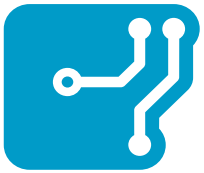

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E3 - Education, Employment & Entrepreneurship

Electric Vehicles Aggregation Agents: a Business Opportunity

Ricardo Bessa (rbessa@inescporto.pt)

Doctoral Program on Sustainable Energy Systems - MIT Portugal

Lisboa, June 28, 2012

EV Aggregation Agent

Concept

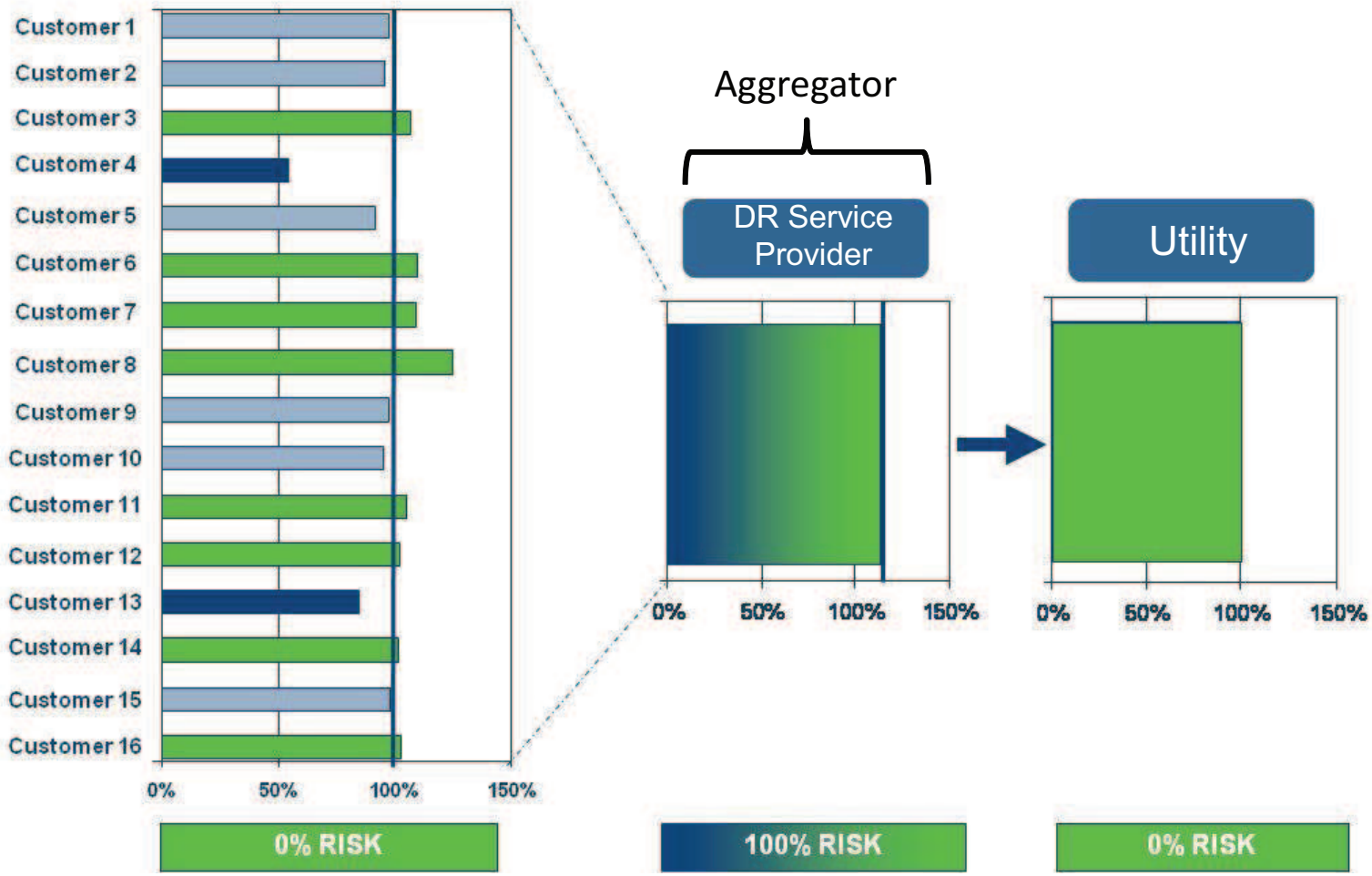
Intermediary between EV drivers, electricity market, distribution system operator (DSO) and transmission system operator (TSO)

The main reasons for the deployment of EV aggregators are:

- current market rules do not allow the individual participation of small loads (minimum bid is 5 MW)
- facilitates the interaction with the DSO for solving technical issues
- mitigates the forecast errors of EV load
- with an appropriate strategy, it can offer competitive retailing tariffs

EV Aggregation Agent: present or future?

"A diverse portfolio ensures reliability"



ENERNOC

EV Aggregation Agent: present or future?

in the U.S. companies like **EnerNOC** and **Comverge** operate in a potential $4–5 billion market, managing demand response capacity of more than 30 GW

Wide Range of Services

Client Acquisition	Client Management	Load Control	Measurement	Analysis	Program Refinement
Prospect analysis	**Call center**	Control strategies	Event performance	System performance	Dynamic forecasting
Segmentation	Work order generation	Notification & alerts	**M&V data**	Network performance	**Performance modeling**
Marketing	Customer tracking	**Dynamic pricing**	Device metrics	Device heuristics	Grid impacts
Channel management	Customer support	Event & device management	Forecasting	**Load analysis**	Customer forecasting
Messaging	Accounts / customers	Constraints	Performance baselines	System forecasting	Weather impact
Acquisition tracking	System topology	Grid operations	Device operations	Customer analysis	Grid constraints
	Rate & tariffs	MW tracking	System operations	Segmentation	DMS dispatch
	Trouble ticketing	Event reporting			

comverge

EV Aggregation Agent: present or future?

. . . and in Europe

Entelios is Germany´s first Demand Response Aggregator and has taken a market leading role in Europe.

Facts

- **Founded 2010**
- **Services**:
  - Demand Response **Aggregation**
  - Demand Response **as-a-Service** to utilities and TSOs
  - Intelligent Energy **Efficiency Services**
- **Focus**:
  Industrial, **Commercial** & **Institutional** load control & management
- **Offices**:
  Germany – Berlin and Munich.
  Development team in India.

EV Aggregation Agent: present or future?

Presently, EV Aggregators are start-up companies

HOME ABOUT US TECHNOLOGY OUR SOLUTION PRESS CONTACT US

NUVVE

SMART GRID powered by V2G

V2G is a Proven Technology

- Spin-off of University of Delaware
- More than $2.5 invested in the solution
- Up to 9 Electric Vehicles aggregated over 24 months
- Achieved between $200 - $500 annual revenue per KW per vehicle in trial

The next step is to commercialize and scale the technology around the world.

Prof. Willett Kempton, Nuvve's CTO has been working on this problem since 1996, looking for the most economic and ecologic solution based on Electric Vehicles

EV Aggregation Agent: present or future?

Other candidate companies for an EV aggregator are:

- **Better Place**: core business consists in a creation of an Electric Recharge Grid Operator
- **REIV2G**: aggregating EV for participating in the PJM and NYISO markets
- **Coulomb Technologies**: with their Chargepoint network is capable of aggregation
- **Intel**: developed an intelligent energy management system for EV (with aggregator)

PhD Thesis

Development of Methodologies for Technical and Economic Management of Aggregation Agents of EV

Objective

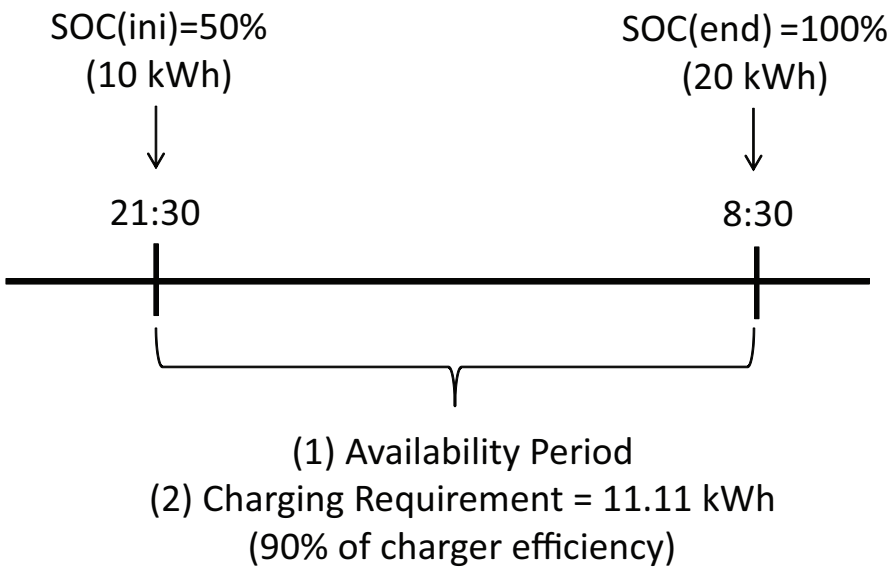
Develop a business model, optimization and forecasting algorithms for the participation of an EV aggregator in the electricity market

Bussines Model of an EV Aggregator

- Three type of clients are envisioned
  - **flexible**: direct control of the charging process
  - **inflexible**: **no** direct control, simple retailer
  - **mix**: inflexible when plugged-in to public and fast charging stations; flexible in slow charging points (e.g., household)
- The aggregator offers cheap charging tariffs to flexible clients
- Inflexible clients pay a normal tariff that can be competitive for attracting new clients
- The vehicle-to-grid (V2G) mode is not considered
  - a operating point is defined P (purchased electrical energy)
  - upward reserve: $P - P^{up}$
  - downward reserve: $P + P^{down}$
- The aggregator supports all the financial costs of deviations from market bids (i.e., takes all the risk)

Bussines Model of an EV Aggregator

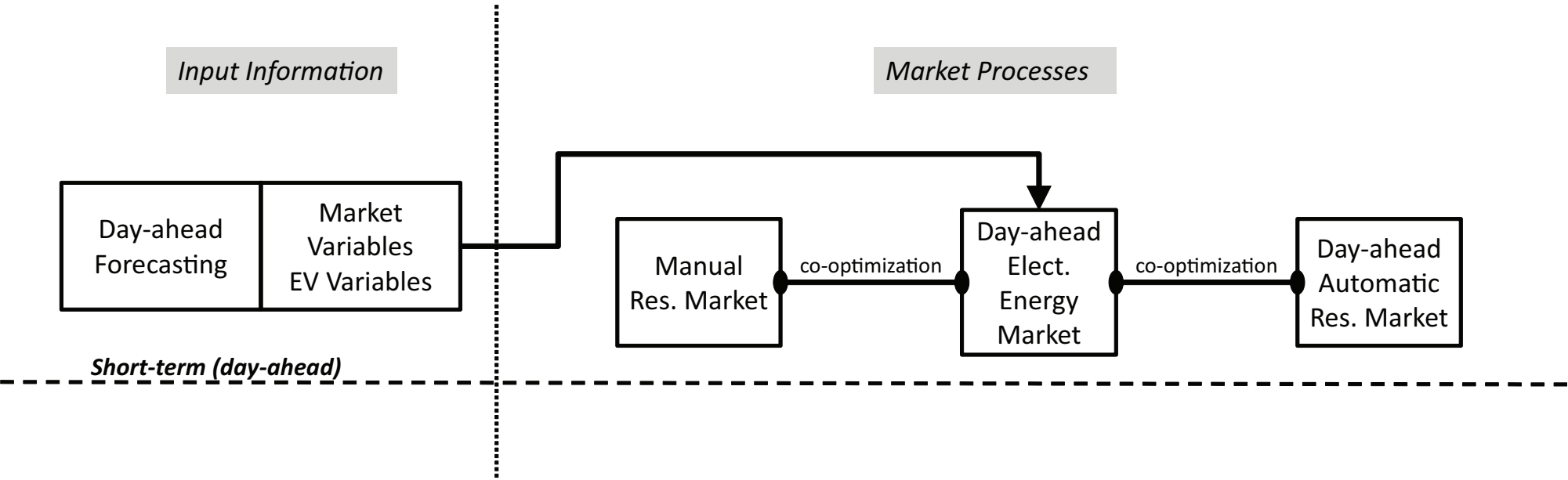
- The fundamental goal is to keep the driver's autonomy
- The contract with the aggregator establishes the following:
  - the driver when parks for charging defines the target SOC and charging completion hour
  - a default profile is defined for the availability period (e.g., 6 hrs) and target SOC (e.g.,100%)
  - the EV is completely free to arrive for charging and depart before charging completion
  - use the minimum information about the driver



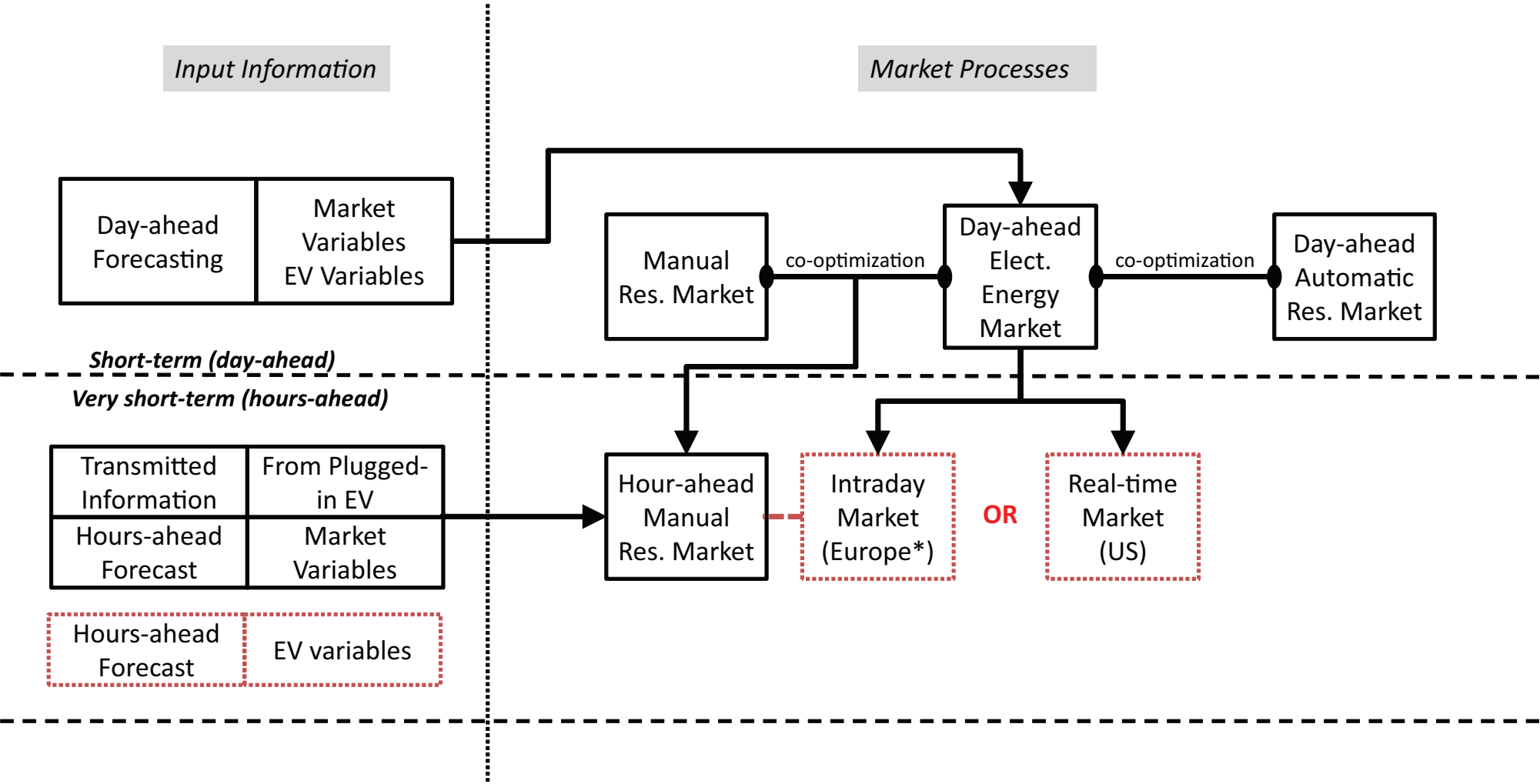
Electricity Market Opportunities

- Participation in the electrical energy market
  - control the charging process for decreasing the wholesale costs
- Participation in the manual (tertiary) reserve market
  - downward reserve is cheap charging, upward reserve is profit from reducing consumption
- Participation in the automatic (secondary) reserve market
  - receive a payment for being in standby as reserve capacity

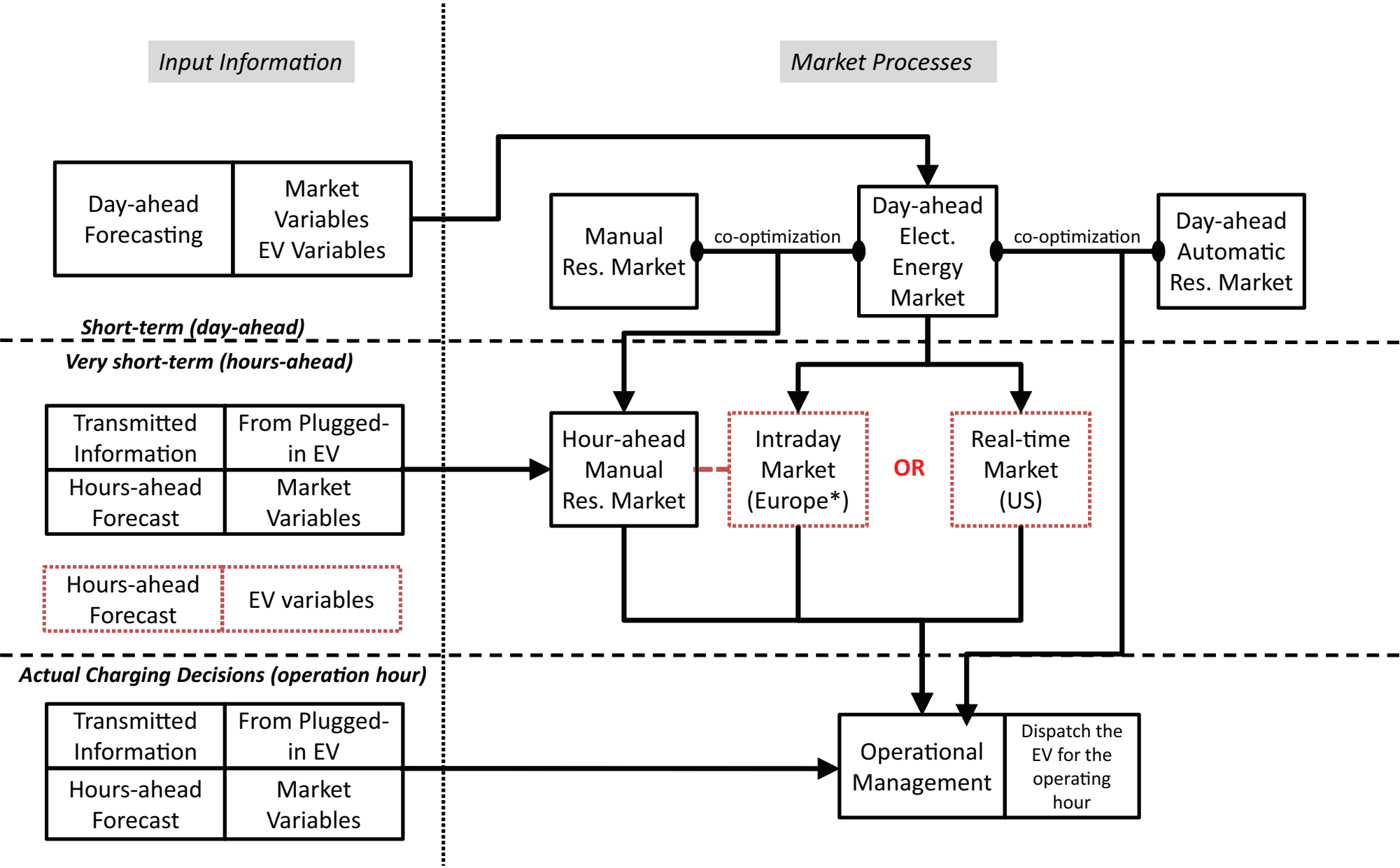
PhD Thesis Framework



PhD Thesis Framework



PhD Thesis Framework



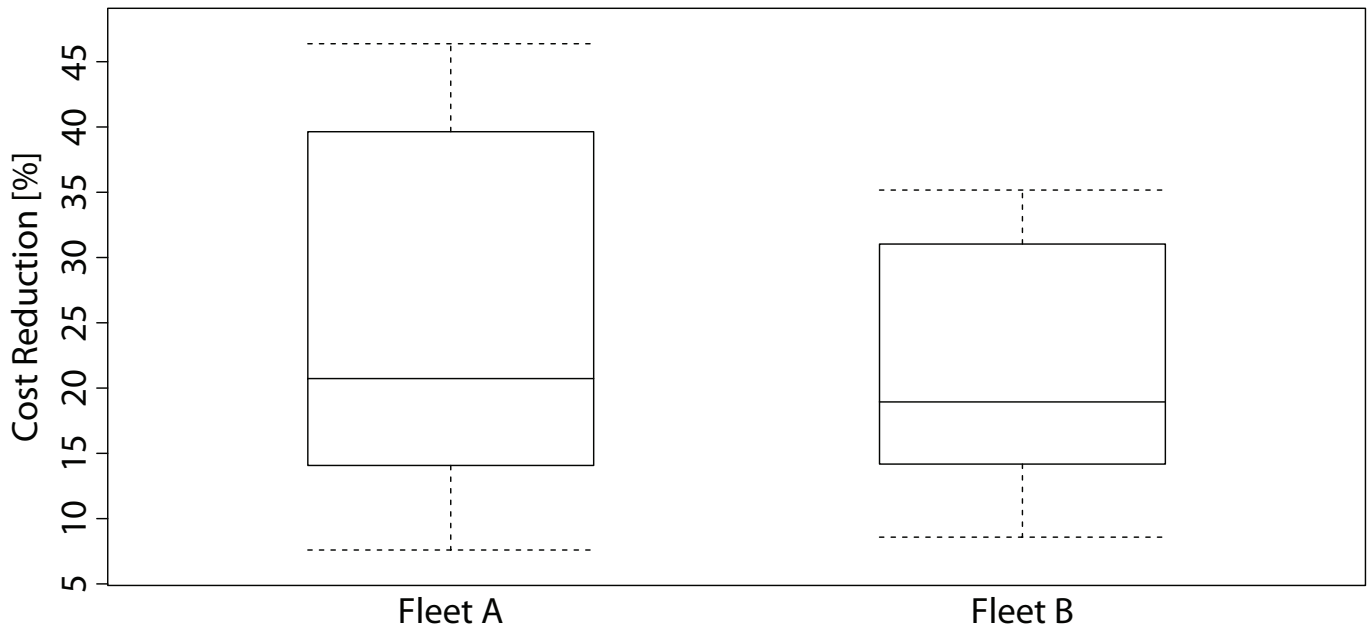
Results for Two EV Fleets

Participation in the electrical energy market (Portugal)

Breakeven Tariffs

	Flexible Clients	Inflexible Clients
Fleet A	0.033 kWh	0.045 kWh
Fleet B	0.035 kWh	0.042 kWh

+ participation in the manual (tertiary) reserve market (Portugal)



Wrap Up

- The aggregator is important for several stakeholders:
  - is financially attractive for EV owners (is the *hard worker*)
  - offers controllability and ancillary services to system operators
  - promotes the full participation of demand-side resources in the electricity market
- This thesis covers only one part of the business, and the mid and long-term horizons are also important
  - marketing strategies
  - determination of retailing tariffs value and schemes
  - participation in financial markets
- The ideas and models from this thesis can be adopted by aggregators of other types of flexible loads

Acknowledgements

MIT Portugal

FCT Fundação para a Ciência e a Tecnologia

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

Ph.D. Scholarship SFRH/BD/33738/2009