

Roadmap 2050:

A practical guide to a prosperous, zero-carbon Europe

Volume I: technical and economic assessment



ECF's Roadmap 2050 project: three reports

1

Roadmap 2050: a practical guide to a prosperous, low carbon Europe



2

Power Perspectives 2030: on the road to a decarbonised power sector



3

From Roadmaps to Reality: how to tackle implementation

2010

European Commission
Low-Carbon Economy
2050
Roadmap

2011

2012

European Commission
Energy 2050
Roadmap

2013

2014

European Commission
2030 Climate & Energy
Communication



The EU-27 decided on 80 - 95% emission reduction

-
- **Europe agreed to 80% reduction** from 1990 levels by 2050 at the 2009 G8 meeting in L' Aquila. The target of 80-95% was confirmed by the EU environment ministers and Heads of State in autumn 2009.
 - Political demand for greater EU energy security, realizing the climate goals, as well the political momentum created by the new European Commission combine to create a **window of opportunity for infrastructure investments** and related policies.
 - The European Commission is actively working on its **European Infrastructure Package** and a **Communication on 2050 Energy Strategy**, which need to reflect the long-term GHG reduction targets
-



The objective is to develop a fact based report that is supported by key stakeholders and feeds in directly to EU decision making

Key deliverables

- A set of **plausible and visionary emissions pathways with an 80% reduction** across the EU-27 below 1990 levels by 2050
- Deep dive **on the decarbonization of the power sector**
- Implications on **strategic options** for the EU
- A related **set of policy options** highlighting potential decisions for the next 5 years

Overarching objective

Develop a fact based, **ECF branded report** to support the European Commission and Member State agencies to chart an energy strategy for 2010-2014 consistent with the EU's 2050 climate and energy security commitments



Political agenda

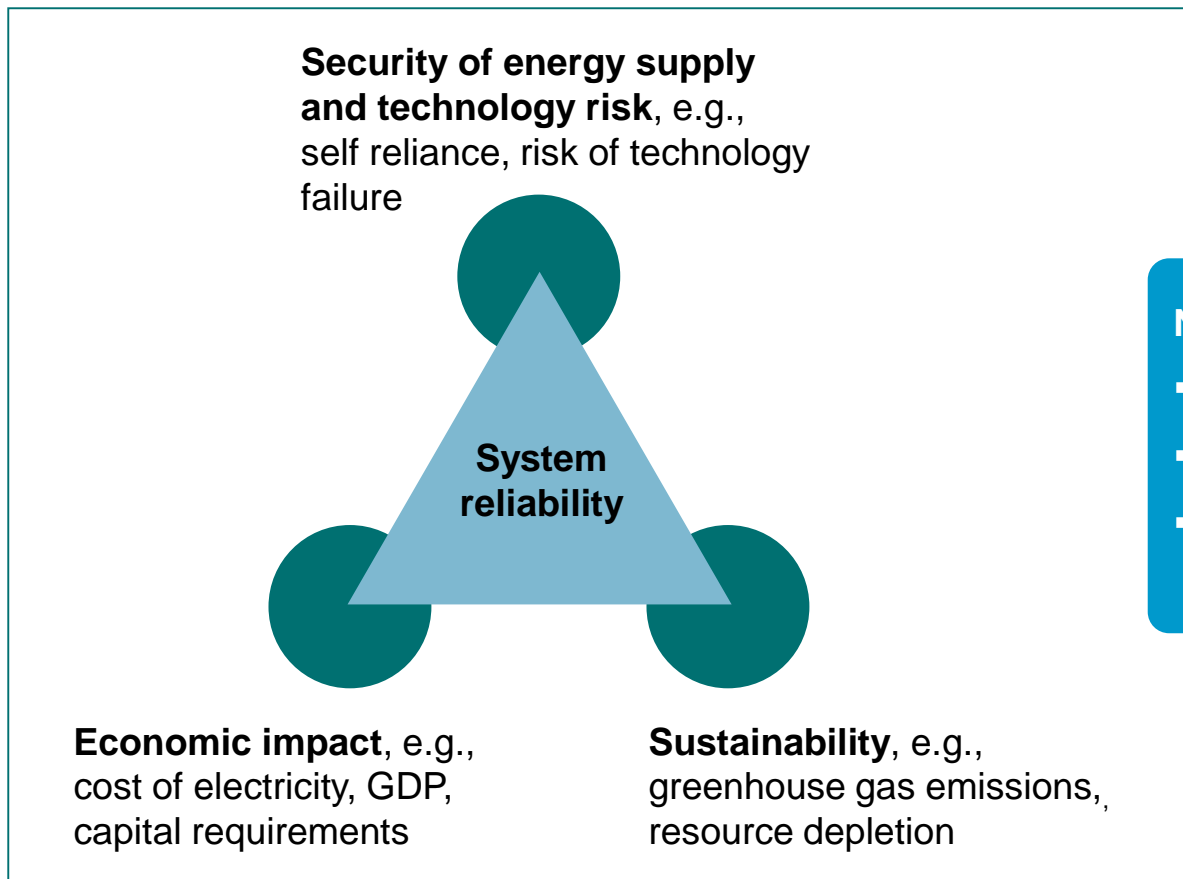
Post-Copenhagen **political agenda** to inform the new Commission & parliament:

- **Around summer 2010**
 - 3rd Strategic Energy Review
 - Energy Action Plan 2010-2014
- **Late 2010 (tbc)**
 - Energy Infrastructure Package due to be presented by the Commission
 - Commission to publish its communication on the 2050 Energy Vision
 - Heads of State endorsement at European Council



The decarbonization pathways should be sustainable, technically feasible and have a positive impact on the economy

Assessment criteria



Not assessed:

- Public acceptance
- Change required
- National energy policies



ECF is supported by a broad set of specialized consultants

ECF (Philanthropic European climate foundation)

- Overall sponsor and funder
- Final report will be ECF branded

McKinsey & Company (Strategic consultancy)

- Overall content leadership, project management, data collection, analysis
- Reach out to industries, workshop facilitation

ECN (Energy research center)

- Support on assumptions for technologies (lead on nuclear)
- Policy development and recommendations based on analytics

KEMA (Technical grid consultancy)

- Grid design and investments, production capacity and costs associated with providing a plausible, secure electricity system for each of the pathways

Imperial College London

- In-depth modeling of system balancing requirements, reliability, optimization of transmission and back-up investment

The Centre (Political consultancy)

- Manage contact to EU-commission and parliament and ensure alignment with their needs. Participate in outreach to member states

Office of Metropolitan Architecture – R. Koolhaas

- Provide creative participation in the development of narrative. Provide conceptual framing and visual communication

ESC (European Strategy Centre)

- Design the report launch communication strategy
- Manage the launch of the report including holding presentations, meetings

RAP (Regulatory Assistance Project)










































- Provide technical and policy input from their global experience

Oxford Economics (Macro-economic consultancy)

- Provide analysis of macro-economic impacts of decarbonization scenarios

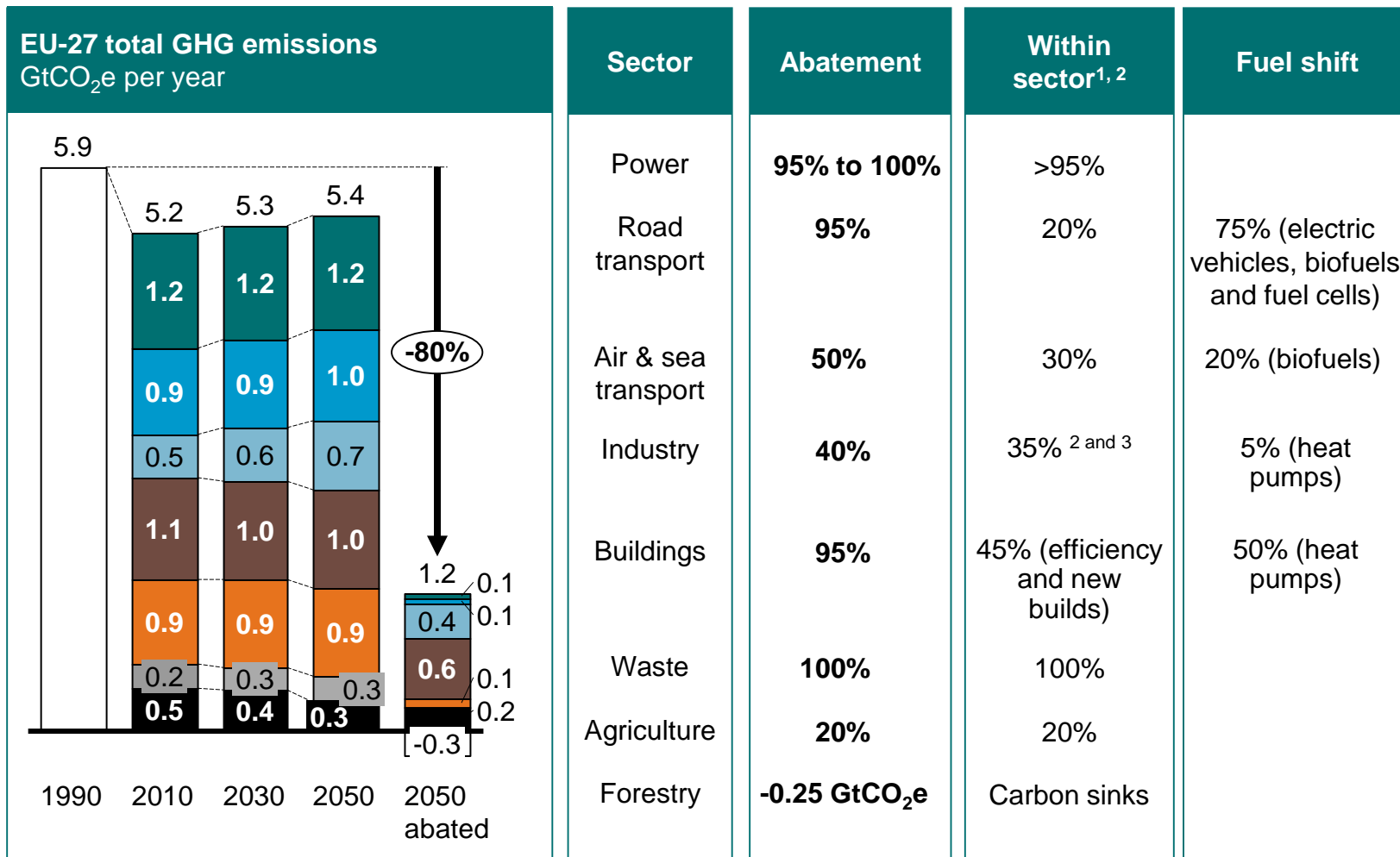


ECF's Roadmap 2050 project: stakeholder involvement

Coordinator	Participants					Expert panel
	Utilities	  	  	  	 	Prof. Dr. Jean-Michel Glachant, Florence School of Regulation
Lead authors	Energy					Dr. Goran Strbac, Imperial College London
	Tech Manufacturer s					Georg Zachmann, Brueghel
	TSOs					Prof. Dr. Christian Von Hirschhausen, TU Berlin
	DSOs					Prof. Jorge Vasconcelos, TU Lisbon
Imperial College London	NGO					Dr. Christina Hood, IEA
	Other organisations					Prof. Dr. Felix Matthes, Oeko Institut
	IT companies					Michael Grubb, Cambridge
	Finance					
	Consumer s					
WORKING DRAFT						



An 80% GHG reduction could be achieved by maximum abatement within and across sectors



1 Based on the McKinsey Global GHG Abatement Cost Curve

2 Large efficiency improvements already included in the baseline

3 CCS applied to 50% of industry (cement, chemistry, iron and steel, petroleum and gas, not applied to other industries)



The assessed pathways cover a wide range of technology mixes

Decarbonization pathways

**40% RES¹
30% Nuclear
30% CCS**

- RES share close to currently legally committed by the EU and the IEA baseline
- Sensitivities on a high nuclear share and a high thermal / CCS share are included

**60% RES
20% Nuclear
20% CCS**

**80% RES
10% Nuclear
10% CCS**

- RES mix based on current deployment (minimum), aim for a broad mix of technologies and theoretical deployment (maximum)
- Equal shares for nuclear and thermal / CCS

100% RES

- Builds on the same RES mix as the 80% pathway,
- The remaining 20% is completed by enhanced geothermal and the use of CSP from North Africa

Additional sensitivities

- Fuel prices (coal, gas, uranium)
- Cost of capital
- Learning rates
- Grid solutions
- Electricity demand

¹ Renewable energy sources



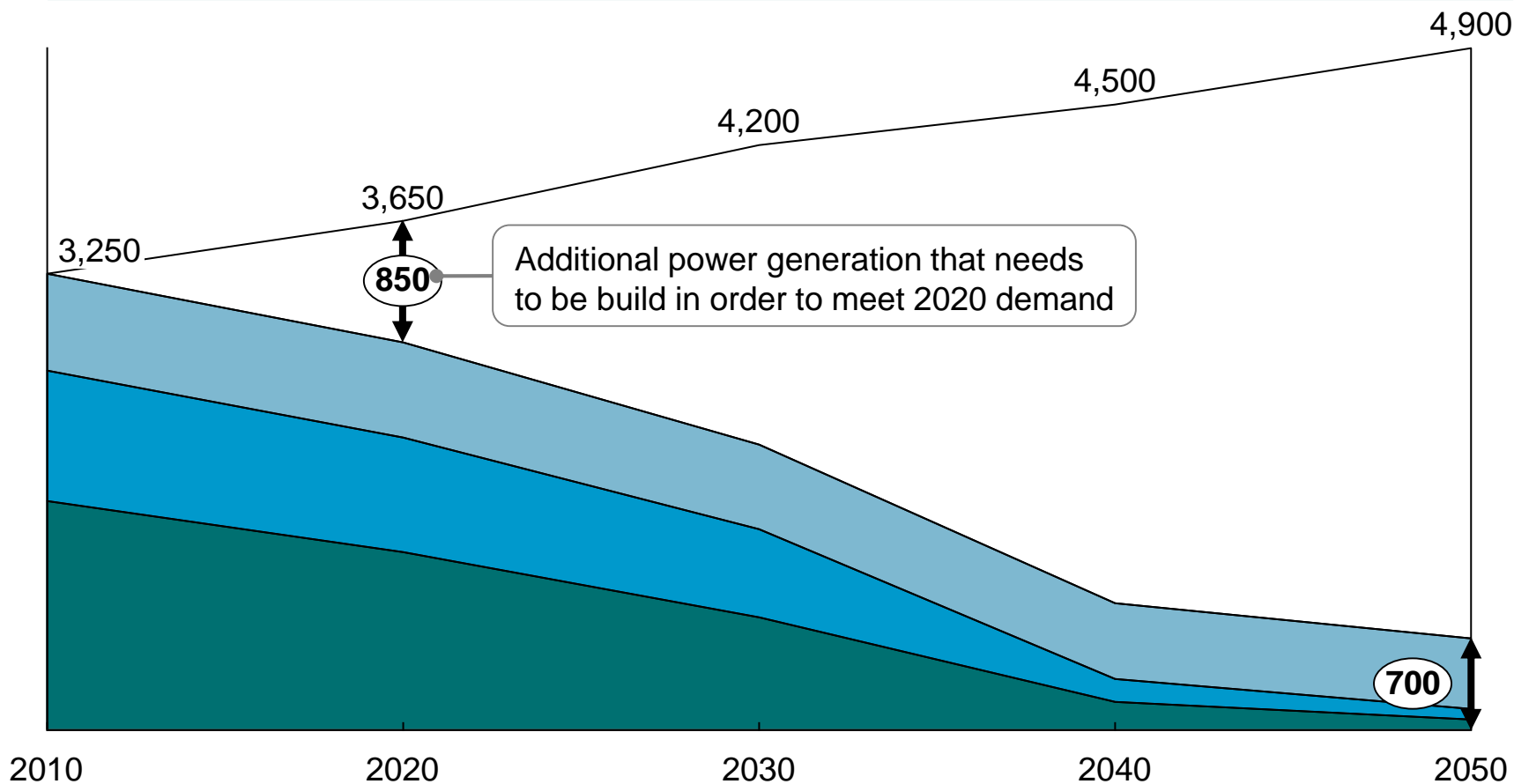
Most existing fossil fuel generation will be retired by 2040

PATHWAYS

TWh per year

- Total power demand
- Existing nuclear
- Existing RES¹
- Existing fossil

Power supply of existing power plants¹ and forecasted power demand for pathways



¹ Existing RES mainly hydro; remains in operation until 2050



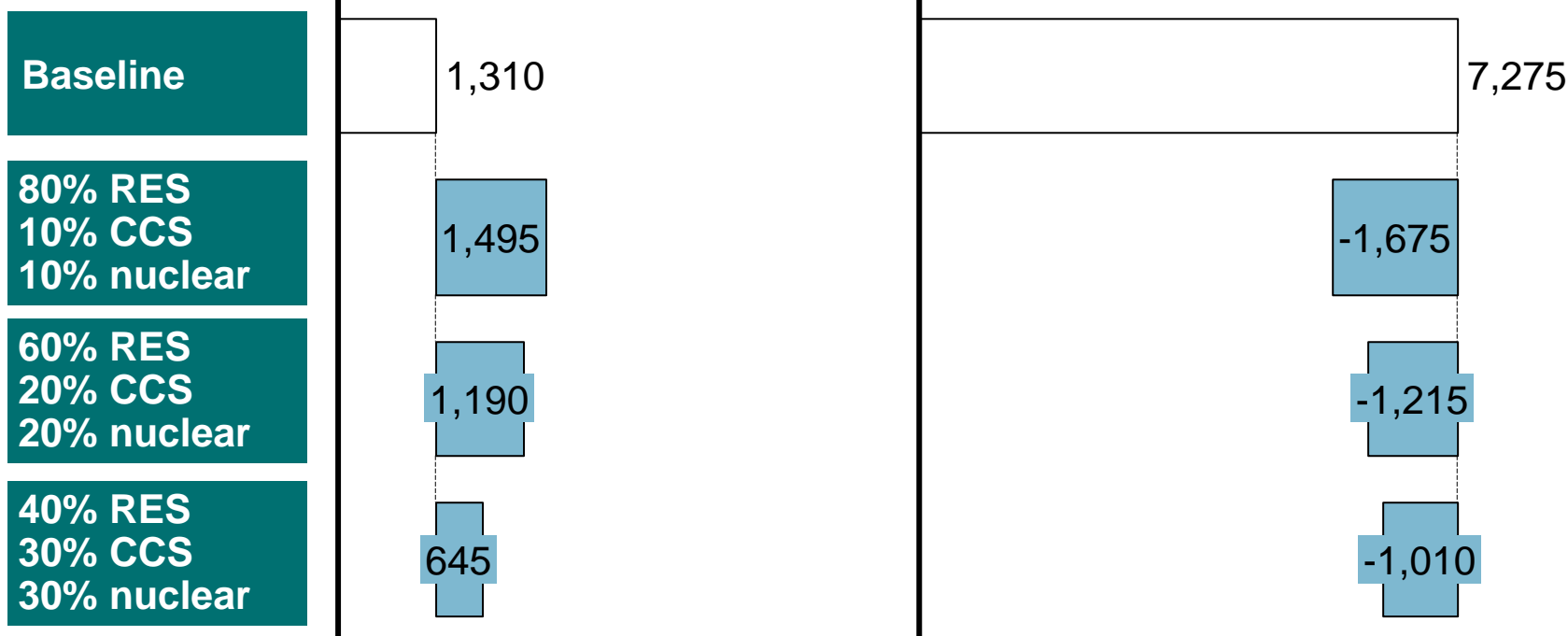
Decarbonized electricity requires more capex and less opex

INCLUDING GENERATION AND GRID

Cumulative cost, 2011-2050, EUR billion,
Real terms and no discounting, no CO₂ costs included

Capex¹

Opex²



1 For new builds from 2011 to 2050, including additional grid capex

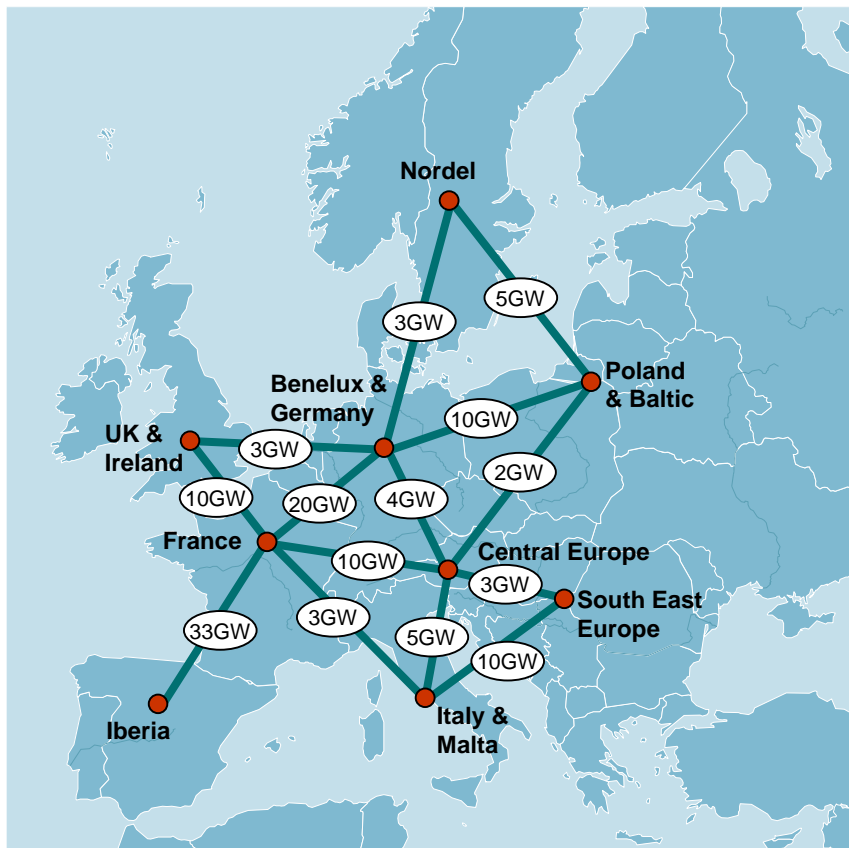
2 Opex for all new and operating plants includes variable, fixed, as well as fuel cost; also includes opex for additional backup plants and additional grid



A three fold increase of the transmission capacity is required to leverage the renewables potential best

60% RES, 20% DSM

Total capacity requirements between regions, GW



● Centre of gravity

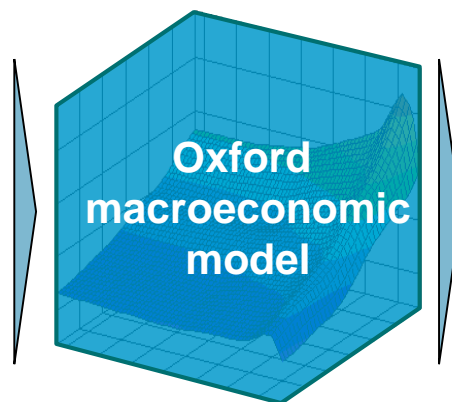
Interconnection	Capacity addi- tional (existing) [GW]	Annual utilization [%]
UK&Ireland-France	8 (2)	75
UK&Ireland-Nordel	0 (0)	0
UK&Ireland-Benelux&Germany	3 (0)	83
France-Iberia	32 (1)	83
France-Benelux&Germany	14 (6)	78
France-Central-Europe	7 (3)	93
France-Italy&Malta	0 (3)	92
Nordel-Benelux&Germany	0 (3)	75
Nordel-Poland&Baltic	4 (1)	60
Benelux&Germany-Central-EU	0 (4)	74
Benelux&Germany-Poland&Baltic	9 (1)	81
Central-Europe-Poland &Baltic	0 (2)	77
Central-South East EU	1 (2)	80
Central-Europe-Italy	0 (5)	58
South East EU-Italy	9 (1)	79
Total	87 (34)	



The Oxford Economics macro-economic model is used to assess the impact of power pathways on the economy

Inputs to the model

- Energy demand, efficiency
- Power demand, efficiency
- Power generation supply over time according to different pathways
- Costs for power over time
- Costs for shifting to EVs, biofuels and heat pumps
- Employment by unit of energy
- Policy assumptions

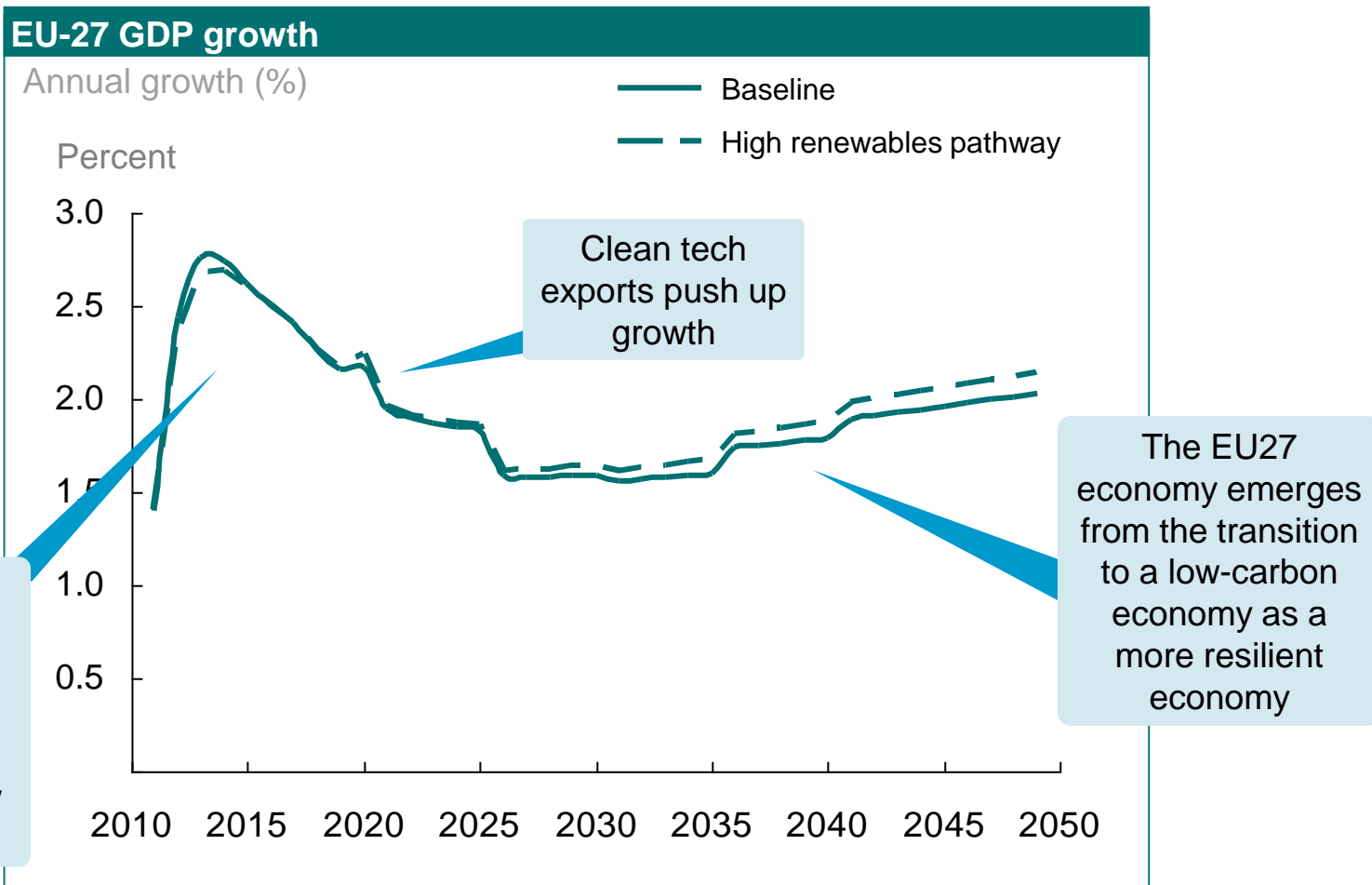


Outputs from the model

- Economic performance
 - GDP by pathway
 - Decomposition of GDP changes, e.g., new sectors, higher prices, etc.
 - EU competitiveness
 - Overall energy prices and inflation
 - Employment in new sectors and overall
- Carbon shadow prices required to trigger the projected energy investment



GDP growth rates are similar in the baseline and the low-carbon pathway





Please visit our website for more details

<http://www.roadmap2050.eu>

Thank you!