e-Highway2050 project
Tomorrow’s grid for low-carbon energy in Europe

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Introduction of e-Highway2050

Background

The Energy Roadmap 2050 is the basis for developing a long-term European framework.

General requirement of the project

“Planning for European Electricity Highways to ensure the reliable delivery of renewable electricity and Pan-European market integration”
How the issue has been processed?

Stakes by 2050?
- Identification of the electricity demand/generation by 2050.
- State of the electricity system, with the ‘present’ transmission grid.
- Highlighting the need for solutions in order to solve the congestion/spillage/energy not supplied

Which additional transmission grid by 2050?
- Which transmission requirements in order to solve the constraints?
- Which technologies should be available by 2050?
- Which cost and benefit of the new grid architectures?
- Are the 2050 grid architectures operable?

How to develop the transmission grid from now up to 2050?
- Which intermediate architectures in order to reach the 2050 grid architectures?
- Which governance for a pan-European transmission grid?
The main results
The grid model of e-Highway2050

1. Grid model
2. Scenario definition
3. Grid development
4. Modular plan
The grid model of e-Highway2050

- Not the real grid (> 8000 electrical nodes), but a model with 100 clusters (electrical nodes).
- The starting grid is grid foreseen until 2030, and included in the TYNDP (ENTSO-E).
Scenario definition

1. Grid model
2. Scenario definition
3. Grid development
4. Modular plan
5 “extreme but realistic” scenarios

- Target: reduce by 95% the CO2 emissions
- 5 European scenarios were selected to encompass a wide range of possibilities at 2050 regarding the following criteria:

- Large scale RES
  - From 100% to 160% of 2013 demand
- 100% RES el.
  - From 50% to 100%
- Nuclear
  - From 0% to 25% of the European generation
- Fossil with CCS
  - From 0% to 30% of the European generation
- Exchanges
  - From 10% to 80% of the demand
- Big & Market
- Large fossil fuel
- small and local
Grid development

1. Grid model
2. Scenario definition
3. Grid development
4. Modular plan
Results: scenario 100% RES
Results: scenario 100% RES

100% RES
- Hydro
- Wind
- Solar
- Biomass
- Fossil
- Nuclear
- average load

2030 grid
Reinforcements (GW)
+X : Compared to 2012 (GW/%)

- 100 GW
- 50 GW
- 10 GW

2030 grid
Reinforcements (GW)
+X : Compared to 2012 (GW/%)

- 100 GW
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- 100 GW
- 50 GW
- 10 GW
Results: scenario 100% RES

- 51 TWh of ENS avoided /year
- 465 TWh of spillage avoided /year
- 39 b€ of annual savings in operating costs

Total investment cost: 245-345 b€
The 2050 grid architectures

- An invariant set of new lines and reinforcements has been identified.

100% RES
Transmission requirements (GW)
- 2050 reinforcements
- Starting grid

- 2 scenarios
- 3 scenarios
- 4 scenarios
- 5 scenarios
[min – max] GW

250 – 350 b€

250 – 400 b€

100 – 400 b€

100 – 200 b€
Modular plan

1. Grid model
2. Scenario definition
3. Grid development
4. Modular plan
From 2030 towards 2050

2030

2040

2050

100% RES
Transmission requirements (GW)
- 2050 reinforcements
- Starting grid

Big & market
Transmission requirements (GW)
- 2050 reinforcements
- Starting grid

Large-scale RES
Transmission requirements (GW)
- 2050 reinforcements
- Starting grid

Fossil & nuclear
Transmission requirements (GW)
- 2050 reinforcements
- Starting grid

Small & local
Transmission requirements (GW)
- 2050 reinforcements
- Starting grid

- 1 GW
- 2.5 GW
- 5 GW
- 10 GW
- 15 GW
- 20 GW

2015
Projects by 2030

Starting grid
2040 least-regret grid
In conclusion
Main findings of the project

- The ‘present network’ should be not sufficient to face a future with low carbon economy.
  - Especially, huge volumes of RES would be curtailed and compensated by expensive thermal generation emitting CO2.
- To tackle these issues, transmission grid architectures have been developed by the project, with an invariant set of transmission requirements.
- The costs of investment in grid expansion lie between 100 and 400 billions €, but saving up to 500 TWh of RES curtailment, and 200 mega tons of CO2 emissions.
Key messages (2/2)

• Grid Structure
  ➢ no needs for a new separate ‘layer’ within this existing grid.

• Technology:
  ➢ Needs for the improvement
    – of the present technology on the transmission capacities,
    – and their use (e.g. submarine in depth, DC technology).

• System Operation:
  ➢ The consequences of high penetration of RES and HVDC in the power system should be further investigated.
Thank you for your attention!

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