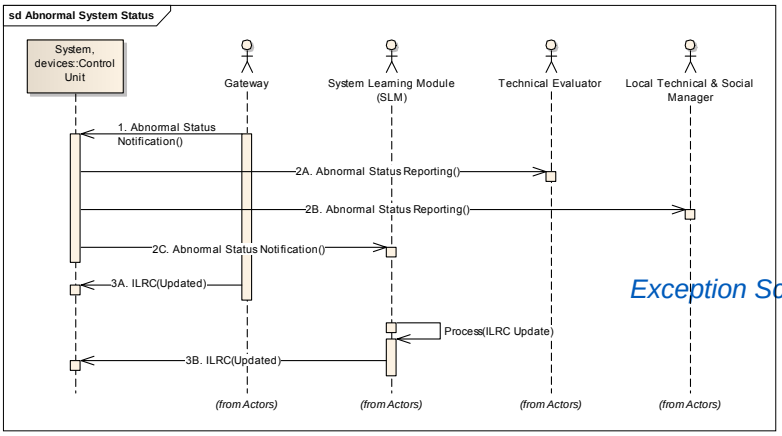


PREMIO Sequence diagram: Direct Load Control



Nominal scenario

PREMIO Sequence diagram: Direct Load Control



Exception Scenario

Lesson Learned – Use Cases

- Starting during implementation phase is late but…
- Improve exchanges on technical aspects thanks to the use of a common language (simplified UML)
- Structure the understanding of PREMIO VPP physical behavior
- Identify possible gaps in a communication sequence and opportunities for optimization
- Improvements of next Smart Grid (SG) demonstration projects
  - Quickly define the scope of the SG
  - Identify need for resources (communication bottleneck, activities involved, etc.)
  - Adopt common language at early stage of the project for efficient collaboration
  - A good beginning of next step of the project: choice of communication language and protocol, communications modeling/simulation, systems development, etc.

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Lessons Learned

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Lessons learned

- In addition to the lessons learned from the Use Cases…
- Modeling is necessary to extrapolate results of the demonstration project
  - Aggregated load profiles per consumption uses can be applied for local load curve modeling (e.g. at city level) by modifying quantity of energy
  - Direct load control impacts can be assessed by using modeling methods which re-shape load profiles of traditional uses
  - ABM enable us to model heterogeneous consumers behavior by using individual agents. Demand is obtain at local level and aggregated
  - Possibility to include local variables that affect behavior and decision making
  - Geo-references can be included

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Lessons learned

- Protocols are a key aspect during the development of the demonstration project. Different criteria as standardization, openness, scalability, security etc… must be taken into account during the study phase
- In the case of SNMP protocol, there were no standard MIBs developped for VPPs (control unit + Distributed Resources). MIBs had to be defined and all tools had to be customized to interact with them
- Maturity of Distributed Resources technologies does not guarantee by it-self the success of the VPP. ICT are crucial!
- In a demonstration project, customers are as important as technologies. Customers' support is necessary during the all project phases:
  - Acceptance of the project
  - Achievement of objectives
  - Quality of data
  - To avoid false expectations
  - Acceptance from non directly involved inhabitants is also important to the project success

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Technologies for load curtailment

1. Load shedding boxes for houses and apartments
2. Load shedding modules for residential and small tertiary buildings
3. Dimming of LED based public lighting

- **Thermal loads at residential level: Heating, ventilating and air conditioning equipment (HVAC), and domestic hot water**
- **Electrical appliances, such as washers and dryers for load shifting purposes. Load are installed in few businesses such as Laundries and Laundromats**

Electrical Storage technologies

4. Individual electric storage units coupled to PV panels

Thermal Storage technologies

5. Hot water tank coupled to a heat pump
6. Solar heat pump along with hot water storage
7. Thermal storage for industrial & tertiary cooling applications

Distributed Generation

8. Electricity generation unit with solar thermal storage
9. Biogas storage for electricity generation