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Scenario writing – Scenario Worlds

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Track changes

Name	Date (dd.mm.jjjj)	Version	Changes	
			Subject of change	page
RWTH – Szczechowicz	23.07.2010	V01		
TU Dortmund			Some comments	
EDF			Input for France	
ENEL			Input for Italy	
ECN			Input for the Netherlands	
ENDESA + UPV			Input for Spain (have to be harmonized between ENDESA and UPV)	
Chalmers & Vattenfall	08-04-2010		Input for Sweden	
Imperial			Input for UK	
EDP			Included	

Scenario Writing

The aim of the scenario writing is to develop different scenario for the assessment of the models and ideas in G4V. Therefore, the scenarios are an important part of the project because of their relevance for the final results.

The chosen approach defines possible worlds describing how the energy sector can develop in the next decades. There will be three different worlds with different initiation values for different countries if there exist mayor differences in some important aspects.

First, a short description of the approach will be presented. Second, a basic scenario will be shown with the possible parameter ranges for further calculations.

The main important parameters have to be varied in each scenario and therefore are not fixed at all. This requires a high number of calculations due to all possible constellations to assess the influence of each parameter.

1. *Scenario Worlds*

The scenario worlds present possibilities for a development in the European energy sector. Therefore, different worlds are defined in which different assumptions are valid.

The point of origin is our world as it is today with all established technologies and rules. Coming from this point, different developments concerning technology or regulatory frameworks are imaginable. The aim is to reveal the best technical solution according to the evaluation criteria from WP1.3 concerning different aspects such as infrastructure or different charging controls.
Figure 1 shows an overview about the three chosen scenario worlds. As the names already indicate, they vary in their adoption of new technologies and in their willingness to change an existing system.

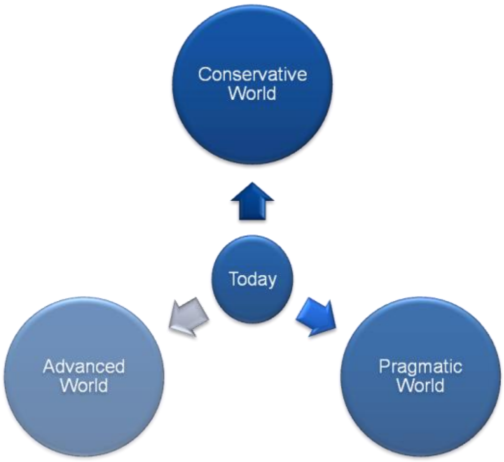

Figure 1: Overview about the scenario worlds

The **conservative world** pursues a business as usual approach. Like in the last decades, changes in the energy sector need a lot of time. Therefore, integration of innovations into the system is quite difficult. The grid planning and control will be organized as today and no avoidable changes will happen.
The **pragmatic world** operates a bit different. Innovations like a new technology or a new organisation of grid control are likely as long as these changes are reasonable. An example might be Italy where it was reasonable to install smart meters because it is profitable. In this world the countries might have differences in their installed technologies.
The third world is called **advanced world**. It is assumed that nearly all technical solutions are possible and the situation for EVs is nearly optimal. The reason might be that the EU forces developments in the energy sector such as an installation of certain technologies even if the profitability is low.

Overview about the main difference in the scenario worlds:

	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.

Normally, the chosen fixed parameters are dependent on each other in certain ways. This means that a complex tariff structure needs smart meters or even smart grids. To provide certain V2G services, the regulation rules have to be liberalized or completely changed.

The aim of the scenario worlds is to develop consistent worlds. **The worlds have the same idea for each country. However, the current situation in each country can differ.** Therefore, it is necessary to consider each country. The following tables show the differences in the three scenario worlds for each country.

Conservative World

The **conservative world** pursues a business as usual approach. Like in the last decades, changes in the energy sector need a lot of time. Therefore, integration of innovations into the system is quite difficult. The grid planning and control will be organized as today and no avoidable changes will happen. The charging control has the same possibilities as today. Therefore, there might be some differences depending on the country. Mainly, there is no charging control or only day-night-tariffs. The regulation will be as today and EV cannot participate in all regulation markets. This is the reason why EVs are not allowed to provide V2G services or DSM. The grid infrastructure has change a little bit depending on the European rules. Smart meters are installed but not everywhere and have a very limited functionality. The tariff structure for energy is the same as today but can vary between each country.

Country	Charging control	Regulation	Services	Grid infrastructure	Energy prices
France	None	Conservative as today. Flexibility of LV and MV loads cannot be used by the DSO.	Unidirectional charging, no V2G services can be provided by EV, no DSM (out of the two tariffs) The network tariff includes a fee based on energy and another fee based on maximum power (subscribed power). This is an incentive for customers to manage the power in their premises (with an automatic non priority load shedding system)	European rules will oblige all distributors to have smart meters in 2020.	As today, time of use tariffs (at least day and night tariffs)
GB	None or limited: or use of night tariffs	Conservative, as today, primary reserve not allowed to be pooled, Difficult conditions for EVs	Unidirectional charging, no V2G services can be provided by EV, no DSM (Except the two tariffs)	Smart Meters in many regions and may provide limited services like automatic use of low tariffs	May vary in different regions. Some with flat tariff throughout the day others with different day/night tariffs
Germany	None	Conservative, as today, primary reserve not allowed to be pooled,	Unidirectional charging, no V2G services can be provided by EV, no	Conventional development, small number of smart meters	As today, constant tariffs over the day within the whole year

		Difficult conditions for EVs	DSM	with limited functions such as no charging control, Smart meters only in certain regions, Overloads in the grids have to be compensated only with grid enhancement	
Italy	The maximum current can be different for each charging point. Using PWM or communication protocol, the CP sends this data to the vehicle.	Conservative as today.	Unidirectional charging, no V2G services can be provided by EV, no DSM	Dedicated connection for **CPs?**, with smart metering functionalities integrated in DSO AMM Slow charge for domestic/private use. Quick charge for public installations	Dedicated tariff for electric mobility in open market based on **TOU?** rates. Each energy retailer shall be able to provide its own offers to clients. Also the fixed part of the tariff (regulated decided by Authority) shall be dedicated to electric mobility.
Netherlands	None or limited: time delay after connection, or use of night tariffs	Conservative as today. If regulations do not change it will be difficult/impossible to optimise the grid usage since requested power needs to be delivered.	Unidirectional charging, maybe automatic use of night tariffs is possible	Smart Meters are optional, and maybe can provide very limited services like automatic use of low tariffs	Probably no real changes with today
Portugal	The publicly available Charging points are controlled, allowing for On/off during planned or emergency peak times. Homecharging is uncontrolled, allowing	Conservative as today. No specific benefit for EVs	Unidirectional charging. There is no real economic market benefit from DSM because of its cost to implement	All publicly available CPs are controlled in planned or emergency mode. Smartmeters are implemented but not widespread and do not manage EVs	As today, bi and tri periodic tariffs but not sufficiently economically different from constant tariffs to be of widespread usage.

	only timed charging.			individually, but rather the whole power consumption of the connection point.	
Spain	None. However, a timed charge during the off-peak time is possible.	Conservative, as today, primary reserve not allowed to be pooled, Difficult conditions for EVs	Unidirectional charging, no V2G services can be provided by EV, no DSM	Conventional development, small number of smart meters with limited functions such as no charging control, Smart meters only in certain regions, Overloads in the grids have to be compensated only with grid reinforced and enhancement (LV and MV)	As today, constant tariffs over the day within the whole year. Possible adaptation for a night rate.
Sweden	None	As today	Unidirectional charging, no V2G services can be provided by EV, no DSM	Smart meters already installed. The usage of the advanced functions is limited.	As today, most used are “constant tariffs” over the day within the whole year, but time-dependent tariffs also exist

Pragmatic World

The **pragmatic world** operates a bit different. Innovations like a new technology or a new organisation of grid control are likely as long as these changes are reasonable. There will be some simple charging controls installed at least the ideas presented in WP6. Some regulation aspects will be liberalized with the result that EVs can participate in the reserve energy market. This enables EVs to provide certain services to the grid depending on the charging connection (unidirectional). Some DSM services will also be possible. To provide these services, smart meters with a higher functionality are necessary and can be called smart grids. With help of the smart grids, energy prices can be designed in a more complicated way than before. They can be variable and dynamic based on energy prices or even on the load profile in the grid.

Country	Charging control	Regulation	Services	Grid infrastructure	Energy prices
France	3 simple solutions	Flexibility of LV and MV loads cannot be used by the DSO	Unidirectional charging, no V2G services can be provided by EV, no DSM (out of the two tariffs) The network tariff includes a fee based on energy and another fee based on maximum power (subscribed power). This is an incentive for customers to manage the power in their premises (with an automatic non priority load shedding system)	Smart meters, able to send signals to the customer	Simple tariffs , Tariffs can be modified the day before but not in real time
GB	Simple charging control possible → For example charging EV's in off-peak time (timed charge) do domestic customers	Possible participation in reserve market using EVs as interruptible loads.	Mostly unidirectional charging, limited V2G services can also be provided by EV, DSM possible.	More usage of the advanced functions of smart meters, significant communication with grid and corresponding control of charging	Variable and dynamic tariffs possible
Germany	Simple charging control	Some liberalization,	Unidirectional charging,	Area-wide smart meter	Variable and dynamic

	possible → Simple solution in WP6	reserve energy market open for EV, no general changes	V2G services can be provided by EV, DSM possible	installation → Smart grids	tariffs possible
Italy	Simple charging control possible → Simple solution in WP6 in line with Italian regulation	Possibly participation in reserve market using EVs as interruptible loads.	Unidirectional charging, V2G services can be provided by EV, DSM possible	Initial integration of infrastructure into remote grid control procedures	Additional contractual possibilities thanks to accession to reserve market. Possible to have prices based on the whole load profile.
Netherlands	Simple charging control possible → Simple solution in WP6 Availability of surplus of electricity or price signal to be sent to EV can be used, no return communication.	If regulations do not change it will be difficult/impossible to optimise the grid usage since requested power need to be delivered	Unidirectional charging, will be possible to adjust at which signals the EV will start and stop loading	Smart Meters is a good option to interface with the EV for the provision of data required for the services described	Can be kept the same, but price can also be variable in case of Smarter Grid
Portugal	The publicly available CPs are real-time controlled, on/off. The national network of these CPs is coordinated with the DSO and TSO management, available for technical power management. Homecharging is uncontrolled allowing only timed charging.	EVs can enter the reserve market, specially the tertiary market (market for reserve power), under the concept of the aggregator already existing . This aggregator is basically a virtual power plant that offers to primarily reduce system load, under need from the System operator, turning the CP gateway on/off.	DSM on publicly available CPs implemented on the market through the aggregator concept. (No V2G.)	All publicly available CPs are real-time controlled. Smartmeters are implemented but they do not manage EVs individually, but rather the whole power consumption of the connection point. Hence it is not possible to control the charging of EVs in all private access locations.	EV users have power contracts with interrupt ability conditions for charging on publicly available CPs. They get an economic value out of those conditions from the aggregator which should be the retailer. They also have different prices for time of day.

		This functionality is however only working for publicly available CPs, not home charging.			
Spain	Simple charging control possible → For example Charging EV's in off-peak time (timed charge) Local aggregators will be required. The integration of wind energy has to be facilitated.	• It would require an extensive communications network which implies an investment • User's acceptance (may be a situation where the battery is discharged but the user needs the EV) • There are doubts that this regulation mechanism based in EV are profitable Significant changes are required. - To liberalize the energy supply to the EV - Promotion initiatives are necessary. - Green cars (that are charged with wind energy)	Unidirectional charging is the most used type of charging but V2G services can be provided in some specific installations (for example in installations to charge fleets, supermarkets, offices etc)	Strong presence of local smart grids (microgrids) and complete implementation of remote meter reading and remote control.	Deployment of new pricing schemes allowing more customer participation in market.
Sweden	Simple charging control possible	Some liberalization, reserve energy market open for EV, no general changes	Unidirectional charging, some V2G services can be provided by EV, DSM possible	More usage of the advanced function in the smart meters	Variable and dynamic tariffs possible

Advanced World

The third world is called **advanced world**. It is assumed that nearly all technical solutions are possible and the situation for EVs is nearly optimal. The reason might be that the EU forces developments in the energy sector such as an installation of certain technologies even if the profitability is low.

The advanced world should be oriented at the vision document. Due to the fact that the possibilities of the vision document are very complex, the scenarios are developing a simpler version of it that can be used for the most work packages to assess the scenarios.

Country	Charging control	Regulation	Services	Grid infrastructure	Energy prices
France		Real time markets	Flexibility of load can be offered to the balancing mechanism and the distributor can use this flexibility to manage congestions		Direct access to the market with offers
GB	Complex charging control possible, centralized as well as decentralized control possible	Active demand permitted by regulator. Moreover EV incentivized to support renewables integration.	Bidirectional charging, V2G services can be provided by EV, Flexibility of load can be offered to the balancing mechanism and the distributor can use this flexibility to manage congestions and intermittency of renewables	Advanced smart grids, virtual power plants possible, a high level of communication and control	Real time pricing possible. User will be actively involved in choosing the service and price.
Germany	Complex charging control, centralized and decentralized control possible, charging control with multi agents	Optimal situation for EVs, no restrictions	Bidirectional charging, V2G services can be provided by EV, advanced DSM, a high percentage of customers participate at the DSM	Advanced smart grids, virtual power plants possible, a high level of communication and control	Real time pricing possible, complex tariff structure, no limitations
Italy	Charging procedures controlled in synergy	Active demand permitted by regulator.	Same as Germany	Same as Germany	Same as Germany

	with the Aggregator's policies	Moreover EV incentivated as mean to increase renewables integration.	Notes: Bidirectional energy flows penetration will depend on battery capabilities and types of charging (Slow, quick, fast)		
Netherlands	Complex charging control used, centralized and decentralized control possible, charging control with multi agents and bidirectional communication expected.	Regulations will enable optimal use of electricity availability, type of energy and grid usage. New types of companies expected that bundle EV energy requests, buy on the energy market and control the charging	V2G service offered, not widely used. For unidirectional charging several options will be available. Just like GSM phones it will vary from pre-paid, regular formats with different prices and conditions, to company and fleet controlled specialized services.	The grid will be a very active component that also influences the charging to (economically) optimize the use of the grid.	Real time pricing possible, no limitations. User will actively be involved in choosing his service and price.
Portugal	Precise real-time charging control and V2G is possible everywhere, through the usage of Mode 3 communications of the CP with the vehicle, and through the IT network for the publicly available CPs, and through the smartgrid network in all other locations.	EVs are on the tertiary market for DSM, for V2G and for load generation (tor receive excess wind power for example), through the concept of the aggregator. There is also the possibility for emergency technical management of loads directly by the DSO	DSM, V2G and load generation on all CPs on all locations implemented on the market through the aggregator concept	All CPs are real-time controlled. Smartmeters can manage the EV independently from the other applications connected to the customer installation. Aggregators have access to manage the EV directly, and DSOs can also enforce a technical management of the CPs, if necessary.	Real time pricing possible, complex tariff structure, no limitations
Spain	Complex charging control, centralized and decentralized control	Participation of EV in the primary, secondary and tertiary regulation	Bidirectional charging, V2G services can be provided by EV,	Advanced smart grids, virtual power plants possible, a high level of	Real time pricing possible, no limitations

	possible, charging control with multi agents	services (both frequency and voltage). -Regulation for optimal participation of EV in ancillary services, balancing mechanisms and helping in the wind integration. - To facilitate the full integration of aggregators (to provide services to TSO/DSO)	advanced DSM, a high percentage of customers participate at the DSM	communication and control.	
Sweden	Complex charging control, centralized and decentralized control possible, charging control with multi agents	Optimal situation for EVs, no restrictions	Bidirectional charging, V2G services can be provided by EV, advanced DSM, a high percentage of customers participate at the DSM	Advanced smart grids, virtual power plants possible, a high level of communication and control	Real time pricing possible, no limitations

Basic parameters values for the three scenario worlds

Relevant parameters have to be varied within their parameter ranges in **every scenario world**. In the following table the relevant parameters are shown with their parameter ranges and a starting value for the calculations. The initial value will not be varied for each world!

Parameter	Subparameter	Ranges	Initial value
Connection power	Depending on each country	- Slow - Quick - Fast / Changing stations	**Slow**
Charging places		- At home - At home and at work - Everywhere	**At home and at work**
Battery capacity	BEV City-BEV PHEV90	25-35 kWh 10-16 kWh 12-18 kWh	**35 kWh** **16 kWh** **18kWh**
Consumption	BEV City-BEV PHEV90	0,13 – 0,25 kWh/km 0,12 – 0,16 kWh/km 0,15 – 0,25 kWh/km	**0,2 kWh/km** **0,12 kWh/km** **0,2 kWh/km**
Composition of different EV Types	**Depends on the region and the penetration rate → parameter manual**		
Directionality of the charging process		Unidirectional Bidirectional	**Unidirectional**
Market penetration		0% - 100%	**30%**
Area of supply	Grids for every G4V Countries!	- Rural - Suburban - Urban	- **Rural** - **Suburban** - **Urban**
Energy mix	Scenarios from the report of basic trends in the future energy supply in EU	- Conventional scenario - Basic scenario - Renewable scenario	**Basic Scenario**

Table 1: Parameter ranges for the scenario worlds

Parameters not included in the table are either calculated for each region separately or have a fix value or approach described in the parameter manual.

2. Summary

	Scenario worlds
Fixed parameters	The framework is fixed: - Grid infrastructure - Regulation framework - Charging control - Prices - Services
Possible results based on the evaluation criteria (technical, economical etc)	In the scenario worlds the frameworks are the differentiating factors. We will be able to say which technical approach is the better one in which world. On the one hand, in the conservative world, a high penetration could be very expensive because the rural grids have to be extended due to the missing charging control. On the other hand, in urban areas no problems will occur. In the advanced world, a high penetration of EV will be possible because of the high revenue only available in this world. The recommendation will be which framework is the better one due to different evaluation criteria. The cost-effective scenario might be the pragmatic world but the scenario with the highest integration of EV and the lowest CO_2 emissions is the visionary world and so on.
Target groups	The target groups in this case are on the one hand the EU and every regulation government because they can influence the existing framework. The results are understandable and interesting for everyone not familiar with the technical aspects.
Pros and cons	- Complicated to describe because the development of reasonable worlds is necessary - Results are understandable for a very large target group - Political and social aspects can be taken into account

Table 2: Summary of the scenario worlds

The scenario worlds define a framework for our calculations. The number of fixed parameter can be defined due to the prospects of each partner. Nonetheless, it is important to vary the important technical parameters to gain the best results.