EU FP-7 ADDRESS
Active Demand

Dr. Cherry Yuen
Corporate Research, ABB Switzerland Ltd

Salzburg 24th June 2010

active demand

address
interactive
energy

SUSTAINABLE ENERGY EUROPE
Official Partner

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 207643

Content

- Project Introduction
- Main Concepts
- “Toy Example”
- Recent Development and Progress
- Conclusions
- Future Contributions from ABB

ADDRESS Target and Objectives

Target

Active Demand (AD): active participation of domestic and small commercial consumers in the power system markets and service provision to the power system participants

Objectives

To enable active demand

- Develop technical solutions at the consumers premises and at the power system level
- Propose recommendations and solutions to remove the possible barriers

To exploit the benefits of active demand

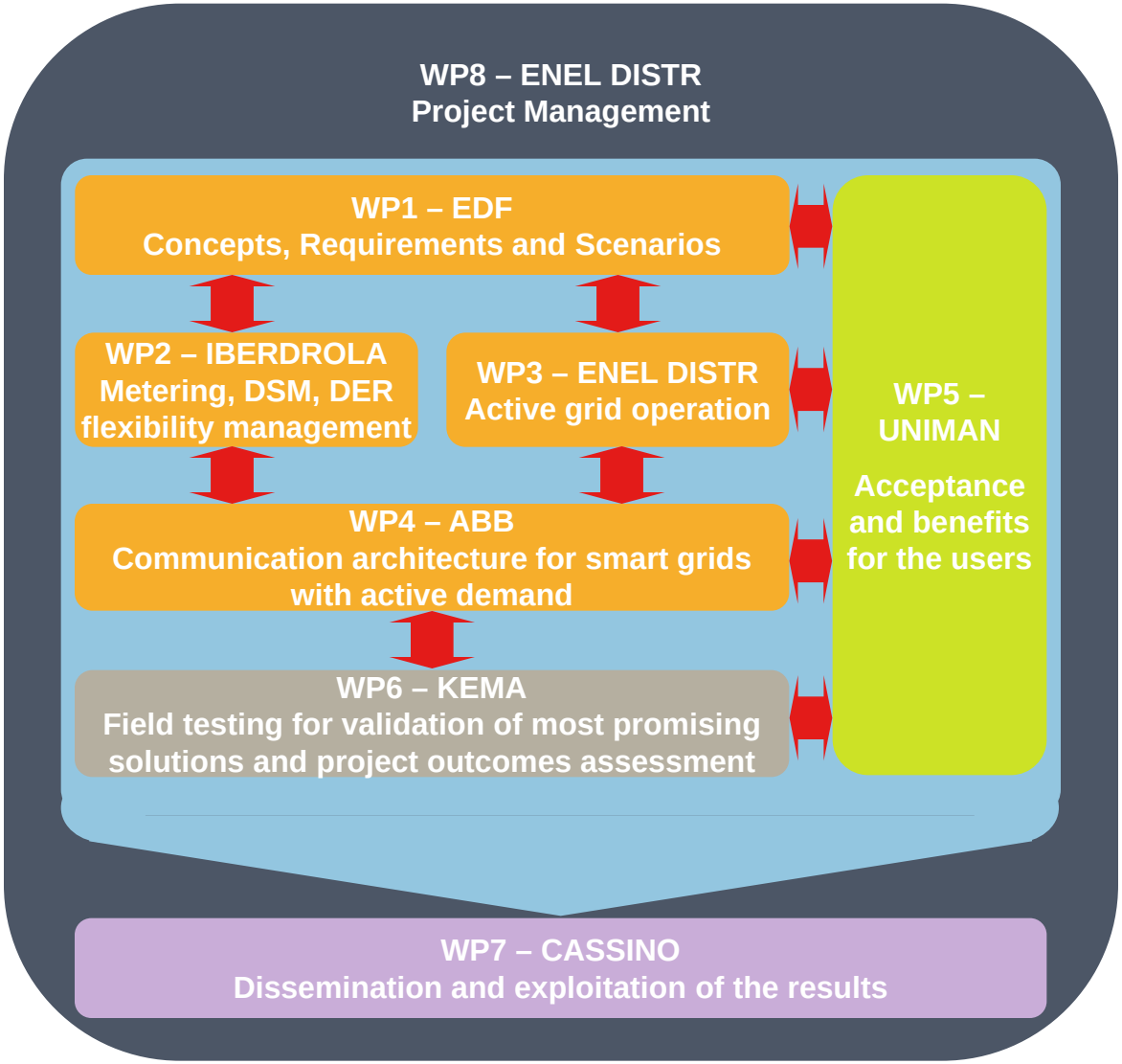
- Identify the potential benefits for the stakeholders
- Develop appropriate markets and contractual mechanisms

Study of accompanying measures to deal with societal, cultural, behavioural aspects

Validation in 3 complementary test sites with different demographic & generation characteristics

Dedicated dissemination activities for the stakeholders

ADDRESS Methodology (1/3)



ADDRESS Methodology (2/3)

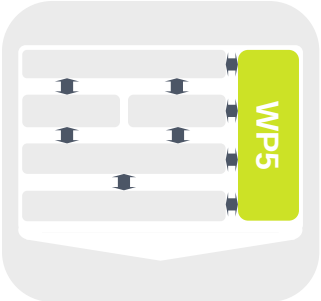
1. Develop
    - the concepts, in particular the mechanisms for the design of price and volume signals
    - ADDRESS technical and commercial architectures along with functional requirements based on the concepts
    - 4 or 5 scenarios representative of European power systems
    - ➢ WP1

2. Develop
    - enabling technologies, algorithms and prototypes,
    - test them individually in laboratories.
    - ➢ WP2 for consumers, aggregators and other deregulated market participants
    - ➢ WP3 for DSOs and TSOs and grid operation
    - ➢ WP4 for communication architecture.

ADDRESS Methodology (3/3)

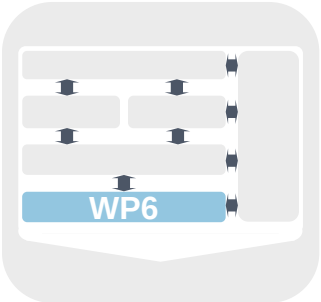
3. Develop
    - contractual, market & regulatory mechanisms for exploitation of the benefits
    - recommendations for accompanying measures for social acceptance

    ➢ WP5



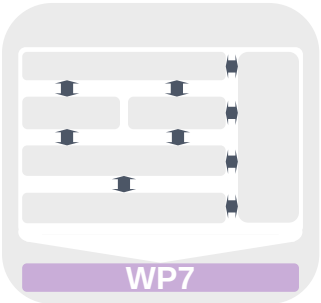
4. Validate and assess
    - Validate the concepts and the solutions developed at 3 different field test sites in Spain, Italy and on a French island
    - Assess the solutions performance and project outcomes (concepts, architectures, …)

    ➢ WP6.



5. Recommendations and dissemination
    - Define recommendations for the different stakeholders: regulators, communities, power system participants, R&D “world”, standardization bodies, …
    - Deploy and communicate the results

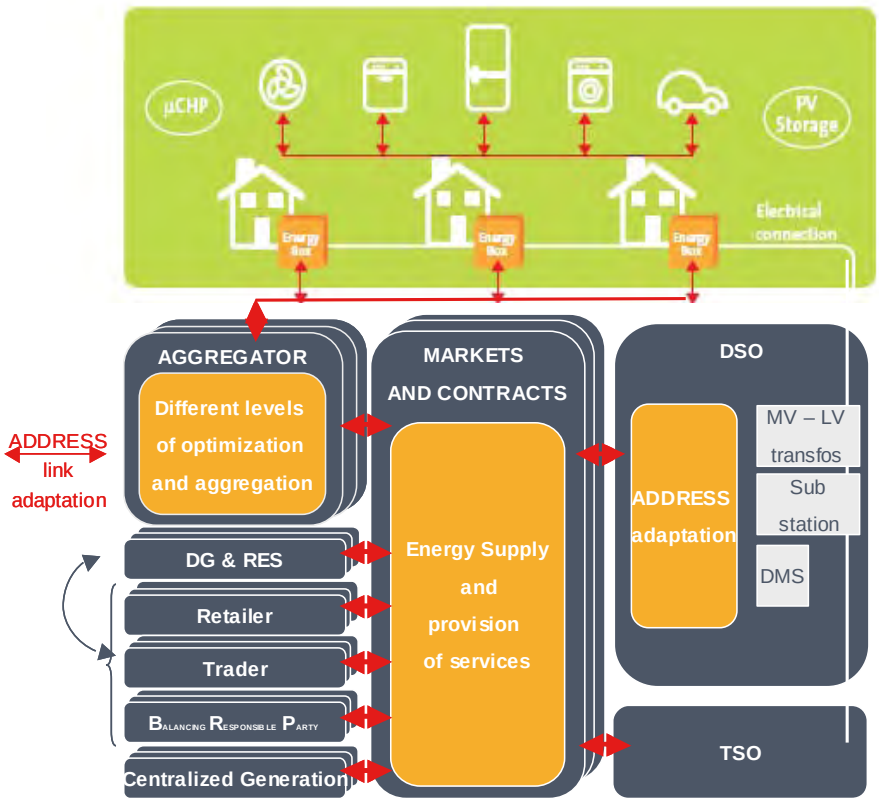
    ➢ WP7



The Conceptual Architecture

Aggregators

- Mediator between consumers and markets
- Different levels of optimisation to meet the requirements of topologically dependent services



Consumers

- Households and small businesses directly connected to distribution network
- Provide flexibility to aggregators
- Energy box: interface with the aggregator
- Optimisation and control of appliances and DER

Distribution System Operator

- Enable AD on their network and ensure secure and efficient network operation
- Interacts with aggregators through markets
- Direct interaction with TSO for system security

Markets & Contracts

All types of commercial relationships (organized markets, call for tenders, bilateral negotiations)

- Energy supply
- Relief of overload & network congestion
- Balancing services (incl. compensation of RES variability)
- Ancillary services: steady state V control, tertiary reserve
- Load shaping services (e.g. peak shaving)

The Project Main Concepts

Interaction based on real-time price and volume (mainly P) signals

- Real-time = 15 to 30 min ahead or longer
- Modulated by geographical / topological information
- Direct load control by DSO will be not considered
- Emergency situations are not considered

"Demand" approach

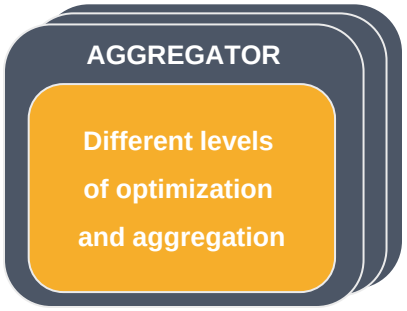
- Services "requested" through appropriate price and/or volume signal mechanisms and provided on a voluntary and contractual basis
- Deployment of appropriate technologies at consumers' premises
- Accompanying measures for societal and behavioural aspects

Distributed intelligence and local optimisation

- Topologically-dependant services
- Participants optimise real-time response according to the real-time signals

Put the "right amount" of intelligence at the "right place"

The ADDRESS Aggregator



Mediator between:

- the consumers, and
- the markets and the other participants

Main functions

- Gathers (“aggregates”) the flexibilities and contributions of consumers to “build” Active Demand (AD) “products”
- Offers/sells the AD products to the power system participants via the markets and in this provide AD services to the electricity system players
- Manages the risks (price and volume risks) associated with uncertainties in
  - the markets and
  - responsiveness of the consumer base.
- Maximizes the value of consumers’ flexibility
- Interacts with consumers through price and volume signals and assesses their response and behavior

The System Participants

Archetypes of electricity system players to which AD services could be provided

- Regulated players: **DSOs** and **TSOs**
- Deregulated players:
  - **Producers:** central producers, decentralised electricity producers, producers with regulated tariff and obligations (reserve, volume, curtailment, etc.)
  - **Intermediaries:** retailers, production aggregators, energy traders, electricity brokers, Balancing Responsible Parties (BRPs),
  - **Consumers:** large consumers

Study of the players' expectations with respect to AD ⇒ for each player:

- Role and main functions in the system
- Main stakes and contextual constraints
- **Short-term and long-term needs generated by the stakes**
- **How can AD meet these needs**

➔ identification of **possible services provided by AD** and basic requirements

The AD Services

31 AD Services

7 AD services for regulated players:

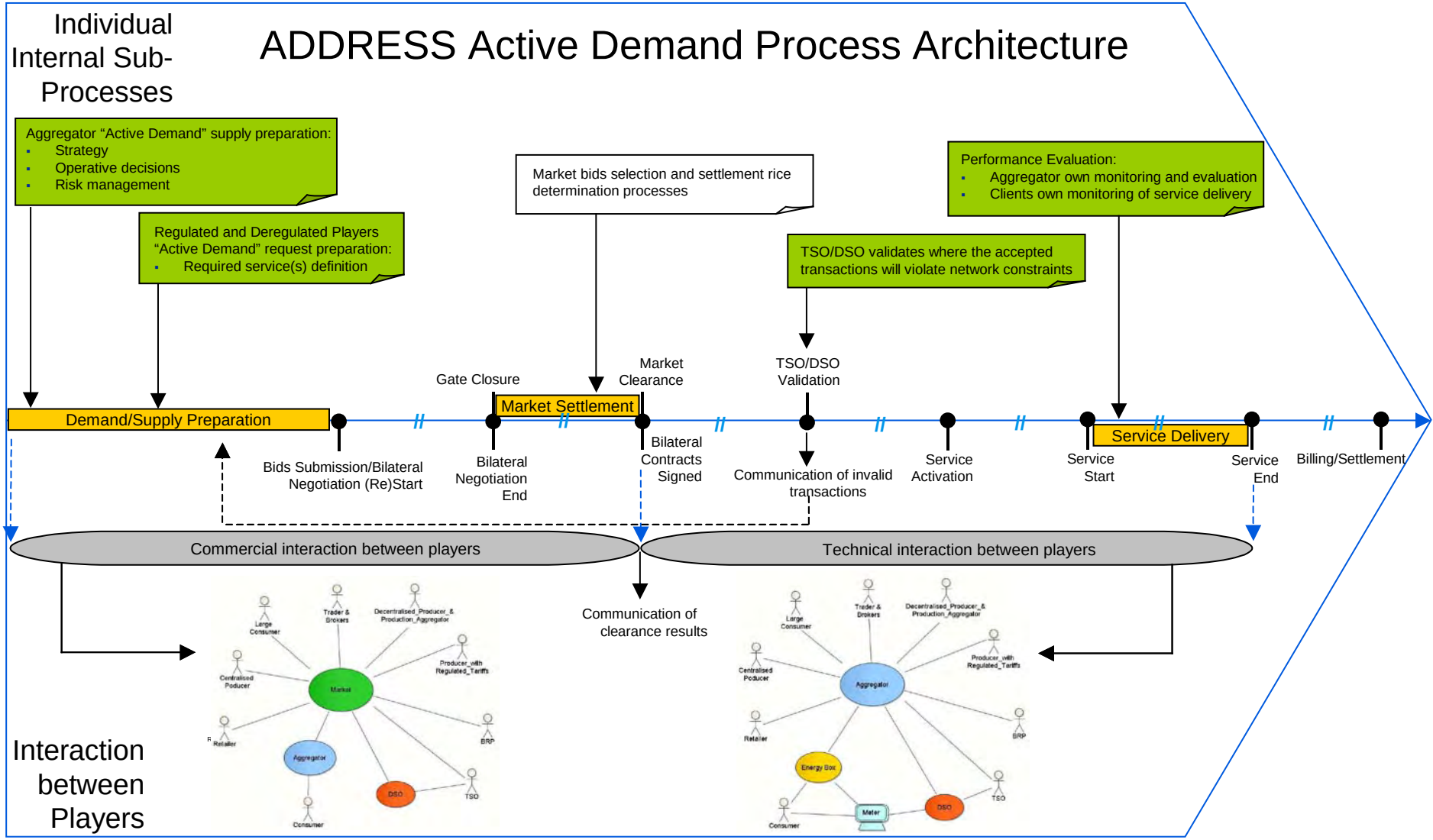
- Voltage regulation and power flow control
- Tertiary active power reserve
- Smart load reduction to avoid “blind” load-shedding

Player	Principal services	Type of AD Product	ID
Retailer	Short-term load shaping in order to Optimise Purchases and Sales.	SRP	SRP-SOPS-RET
	Management of Energy Imbalance in order to minimise deviations from declared consumption programme and reduce imbalance costs.	SRP	SRP-MEI-RET
	Reserve capacity to manage short-term Risks.	CRP	CRP-SR-RET
Centralised Producer	Short-term optimisation through load shaping in order to Optimise the Operation of its Generation portfolio.	SRP	SRP-SOG-CP
	Management of Energy Imbalance in order to reduce imbalance costs.	SRP	SRP-MEI-CP
	Tertiary Reserve provision in order to meet obligation of tertiary reserve provision contracted with the TSO.	CRP	CRP-TR-CP
Decentralised electricity Producer or Production Aggregator	Short-term Management of Energy Imbalance in order to minimise deviations from declared production programme (low uncertainty).	SRP	SRP-SMEI-DP
	Load shaping in order to Optimise its Economic Profits.	SRP	SRP-OEP-DP
	Tertiary reserve provision in order to meet contracted tertiary reserve programme.	SRP	SRP-TR-DP
	Reserve capacity to Short-term Manage Energy Imbalance in order to minimise deviations from declared production programme (high uncertainty).	CRP-2	CRP-2-SMEI-DP
	Reserve capacity to Short-term Manage Energy Imbalance but the DP knows the direction of the imbalance probably because the time to the forecasted imbalance is shorter (medium uncertainty).	CRP	CRP-SMEI-DP
	Reserve capacity to manage provision of contracted Tertiary Reserve (medium uncertainty).	CRP	CRP-TR-DP
	Reserve capacity to manage provision of contracted Tertiary Reserve (medium uncertainty).	CRP-2	CRP-2-TR-DP
Producer with Regulated tariffs	Short-term Local Load Increase in order to compensate the effect of network evacuation limitations and to be able to produce more.	SRP	SRP-SLLI-PwRT
	Short-term Load Increase in order to avoid being cut-off.	SRP	SRP-SLI-PwRT
	Local Load Increase reserve in order to compensate the effect of network evacuation limitations and to be able to produce more or to invest more in generation capacity	CRP	CRP-LLI-PwRT
	Load Increase reserve in order to avoid being partially cut off, or even to be authorized to invest more.	CRP	CRP-LI-PwRT
	Reserve capacity to Manage Energy Imbalance in order to minimise deviations from the production program previously declared and reduce the imbalance costs.	CRP-2	CRP-2-MEI-PwRT
Traders and brokers	Short-term Optimisation of Purchases and Sales by load shaping	SRP	SRP-SOPS-T&B
	Short-term Optimisation of Purchases and Sales through Reserve Capacity	CRP	CRP-SOPS-T&B
Balancing Responsible Parties	Management of Energy Imbalance (low uncertainty)	SRP	SRP-MEI-BRP
	Management Energy Imbalance (medium uncertainty)	CRP	CRP-MEI-BRP
	Management Energy Imbalance (high uncertainty)	CRP-2	CRP-2-MEI-BRP
Large consumers	Minimisation of Energy procurement Costs	SRP	SRP-MEC-LC
DSO/TSO	Scheduled Re-Profiling Load Reduction (slow).	SRP	SRP-LR-SL
	Scheduled Re-Profiling Load Reduction (fast).	SRP	SRP-LR-FT
	Scheduled Re-Profiling for Voltage Regulation and Power Flow Control (slow)	SRP	SRP-VRPF-SL
	Conditional Re-Profiling Load Reduction (Fast).	CRP	CRP-LR-FT
	Conditional Re-Profiling for Voltage Regulation and Power Flow control (Fast).	CRP	CRP-VRPF-FT
TSO	Bi-directional Conditional Re-Profiling for Tertiary Reserve (Fast).	CRP-2	CRP-2-TR-FT
	Bi-directional Conditional Re-Profiling for Tertiary Reserve (Slow).	CRP-2	CRP-2-TR-SL

24 AD services for deregulated players:

- Optimisation of purchases and/or sales of electricity
- Balancing of generation or consumption (to reduce imbalance costs)
- Optimisation of generation investments costs
- Optimisation of generation management
- Reserve capacity to minimise risks (price-volume)
- Tertiary reserve to fulfill obligations for TSO

Conceptual Architecture Process Diagram



Deliverable 1.1
ADDRESS technical and commercial conceptual architectures

vision

address interactive energy

Available on http://www.addressfp7.org

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 207643

ADDRESS Technical and Commercial Conceptual Architectures - Core document

Deliverable D1.1 - Conceptual architecture including description of: participants, signals exchanged, markets and market interactions, overall expected system functional behaviour – Core document.

Programme	FP7 – Cooperation / Energy
Grant agreement number	207643
Project acronym	ADDRESS
Type (distribution level)	Public
Date of delivery	21st October 2009
Report number	D1.1
Status and Version	Final, V 1.0
Number of pages	129
WP/Task related	WP1/T1.5
WP/Task responsible	R. Belhomme/F. Bouffard
Author(s)	R. Belhomme, Maria Sebastian, Alioune Diop, Marianne Entem, François Bouffard, Giovanni Valtorta, Angelo De Simone, Ramon Cerero, Cherry Yuen, Seppo Karkkainen, Wolfgang Fritz
Partner(s) Contributing	EDF SA, University of Manchester, Enel Distribuzione, Iberdrola, ABB, VTT, Consentec
Document ID	ADD-WP1-T1.5-DEL-EDF-D1.1-Technical_and_Commercial_Architectures-V1.0
	ADD-WP1-T1.5-DEL-EDF-D1.1-Technical_and-Commercial_Architectures-V1.0.doc

vision

address interactive energy

This research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 207643

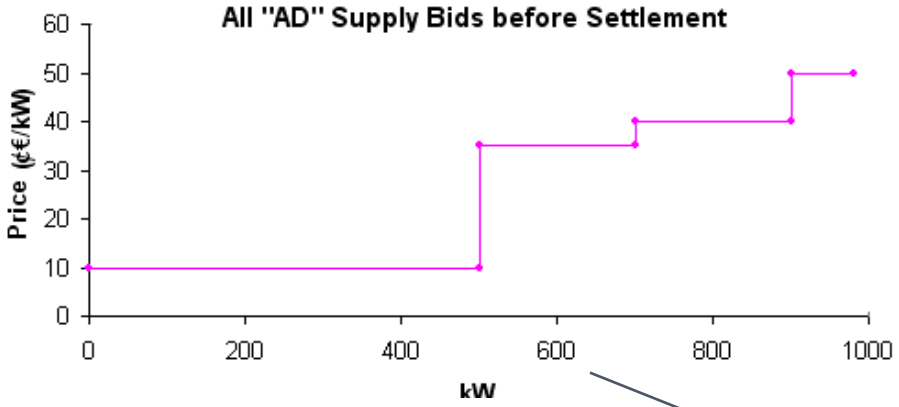
Purpose of the Toy Example and ... ... Market Simulation

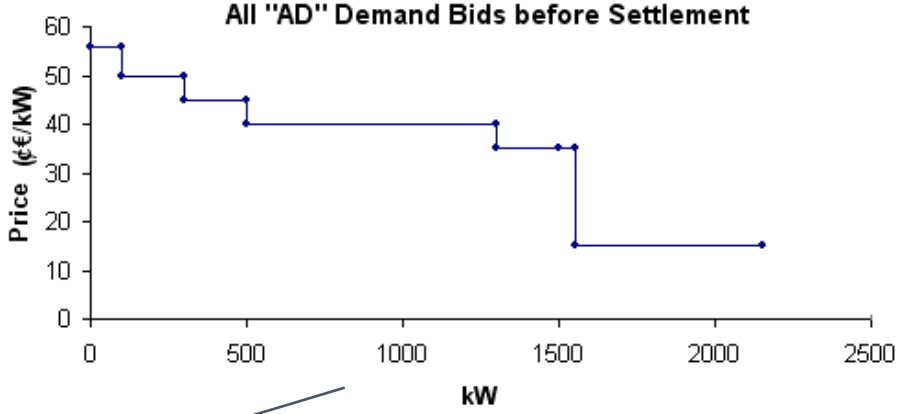
- A tool to illustrate the concepts of ADDRESS
  - Better understanding, pedagogical purposes, play with “numbers”, …
  - Provision of services by AD aggregators to retailers and DSOs
  - Information flow between players for Active Demand
  - Cash flow between players acquiring and supplying Active Demand
- Market simulation focuses on cash flow illustration
  - To study the business case and potential profits of players
  - To help calculate the revenue and net income of players
- Requirements
  - User-friendly
  - Focus on illustration of concepts but not detailed methodology
  - Usable on a common platform/software available to most PCs

Market Mechanism

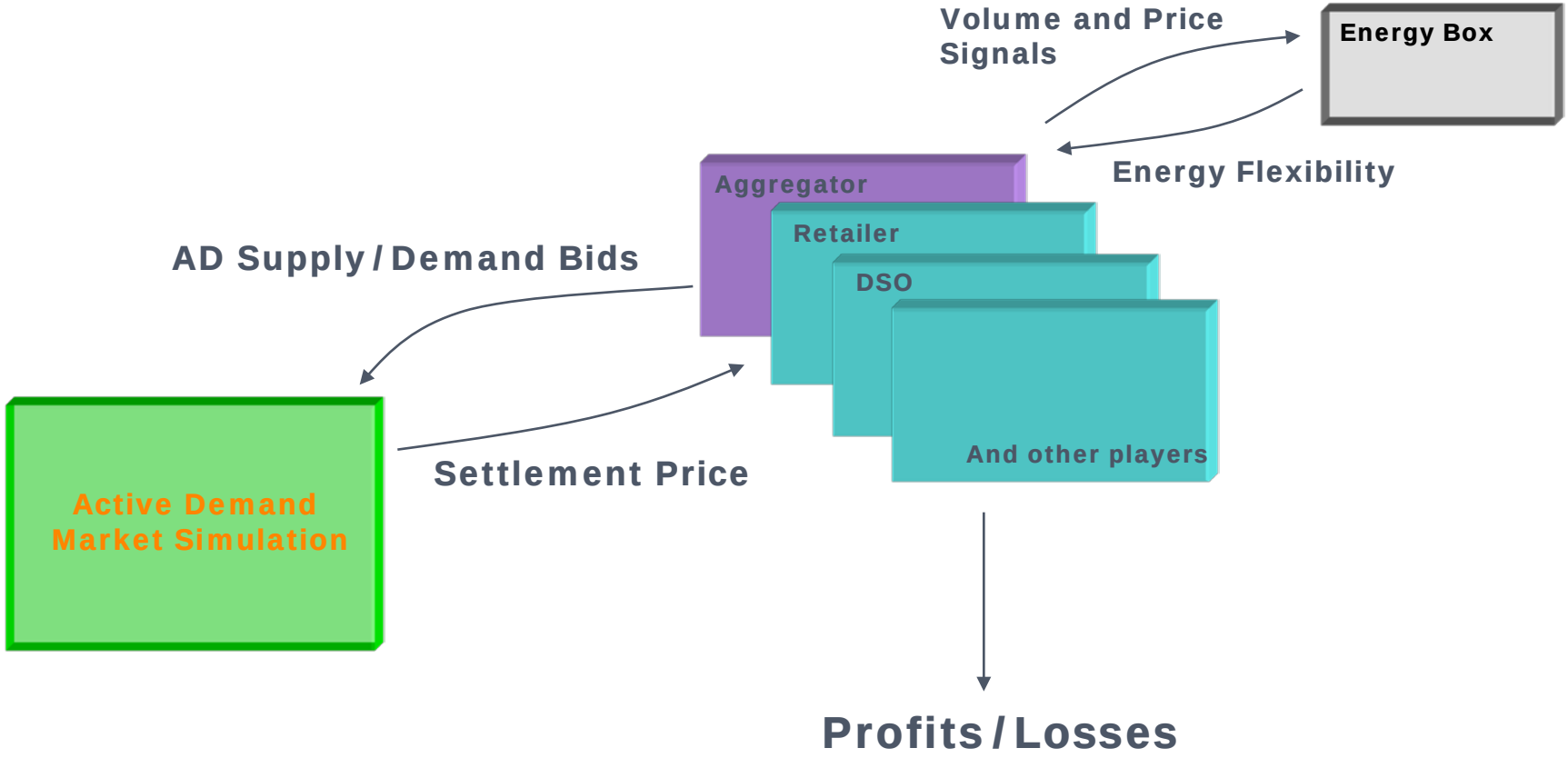
– Uniform Pricing Auction is adopted:

- All accepted bids/offers settle at one price
- Simple and well-studied
- Widely adopted in existing European energy markets



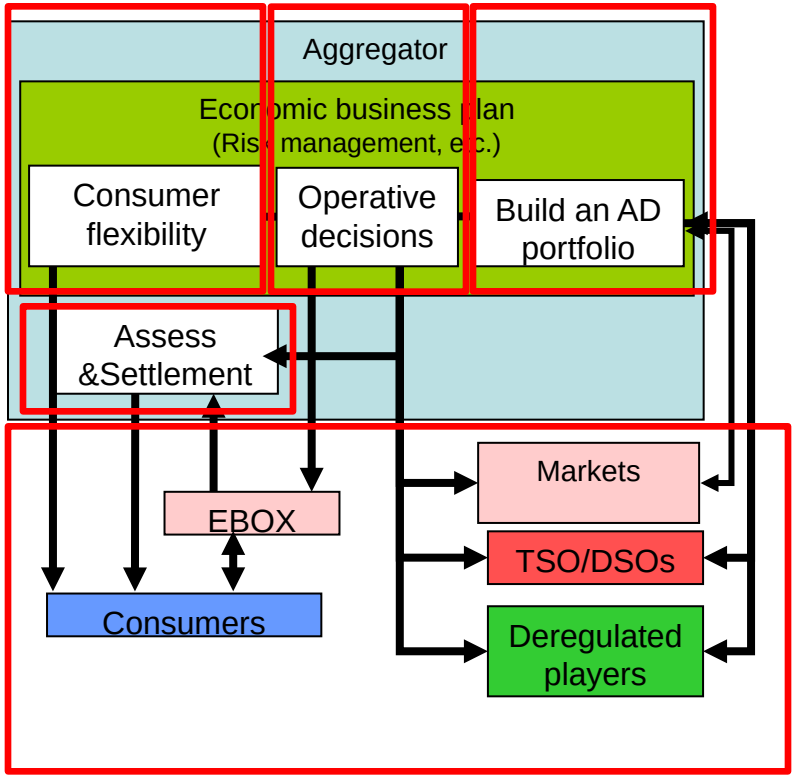


Linkage with Other Players'...
... Internal Optimization Processes



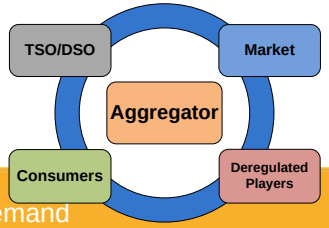
Recent Development & Progress:
The Aggregator Core Modules

Aggregators need to have the following key modules, to be implemented within the project following ADDRESS strategic approach:



- ***Consumption and flexibility forecasting***: Forecast flexibility in the short and long term (this forecasting is tuned as feedback & consumer understanding is achieved)
- ***Market and consumer portfolio management***: Consumers and other players contractual relationship, long term operations (strategy) and risk management
- ***Settlement and billing***: Assessing services delivery and performing billings.
- ***Operational optimization***: Algorithms (short term) to interact with other players **(AD buyers and system operators)** and activate demand flexibility. Markets short term price forecasting

✓Algorithms: Under implementation. ✓Interaction: Defined:



Recent Development & Progress: Active Demand Roll-out Scenarios

4 Scenarios developed using the following approach:

- Establish the set of underlying factors at the 2010 boundary
- An experts' panel judges how an emerging ADDRESS in 2010 could be globally successful in helping industry actors meet their stakes
- Step 2 again for 2020 hypothesising about evolution of factors and roll-out of ADDRESS conceptual architecture
- Elaborate scenario narrative describing chain of events leading to 2020

Full details in public deliverable D1.2 now available on the project website (http://www.addressfp7.org)…

Recent Development & Progress: Communication Requirements & Architecture

– Communication requirements identified based on survey:
  – Flexibility with respect to physical media (especially on last mile)
  – Full interoperability for all electricity network elements (e.g. CIM standards)
  – Secure remote access to all elements of the electricity network
  – Implementation to be compatible with TCP/IP and Web Services
  – Communication performance should be independent of grid state
  – At aggregator & E-Box level the network should be self-configuring
  – Electricity network management: visualization & remote configuration

– A service oriented architecture based on web services and standardized XML messages forms the basis for ADDRESS communications

– The Traffic Matrix has been introduced as a tool for estimating & representing the overall performance requirements for a specific scenario

Recent Development & Progress: How to get people involved in field trials?

– Financial benefit is an obvious reason for participation:

- Free, or cheap smart appliances
- Fixed financial payment, linked to completion of trial
- Variable financial payments
  - Fixed fee with penalties/rewards for using an over-ride feature
  - Shadow market

– Others are less obvious but equally important:

- Social and community benefits
- Enthusiasm for the trial

Conclusions

- FP 7 ADDRESS “Active Demand “
  - Aggregation of demand flexibility
  - Multi-national European project involving 25 partners
- Development of the technical and commercial conceptual architectures describing:
  - The players involved, their interactions and the signals exchanged,
  - The services provided by AD and the products traded
  - The requirements for the implementation of the architectures and
  - The issues and potential barriers
- “Toy example” market simulation
  - Help understand an example of implementing market mechanism for active demand
- Recent development and progress
  - Aggregator’s core modules and interaction with other players
  - Scenarios
  - Worldwide experience of customers recruitment

Future Main Contributions from ABB

Algorithms for active grid operation and management (WP3):

- Evaluate, design and implement a centralized or decentralized algorithm capable to validate on- and off-line AD products cleared by the market or according to bilateral contracts
- Develop new or modify existing power flow and voltage control algorithms using DER's and AD as actuators

On communication (WP4 – WP Leader):

- Modelling of data exchange using CIM objects (inputs for CIM standardization committee)
- Contributions to survey on SG communications possibilities
- Contributions to communication architecture enabling AD

Contributions to design and implementation of a market simulator for test sites (WP5) which:

- clears and settles markets real-time
- communicates to market participants of market clearance and settlement results

Thank you for your attention !

http://www.addressfp7.org

active demand

address
interactive
energy

SUSTAINABLE ENERGY EUROPE
Official Partner

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 207643