G4V™ Grid for Vehicles

SEVENTH FRAMEWORK PROGRAMME

Session IV –

The G4V Roadmap

CHALMERS

ECN

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endesa

Enel
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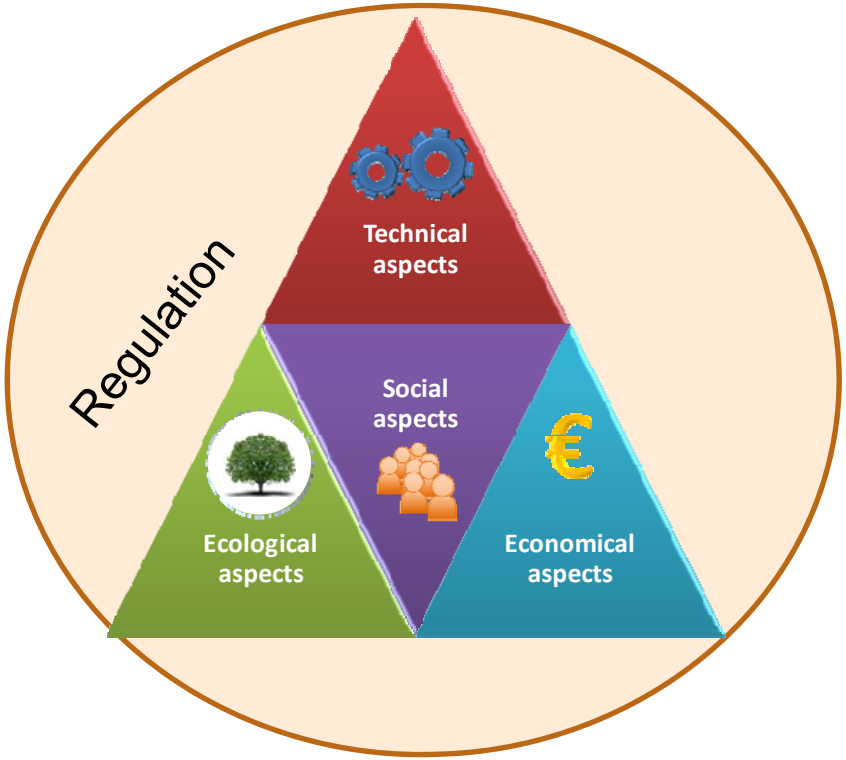
VATTENFALL

G4V Key Messages and Conclusions

Carlos ALVAREZ

UPV

One Topic. Multiple aspects.



The analysis could not be focus only on one aspect, multiple factors and impacts have to be taken into account.

Different topics are considered within the Key messages.

TOPICS

System operation:

- Control strategies
- Services provided by EVs:
  - -V2G, Ancillary services …

Infrastructure development:

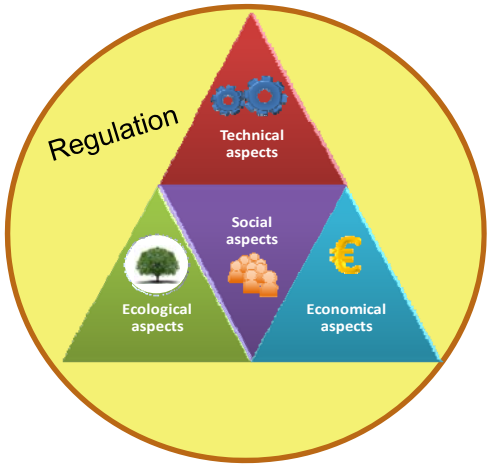
- Capability to integrate EVs
- Charging infrastructure
- Assets management

ICT:

- Technology
- Billing
- Security
- Standards

Different aspects are considered:

- Technical
- Economical
- Social
- Environmental
- Regulation

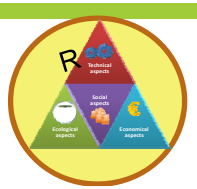


topic	Technical	Economical	Social	Environmental	Regulation	Recommendation	
System operation							
Infrastructure development							
ICTs							

System operation – Control strategies

Control strategies

SYSTEM OPERATION



TECHNICAL ENVIRONMENTAL SOCIAL ECONOMICAL REGULATOR

-Integrating EVs will reduce the networks margin however implementing the **right control strategies** can **postpone reinforcements.**

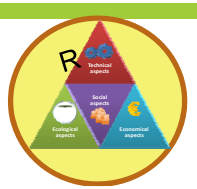
- **Inadequate** charging strategies may **increase network constraints**

-**Advanced solutions** as the decentralized market based approach **improve the system ability of integrating EV.**

System operation – Control strategies

Control strategies

SYSTEM OPERATION



TECHNICAL | **ENVIRONMENTAL** | SOCIAL | ECONOMICAL | REGULATOR

-**CS** can **postpone reinforcements.**

- **Inadequate** CS may **increase network constraints**

-**Advanced solutions improve the system ability of integrating EV.**

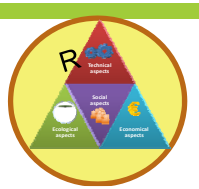
- **from low** penetration of EV, charging (controlled or non-controlled) will have a **significant impact** on **environmental** performance of electricity systems.

-**Controlled charging** of EV results in significant **environmental benefits** due to **avoiding the curtailment of wind energy** and a consequential **reduction of environmental emissions**.

System operation – Control strategies

Control strategies

SYSTEM OPERATION

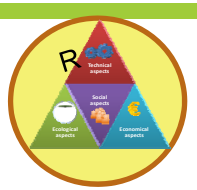


TECHNICAL	ENVIRONMENTAL	SOCIAL	ECONOMICAL	REGULATOR
-**CS** can **postpone reinforcements.** - **Inadequate** CS may **increase network constraints** -**Advanced solutions improve the system ability of integrating EV.**	- **from low** penetration - **impact** on economic performance of electricity systems -Controlled charging : to **avoid** the **curtailment** of wind energy . **Reduction** of environmental **emissions**.	-People are **willing to participate** in off-peak charging schemes (22:00-06:00) with a price **incentive** compared to normal charging .		

System operation – Control strategies

Control strategies

SYSTEM OPERATION

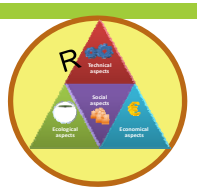


TECHNICAL	ENVIRONMENTAL	SOCIAL	ECONOMICAL	REGULATORY
-**CS** can **postpone reinforcements.** - **Inadequate** CS may **increase network constraints** -**Advanced solutions improve the system ability of integrating EV.**	- **from low** penetration - **impact** on economic performance of electricity systems -Controlled charging : to **avoid** the **curtailment** of wind energy . **Reduction** of environmental **emissions**.	-People are **willing to participate** in charging CS with a price **incentive**	- **Control strategy** could **reduce** the amount of **investment** in grid reinforcement. - **Controlled charging** can **reduce the cost** of supplying additional EV demand -Advanced control strategies requires **new market design**.	

System operation – Control strategies

Control strategies

SYSTEM OPERATION



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System operation – Control strategies

Control strategies

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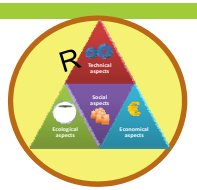

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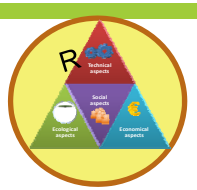
System operation – Control strategies

Control strategies

SYSTEM OPERATION



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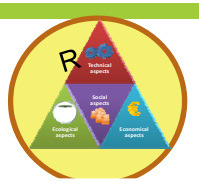
Charging Strategies should be **flexible** and **adjustable** to market penetration level of EVs. The **charging** of EVs should be **controlled** including the needs and constraints of the DSOs. DSO has to have observability and control of the system.

System operation – Services

Services

SYSTEM OPERATION



TECHNICAL ENVIRONMENTAL SOCIAL ECONOMICAL REGULATORY

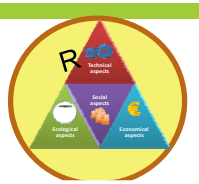
- **EV can serve for the provision of various system support services in a stable way (V2G, active and reactive power support…).**

- **The value of EV services is system specific and sensitive to the charging power and efficiency and battery degradation costs**

System operation – Services

Services

SYSTEM OPERATION



TECHNICAL | **ENVIRONMENTAL** | SOCIAL | ECONOMICAL | REGULATORY

- EV for the provision of various system **support services**.

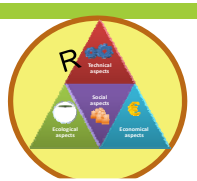
- The value of flexibility services is **system specific** and **sensitive** to the charging power and efficiency losses and battery degradation costs

-**Environmental gains due to bidirectional (V2G) control** of EV charging/discharging process compared to controlled Unidirectional charging are found to be relatively **marginal**

System operation – Services

Services

SYSTEM OPERATION

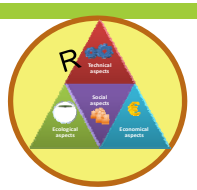


TECHNICAL	ENVIRONMENTAL	SOCIAL	ECONOMICAL	REGULATORY
- EV for the provision of various system **support services**. - The value of flexibility services is **system specific** and **sensitive** to the charging power and efficiency losses and battery degradation costs	-**Environmental gains** due to V2G are found to be **marginal**	-**Low user acceptance is observed for participation in V2G scheme**		

System operation – Services

Services

SYSTEM OPERATION



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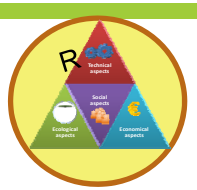
System operation – Services

Services

SYSTEM OPERATION



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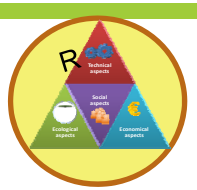
REGULATORY

System operation – Services

Services

SYSTEM OPERATION



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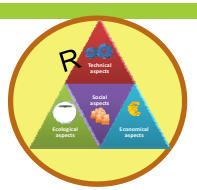
System operation – Services

Services

SYSTEM OPERATION



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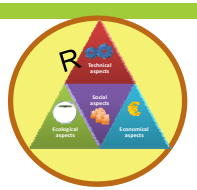
V2G is not a profitable business at this moment. Unidirectional charge strategies, at a distributed level, should be first promoted.
Bidirectional strategies should be reconsidered for a large penetration of EV

Infrastructure development– Charging infrastructure

Charging infrastructure (CI)

Infrastructure development



TECHNICAL	SOCIAL	ECONOMICAL	REGULATORY
-The **DSO** shall equip its distribution grid with **devices** able to **detect grid constraints** if he wants to apply more **advanced strategies** - The power quality disturbances of electronic equipment has to be **limited**. Standards are proposed (IEC 61000, EN50160)	-People **prefer home recharging** due to convenience and safety reasons -to enhance user confidence **public infrastructure will also need to be rolled-out.**	-**Private charging** constitutes the **cheapest solution** for the charge of EVs -**Public slow charging is an expensive solution** due to its high installation and operating costs**.**	-**Appropriate** policies and **regulatory framework** will be required for development of all types of CI (i.e. private, semi and public); needs to be **coordinated at pan-European level** -**Investigation of the possibility of shared investment**

A cost effective deployment of EV should be done by promoting home charging (up to 3.7kW), complemented with the network of faster public charging poles.

ICT– Technology, billing, security and standards

Information & communication technologies

TECHNICAL	SOCIAL	ECONOMICAL	REGULATORY
-**Necessary** communication **technologies already exist** -**Security** and **reliability** are the most important factors -**ICTs** smart grid functionalities for EVs shall be **coordinated with** future and utilize already implemented **smart grid solutions** -**ICTs should focus to implement control strategies** at higher EV market penetration rates **to reduce grid impact.** -**Standardization needs**: data model for the ID of the user, type of information to communicate, type of modulations and protocols	-**Standards are needed for the communications interfaces to facilitate customers access to charge services** -guarantee **data privacy**	-**Standards for the communications interfaces reduce risk investments** - cost-efficient application of ICT infrastructure is indispensible for large-scale roll-out of EVs.	- **European Union Legislation for protection of personal information shall be considered.** -**Security aspects must be a priority in the technologies selected in all the ICTs interfaces** (ID, EV communications, billing,..)

ICTs do not represent a barrier for the integration of EVs. Its “utilization” to apply control strategies may help to reduce grid impacts. Synergies with Smart Grids should be respected in the development of ICT.

Conclusions

System operation:

Charging Strategies should be **flexible** and **adjustable** to market penetration level of EVs. The **charging** of EVs should be **controlled** including the needs and constraints of the DSOs. DSO has to have observability and control of the system.

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Infrastructure development:

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ICT:

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Thank you for your attention!

Carlos ALVAREZ. UPV.

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The Roadmap Enabling Grid For Vehicles

Step by step towards 2030 and beyond

Thomas THEISEN

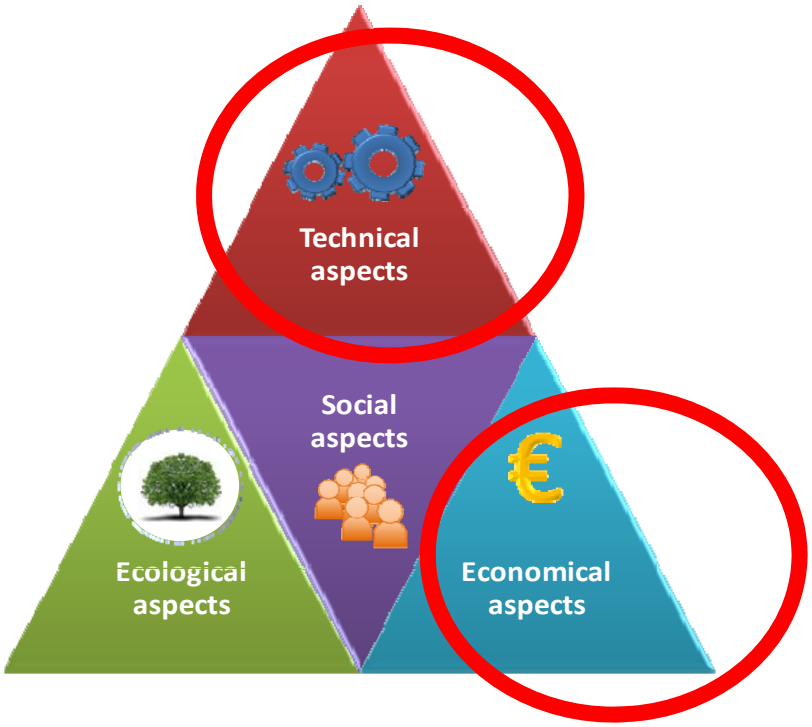
RWE

Scenarios set the framework of the market development and are the environment of the roadmap

- **All topics were worked out within the different G4V work packages**

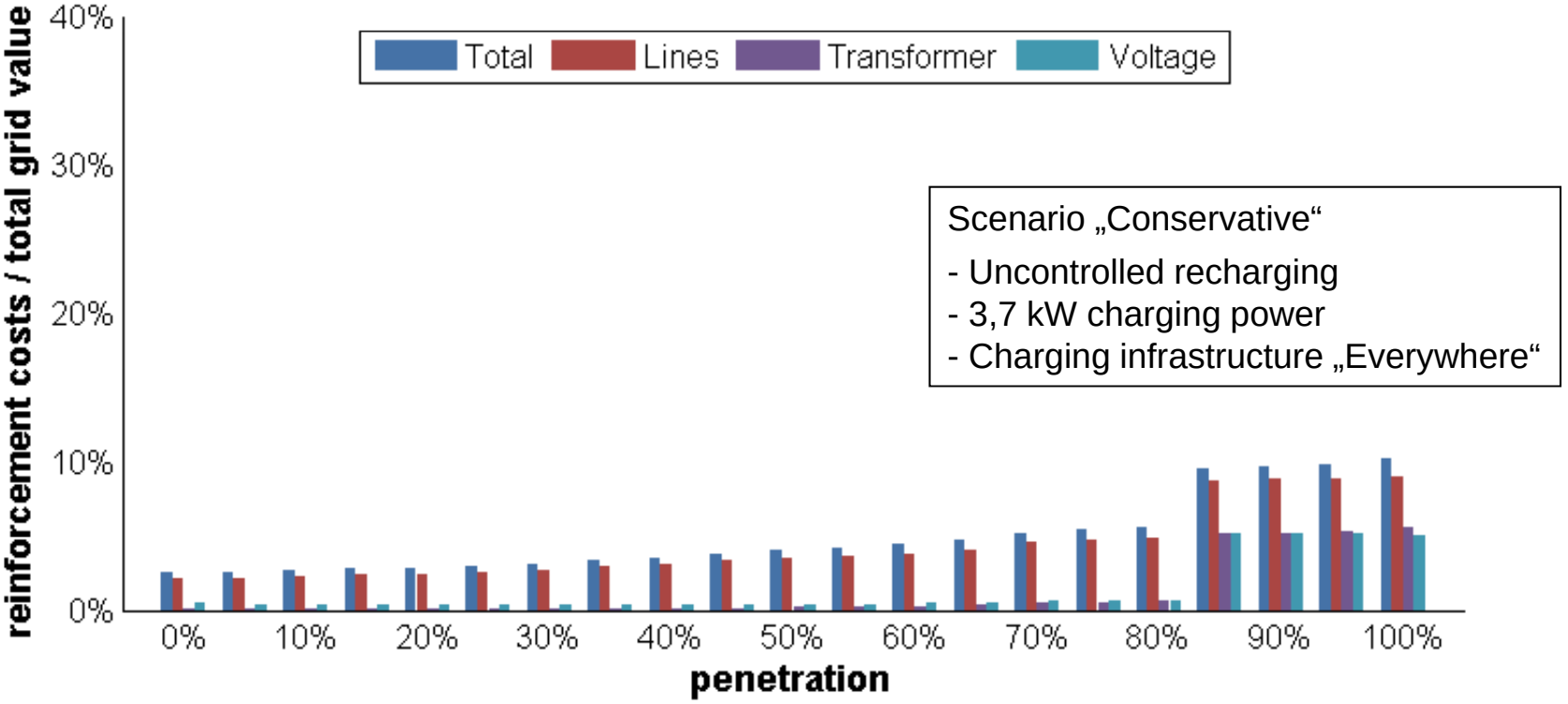
Topic	Conservative World	Pragmatic World	Advanced World
Charging control	No	Yes, simple charging control	Yes, complex charging control
Prices	As today	Dynamic tariffs	No limitation
Regulation	Conservative	Some liberalization	Optimal situation for EVs
Services	Unidirectional, no services	Unidirectional, all services can be provided	Bidirectional, all services can be provided
Grid infrastructure	Conventional development	Smart grids	Advanced smart grids, virtual power plant etc.
ICT	As today	Improved	Advanced
Stakeholders	Traditional stakeholders	Traditional stakeholders with new roles	New stakeholders

The Roadmap will describe a holistic design of the ideal technical –economical structure



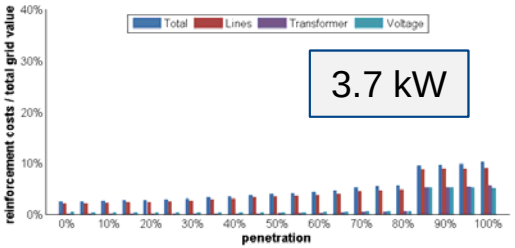
The results indicate the time of grid re-inforcement and impact of control strategies

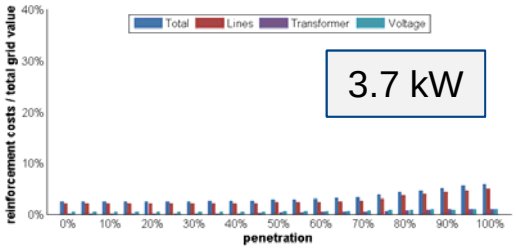
- The average simulation results of all investigated MV and LV grids show the general effect of an increasing EV market
- A specific analysis of the individual state of grid has to be done to priorize the actions for improvement

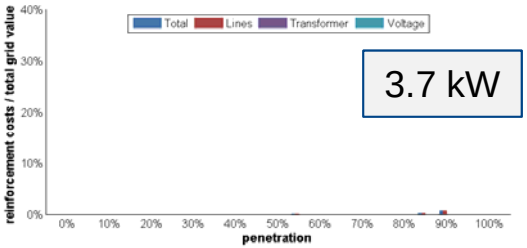


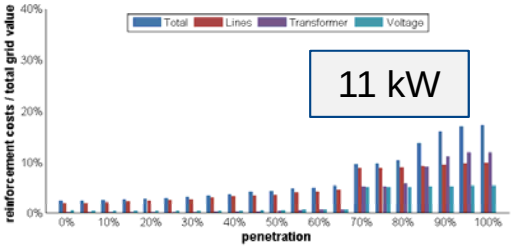
Control strategies have a great impact on grid reinforcements

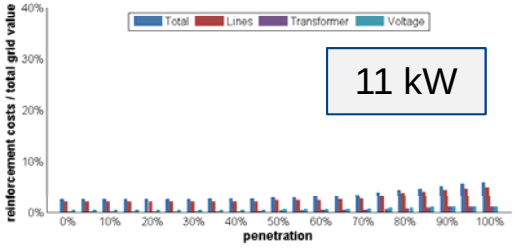
Scenario: **Conservative**	Scenario: **Pragmatic**	Scenario: **Advanced**
No control strategy	Control strategy: **Unidirectional power flow** **Bidirectional communication**	Control strategy: **Bidirectional power flow** **Bidirectional communication**

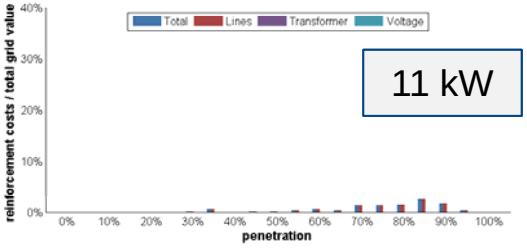






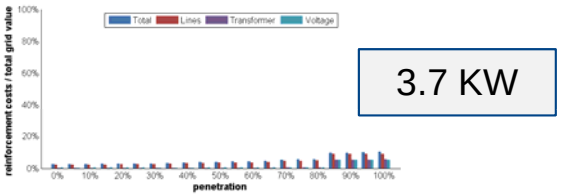






A control strategy applied in a wrong way can produce a negative effect

No control strategy



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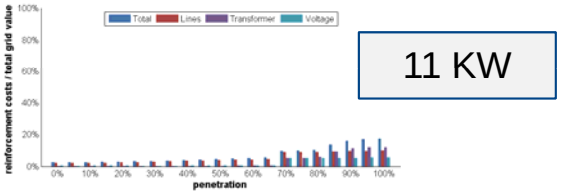

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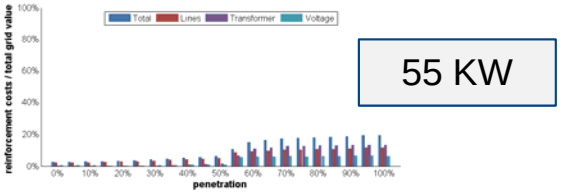

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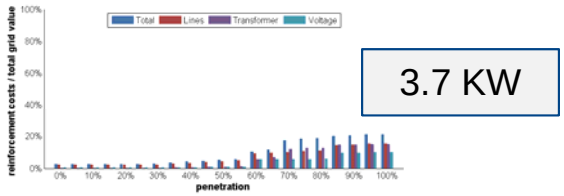
Control strategy applied in a wrong way



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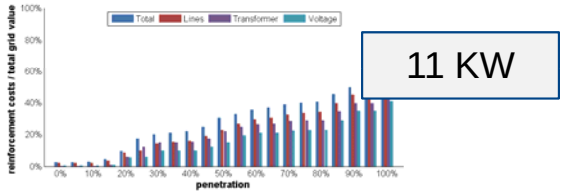

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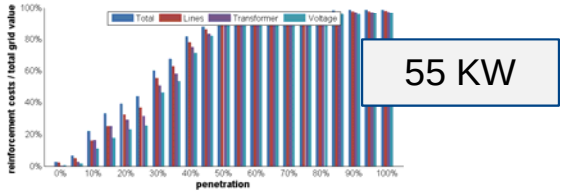

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Simultaneous ToU

It is necessary to select the most suitable control strategies respecting the characteristics of the grid.

The scenarios are the framework where the EV integration is analysed

- Opportunities and requirements appear to apply one control strategy
- If a change of scenario is desirable (mandatory to apply some strategies) some **requirements** have to be achieved:

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ICT	As today	Improved	Advanced
Stakeholders	Traditional stakeholders	Traditional stakeholders with new roles	New stakeholders

Different opportunities appear in different frameworks…

…and some **opportunities** appear as a consequence of the new framework:

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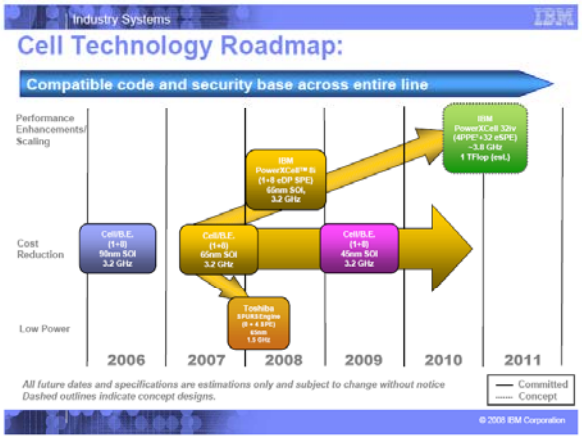
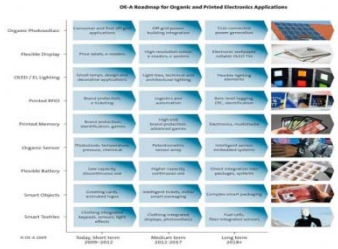
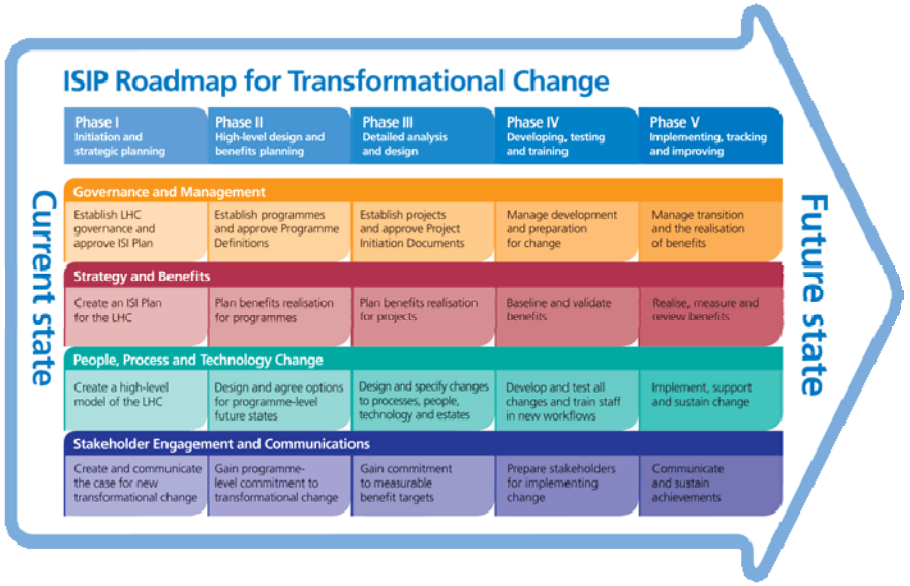
Regulation	Conservative	Some liberalization	Optimal situation for EVs
Services	Unidirectional, no services	Unidirectional, all services can be provided	Bidirectional, all services can be provided
Grid infrastructure	Conventional development	Smart grids	Advanced smart grids, virtual power plant etc.
ICT	As today	Improved	Advanced
Stakeholders	Traditional stakeholders	Traditional stakeholders with new roles	New stakeholders

The Roadmap…

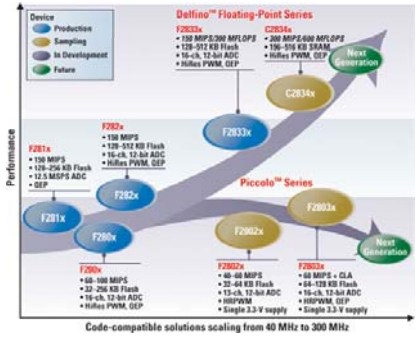


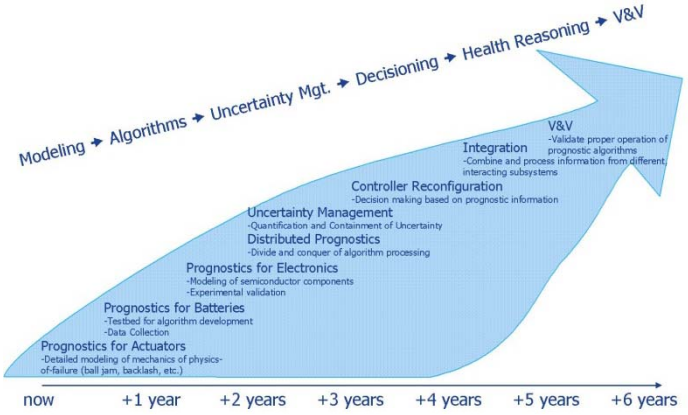




The Tapping Road Map

Spiritual Enlightenment		
Living Your Life Purpose	Accepting the World	Ego-Detachment
Health	**Wealth**	**Relationships**
Eating Healthily Exercising Regularly Having the Body you Want	Your Ideal Lifestyle Abundance of Money Achieving Your Goals	Open to Love Healthy Relationships with Friends and Family
Finding Happiness		
Self-Acceptance	High Self Esteem	Organised Life
Healing and dealing with Problems		
Stress and Anxiety	Forgiveness	Addictions

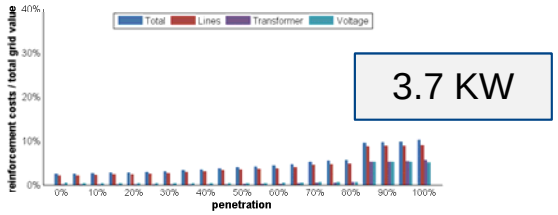




The jump

Grid for Vehicles

Scenario: **Conservative**	→	Scenario: **Pragmatic**	→	Scenario: **Advanced**
The regulation is conservative as today so that the conditions for EVs are difficult. EVs are not able to generate additional benefits. They can only adapt their behaviour to different price signals as they are possible today	→	A major change compared to the conservative world is the possible influence on the charging of the EVs. The loading can be postponed or interrupted. Participation in reserve market is possible due interruptible loads	→	EVs have an optimal situation and can participate at different markets providing V2G services. Moreover, real time markets and active demand is possible and permitted by the regulator. EV are incentivized to support renewables integration.



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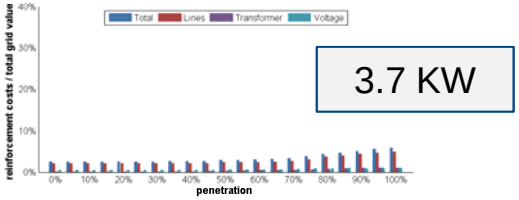

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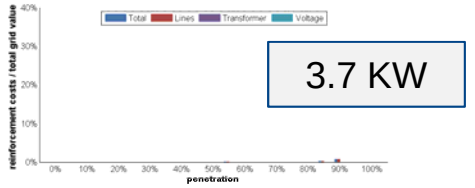

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SEVENTH FRAMEWORK PROGRAMME

Final observation, conclusions (1/2)

- A clear **relation** between the different countries and the **capability to integrate** EVs **cannot be observed**. The diversity of grids in every country is too large
    - The single information of voltage level is not a decisive parameter to cluster a grid. MV and LV level are expected to show - on average - an similar ability to integrate EVs
- Actions to improve the integration of vehicles should not be carried out country by country, but in joint effort by all European countries and in common with the car industrie

Final observation, conclusions (2/2)

- **Control strategies** which allow the **steering** of the specific load of **EV charging** avoid grid re-inforcement
    - Control strategies which start from country specific enhanced „business as usual“ solutions in the short term have to be developed to more advanced solutions and taking over existing smart grid functionalities
- The **pragmatic control strategies** shall be **implemented** as an europeanwide **approach for EV integration.** The **specific requirements** in terms of regulation, ICT and grid infrastructure **have to be fulfilled**

Thank you for your attention!

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G4V™ Grid for Vehicles

SEVENTH FRAMEWORK PROGRAMME

Coffee Break

15:30 – 16:40

Presentations will be made available on: www.g4v.eu

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