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9th EU-US Energy Regulators Roundtable

Integration of electric vehicles in smart distribution grids: Regulatory issues

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Spanish National Energy Commission

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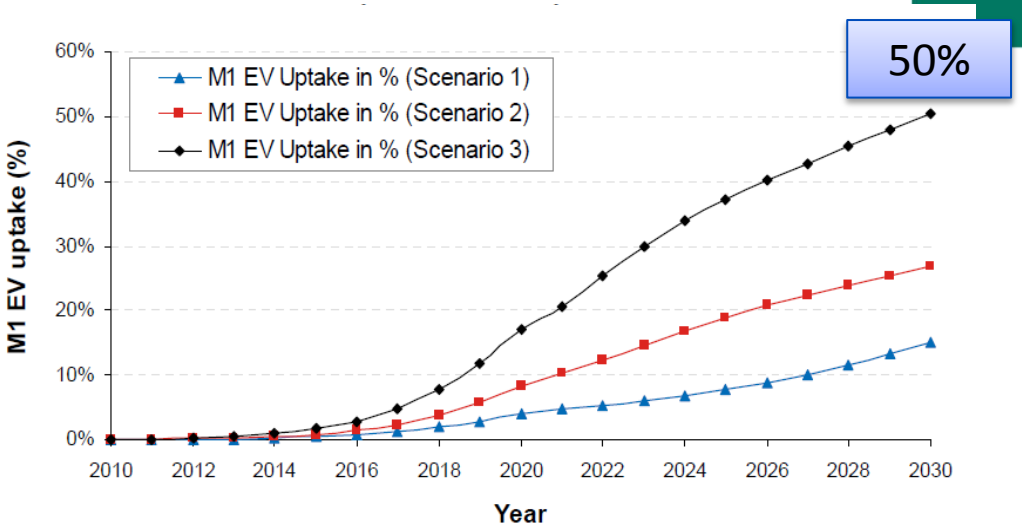
Contents

Electric vehicles

- A massive EV penetration is expected in the decade 2020/2030



VEHICLE CLASS	DESCRIPTION	
L7e	Quadricycle - Four wheels, with a maximum unladen mass of 400kg or 550kg for a goods carrying vehicle (not including the mass of the batteries in an electrically powered vehicle) and a maximum net power, whatever the type of engine or motor, of 15kW	
M1	Passenger vehicle, four wheels and up to 8 seats in addition to the driver's seat.	
N1	Goods-carrying vehicle, four wheels, with a maximum laden mass of 3500kg.	
N2	Goods-carrying vehicle, four wheels, with a maximum laden mass between 3,500kg and 12,000kg.	

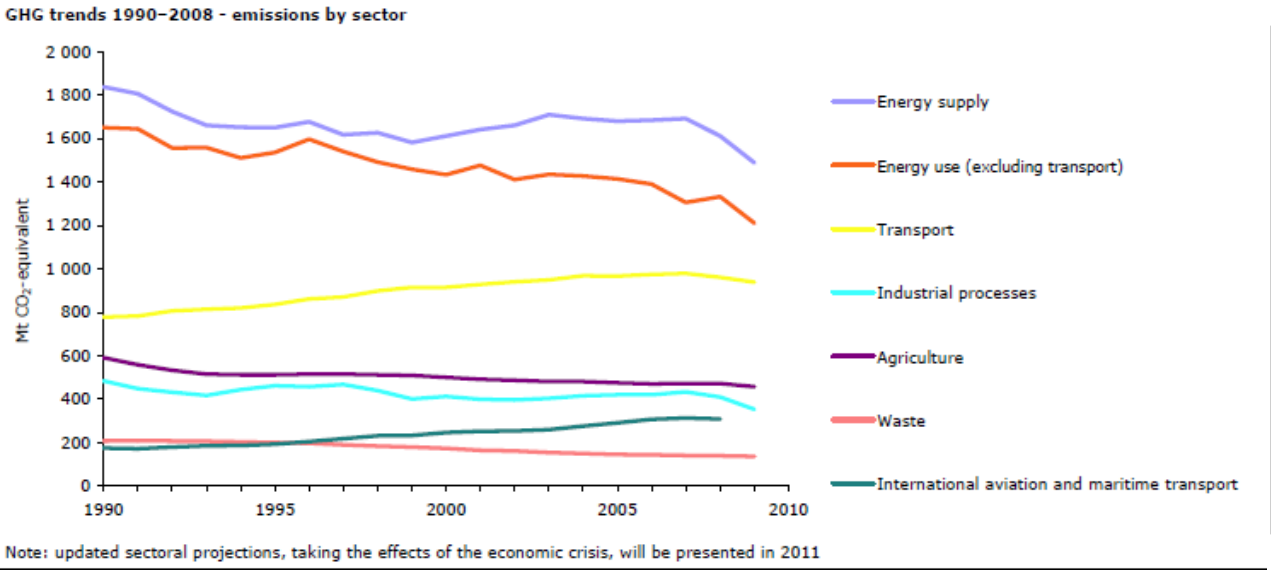
Table 5: Vehicle classes [5]

Type		Standard Battery Charging Rates (kW)			Fast Charge Rate* (kW)
		Mode	Min	Max	Range
L7e	BEV	3	1	3	3-7.5
M1	BEV	3	2	9	3-240
	PHEV	3	3	5	11
	EREV	3	3	5	-
N1	BEV	3	1	3	10-45
	PHEV	3	3	3	11
	EREV	3	3	5	-
N2	BEV	10	-	-	35-60

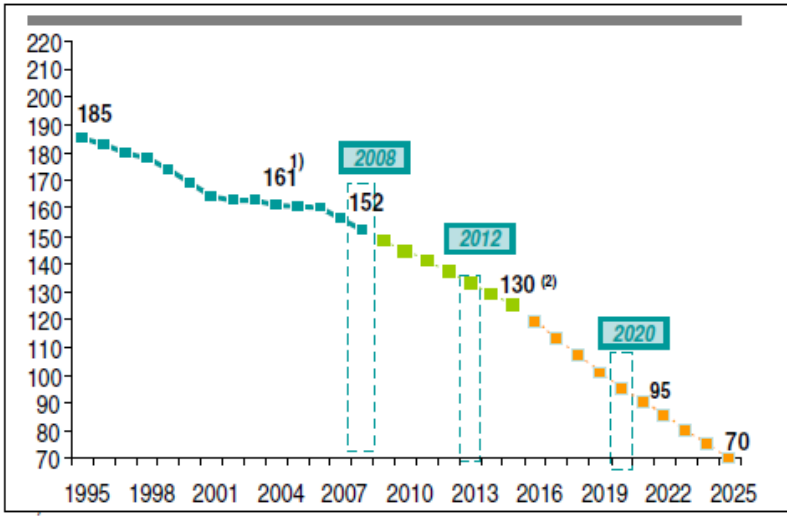
Table 19: Summary table of battery charging rates for use in model. (*Maximum value of fast charge rate may exceed charging point capabilities, so maximum values if used in modelling should be used with caution)

Advantages of EVs

- Reduction of carbon emissions and increasing energy efficiency (road transport)
- Reduction of pollutants and noise in urban areas
- Reduction of dependence on external fossil fuels
- Increasing power system flexibility for high penetration of renewables (Spain)



Source: European Environment Agency



EU CO2 emission targets per vehicle (g/km)
Source: ACEA / European Parliament

Economic benefits from smart EV charging: generation

- No need for new generation investment and reduction of fuel costs

Dumb charging at peak hours

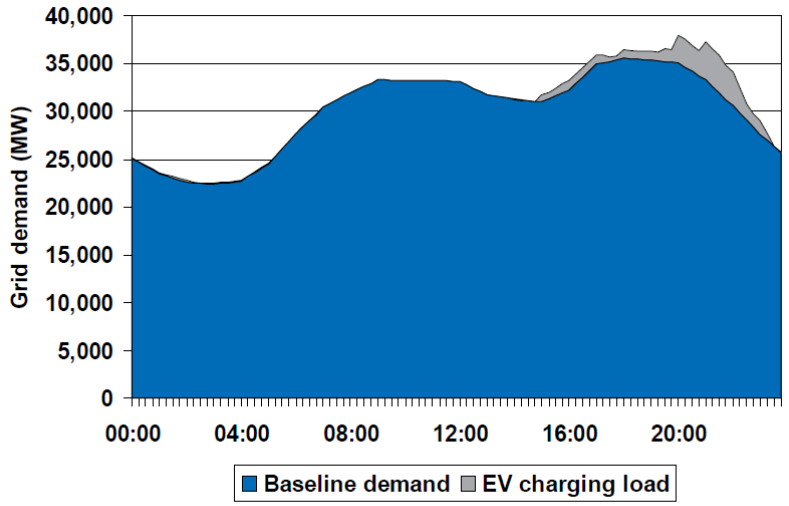


Figure 90 – Effect of dumb charging scenario on Spain's electricity demand

Smart charging at valley hours

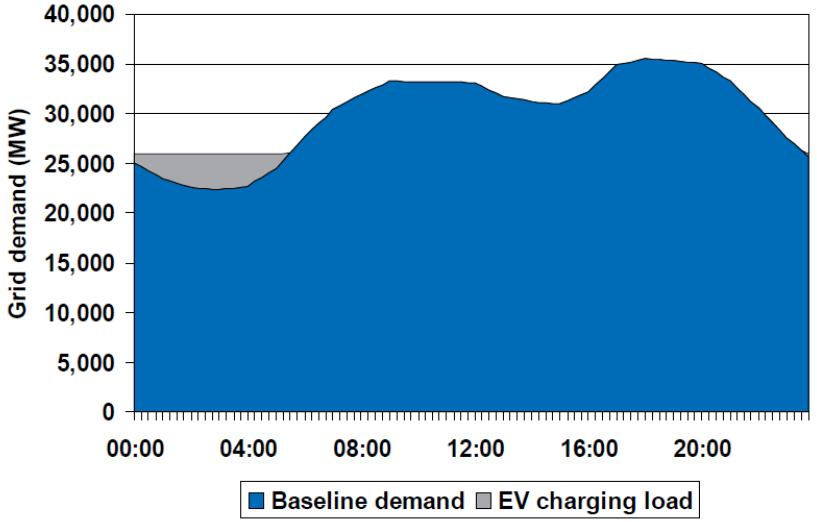


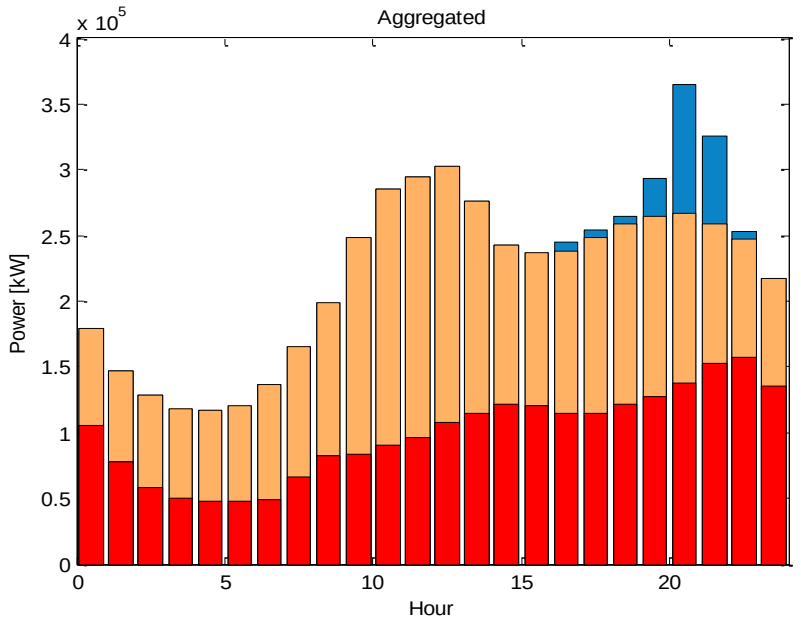
Figure 96 – Effect of smart charging scenario on Spain's electricity demand

Source: Report D2.1. Merge project. http://www.ev-merge.eu

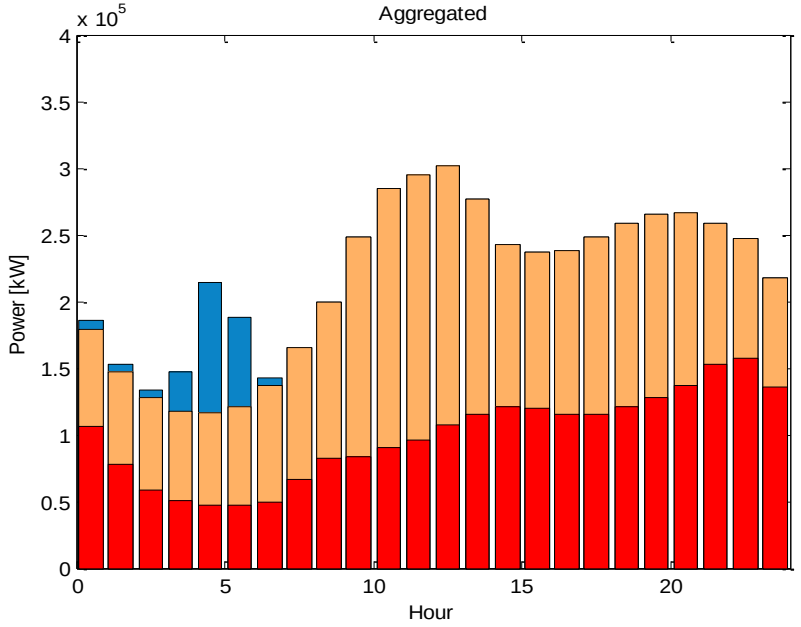
Economic benefits from smart EV charging: distribution

- Simulation: Area with 170.000 electricity consumers and 31.200 EVs (2030)

Dumb charging at peak hours



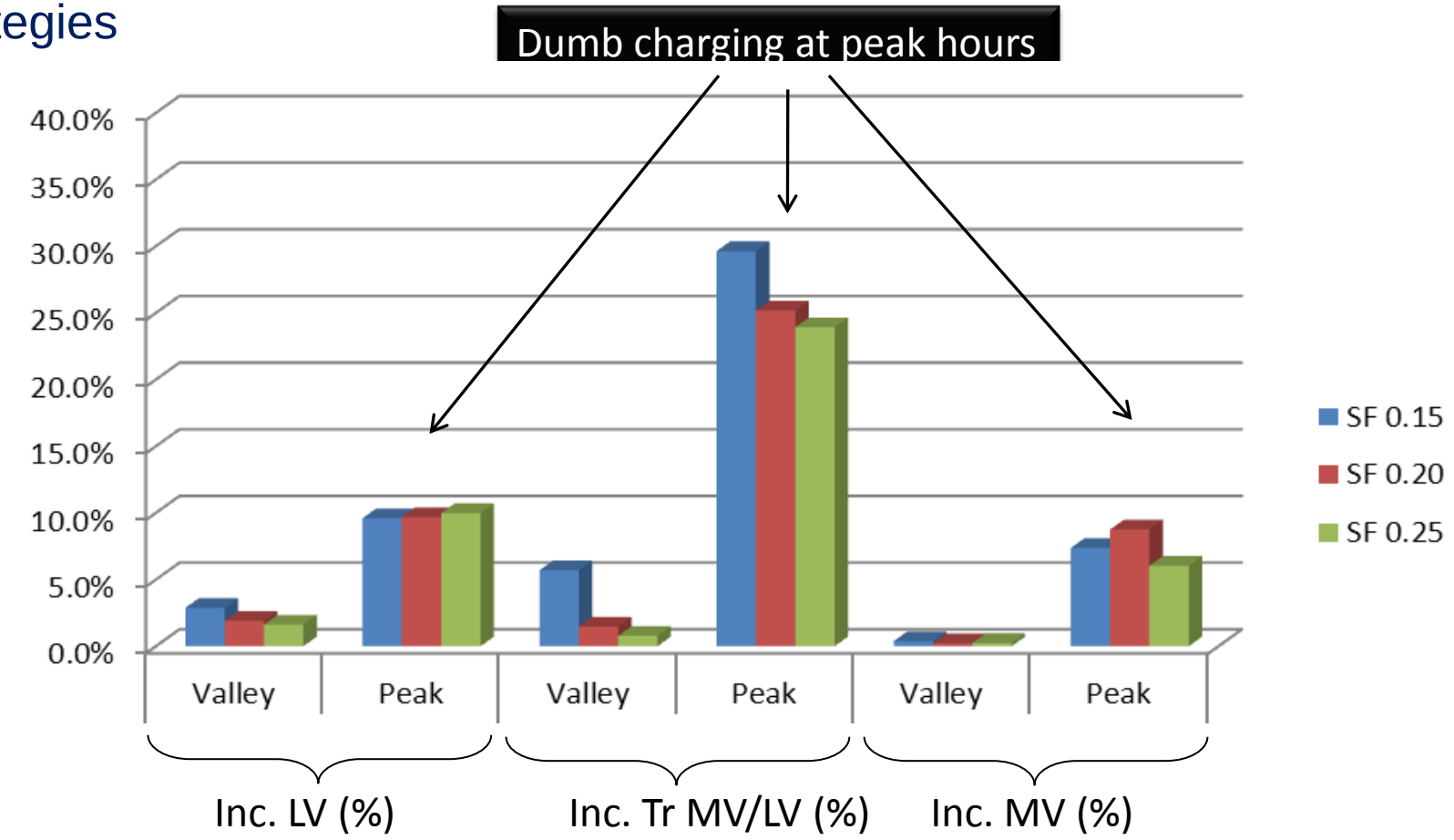
Smart charging at valley hours



EV charge
Industrial load
Domestic load

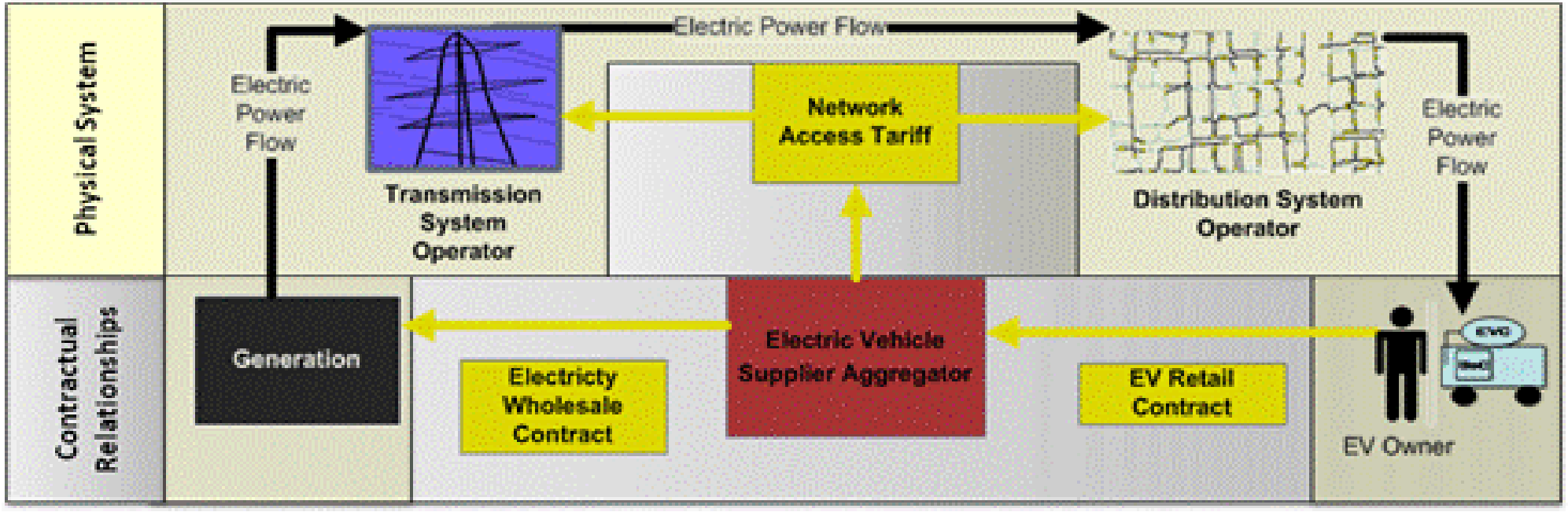
Economic benefits from smart EV charging: distribution

- Need for new network reinforcements is reduced with smart charging strategies



Source: Report D4.1. Merge project. http://www.ev-merge.eu

REGULATORY FRAMEWORK



Existing and new agents:

- TSO,DSO, Supplier, Final customer
- EV charging manager, EV supplier-aggregator

REGULATORY FRAMEWORK

- New Entrants in the Electricity Market

  - ***EV charging (point) manager (CPM)*** *in private charging areas*
    - Office-/Commercial Building/Recharge Station Owner
    - Acts as final customer but may buy and resell energy under commercial agreements for EV charging services (RD 647/2011 Spanish legislation)
    - Technical capability and financial liability required by legislation

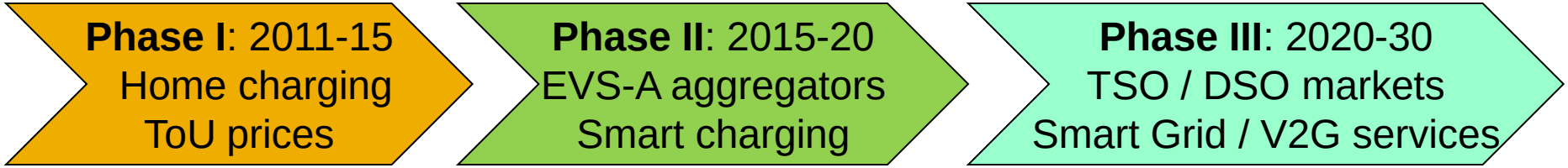
  - ***EV electricity supplier-aggregator (EVS-A)***
    - Procurs and resells energy for EV charging in competition with others
    - Contracts with EV not location based
    - Aggregates multiple EV contracts and would play key role for V2G

EV CHARGING MODES

- **Location**:
  - *home*
  - *private areas ownership (shopping, office, gas station...)*
  - *public infrastrucutre*
- **EV charging agent**:
  - *Charging point manager (CPM as electricity final consumer)*
  - *EV Supplier-aggregator*
- **EV charging control**:
  - *dumb charging (uncontrolled)*
  - *time-of-use prices (home and CPMs)*
  - *smart charging via EV aggregators (market optimization)*
  - *V2G injecting power into the grid (V2G-V2B-V2H)*

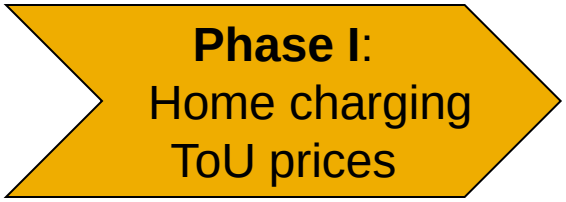
POLICY AND REGULATORY ROADMAP

- Three development stages of EV integration



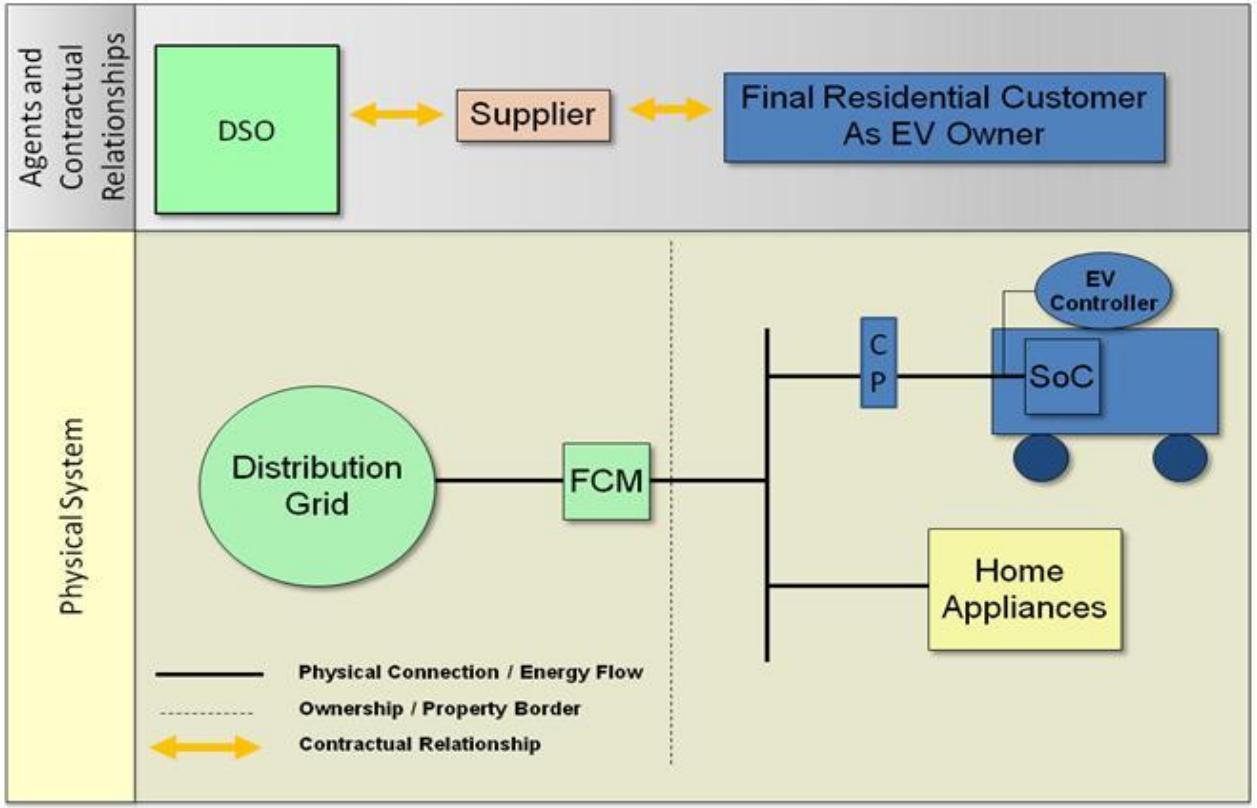
POLICY AND REGULATORY ROADMAP

- Three development stages of EV integration



- ***Phase I**: EV home charging and private areas charging (charging stations and others)*
  - Charging based on time-of-use prices (with a timing device night charging would be cheaper)
  - Implementation of smart meters in the interface with the electric company
  - Legislation should develop the figure of Charging Point Manager (CPM) allowed to resell energy for EV charging
  - Keep the technical requirements and financial liabilities for CPMs simple => facilitate the uptake of EV

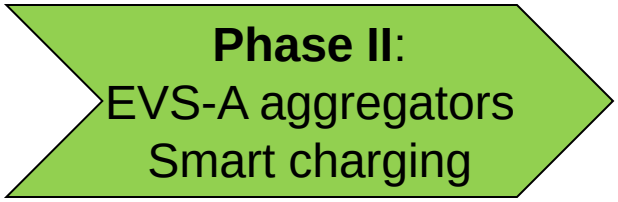
EV home charging



- EV is integrated with the rest of home loads
- Supply contract with the home supplier
- Charging installation very simple owned by the home
- Recommended to install a smart meter for time-of–use prices

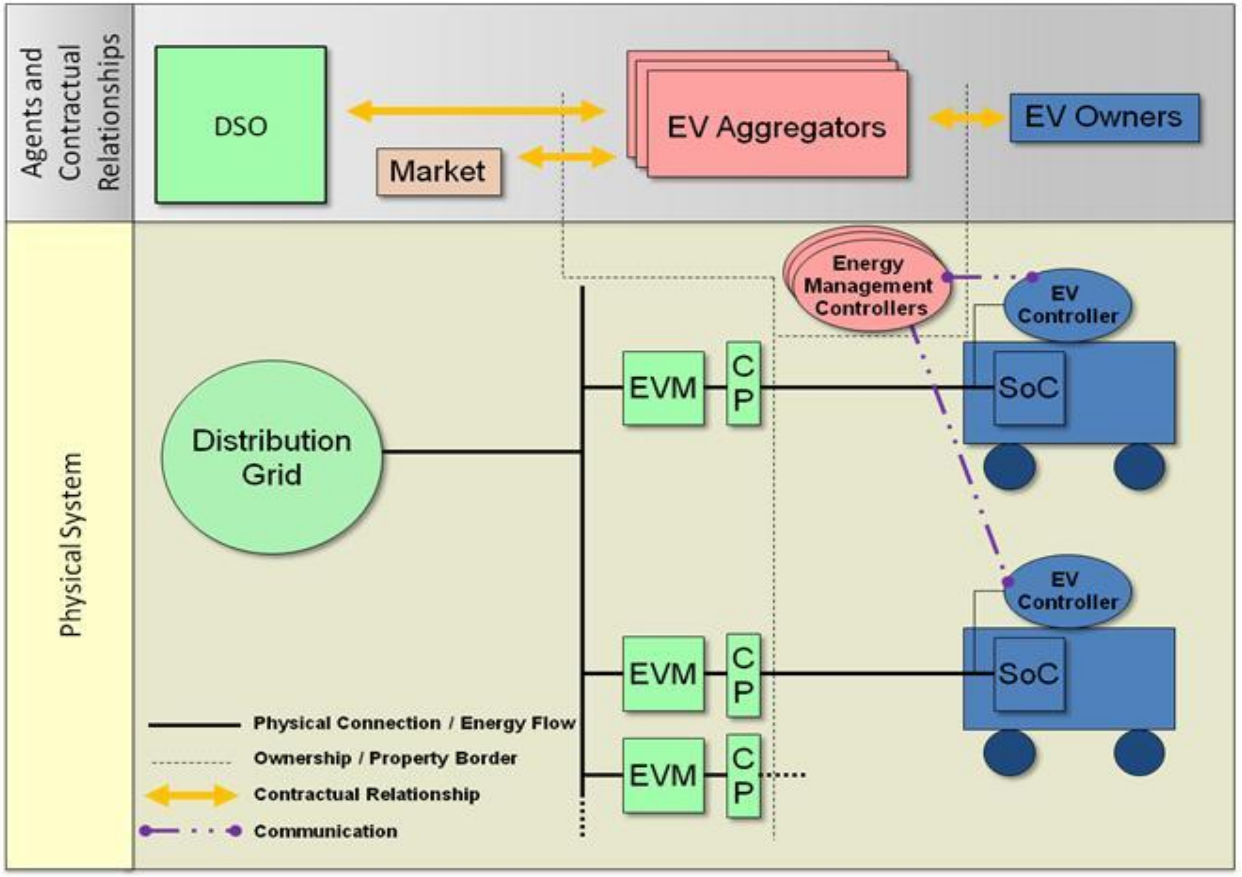
POLICY AND REGULATORY ROADMAP

- Three development stages of EV integration



- ***Phase II**: Multiple EVS-As and smart charging (market optimization)*
  - New business model of EV supplier-aggregators with thousands of EV contracts
  - Smart charging of EVs for load management and risk hedging in the electricity market
  - Development of expensive charging infrastructure in public sites (role of DSOs / municipalities)
  - Design a regulatory framework for recovering those investments

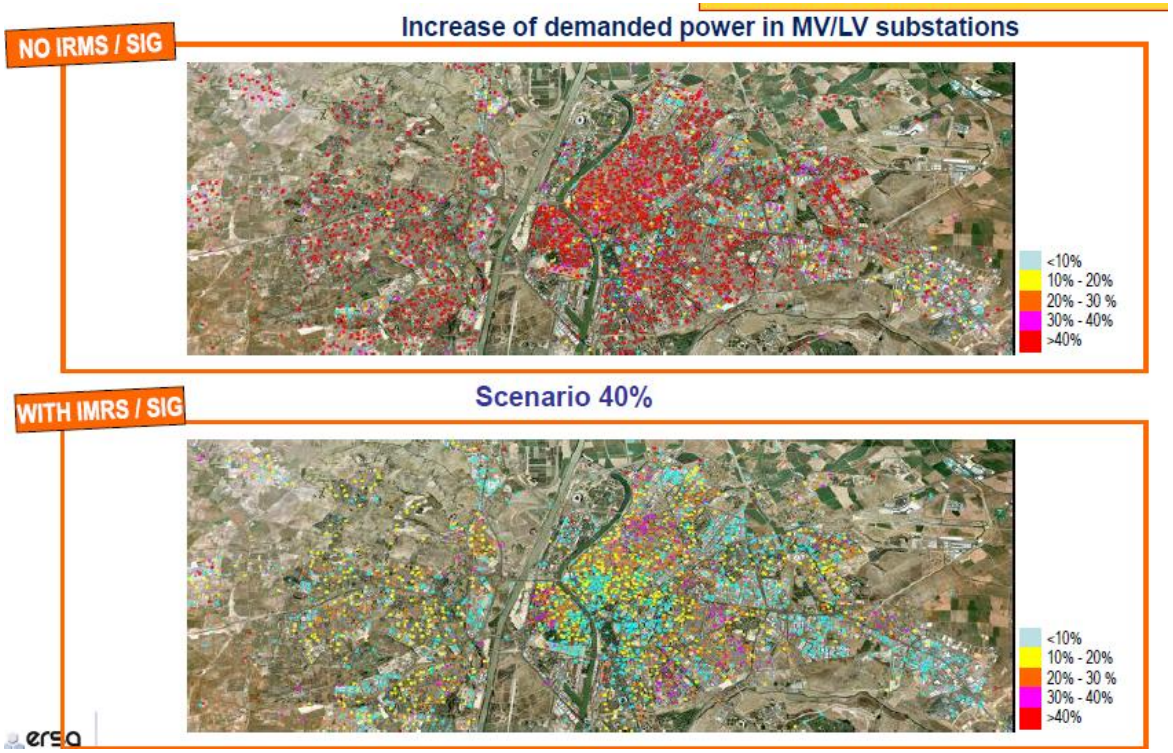
EVS-A aggregators (role for DSOs or municipalities)

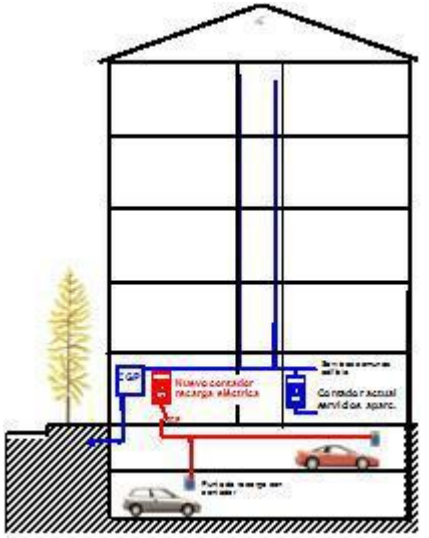


- Multiple EV supplier-aggregators (EVS-A)
- Supply contract between each EV owner and each EVS-A (not location based)
- The EVS-A would manage the portfolio of EVs in the market (load forecast and control)

Role for DSOs and load control

- Saving investment through active networks (DMS functions including load response)
- Adequate remuneration scheme for investment in new technologies
- Savings in network infrastructure should be quantified (performance based regulation)
- Example: Intelligent recharge management system (IRMS) located in garage building blocks: distribution network investment reduced by 6 times





Source: ENDESA

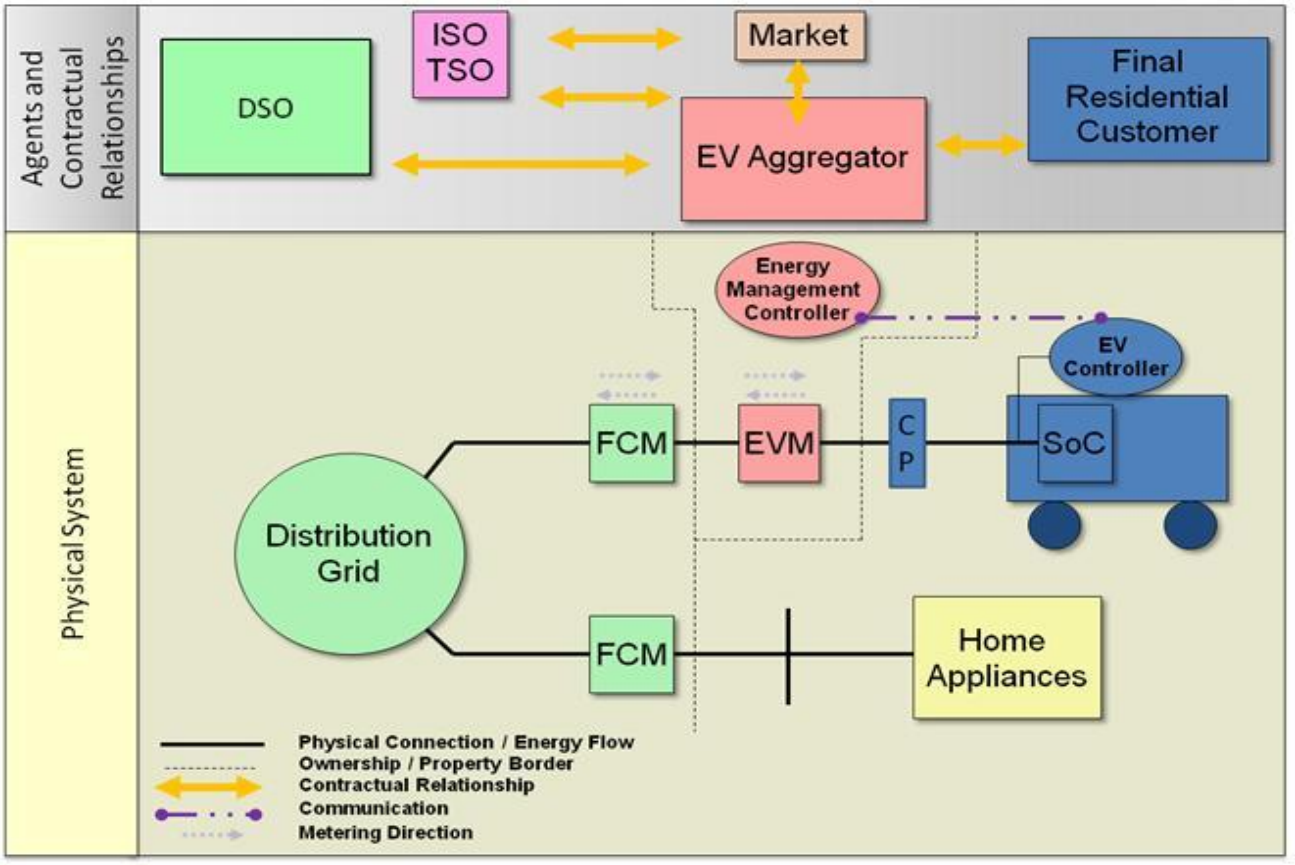
POLICY AND REGULATORY ROADMAP

- Three development stages of EV integration

Phase III:
TSO / DSO markets
Smart Grid / V2G services

- ***Phase III****: V2G services procurement in balancing and ancillary services markets and DSO local requirements*
  - More sophisticated control, measurement, and billing infrastructure deployed by EVS-As (full deployment of smart grid concept)
  - Procurement of frequency reserves and voltage services (role in the integration of renewables)
  - Need of cost/benefit studies to assess the profitability of these businesses (open issue is the warranty of battery performance by car manufacturers)

V2G services through EVS-A (smart grid applications)



- EV supplier-aggregator (EVS-A) provides services to the TSO
- The EVS-A aggregates thousands of home connected EVs
- V2G services: balancing energy and frequency regulation
- The technical requirements for control, metering and billing are more complex
- The use of the batteries for injecting power is still an open issue

European initiatives on standards and regulation

- EC standardization mandate to CEN, CENELEC and ETSI concerning the charging of electric vehicles (Mandate/468, 4th June 2010). Review standards for:
  - *Interoperability and connectivity between:*
    - Electricity supply point <-> Charger of EV <-> EV battery
  - *Smart charging issues*
  - *Safety risks and electromagnetic compatibility of the EV charger*

- CEER questionnaire on electromobility and regulatory challenges for EV recharging
  - *NRAs involvement, scenarios, business cases for EV recharging, smart grids and EVs, role of DSOs, energy selling (monovendor vs. multivendor),…*

European initiatives: smart grids

- EC Communication COM(2011) 202 "Smart grids: from innovation to deployment" 12th April 2011
  - *Standards*
  - *Data privacy and security*
  - *Regulatory incentives*
  - *Retail markets in the interest of consumers*
  - *Support for innovation*

- EC standardization mandate to CEN, CENELEC and ETSI to support European Smart Grid deployment (Mandate/490, 1st March 2011). Deliverables:
  - *A technical reference architecture*
  - *A set of standards for information exchange and integration of all users into the electric system operation*
  - *Enable stakeholder interactions in the standardization process (interoperability, security, privacy, etc)*

Thank You very much for your Attention!

T. Gómez, I. Momber, M. Rivier, and A. Sánchez, “Regulatory framework and Business Models for Charging Plug-in Electric Vehicles: Infrastructure, Agents and Commercial Relationships” Energy Policy 39 (2011) 6360–6375.