e-HIGHWAY 2050			
Modular Development Plan of the Pan-European Transmission System 2050			
Contract number	308908	Instrument	Collaborative Project
Start date	1st of September 2012	Duration	40 months
WP 1	**Setting the Boundary Conditions for 2020-2050 grid planning**		
	Feedback from WP1 workshop 23 January 2013		

Revision:

Due date of delivery: February 2013

		Date & Visa
Written by	Bjorn H. Bakken, SINTEF Eric Peirano, TECHNOFI	
Checked by	Bjorn H. Bakken, SINTEF	2013-03-11
Validated by	Gérald Sanchis	2013-03-12

Document information

General purpose

This memo contains a summary of feedback received after the e-HIGHWAY2050 stakeholder workshop in Brussels 23 January, with comments from the consortium.

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1. Introduction

This report summarizes the feedback received further to the first e-Highway50 WP1 external workshop held on the 23th of January 2013 in Brussels.

The report is based on the PowerPoint file that was distributed after the workshop in order to invite the workshop participants to provide a formal feedback on the main questions addressed for e-Highway50 scenario building.

Stakeholders' comments and the related answers from the e-Highway50 consortium to the different questions are presented below.

2. Identification of the «Uncertainties» and «Options»

2.1. Technologies & RDD Uncertainties and Options

2.1.1. Generation technologies (question 1)
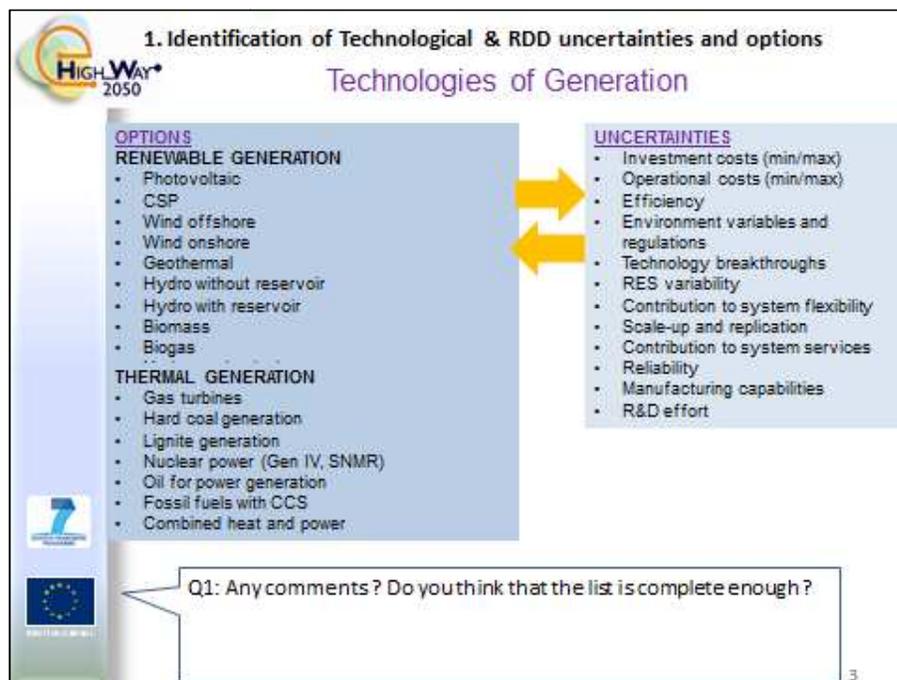
Figure 1: lists of options and uncertainties for generation technologies

- **CECED**: Micro energy generators or co-generators could enable a true smart grid that manages consumption/demand locally.
  - ✓ **e-Highway2050**: CHP is considered as part of the generation mix in the Scenario definition part, but the heat distribution is not specifically included in the market and grid analyses. The ratio of CHP plants to pure electricity generation plants

depends on the competitiveness of each technology considered. In the Scenario Development work, a certain electricity to heat generation ratio will be considered. However different ratios will be used for different technologies.

- **COGEN Europe**: CHP could make a bridge between fossil fuels and RES (in thermal plant).

    - ✓ **e-Highway2050**: CHP is considered as part of the generation mix.

- **ELIA**: Should wave energy or ocean thermal energy conversion be added?

    - ✓ **e-Highway2050**: Marine technologies (wave, tidal, OTEC) should be included in the analyses.

- **ENSIEL**: Electricity generation from waste combustion should be included.

    - ✓ **e-Highway2050**: it is included as part of biomass generation.

- **ENTSO-E**: Will life cycle assessments (LCA) be performed?

    - ✓ **e-Highway2050**: LCA is currently not part of the analyses. However, typical variables such as CO_2 footprint, energy pay-back time, etc., will be taken into account, if available, in the data gathered in WP3 for each technology.

- **RTE**: Is there any possibility for large diffusion of micro-CHP in the household sector?

    - ✓ **e-Highway2050**: Micro generation can be considered as a sub-technology of different technologies such as gas turbines, CHP, etc. At the local consumption level, their contribution will be included in the demand calculations.

- **SIEMENS**: Will electric imports from outside Europe and sustainability of new technologies be considered?

    - ✓ **e-Highway2050**: Electricity exchanges at European borders are one of the main factors in scenarios (Generation/Demand/Exchange profiles); however sustainability of specific technologies (LCA) is not explicitly included (cf. question above raised by ENTSO-E).

- **VGB Powertech**: Marine (tidal, wave, OTEC), nuclear (small modular reactors) should be considered. Add "Load factor" as uncertainty.

    - ✓ **e-Highway2050**: Ocean energy and small nuclear will be included in the analysis. Possible load factors (for generation units) will be a result of the analyses.

2.1.2. Storage technologies
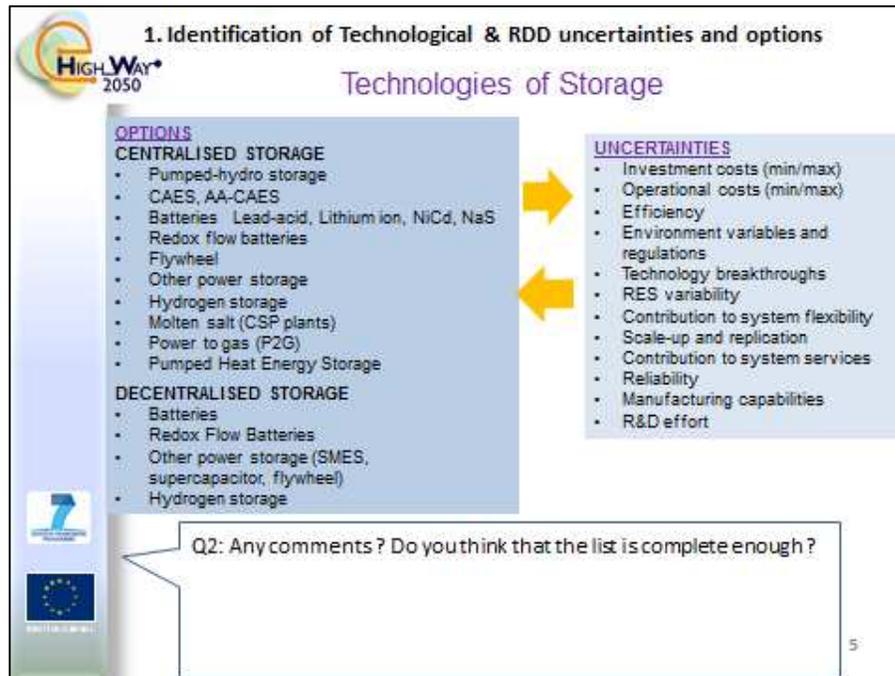
Figure 2: List of uncertainties and options for storage technologies.

- **COGEN Europe**: Electricity storage at decentralized level in a **thermal (heat-steam)** form should be considered.

  - ✓ **e-Highway2050**: Thermal storage is currently only considered as centralized storage.

- **EASE**: It is recommended to segment Storage as **Bulk storage**, **Grid storage** and **End user storage.**

  - ✓ **e-Highway2050**: The consortium has decided to keep the current classification

- **ELIA**: Centralized storage should include **Compressed air energy storage**? Decentralized storage should include **Parked and plugged-in electric vehicles (EVs)**?

  - ✓ **e-Highway2050**: CAES (both current and future technologies) is included in e-Highway2050 analysis. EVs are considered under demand technologies including vehicle to grid applications.

- **ENSIEL**: **Vehicles to grid (V2G)** should be included. **Sea pumping** should be coordinated with offshore wind.

  - ✓ **e-Highway2050**: EVs are considered under demand, not as a specific storage option. Pumped hydro is included with salt water as an option when geologically feasible.

- **EURELECTRIC:** Uncertainties are correlated to each other

  - ✓ **e-Highway2050**: Yes, absolutely, and this will be further elaborated as the project scenarios are built.

- **RTE**: Add "**vehicles to grid**" and "**heat storage**" (for example, hot water storage combined with a heat pump to perform peak shaving)

    ✓ **e-Highway2050**: EV's, heat pumps and peak shaving are considered under demand-side technologies.

2.1.3. Demand-side technologies
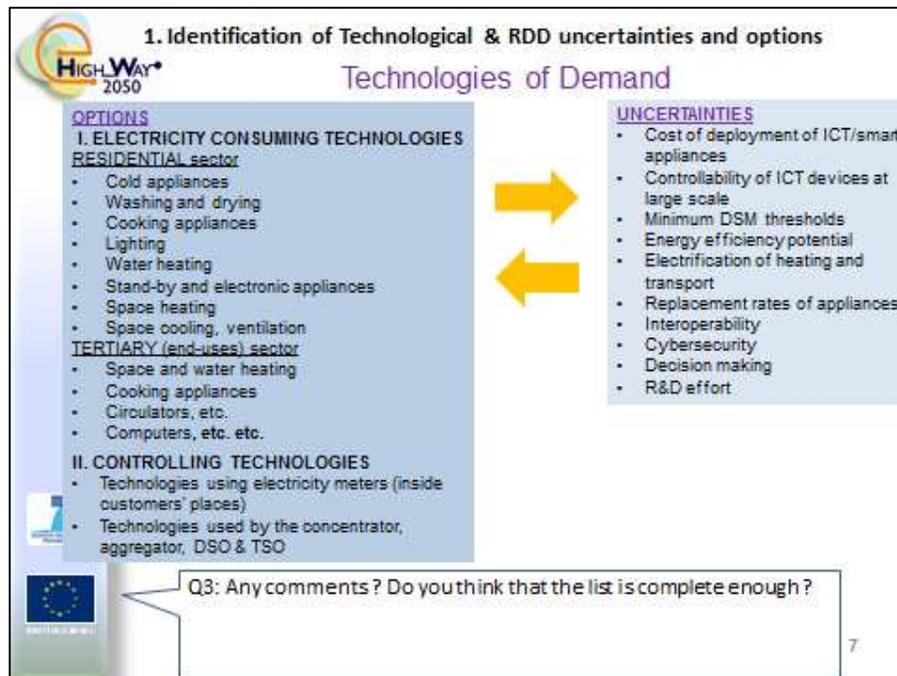
Figure 3: List of options and uncertainties for demand-side technologies

- **CECED:** The possible massive introduction of **electric vehicles** should be considered

    ✓ **e-Highway2050**: Yes, it is considered under demand.

- **ELIA**: Is **Heat pump** assumed as part of heating&cooling?

    ✓ **e-Highway2050**: The effect of heat pumps is considered under demand calculations.

- **ENSIEL**: **Electric transportation** should have more emphasis

    ✓ **e-Highway2050**: Yes, it is considered under demand.

- **EURELECTRIC:** Political decisions might drive uneconomic developments (e.g. smart meter) which being in place might accelerate beneficial services in other sectors.

    ✓ **e-Highway2050**: Yes, such dependencies will be more elaborated as e-Highway2050 scenarios are built.

- **RTE**: Technologies that could have a dramatic impact on demand should be considered: **Electric vehicles or heat pumps**.

✓ **e-Highway2050**: Yes, they are considered under demand.

- **SIEMENS:** The electrical **exports** outside Europe should be considered.

    ✓ **e-Highway2050**: Electricity **exchange** outside Europe (including both import and export) is a main factor in (G/D/E) scenarios.

- **VGB Powertech**: Add "**Temperature Control Devices**" as an option.

    ✓ **e-Highway2050**: Yes, they will be considered under the sub-category renamed "Technologies AFTER electricity meters".

2.1.4. *Transmission technologies*
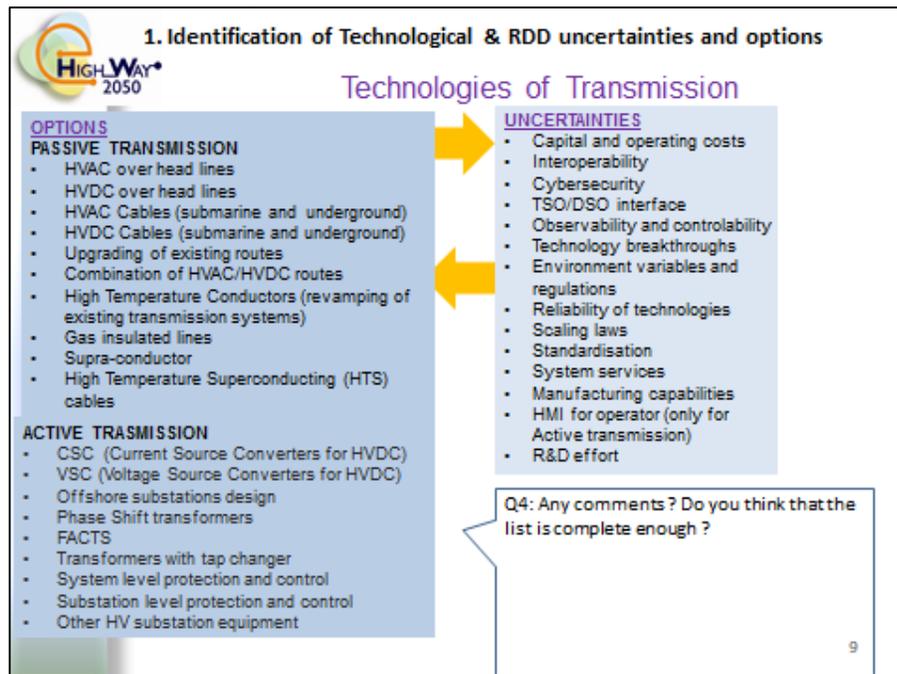
Figure 4: list of options and uncertainties for passive and active transmission technologies.

- **ENSIEL**: **Meshed DC grids** and **Electronic Transformers** should be added in the Options. In the Uncertainties, **bulk power system controllability** should be added.

    ✓ **e-Highway2050**: Meshed DC grids are not as such a key technology. It depends on the development of other technologies, such as VSC, DC breakers, etc., which are considered in the above list. Bulk power system controllability will be added as uncertainty.

- **ENTSO-E:** What about **multi terminal converters** for installing a meshed HVDC-Grid?

    ✓ **e-Highway2050**: Yes, key technologies like CSC or VSC converters, DC breakers, etc., are considered.

- **EURELECTRIC:** Increased capacity of lines by **temperature monitoring** should be considered**.**

  ✓ **e-Highway2050**: This is more an operational option than a technology. RTTR will be considered in OPEX driven technologies.

- **Europacable**: The **combination of overhead lines and cables** (in AC and DC systems) should be treated as an active transmission technology

  ✓ **e-Highway2050**: this technology will be moved to active transmission as suggested.

- **SIEMENS: Automatic European TSO** as Option

  ✓ **e-Highway2050**: Bulk power observability and controllability are considered as uncertainties, but automatic pan-European TSO is not yet considered as an option.

- **VGB Powertech**: "**FACTS, SVC, etc.**" should be added as an Active Transmission option.

  ✓ **e-Highway2050**: Yes, both are already considered.

2.2. Economic, socio-political, and environmental Uncertainties and Options

Figure 5: list of economic and financial options and uncertainties

- **COGEN Europe**: With regards to **energy efficiency for the supply side** (from generation to transmission), a **CHP target** could be considered**?** Political push for **power plants to be sited closer to consumption point?**

- ✓ **e-Highway2050**: Resource (supply side) efficiency is discussed in Task 1.4 Political, Socio-political and Environmental boundary conditions. A specific CHP target is currently not considered. The ratio of CHP plants to pure electricity generation plants depends on the competitiveness of each technology considered. In the Scenario Development work, a certain electricity to heat generation ratio will be considered. However different ratios will be used for different technologies

- **ELIA**: Should the expansion of electricity grid infrastructure be linked with **gas grid infrastructure**?

  - ✓ **e-Highway2050**: Currently, we only consider the electricity infrastructure in the analysis. The connection to gas infrastructure is handled through fuel prices. Installed capacity of gas in the scenarios can account for increased gas availability at areas close to gas infrastructure hubs. Regarding the possibility to use same corridors, the issue will analyzed later in the project within WP4.

- **ENTSO-E:** Among the energy Supply Options, **subsidies** (e.g. feed-in tariffs for green energy) should be considered.

  - ✓ **e-Highway2050**: RES support schemes and capacity mechanisms, as a more general term, are discussed in Task 1.3 Economic and Financial boundary conditions.

- **EURELECTRIC:** Uncertainties for new transmission might be: **missing financing, missing licensing**, **missing capacity of production**

  - ✓ **e-Highway2050**: Missing financing is reflected in the uncertainty of "Cost of capital", missing licencing is discussed in Task 1.4 while capacity of production is discussed in Task 1.5 Research, Development and Deployment boundary conditions.

- **RTE**: **Structure of economic growth** (services/industry/energy-intensive industry) may have a dramatic impact on the level of electricity demand growth.

  - ✓ **e-Highway2050**: Although this issue is currently not discussed as part of WP1, it should be included in the scenario building (WP2).

- **SIEMENS:** Some TSOs are owned an influenced by **international stakeholders.**

  - ✓ **e-Highway2050**: We consider this not to be a main challenge due to natural monopoly economic regulation.

- **VGB Powertech**: Under Energy Demand uncertainty, "**Penetration level**" should be added.

  - ✓ **e-Highway2050**: We are not sure how to interpret this comment. Percentage of consumption for different subsectors is included for Demand technologies.
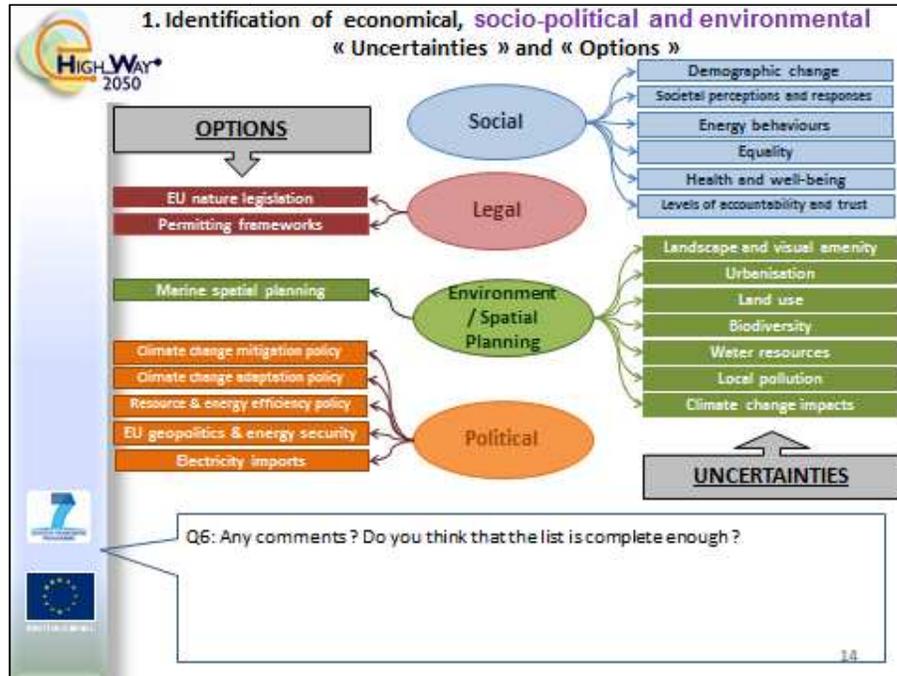
Figure 6: list of economic, socio-political and environmental options and uncertainties

- **EASE:** Will the non-binding **2050 decarbonization aims** be regarded as an uncertainty or as a fixed assumption?
  - ✓ **e-Highway2050**: The Steering Committee has decided to treat the 2050 targets as a fixed assumption for all e-Highway2050 scenarios, with the exeption of a reference/BAU scenario which *might not* reach 80-95% GHG emissions reduction.

- **ELIA**: What about the **share of primary, secondary and tertiary sector**? Will there still be a manufacturing sector in Europe? How will work be organized? Will we all work from home or will we still commute daily by electric vehicle or public transport?
  - ✓ **e-Highway2050**: This aspect has not been directly discussed as a boundary condition; but it will be considered when building the e-Highway2050 scenarios, in WP2.

- **ENSIEL**: We should also take into account social conditions not only in the EU, but also e.g. in **northern Africa**, that can impact exports to EU.
  - ✓ **e-Highway2050**: Yes, this is partly covered both under "EU geopolitics & energy security" and "Electricity imports" options.

- **ENTSO-E:** Is «**Acceptance**» considered?
  - ✓ **e-Highway2050**: Yes, but we use the broader term "social perceptions and responses" to address this issue .

- **EURELECTRIC:** These uncertainties are **too far away from grid modeling**. I am missing **legal and political uncertainties** which turn out to be the major problem in today's framework.

  ✓ **e-Highway2050**: We are not limiting our scope to "grid modeling" but we are considering all uncertainties and options for the development of electricity highways. A broad range of legal and political uncertainties is discussed in Task 1.4.

- **RTE**: The potential impact of **ICT on the organization of work** should be considered.

  ✓ **e-Highway2050**: See comment to ELIA's question above.

3. Selection of <u>MAIN</u> «Uncertainties» and «Options»

3.1. Technological & RDD Main Uncertainties and Options
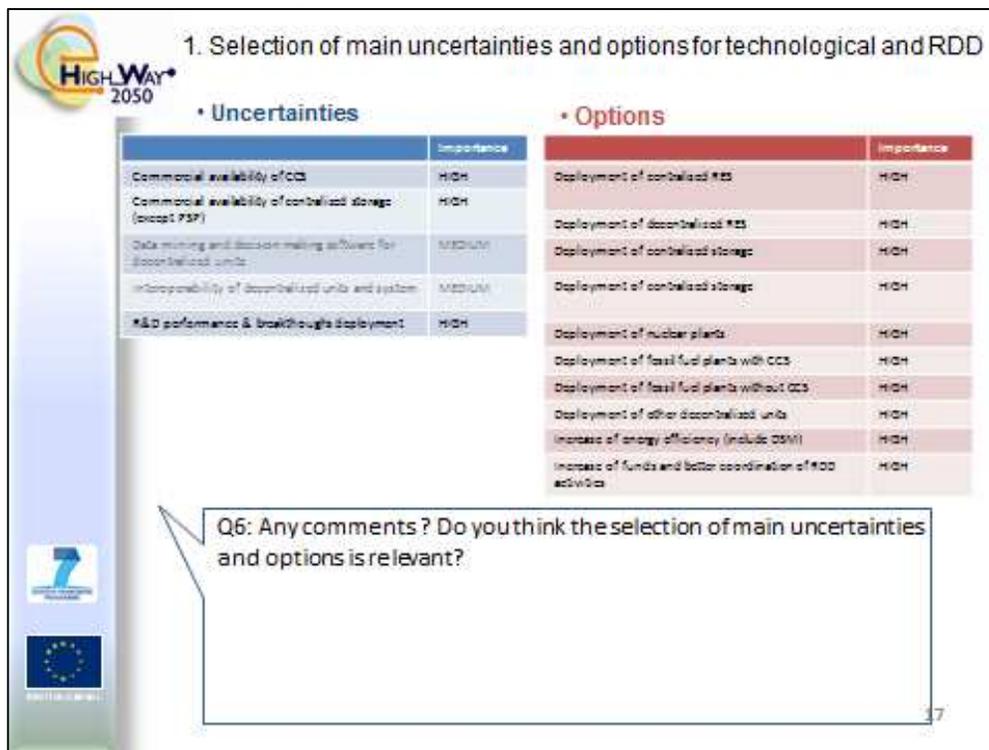
Figure 7: Selection of main options and uncertainties for technologies and RDD (Research & Development and Demonstration)

- **EASE:** The segmentation "**bulk storage, grid storage & end user storage**" should be used.

  ✓ **e-Highway2050**: See reply in previous section.

- **ELIA**: The «Increase of DSM» with **energy efficiency, load shifting and peak shaving** should be mentioned as possible outcomes.

  ✓ **e-Highway2050**: Although this is not listed as a main option, it will be included in the scenario building.

- **ENTSO-E:** Why do you consider centralized Storage (**except PSP**)? No options are considered regarding **transmission technologies**?
  - ✓ **e-Highway2050**: EWI Köln claims in a report that no further investments than planned at present are possible for in pumped hydro storage are possible in Europe, but this does not seem to agree with ongoing discussions in e.g. Norway and the Alpine region. Options for transmission technologies and transmission expansion will be considered in main work packages of the project.

- **EURELECTRIC: Is Commercial availability of CCS** included in R&D-uncertainty?
  - ✓ **e-Highway2050**: Yes, it is considered under RD&D.

- **SIEMENS: Electrical imports** from outside Europe should be considered xith Medium importance
  - ✓ **e-Highway2050**: This is considered under Political uncertainties, but with High importance.

3.2. Economic, socio-political and environmental Main Uncertainties and Options

Figure 8: Selection of main economic, socio-political and environmental options and uncertainties

- **COGEN Europe:** Please rephrase the first option as follows: **EU policy for EE (Energy Efficiency)**. Another option is also «**EU policy in support of better siting of pp** (closer to consumption centers)».

- ✓ **e-Highway2050**: The two terms are not quite comparable. Support schemes are one particular option to be chosen; while "EU policy" is a more general term that could include a number of different options covering support schemes. We do not currently consider a specific option for siting of power plants.

- **ELIA**: Are **societal perception of new transmission corridors** assumed to remain very negative?

  - ✓ **e-Highway2050**: Not necessarily, but social perception is nonetheless an important uncertainty.

- **ENSIEL**: **Electric transportation** should be distinguished from heating.

  - ✓ **e-Highway2050**: Yes, in the modeling it will be; but here it is presented as a bundled uncertainty for simplicity.

- **ENTSO-E: Support schemes for RES** is the main trigger for RES-deployment.

  - ✓ **e-Highway2050**: Yes, probably it is today; but it will not necessarily be up to 2050.

- **EURELECTRIC:** We disagree that **urbanization** is assumed to be less important than demographics. We have the same opinion for **support schemes for RES**.

  - ✓ **e-Highway2050**: We agree. This has been updated.

- **SIEMENS:** The **electrical imports** from outside Europe should be considered as political Uncertainty with Medium importance.

  - ✓ **e-Highway2050**: We think the possibility to import electricity from outside Europe (e.g. solar energy from North Africa) has high importance.

4. Boundary conditions for «Uncertainties» and «Options»
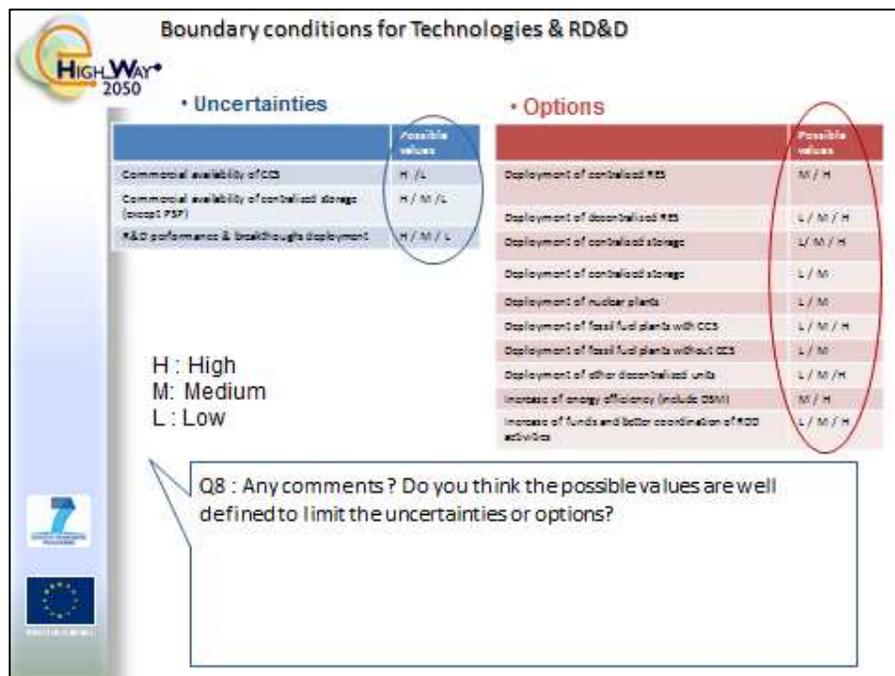
Figure 9: Boundary conditions for technologies and RD&D

✓ No comments were made by stakeholders on this topic.
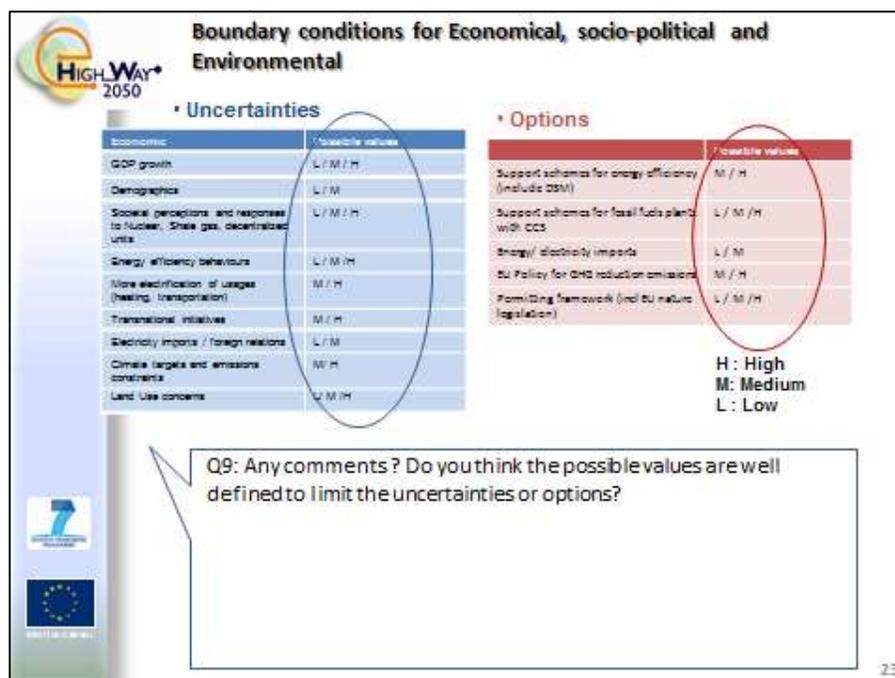
Figure 10: Economic, socio-political and environmental Boundary conditions

- **CEP:**
  1. **Social perception and responses** should not just focusing on nuclear energy, shale gas etc.
  2. Some other **environmental issues** (landscape/visual and biodiversity etc) are not just part of the "acceptability" issue.
  3. **EU geopolitics**, and level of integration and disintegration, is potentially a very important uncertainty.
  4. The impacts of a **changing climate** are an uncertainty we are researching further.
     - ✓ **e-Highway2050**: Since CEP is the leader for Task 1.4 Political, Socio-political and Environmental boundary conditions in e-Highway2050, these points are already taken into account.

- **COGEN Europe:**
  1. **Societal perception**: Same uncertainties hold for the building of centralized pp from local communities.
     - ✓ **e-Highway2050**: Yes, this is included in the more general "Societal perceptions" uncertainties.
  2. **EU policy for energy efficiency** should be mentioned in the first row.
     - ✓ **e-Highway2050**: See comment above
  3. Another row should be on «**EU policy in support to better siting of pp** (closer to consumption centers)».
     - ✓ **e-Highway2050**: See comment above

- **ENSIEL: Electric Transportation** should be distinguished from heating.
  - ✓ **e-Highway2050**: See comment above

- **RTE:** "**Energy prices**" should be added to main uncertainties
  - ✓ **e-Highway2050**: Yes, see "Main uncertainties" slide.

- **SIEMENS: Electrical imports** from outside Europe should be added as a political Uncertainty with Medium/Low importance.
  - ✓ **e-Highway2050**: See comment above

5. Dimensions and futures
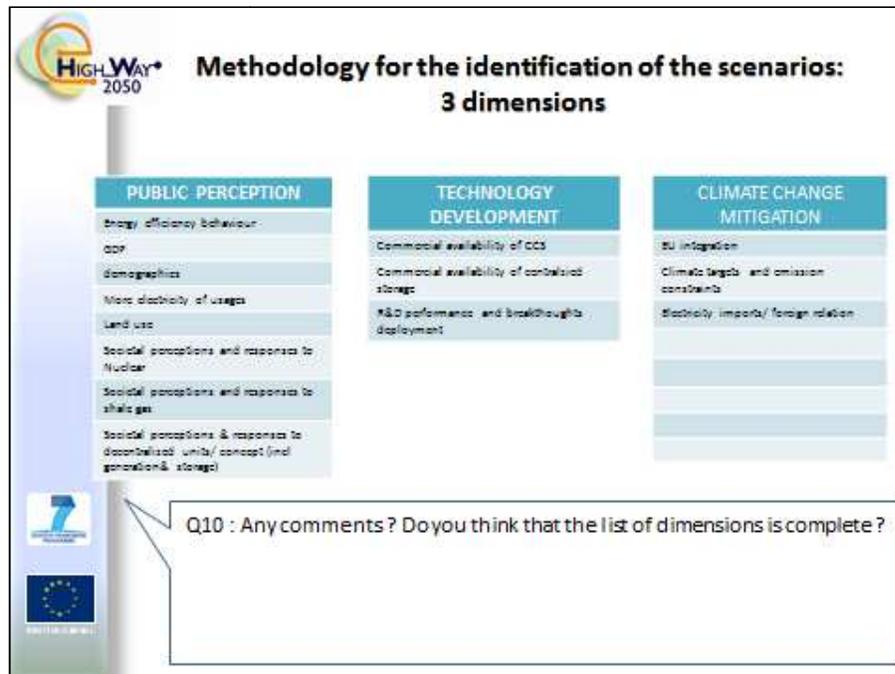
Figure 11: Methodology for scenarios identification

- **COGEN Europe:**
    - Climate change -> Side effects of **EU policies in the field of EE and RES**.
    - **Bioenergy** should also be listed in Public perception.

    - ✓ **e-Highway2050**: We have already changed this structure considerably in the scenario building. Climate change is no longer defined as proxy driver. Public perception encompasses all relevant technologies.

- **E3G**:
    - If we fix the EU carbon target it makes sense to remove '**international climate agreement**' as an uncertainty. Other factors (global economic growth) are perhaps better drivers of fuel price movements. *Keeping it as a core uncertainty will lead to distracting arguments about whether the EU should retain its carbon target if the rest of the world has not adopted a target of its own*.

    - To enable better comparability between scenarios, I would prefer to treat some factors, such as **demographics and GDP as inputs or assumptions, rather than uncertainties.**

- An uncertainty may be '**environmental conflict blocks deployment**' vs '**environmental factors successfully managed**'.

  - ✓ **e-Highway2050**: We have already changed this structure considerably in the scenario building.

- **ELIA**: Public perception of **grid infrastructure** remains negative? Social perceptions to **different types of production**, e.g: Coal, Onshore wind, etc

  - ✓ **e-Highway2050**: These issues are discussed in greater detail in Task 1.4

- **ENSIEL**: You should add **techniques to control storage** in order to allow more RES to be connected.

  - ✓ **e-Highway2050**: This will be an hypothesis in "high tech" scenarios.

- **Europacable**: Recommendation to add "**Blackstart scenario**" as one of the uncertainties:

  - ✓ **e-Highway2050**: That sounds more like a contingency for the grid feasibility study, than a scenario uncertainty itself. The blackstart capability should be tested for all scenarios.

- **RTE**: The title "public perception" is surprising insofar as it contains items like "GDP" or "demography". We should maybe find another title ("**social and economy context**"?) The energy prices should be added.

  - ✓ **e-Highway2050**: It was grouped under perception as a relevant proxy driver; but we have already changed this structure considerably in the scenario building.

- **ENTSO-E**: **Public Perception** and **technology development are** suitable dimensions. **Climate mitigation is** absolutely a crucial dimension; but by focusing on this one aspect is there not the risk of creating a model where some environmental aspects cannot be represented? Concretely, some important environmental aspects of the 'small things matter' scenario may be difficult to place within the created model (i.e. its system boundaries).

  - ✓ **e-Highway2050**: We have already changed this structure considerably in the scenario building.

- **SIEMENS: Integration** between Asia, Africa, America and Australia should be considered under Climate Change Mitigation.

  - ✓ **e-Highway2050**: We are not sure what kind of integration you mean here. Typical variants under Climate Change Mitigation as proxy drivers would be whether there is a global agreement with global CO_2 prices or only regional agreements.

Figure 12: Highway2050 Tentative Futures

- **E3G**: The most relevant underlying uncertainty is the spatial scale of future European energy systems. Are we looking at a political and technological push towards more **decentralised generation and storage**, or alternatively at a move towards accessing **large scale renewable resources** including beyond Europe's borders? Different scenarios that could be included at different points along this axis include:

  – **Decentralised future**: breakthrough on small scale RES, smart grid and storage technology costs; public opposition to large scale generation (including nuclear, CCS and big wind) and big grids; environmental difficulties also limit large-scale energy developments; there is a political move to more localized solutions. A key question facing eHighways in this scenario is whether they add sufficient security or trade benefits to justify the cost.

  – **Heterogenous Europe**: medium level of progress for most technology costs, but differences in public attitudes and political approaches means there is a mix in generation in different parts of Europe. As a result some regions go high-RES, some go decentralised, some deploy CCS or nuclear but others don't. The key question for eHighways is does the trading enabled benefit all regions?

  – **Market-led**: progress on technology costs means multiple technologies are competitive. Strong European integration means competition across Europe. Public opposition and environmental concerns are successfully managed before they create major blockers. The key question for eHighways is : what grid architectures optimises this market?

- **Renewables resource access**: Technology breakthrough on large RES. Strong political engagement with European neighbourhood enables substantial exchange across Europe's borders. Relatively homogenous approach within Europe. Limited public opposition or environmental barriers to large RES but more opposition to nuclear and/or CCS. The key question for eHighways is on connecting large scale resource to demand centres.

  ✓ **e-Highway2050**: We have already changed this structure considerably in the scenario building, and many (most) of these issues are now included.

- **ELIA**:

  - **Smart grid operation**: generalized use of FACTs vs passive robust grid development, mutual dependency of countries for SoS or national autonomy, active management of distribution grids to help relieve congestion, DSM vs passive management etc.

  - **EU energy independence or not** --> link with North Africa to import solar energy vs full autonomy.

  - **Resource-based vs incentive-based RES deployment**. For example, if PV is massively deployed in South Europe rather than in other countries, the grid should be developed accordingly to transport energy northwards. On the other hand, if solar energy is developed in some area in Central Europe, based on subsidies, the grid will be shaped differently.

  - **On the path towards decarbonization**, the level of substitution towards electricity will size the grid architecture.

  - **Which generation will be used to complement RES** in a decarbonized world: gas, coal with CCS or nuclear?

  ✓ **e-Highway2050**: We have already changed this structure considerably in the scenario building, and many (most) of these issues are now included.

- **CEP**: Stakeholders present at the workshop were mostly TSOs or otherwise closely linked to the industry. Hence, the discussion did not potentially reflect a balanced view across the **environmental and social interests** and this potentially contributed to the inclusion/exclusion of certain issues during the scenario discussion. There is a risk of considering the results of this workshop as a general consensus.

  ✓ **e-Highway2050**: Yes, this is always a risk. However, a number of organisations outside the TSO/industry sphere were invited but did not participate. This workshop is in any case just the first of several stakeholder consultations which will be organised by e-Highway2050.

- **ENTSO-E:**

  - What is the logic of model 3 '**market rules**'? If the market rules, then it is technology open; today perhaps it is more likely large scale and in the future as one possibility going towards more small scale?

- – Different point: Scenario "**big is beautiful**" is consistent. The same scenario with **EU alone** instead of global agreement may also be consistent.

- ✓ **e-Highway2050**: We agree. The idea was that a market driven development would mainly rely on local/regional and small-scale technologies; but this type of future has now been shifted to ALL technologies.

- **RTE**: I understand **GDP** part of "public perceptions", but is it high when public perception is green or indifferent ? More generally, why should there be a close link between public perception and GDP?

  - ✓ **e-Highway2050**: We have already changed this structure considerably in the scenario building.

- **SIEMENS**: The issues declared in this document reflects from my perspective a lot of todays (=2012/2013, as is) aspects. **More challenging issues should be elaborated**. The uncertainties and options forming possible futures should be reviewed especially with respect to political and economical impact driven from outside Europe, also their likelihood, especially the boundaries or limits.

  - ✓ **e-Highway2050**: Yes, you are probably right. However, we are reluctant to introduce planning scenarios where "black box" technologies or solutions have a major role. We would rather develop extreme scenarios with levels of deployment of technologies that are known (although not commercially mature) today.