Welcome

Clean energy potential in coal regions: Industry dialogue

Platform for Coal Regions in Transition

#CoalRegionsEU

Energy

The European Commission’s science and knowledge service

Joint Research Centre

Preliminary findings of the JRC study on clean energy potential in coal regions

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JRC –Directorate C: Energy, Transport & Climate

European Commission

Brussels

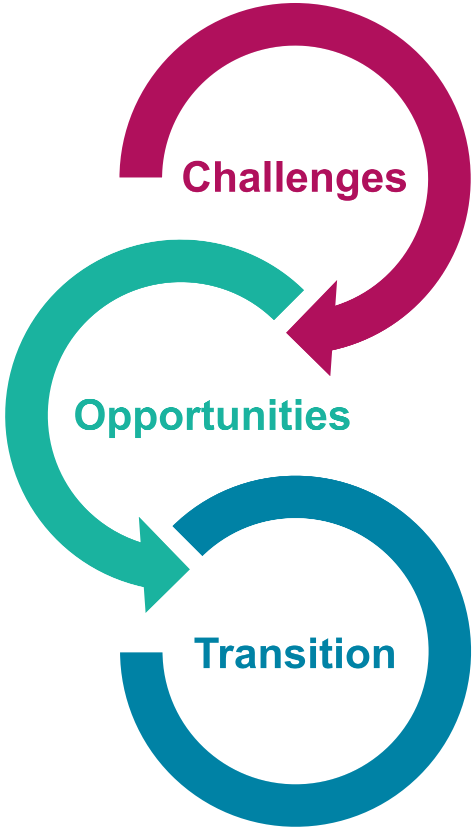
15 July 2019

JRC support to the Coal Regions in Transition

What are the challenges that coal regions face on their transition from coal?

Which options in the clean energy sector? Natural resources (e.g. solar, wind, geothermal, biomass) in coal regions?

What are the opportunities for the coal regions in their transition?



What:

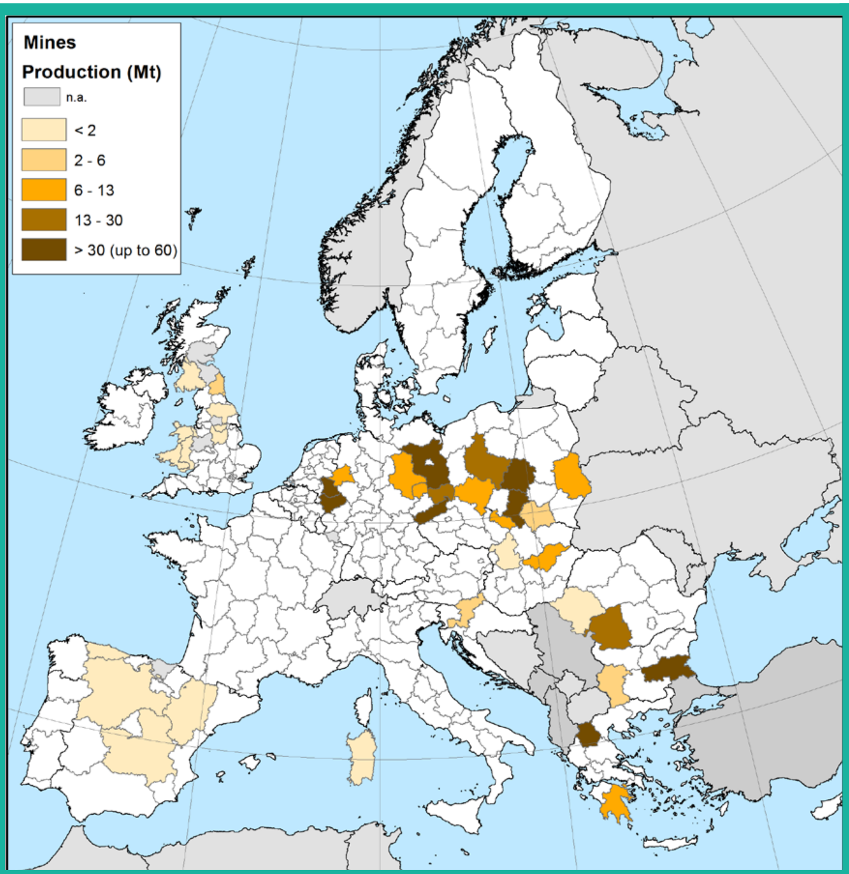
"… estimates on the **renewable** energy and **clean** energy **technology potential** in each region, and assessments on the **potential impact** this could have on **job creation** and regional **economic development**."

How

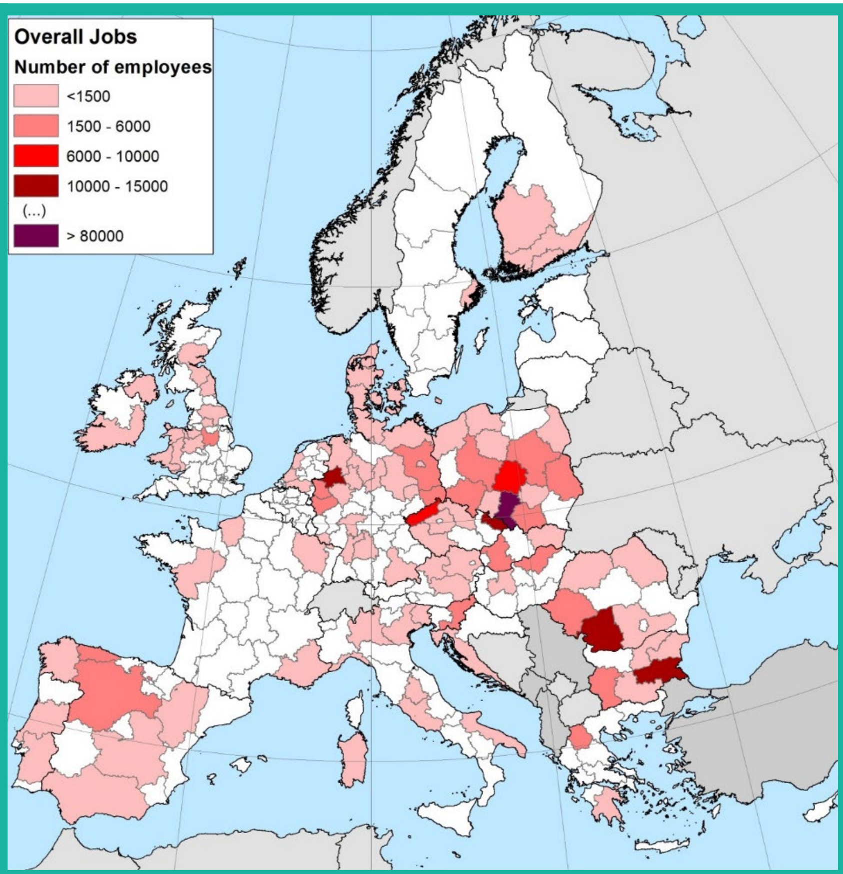
Examining each option on a region by region basis

Challenges of Coal Regions in Transition

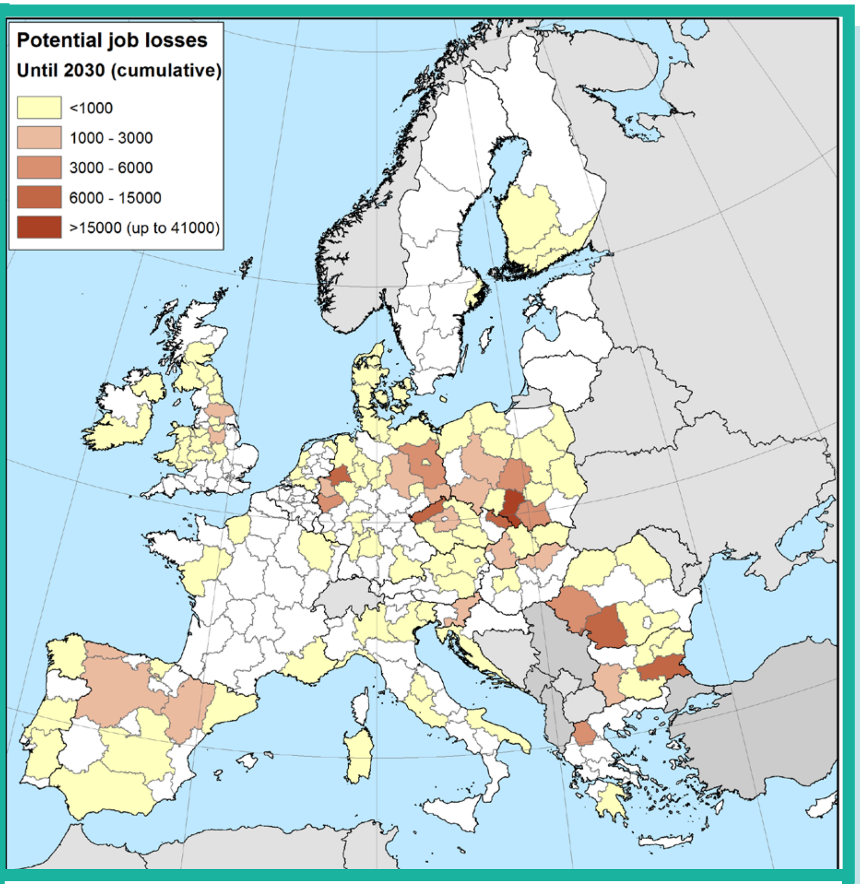
Mapping the coal infrastructure and related jobs



128 coal mines in 12 Member States;
500 Mt of hard coal and lignite
207 coal-fired power plants in 21 Member States;150GW



55 000 in coal power plants
185 000 in mining
215 000 indirect jobs



160 000 potential direct job losses by 2030

Source: JRC (2018). EU coal regions: opportunities and challenges ahead. Science for Policy report. 182p.

Coal mine conversion for renewable energy it's already happening

PV power plant in Visonta, HU:
16 MW, 72 500 PV panels

Wind farms in Klettwitz, DE:
145.5 MW, 5 wind farms

Source: Szabó, S., Bódis, K., Kougias, I., Moner-Girona, M., Jäger-Waldau, A., Barton, G., Szabó, L., 2017, A methodology for maximizing the benefits of solar landfills on closed sites, Renewable and Sustainable Energy Reviews, Volume 76, September 2017, pp. 1291-1300, doi: 10.1016/j.rser.2017.03.117.

JRC support to the Coal Regions in Transition

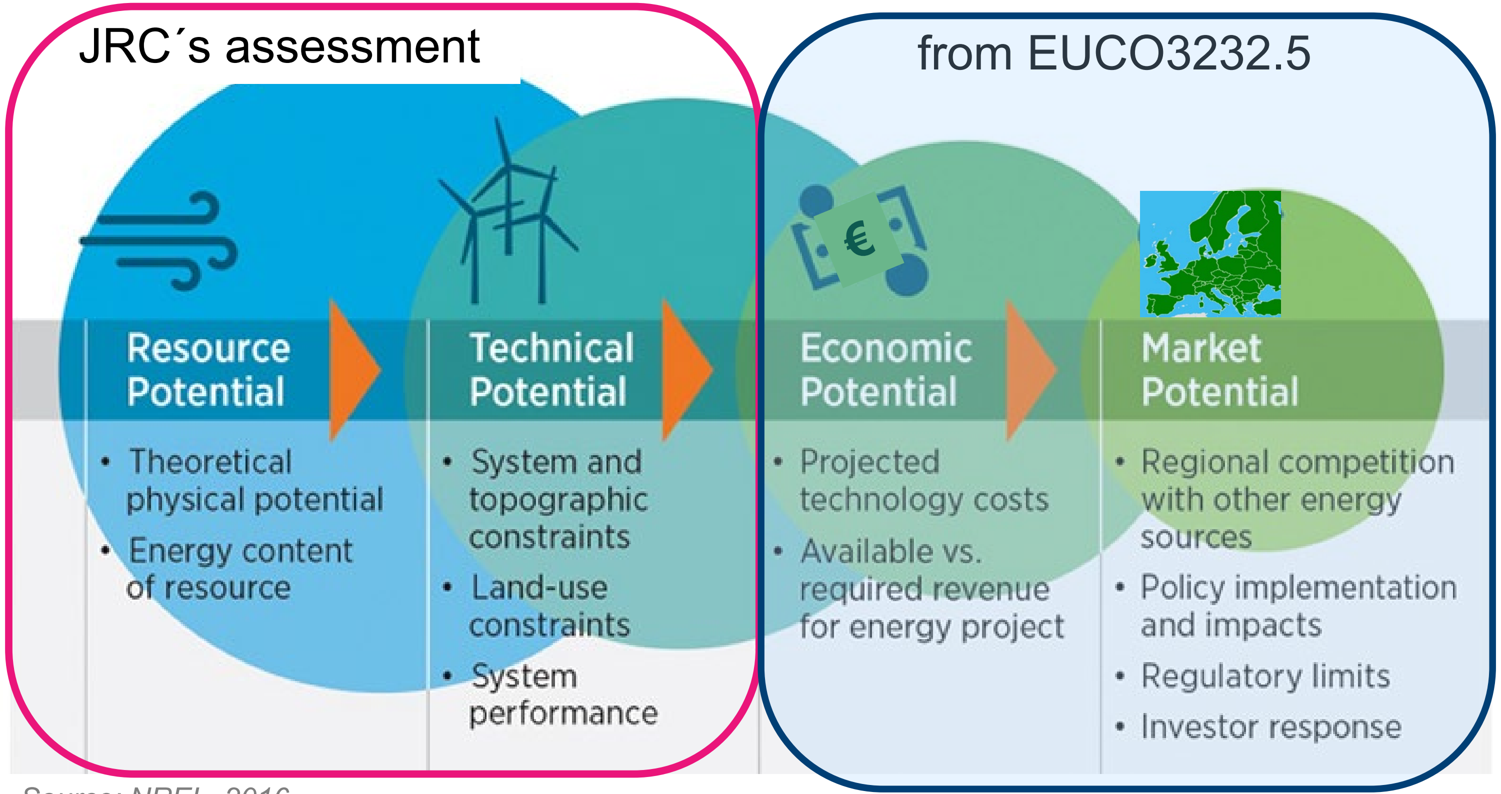
- Potential for energy technologies
- Developing value chains
- Energy efficiency in buildings

We are here

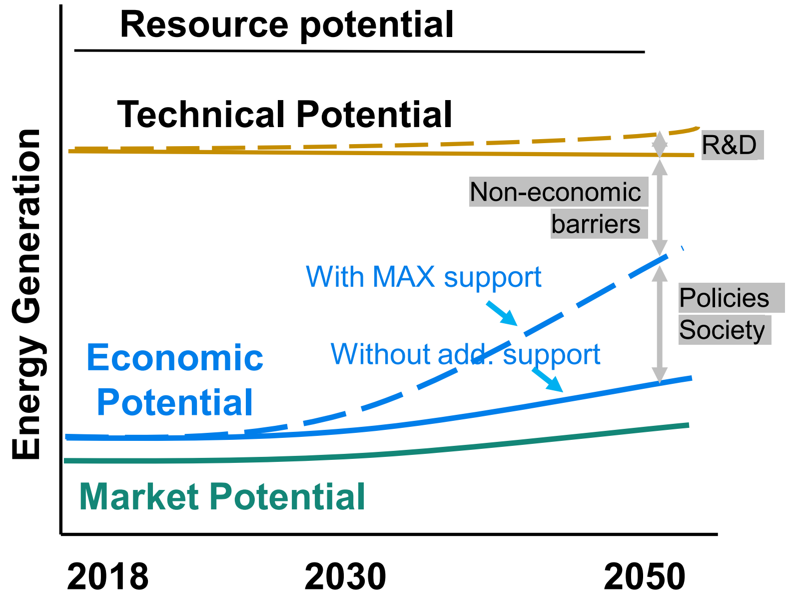
- Investments and jobs

Opportunities in EU coal regions

Our approach



Source: NREL, 2016



EUCO3232.5 available at: https://ec.europa.eu/energy/en/data-analysis/energy-modelling/euco-scenarios

European Commission

Opportunities in EU coal regions

Technical potential for wind power at regional level

$$\underset{\left[\frac{MWh}{y}\right]}{Technical\ potential} = \underset{[km^2]}{Area\ Available} \times \underset{\left[\frac{MW}{km^2}\right]}{System\ Yield} \times \underset{[\%]}{Capacity\ Factor} \times \underset{[h/y]}{8760}$$

Regional coverage	Calculations	Power production	Capacity	Available area (after exclusions)	Yield	Average Capacity factor
NUTS2 In the 6 CRiT regions of Bulgaria, Greece, Romania and Slovenia	**Technical potential** ENSPRESO (reference scenario, areas with CF>20%)	141.0 TWh	65 GW	13098 km^2 (9.4% of total land in the regions)	5 MW/km^2	2154 Full Load Hours or 24.6%
	Projected capacity deployment by 2030 EUCO3232.5 - area based disaggregation of *countries* capacities	8.4 TWh	4 GW	1703 km^2 (1.2% of total land in the regions)		

European Commission

Opportunities in EU coal regions

Technical potential for wind power at EU level

JRC's estimations aligned with other studies

Coverage	References		Power production [PWh]
EU28	JRC	ENSPRESO, reference scenario and CF>25%	5.7
		ENSPRESO, reference scenario and CF>20% (*)	**8.4**
		ENSPRESO, high scenario and CF>15%	14.1
	Other	Bosch et al. (2017)	14.8
		McKenna et al. (2015)	15.0
		Silva (2016)	5.7

(*) Used in this study

Technical potential !!

Total net electricity generation in EU 2016
3.1 PWh

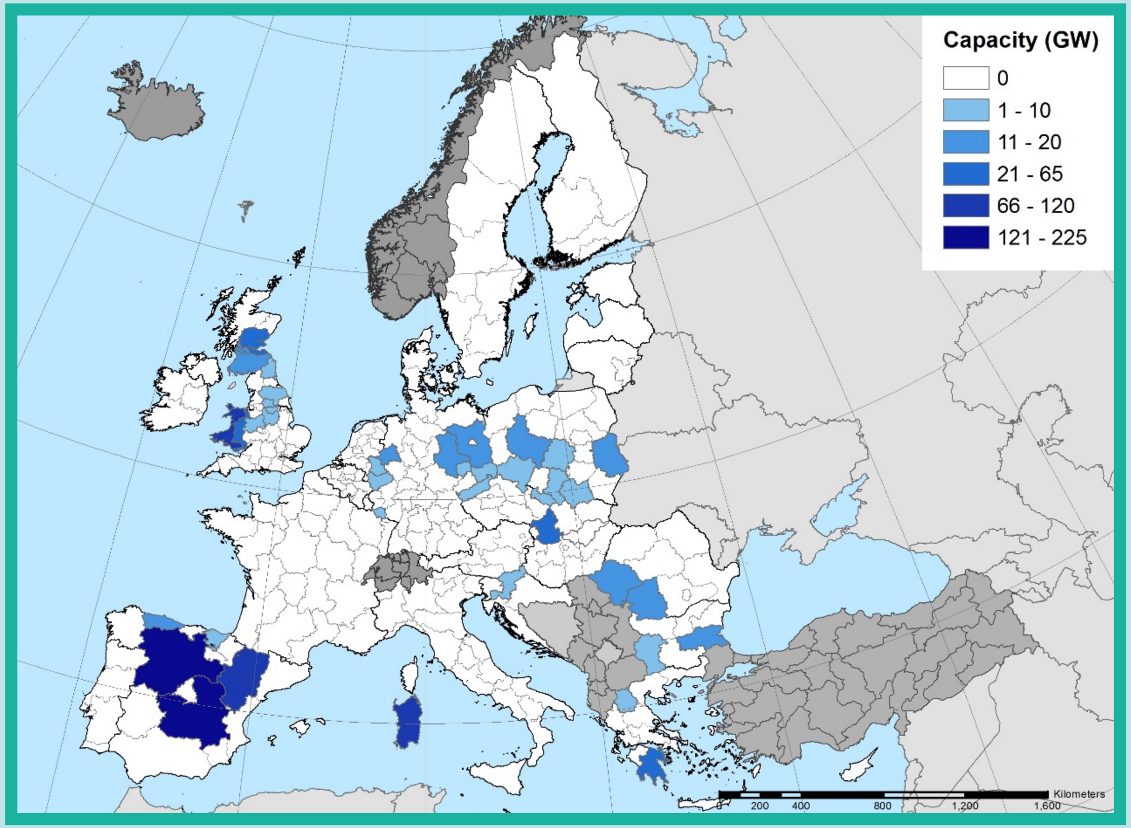
(~10% from wind)

ENSPRESO database is available at: https://data.jrc.ec.europa.eu/

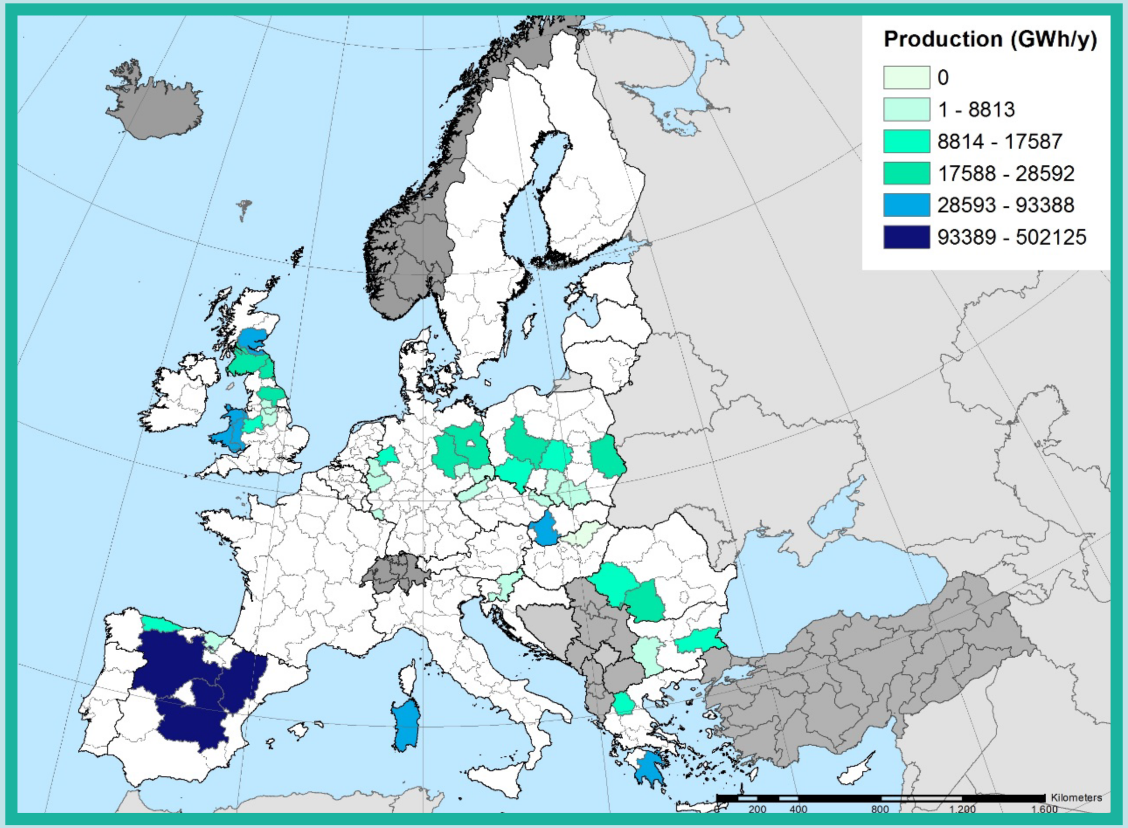
Opportunities in EU coal regions

Wind energy potential

Capacity



Production

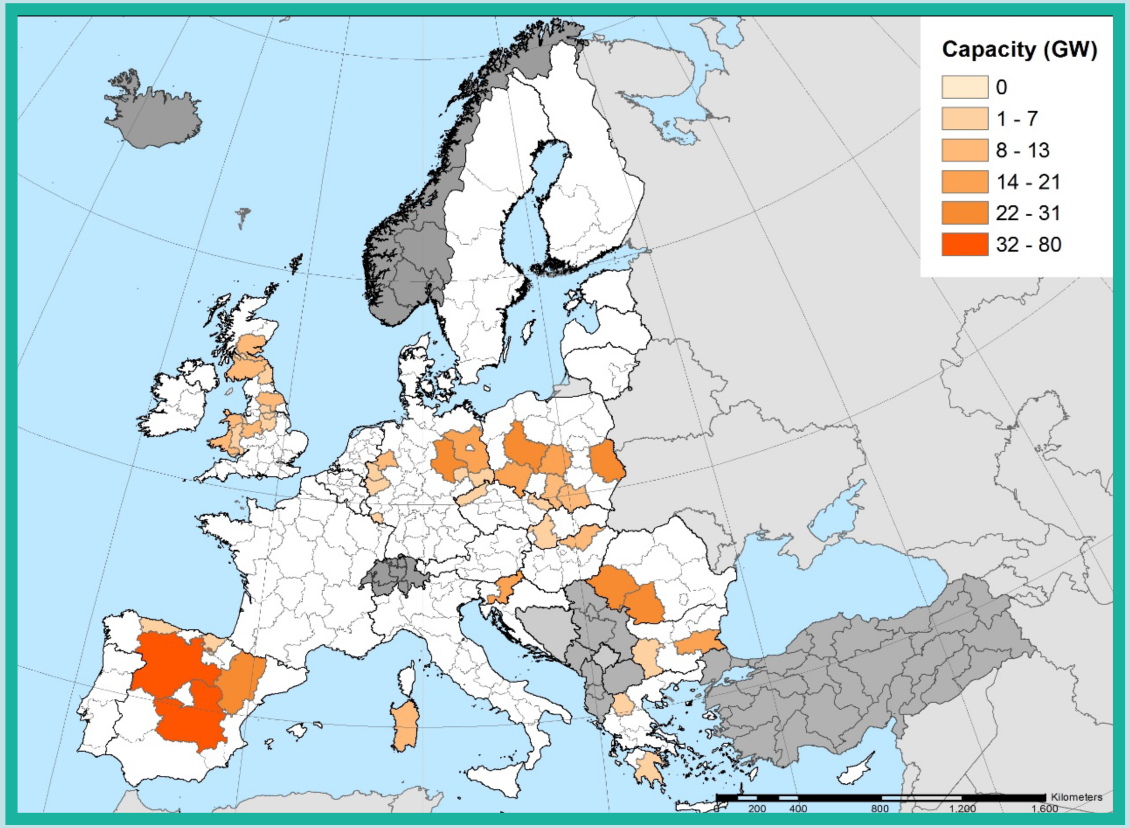


Source: JRC preliminary results-work ongoing

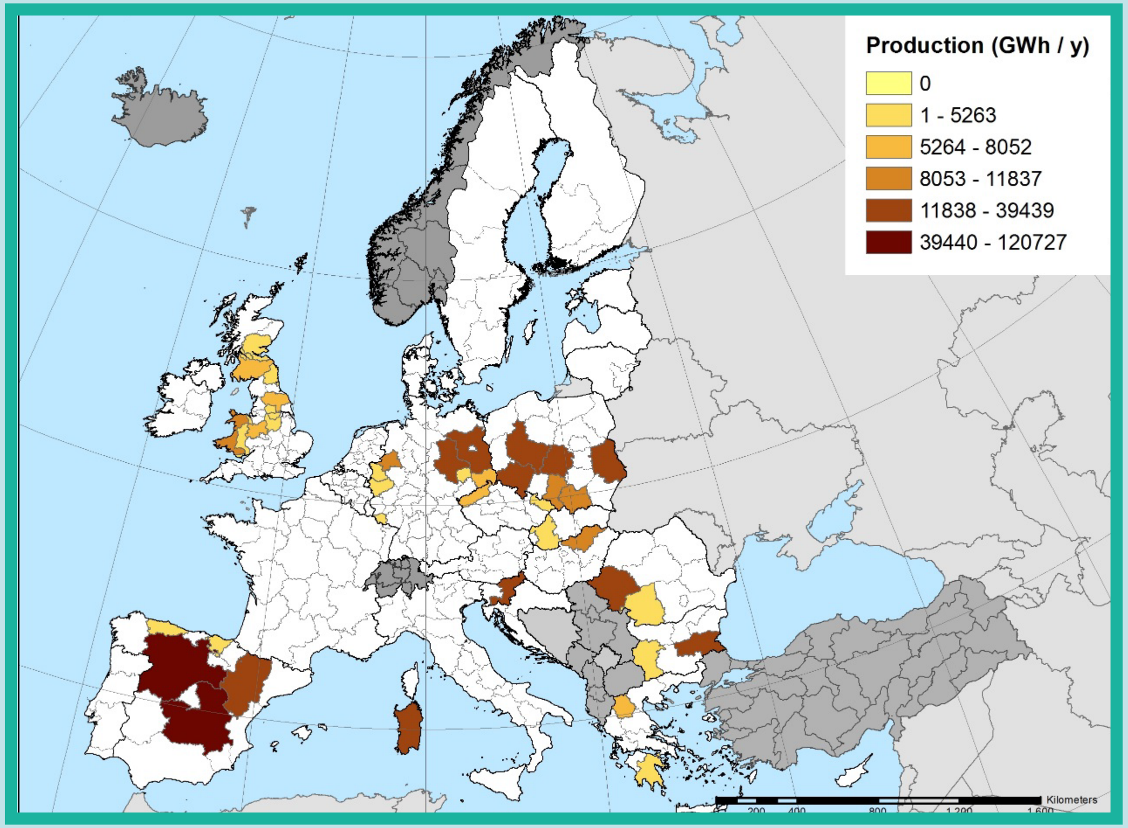
Opportunities in EU coal regions

Solar PV energy potential (ground mounted)

Capacity



Production

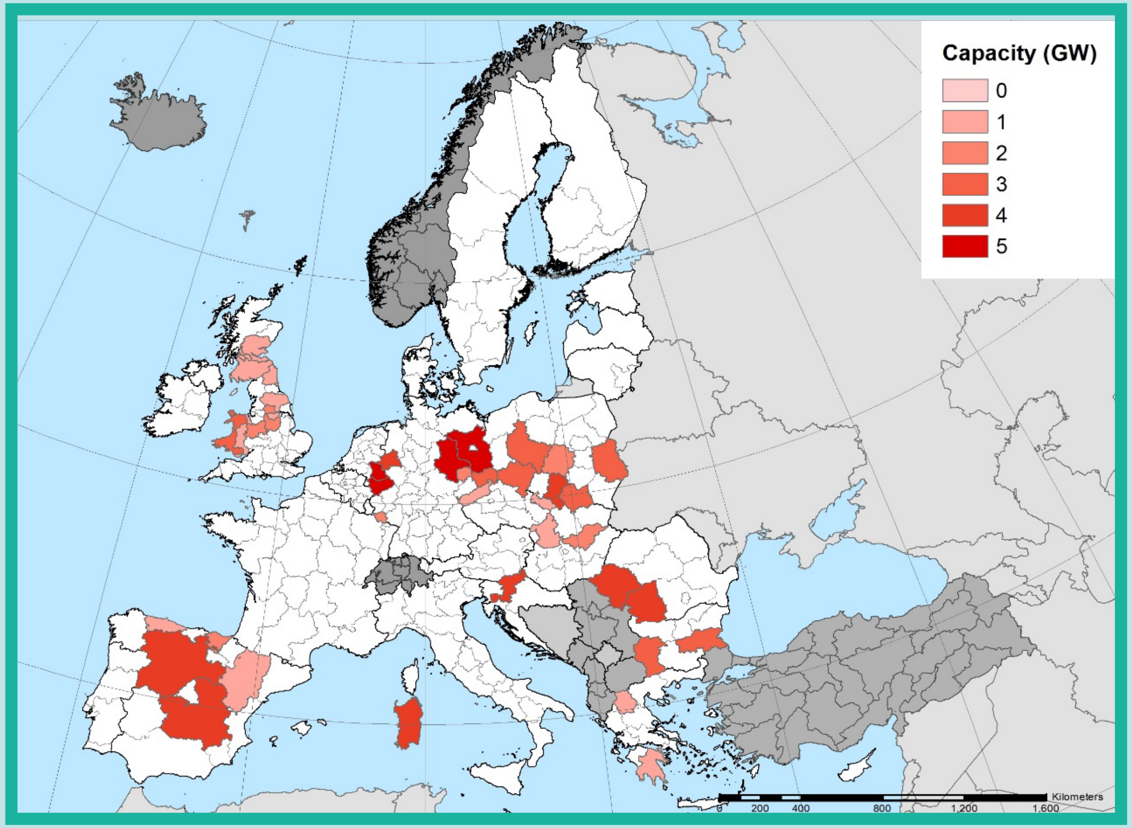


Source: JRC preliminary results-work ongoing

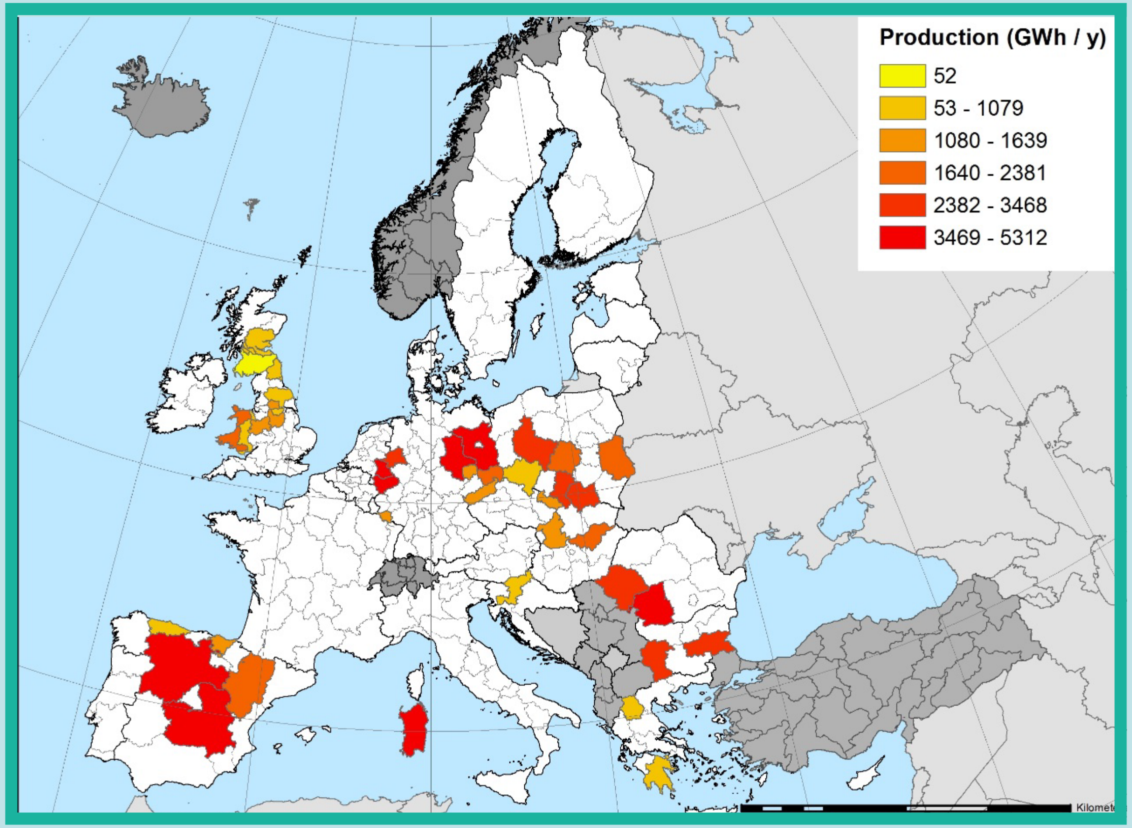
Opportunities in EU coal regions

Solar PV energy potential (rooftop)

Capacity



Production

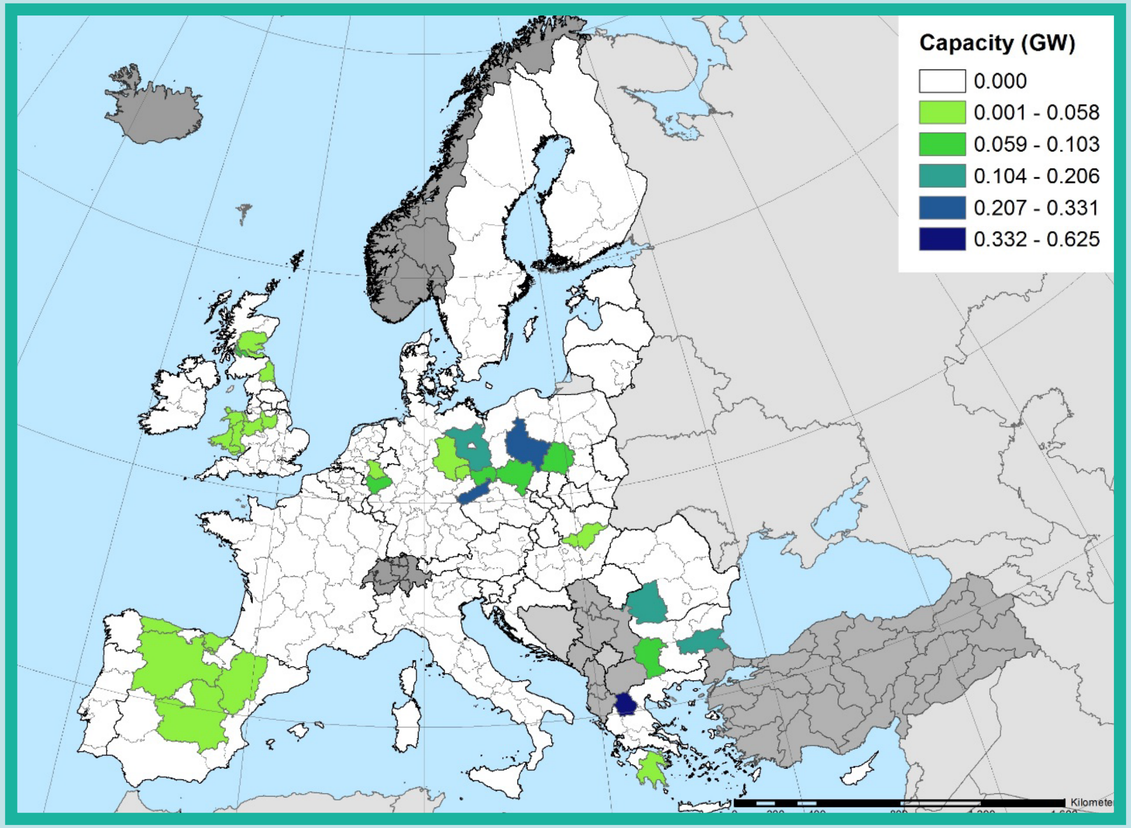


Source: JRC preliminary results-work ongoing

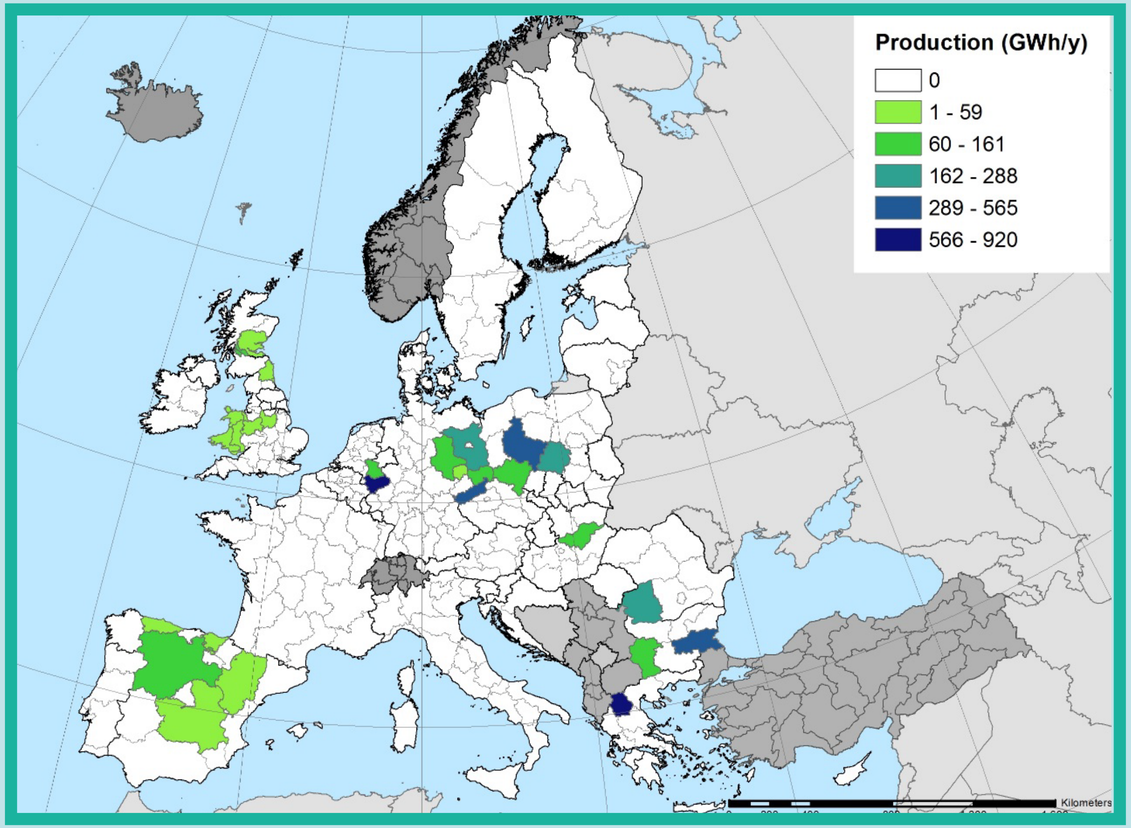
Opportunities in EU coal regions

Optimization of wind and solar PV power in 75 open-pit coal mines in operation

Capacity



Production



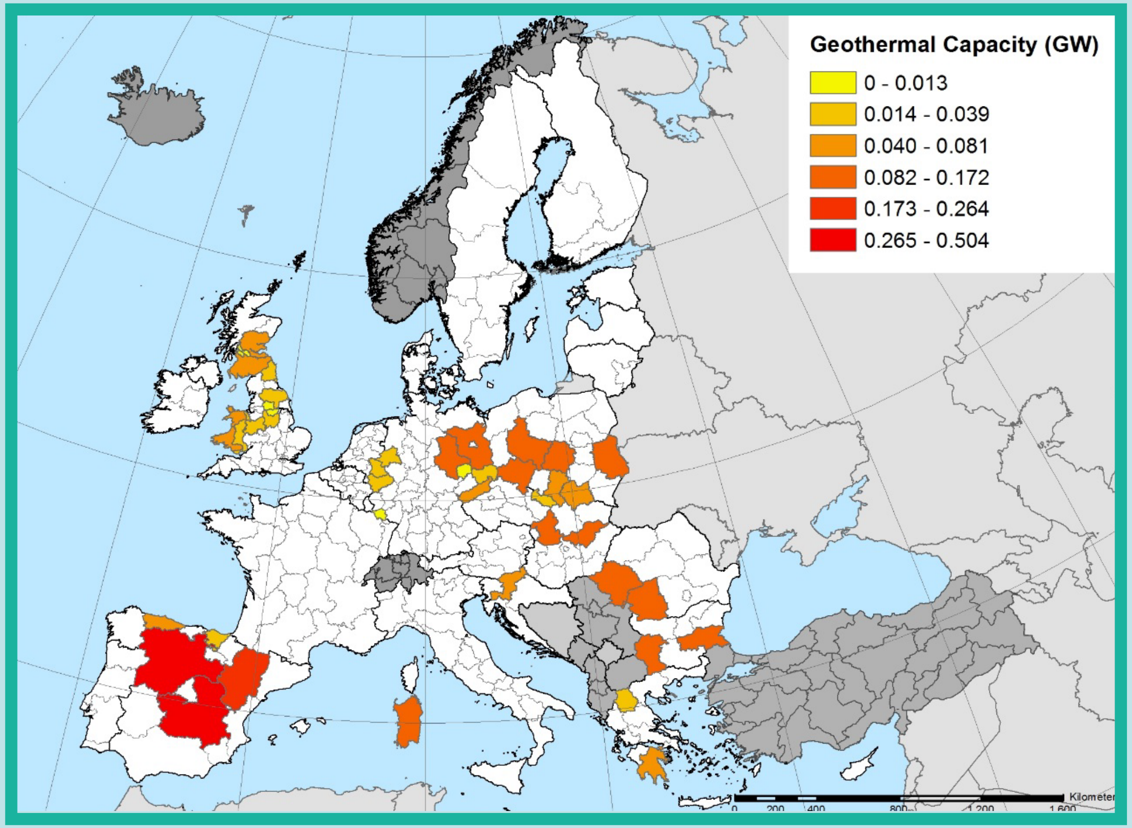
EMHIRES database is available at: https://setis.ec.europa.eu/EMIHIRES-datasets

Source: JRC preliminary results-work ongoing

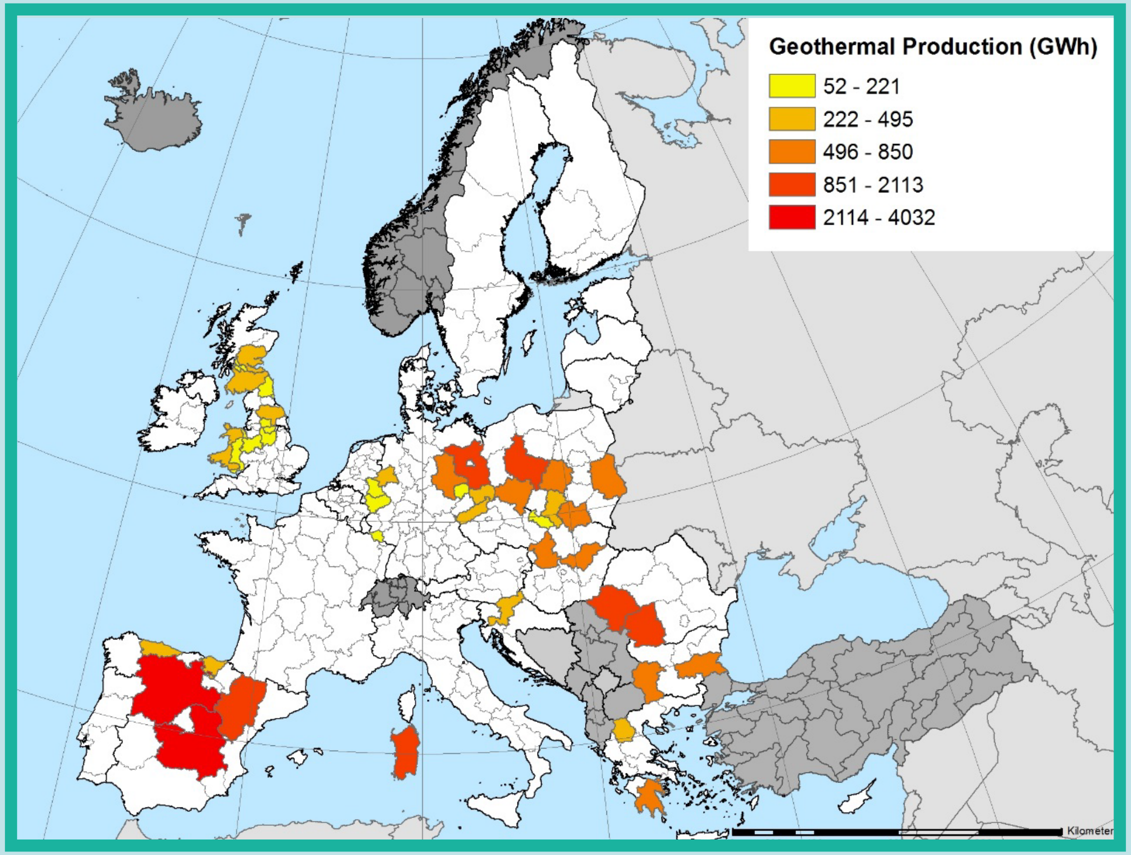
Opportunities in EU coal regions

Geothermal energy

Capacity



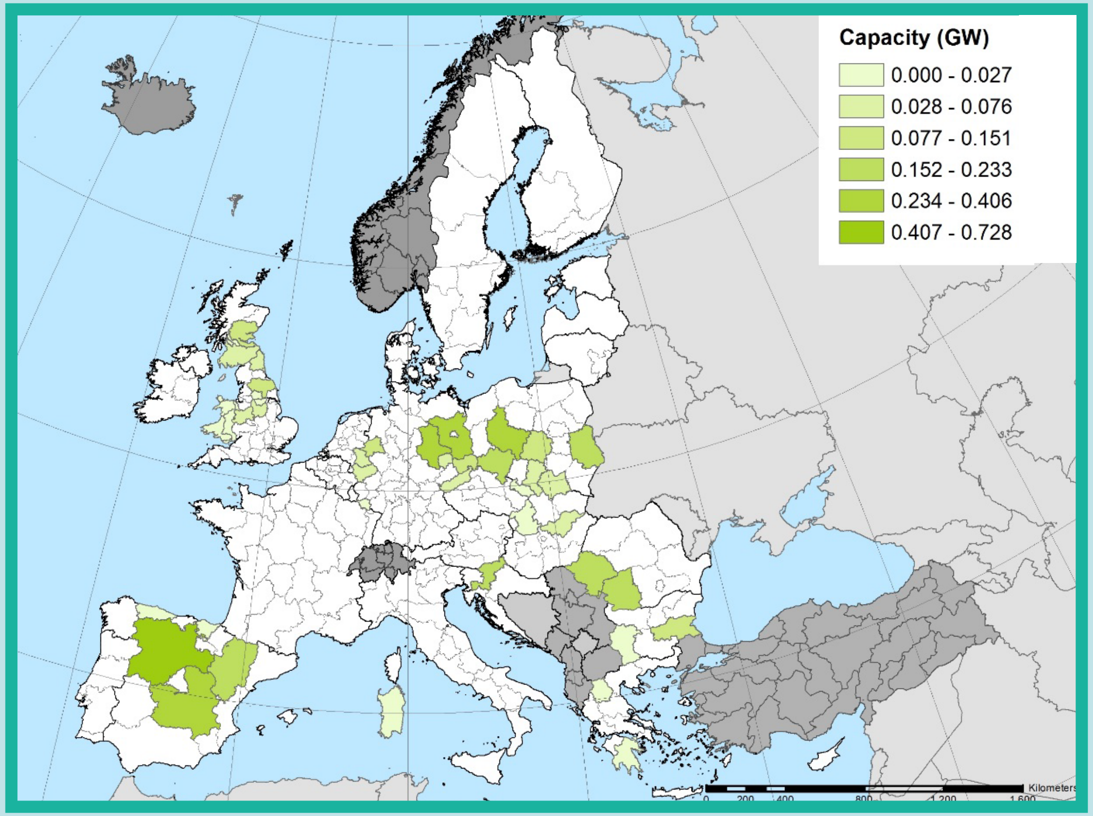
Production



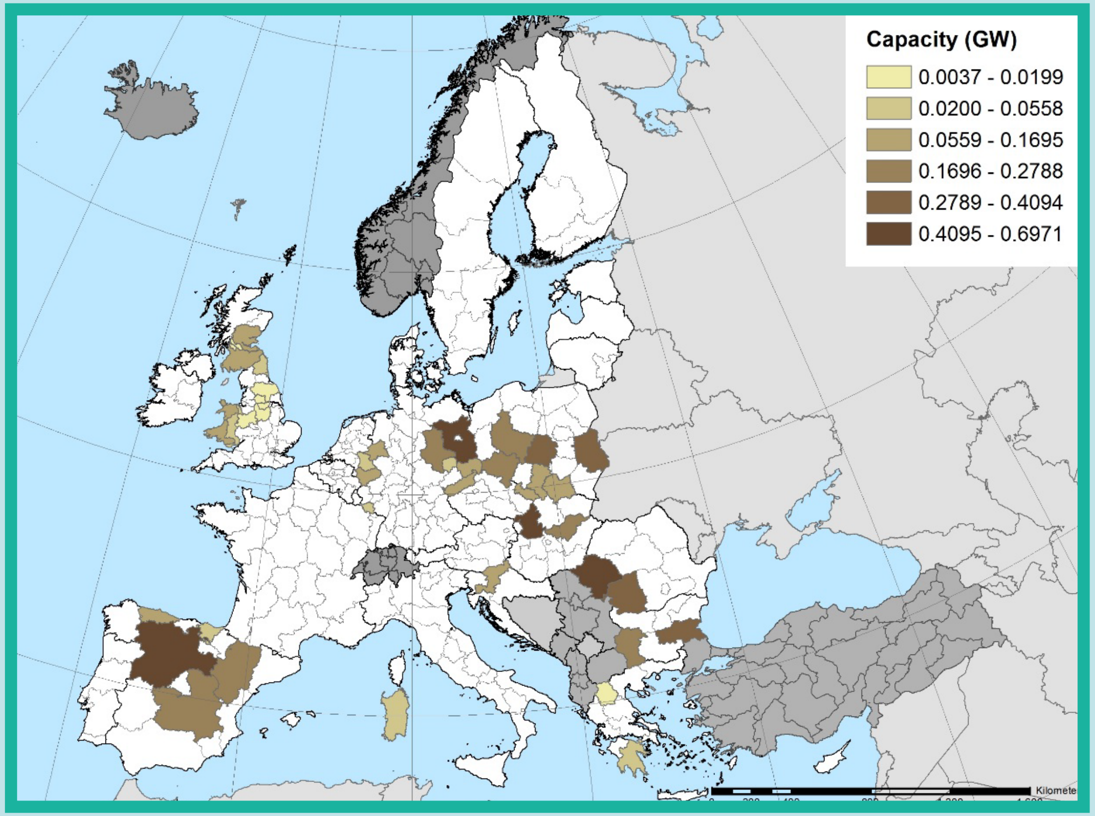
Source: JRC preliminary results-work ongoing

Opportunities in EU coal regions

Bioenergy



Crop residues production

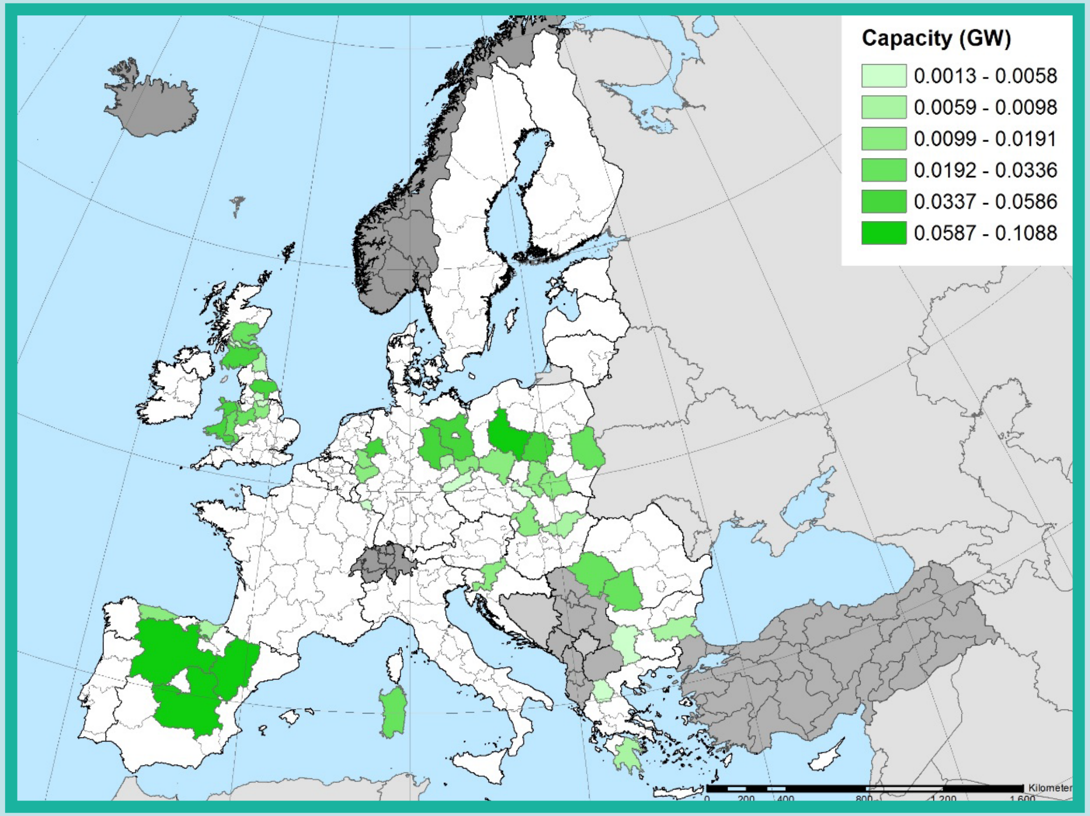


Forest biomass (medium)

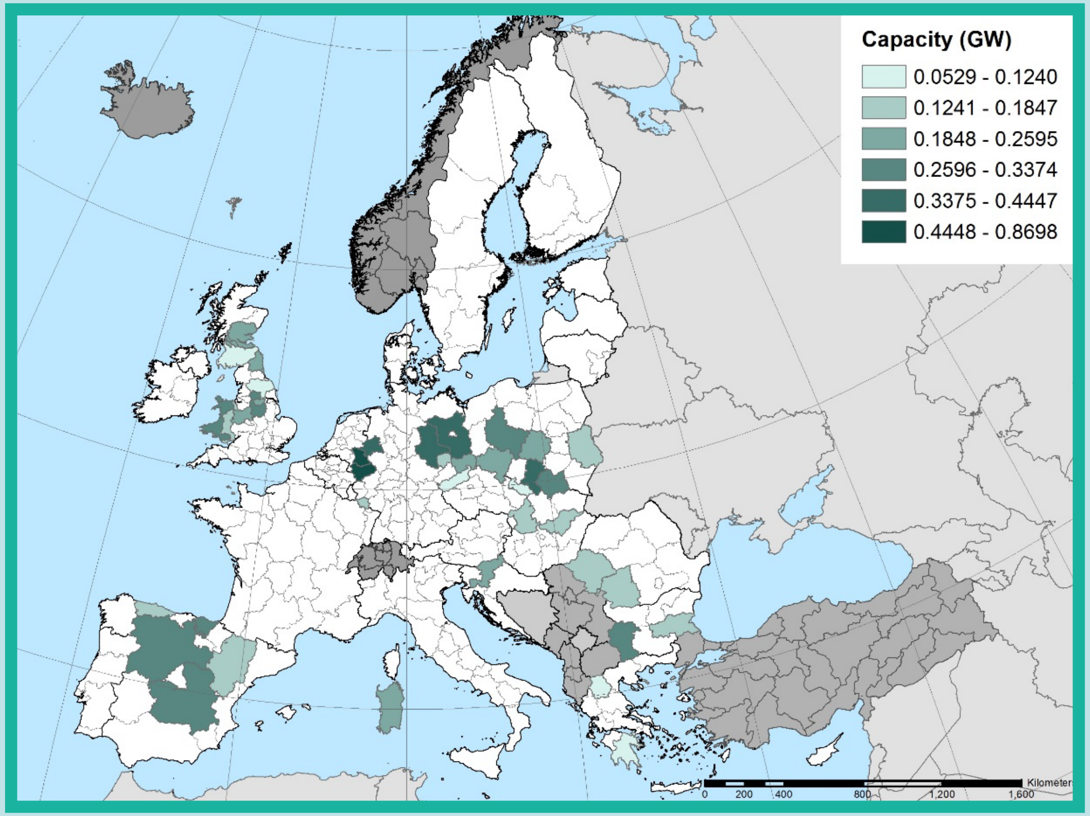
Source: JRC preliminary results-work ongoing

Opportunities in EU coal regions

Bioenergy



Livestock methane

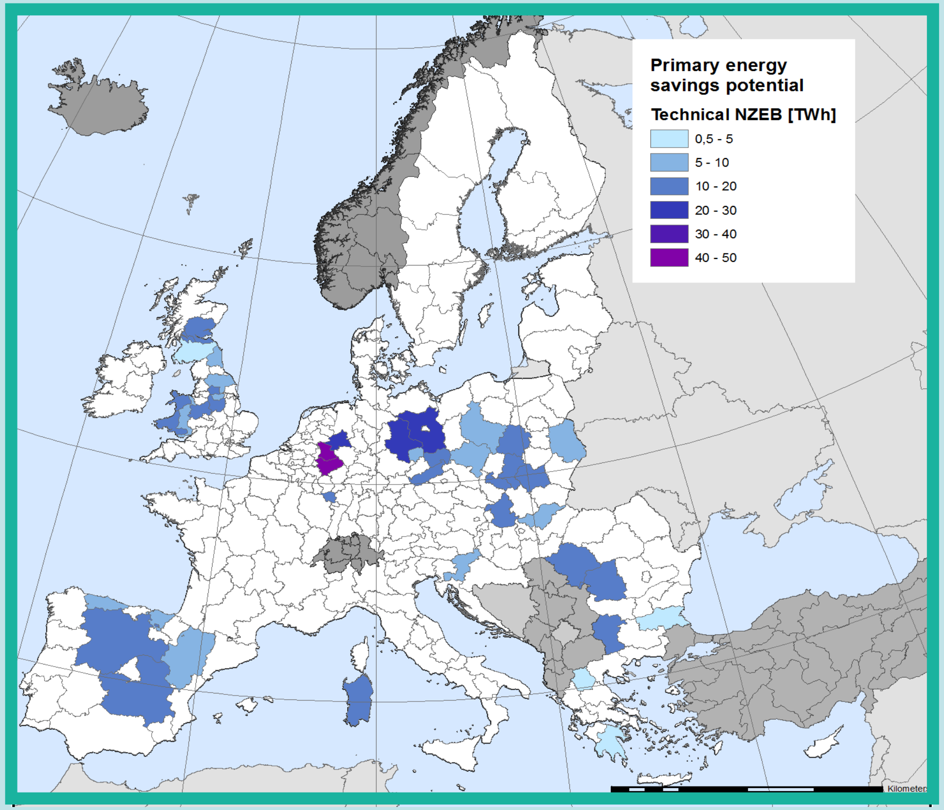


Municipal solid waste

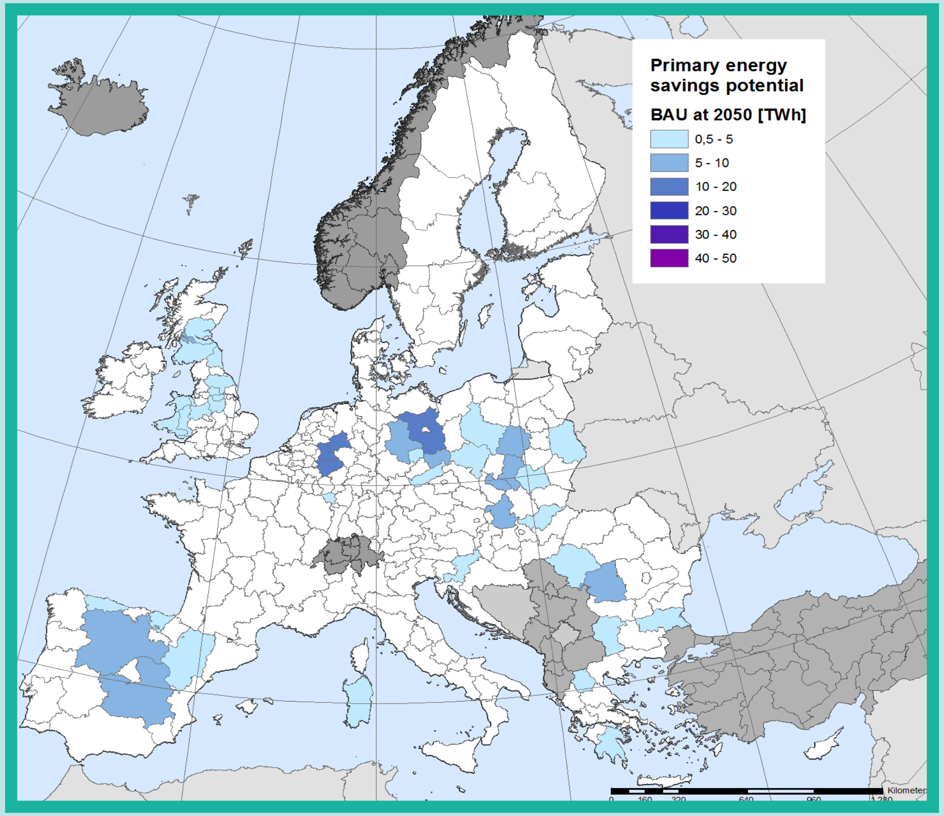
Source: JRC preliminary results-work ongoing

Opportunities in EU coal regions

Energy efficiency in residential buildings



Savings NZEB



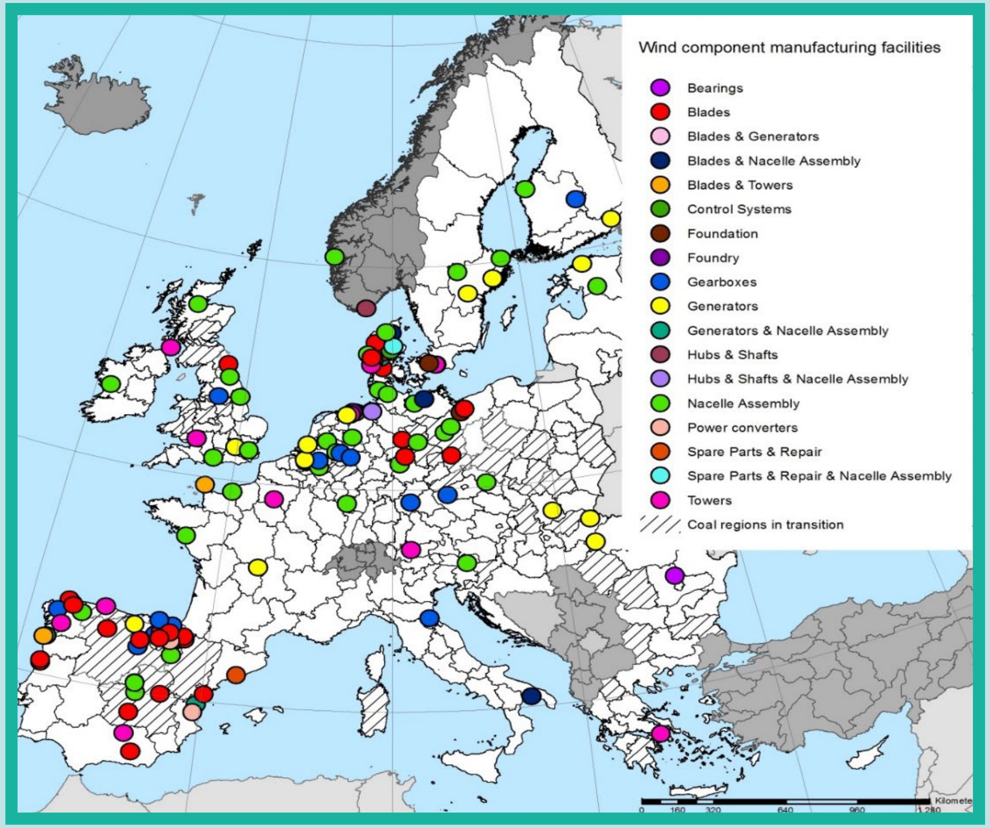
Savings BAU

Source: JRC preliminary results-work ongoing

European Commission

Opportunities in EU coal regions

Value chains - wind

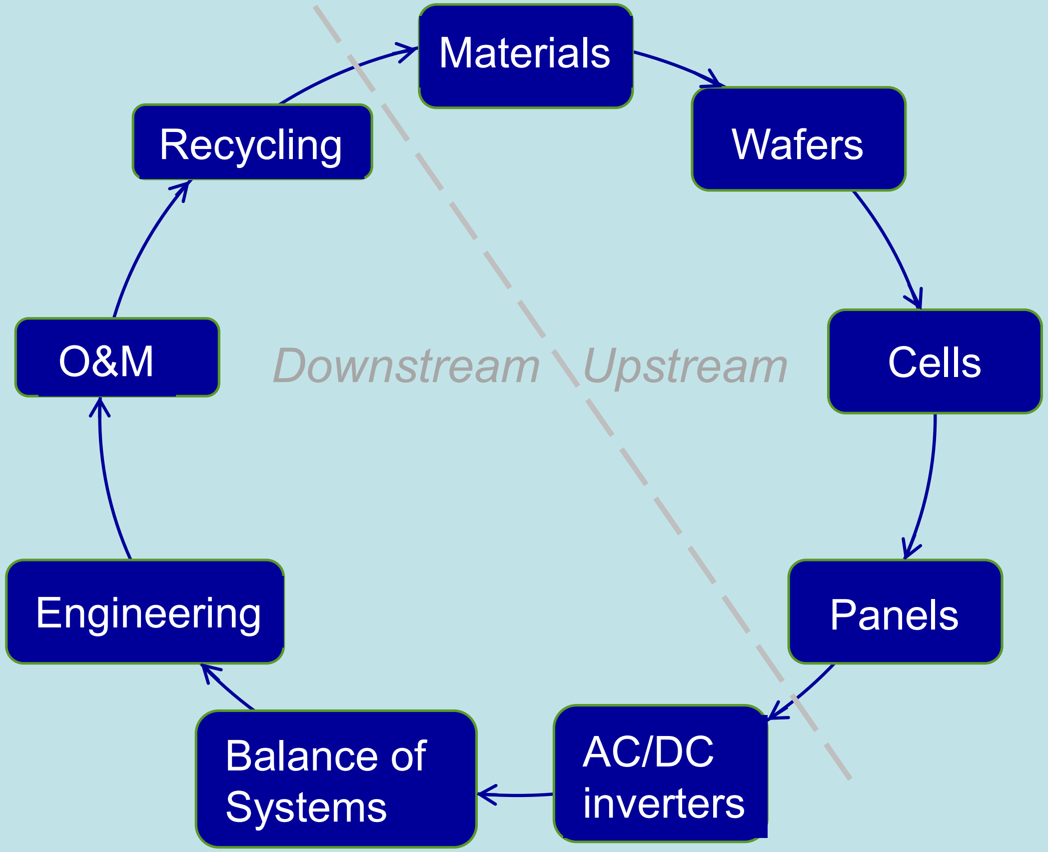


- Most European original equipment manufacturers (OEMs) have located their manufacturing facilities in the main wind markets.
- The highest number of facilities is estimated to assemble nacelle components followed by blade and tower manufacturing facilities.
- 14 out of the 42 coal regions have installed manufacturing facilities of wind turbine components.

Source: JRC preliminary results-work ongoing

Opportunities in EU coal regions

Value chains – PV (top 10 CRiT regions)



Source: JRC preliminary results-work ongoing

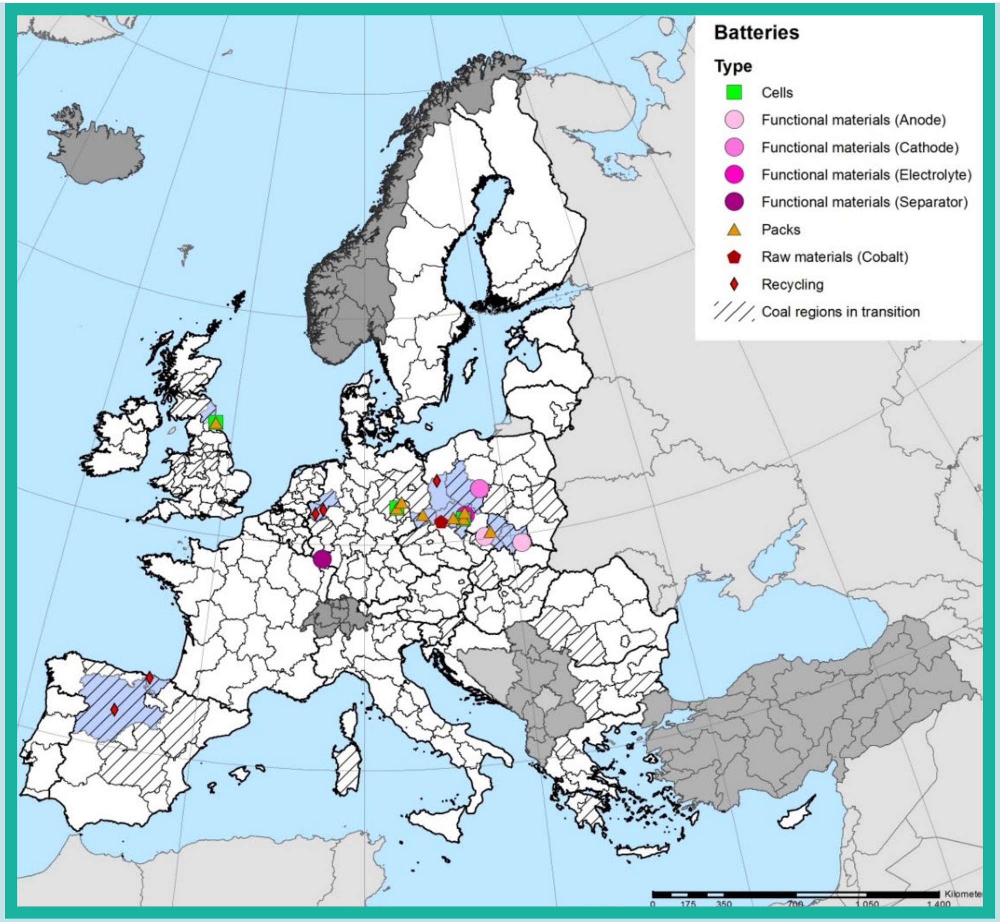
Upstream | *Downstream*

Top 10 regions in CRiT		Prod. Equip.	Materials	Components	Panels	Sellers	Installers	Applications	Services
DEA1	Düsseldorf	4	5	14	8	24	131	1	8
DEA2	Köln	5	3	8	3	6	125	1	9
UKL1	West Wales and The Valleys	2	3	4	1	2	118	5	6
DE40	Brandenburg		4	6	6	6	97	1	6
DEA3	Münster	5	1	4		4	91	1	4
UKE4	West Yorkshire			4	2	4	79	2	5
UKG2	Shropshire and Staffordshire		1	2	1	2	84	3	1
UKF1	Derbyshire and Notts		2	1		1	79	6	2
DED2	Dresden	7	2	2	3	2	67	2	5
DEE0	Sachsen-Anhalt	1	5	4	3	4	60		4
Total in EU 2019 Q1		217	308	1012	347	1230	15686	310	704

ENF directory (*https://www.enfsolar.com/industry-directory*)

Opportunities in EU coal regions

Batteries activities



- Current/prospective manufacture of functional battery materials (cathode, anode, electrolyte and separator) identified in Konin (PL41) and Wroclaw (PL51)
- Battery cells, modules and packs identified in PL51, DED2, DEE0
- Recycling, continues increasing in volume and is expected to grow substantially in the next few years

Source: JRC preliminary results-work ongoing

Opportunities in EU coal regions

KEY MESSAGES

- The clean energy potential in coal regions enables them to be active participants in the energy transition.
- The deployment of this potential contributes to energy security and provides economic value and jobs to post-mining communities.
- The development of clean energy projects benefits from the availability of infrastructure, land, skills and industrial heritage.
- Close cooperation between companies, regulators, investors, land-use planners and local communities is essential to identify the most sustainable uses and maximize social and economic development.
- This transition is already happening as demonstrated by 37 PV and 22 Wind projects in old coal mines.

Stay in touch

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European Commission

Thank you

Any questions?

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European Commission

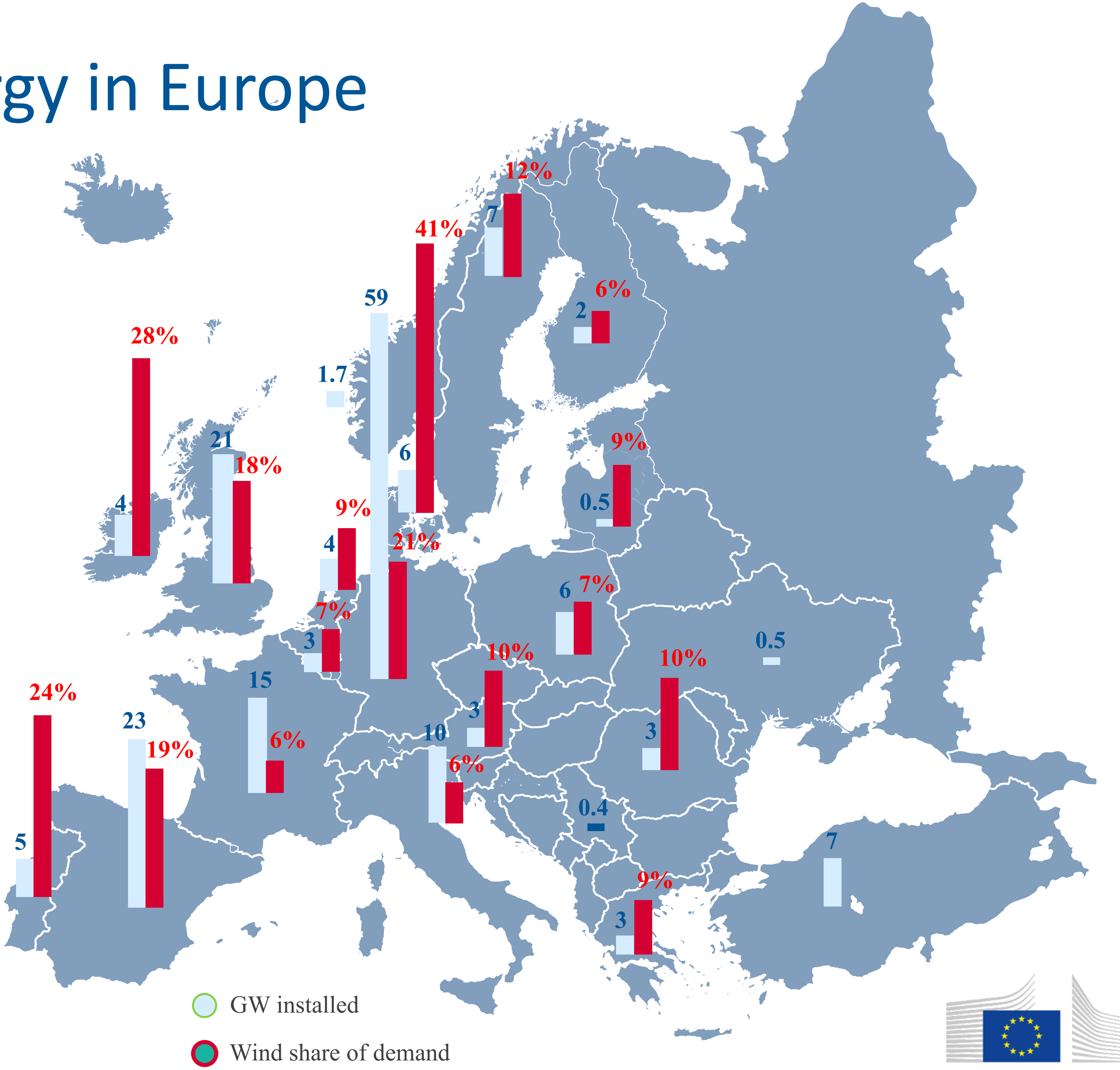
Clean Energy Potential in Coal Regions

Pierre Tardieu
Chief Policy Officer, WindEurope

Wind energy in Europe

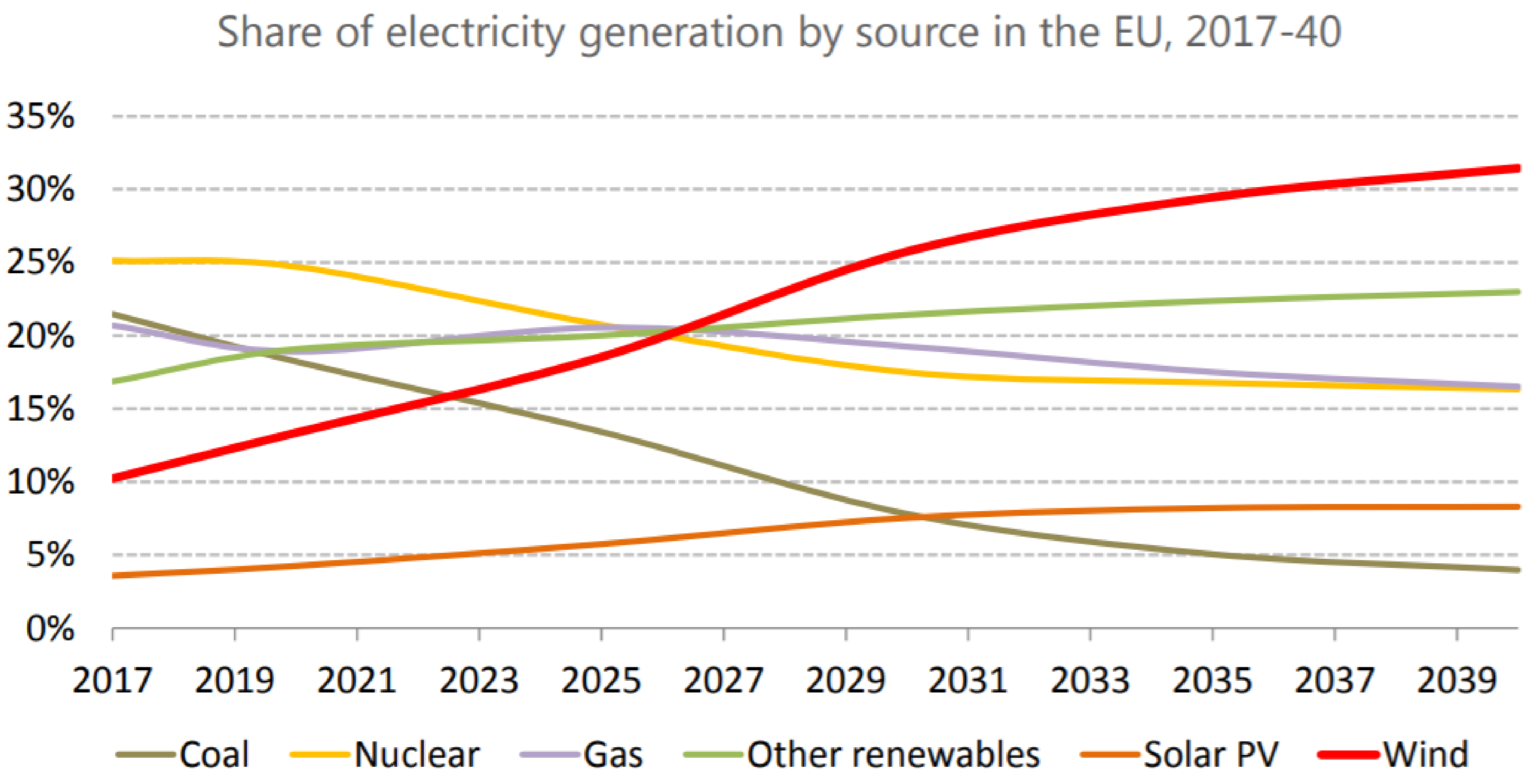
189 GW

14%
of 2018 EU
power demand



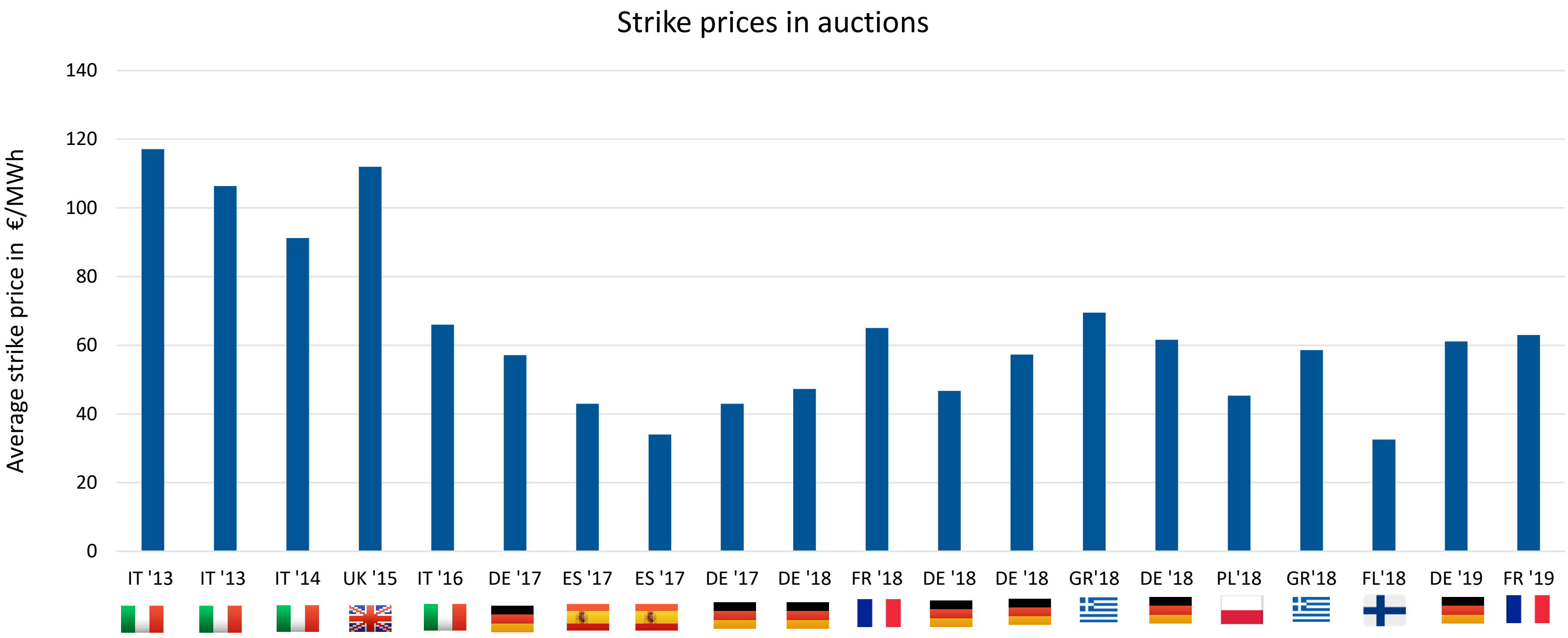
European Commission

Wind will become the largest power source in the EU by 2027



Source: IEA © OECD/IEA 2018

Cost of onshore wind is decreasing

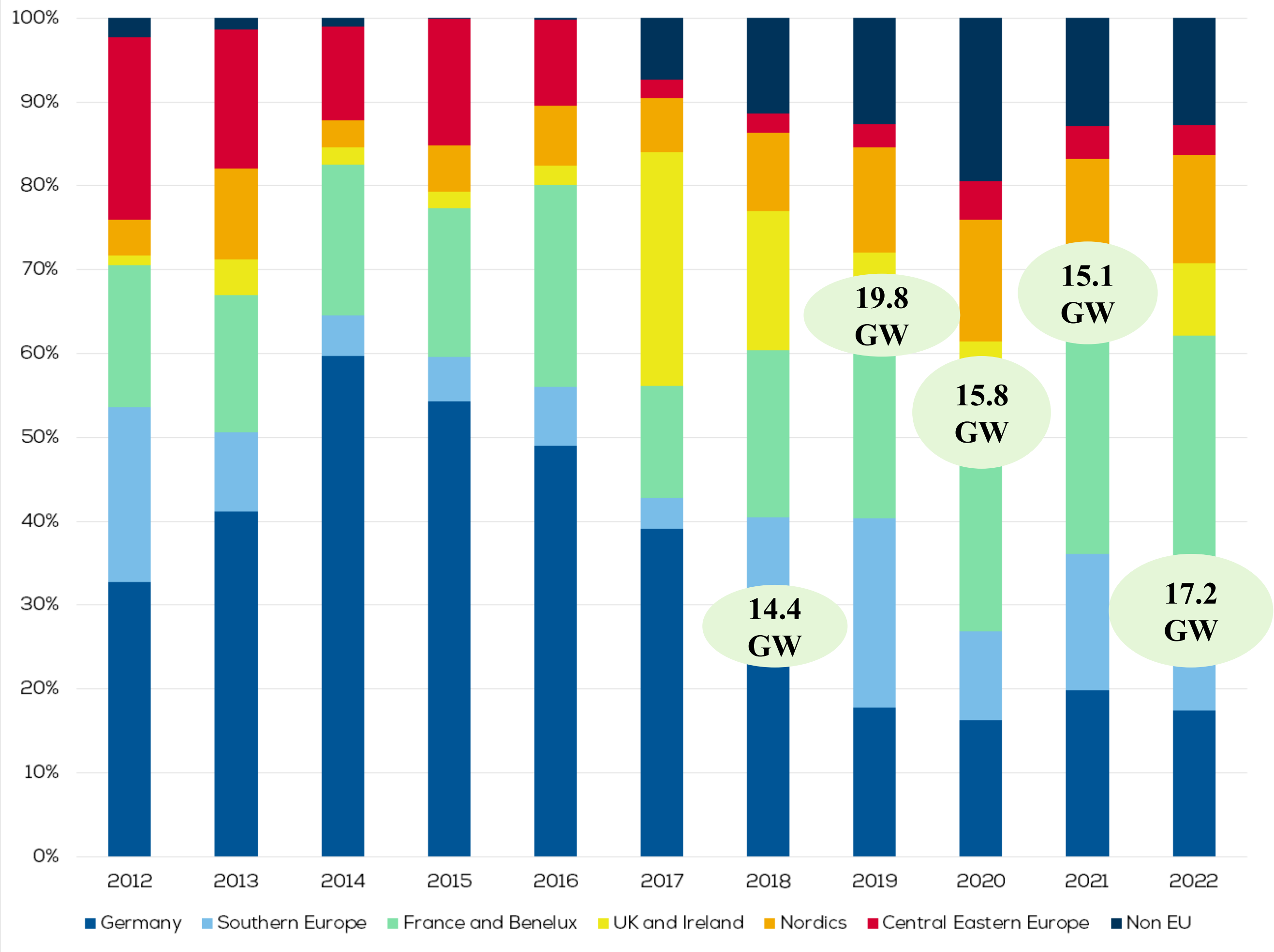


June 2019

European Commission

European geographical wind shares – Outlook to 2022

Central scenario



Germany to all-time low, below 20%

Spanish market recovery in 2019

France and Benelux are a steady market of >20%

UK and Ireland experiencing a slowdown

Central Eastern Europe to remain a marginal market <5%

Non EU markets increasing their share >10%

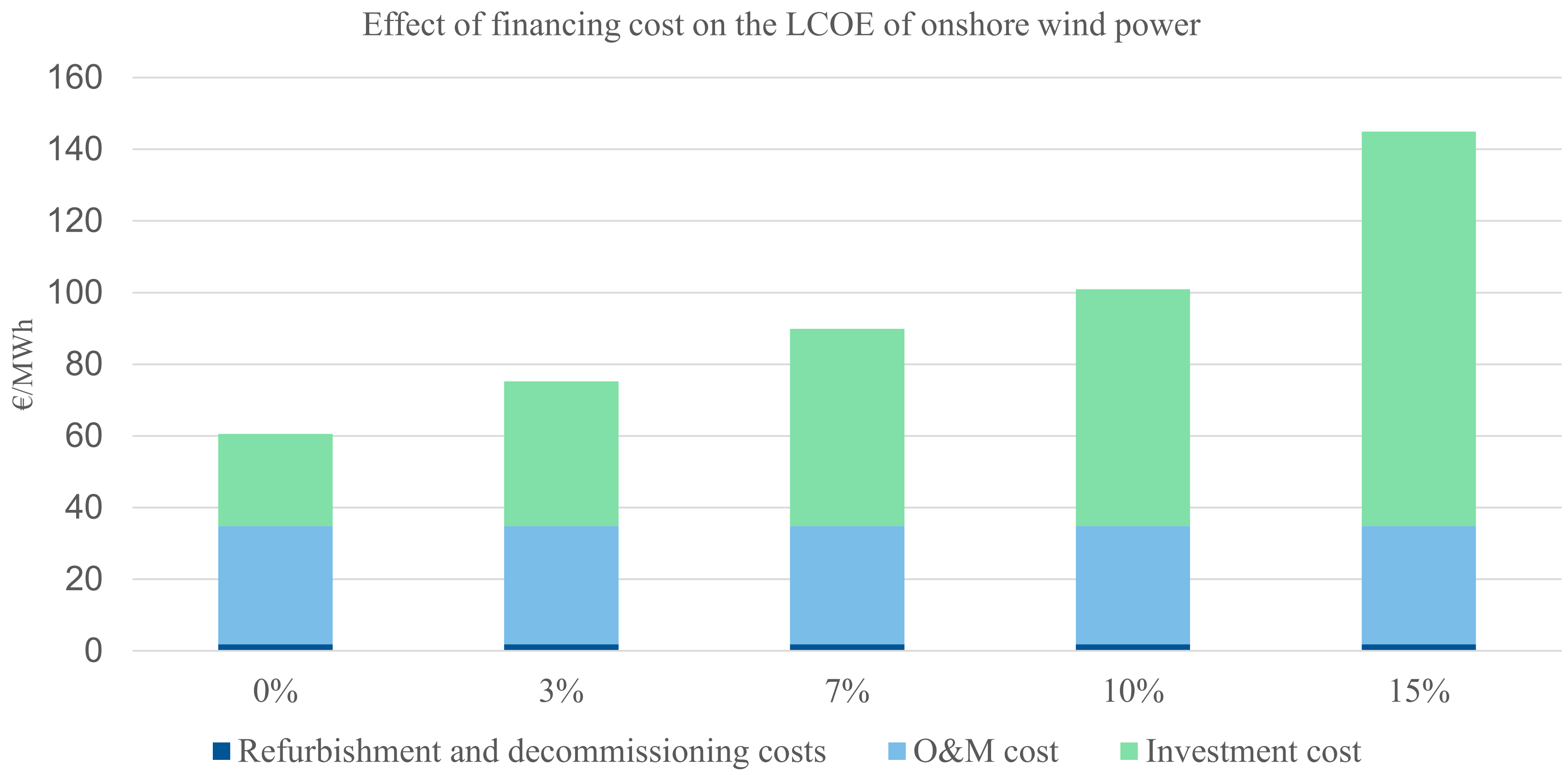
Source: WindEurope

European Commission

82GW

Additional wind potential to 2030

Finance matters



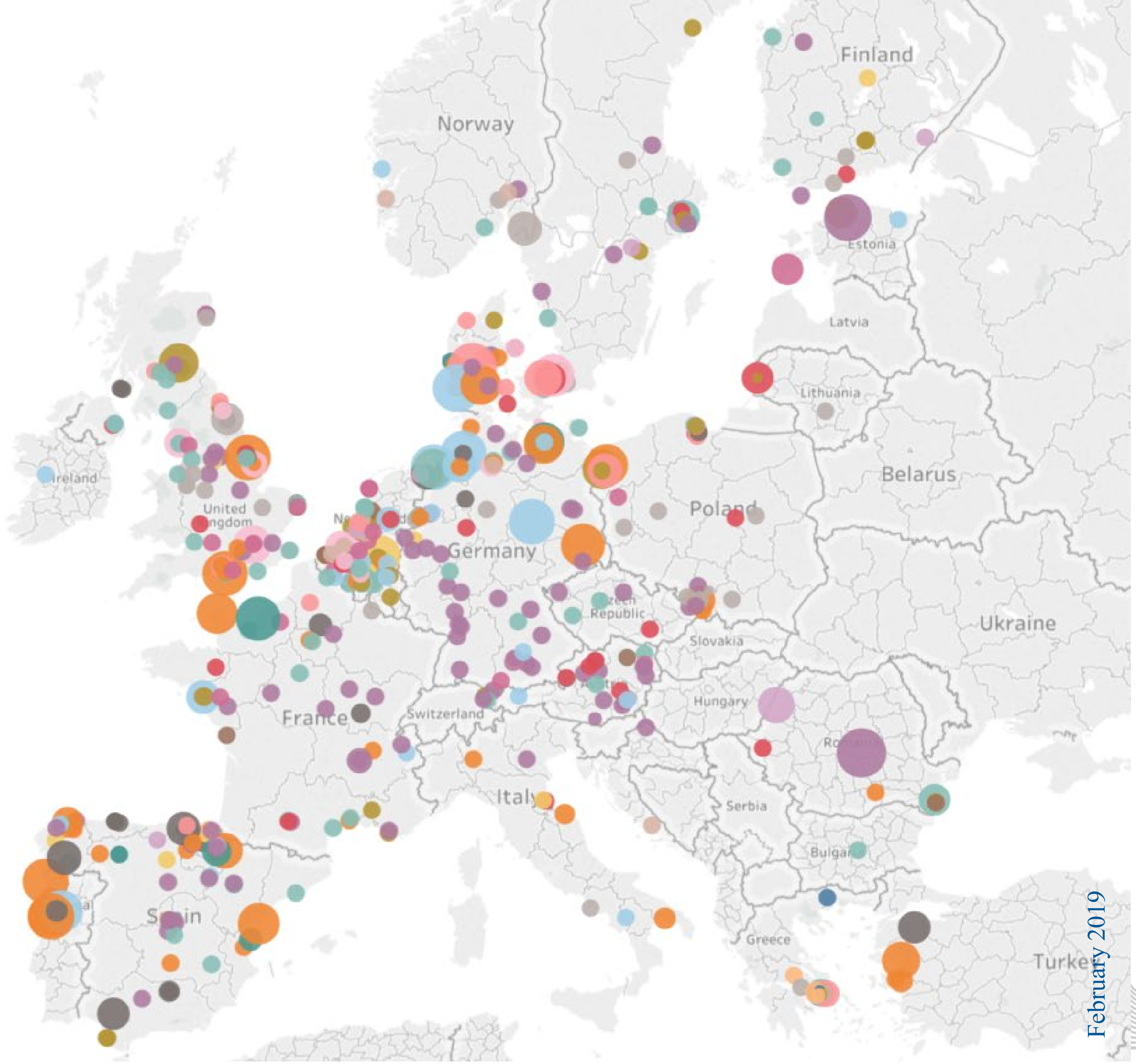
Assumptions: Germany, onshore wind capacity factor 34%

Source: WindEurope based on IEA data, 2015

European Commission

The wind value chain is everywhere

- Components
- Assembly
- Blades
- Foundations
- Gearboxes
- Nacelles
- O&M
- Other
- R&D
- Towers
- Cables
- Generators
- Logistics
- Port

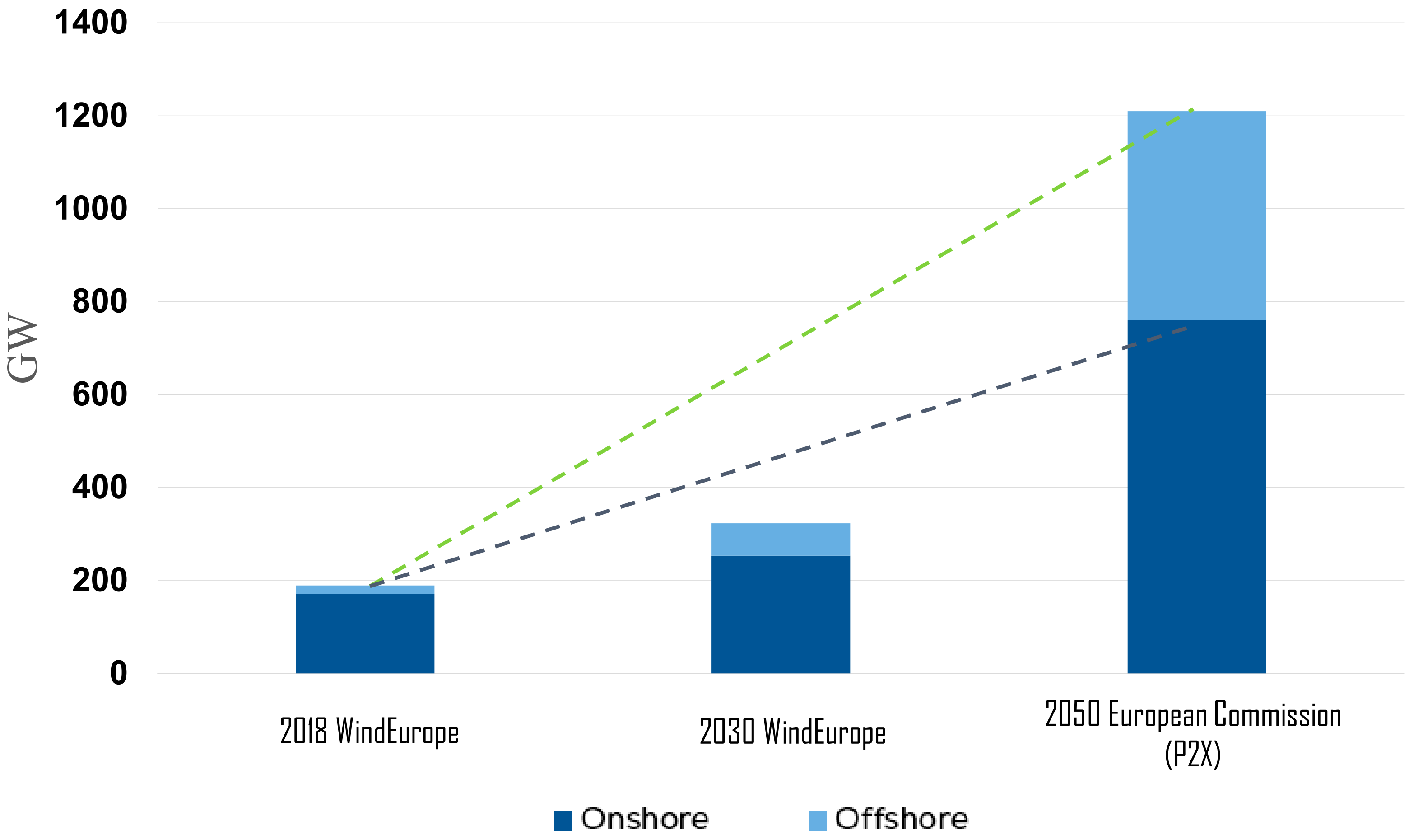


February 2019

European Commission

Wind capacity 2018 to 2050

50 GW pa between 2030 and 2050



Sources: WindEurope, European Commission

European Commission

Coal regions in transition: Unlocking their solar potential

Platform on Coal Regions in Transition
5th Working Group meeting

Walburga Hemetsberger

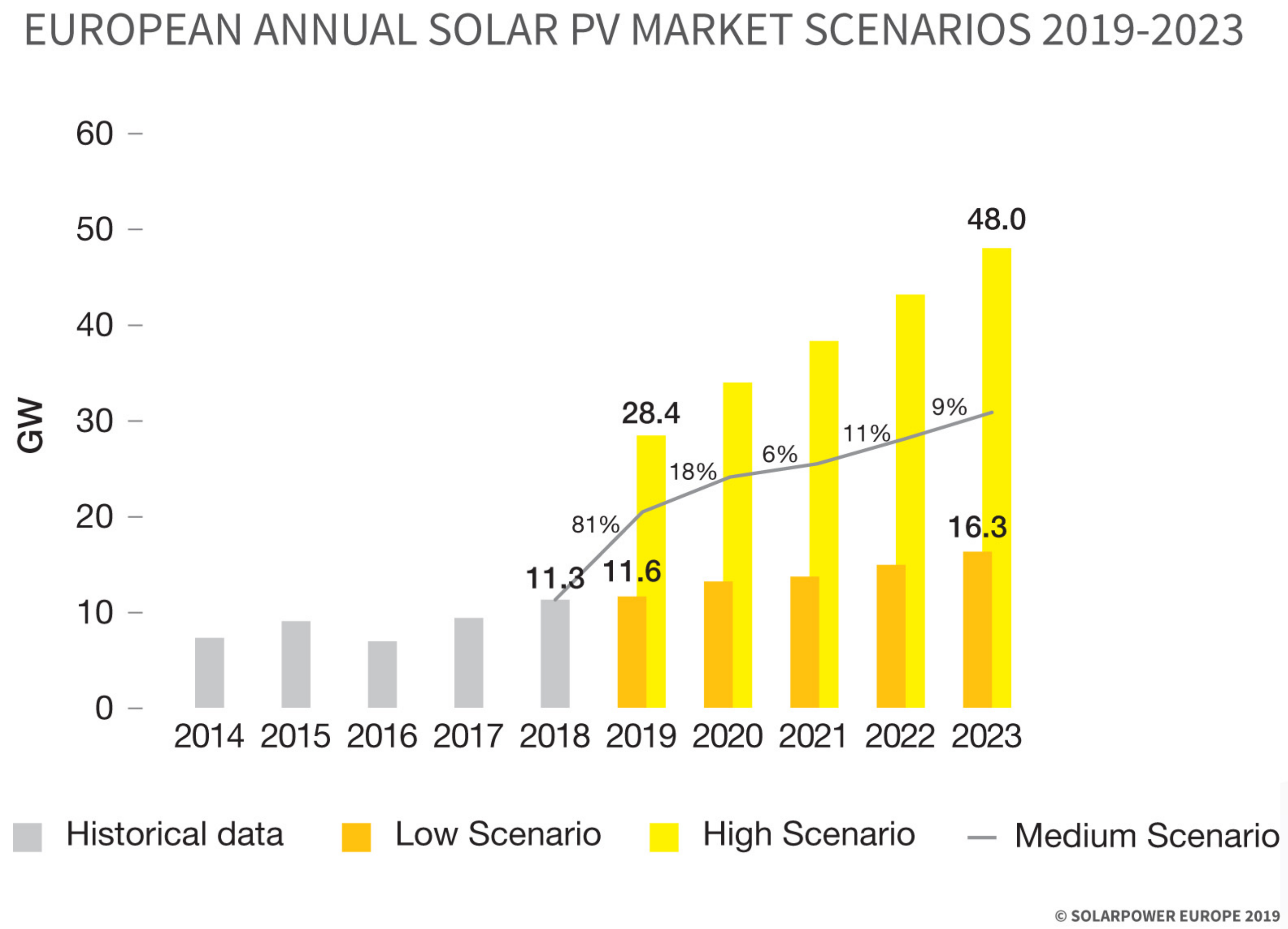
CEO, SolarPower Europe

SolarPower Europe

Heusden-Zolder, Limburg

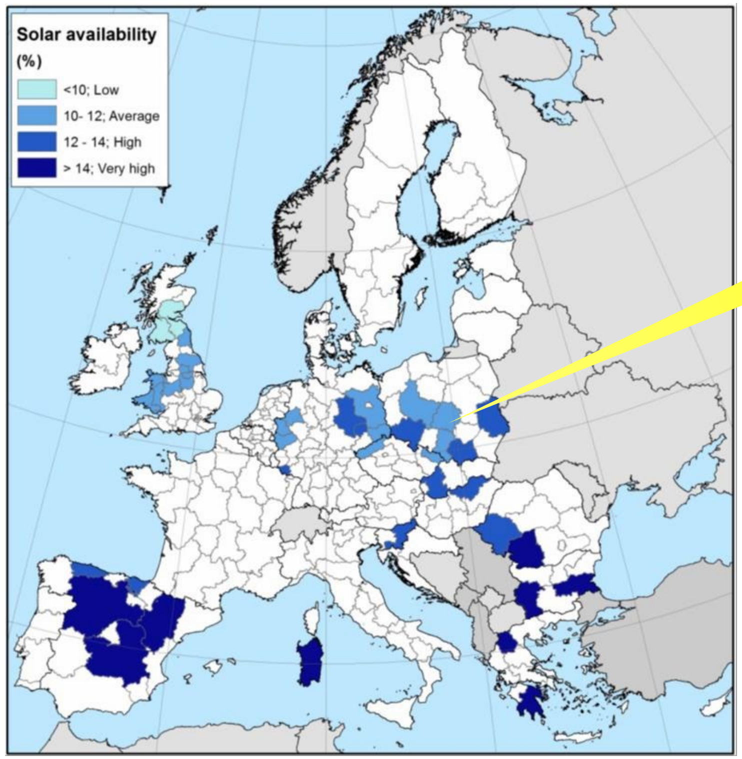
SolarPower Europe

Solar in Europe has entered a new growth phase



SolarPower Europe

The solar potential in former coal regions: The example of Poland



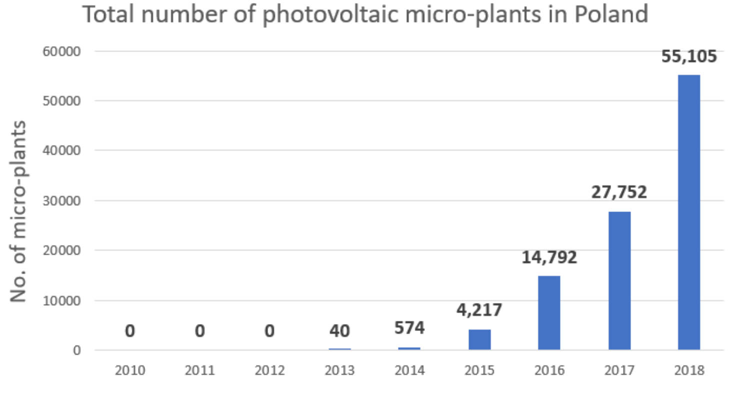
Photovoltaic plants in Poland

as of 31 December 2018

Installed power: 486.5 MW

Plants < 50 kW
339.5 MW

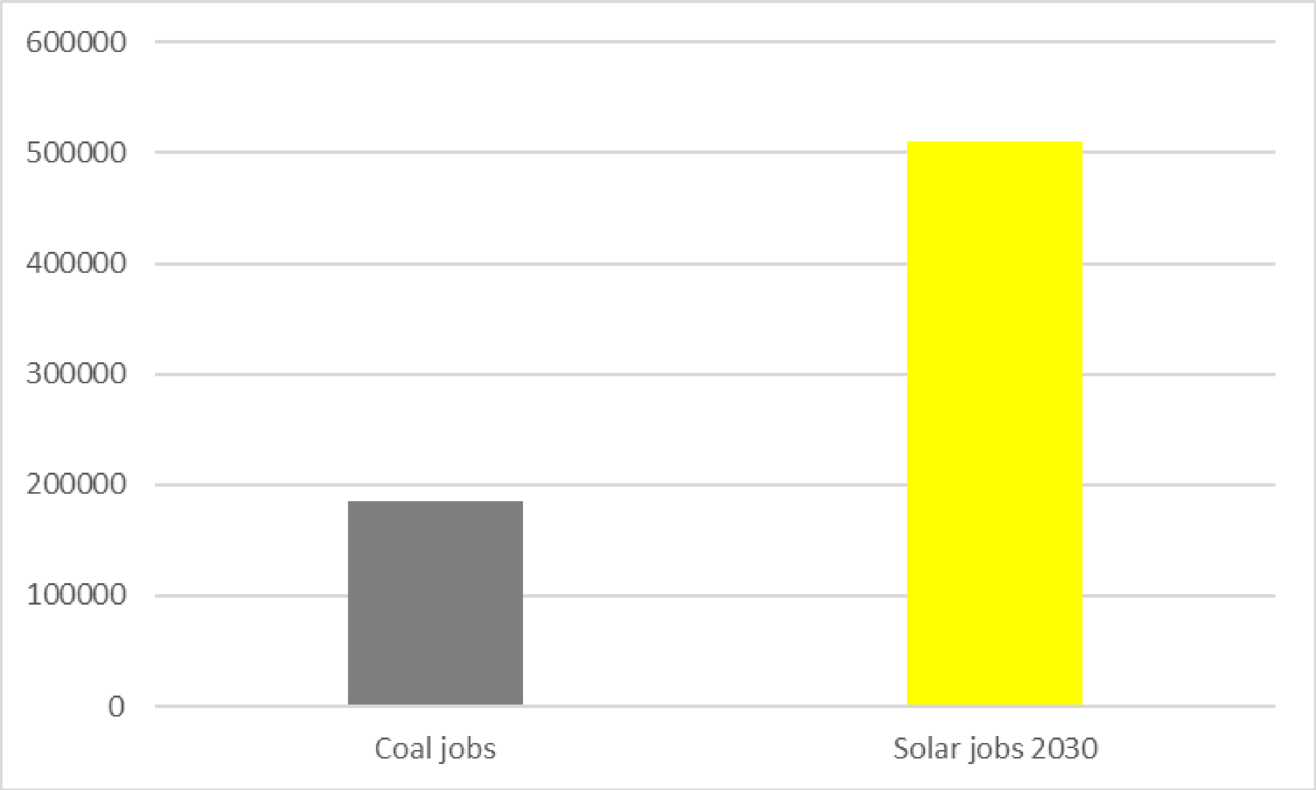
Plants > 50 kW
147 MW



Growing numbers of photovoltaic micro-plants in the years 2010-2018 (source: GLOBEnergia, SBF POLSKA PV,)

SolarPower Europe

Solar can support job creation



41 regions in 12 member states are actively mining coal, providing direct employment to about 185,000 citizens.

Solar alone could create **+500,000 jobs** by 2030

SolarPower Europe

...and diversify economic activity

Widows Creek project by Google (Alabama, USA)

- ✓ A new data centre supplied by 2 nearby solar projects (143MW) at the former coal plant in Widows Creek
- ✓ 75–100 ongoing jobs in the data center operation
- ✓ +500 jobs in construction

Solar potential can be unlocked by enabling regulatory frameworks

Ambitious NECPs are key to supporting stable regulatory environments and fostering investment in solar.

- ✓ Ambitious and clear targets for solar
- ✓ Clear regulatory frameworks providing visibility to investors
- ✓ Enabling framework for small-scale solar and self-consumption
- ✓ Measures for the modernisation of the grid

SolarPower Europe

Europe needs an industrial strategy for solar

Boost the **domestic demand for solar** through ambitious new regulation

Improve the **business environment**

Lead the next generation of **cutting-edge solar technologies**

THANK YOU FOR YOUR ATTENTION

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eurelectric
powering people

Decarbonization pathways

European power sector

Gilda Amorosi, Policy advisor - Sustainability
15 July 2019

eurelectric

We have modelled 3 deep decarbonization scenarios based on electrification of key economic sectors

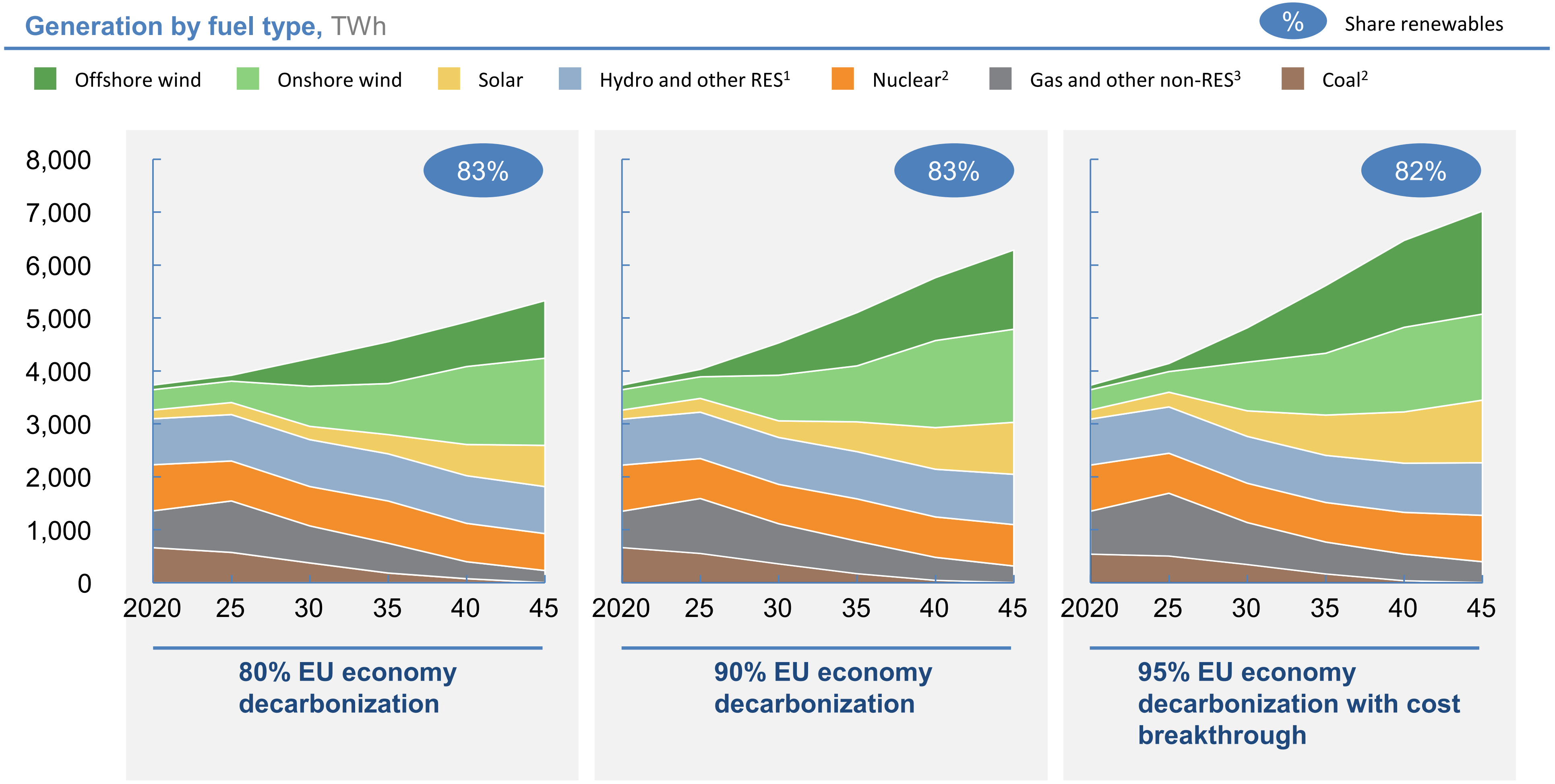
	2015 – Baseline	2050 scenarios: Scenario 1	2050 scenarios: Scenario 2	2050 scenarios: Scenario 3
EU economy decarbonization achieved vs. 1990[1,2]	~22%	~80%	~90%	~95%
Direct electrification rate	~22%	~38%	~48%	~60%
Indirect electrification rate	~0%	~4%	~5%	~5%

Cost breakthrough scenario in which we are driving towards full EU economy decarbonization. Assumes accelerated cost decline for renewables, nuclear, CCS and storage

1 Emissions out of scope are expected to contribute proportionally to the decarbonization effort required in each scenario
2 Decarbonization will be different by sector depending on relative costs and available technologies, industry contributing least with below 80% of emission reduction in all scenarios

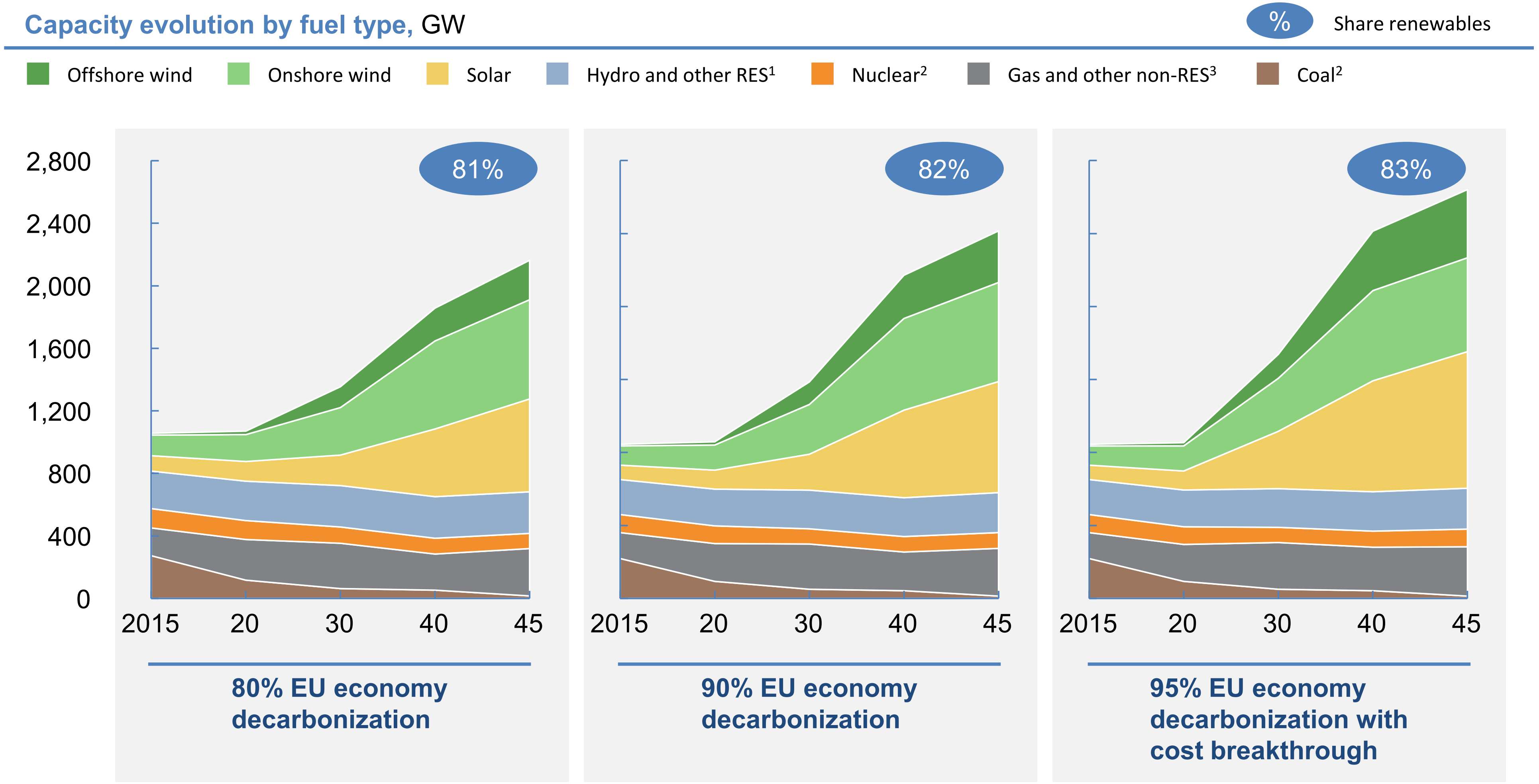
In the least-cost, carbon neutral electricity system the bulk of electricity is provided by renewables and nuclear

Generation by fuel type, TWh



1 Includes also small amounts of geothermal, biomass and biogas
2 National policies on nuclear and coal phase out have been reflected
3 Up to 15% of gas capacity with CCS and other non-renewables

Renewables account for ~80% of total installed capacity by 2045, while coal is phased out over the period

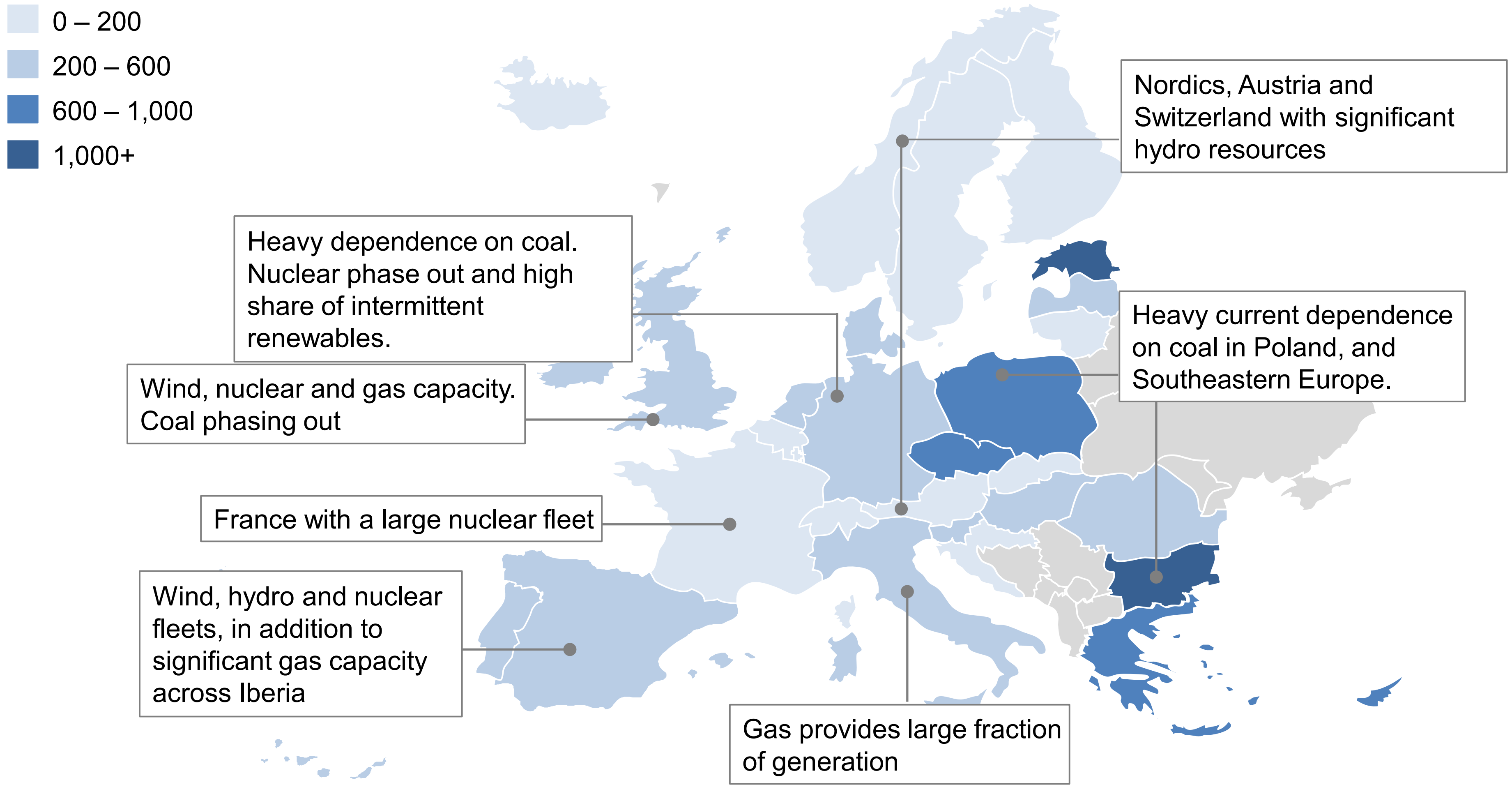


1 Includes also small amounts of geothermal, biomass and biogas
2 National policies on nuclear and coal phase out have been reflected
3 Up to 15% of gas capacity with CCS and other non-renewables

SOURCE: 2015 capacity from Enerdata

European countries have different starting points in the energy transition

2015 carbon intensity of electricity[1], kg CO_2/MWh



1 Refers to carbon intensity of domestic electricity production, i.e. does not take into account the carbon intensity of electricity mix consumed

SOURCE: Eurostat and national statistics

By 2045 we envision a carbon neutral power sector that makes a significant contribution to decarbonization of the EU economy

High penetration of renewables and transmission build will be the main driving force of the European energy transition. Renewables will represent >80% of electricity supply driven by large untapped potential and rapidly declining cost

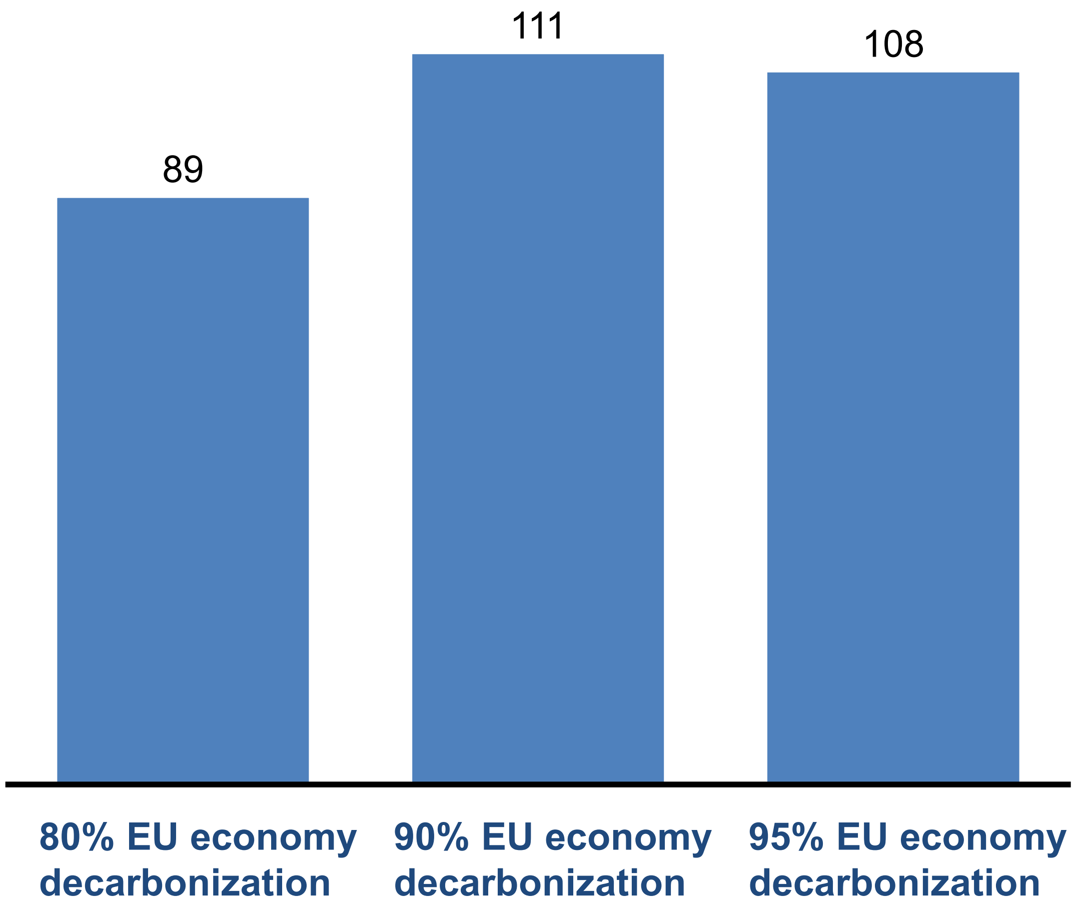
System reliability and flexibility needs provided by multiple sources in the power sector and from other industrial sectors. These include hydro, nuclear power and gas, and emerging sources deployed at scale such as demand side response, battery storage, hydrogen electrolysis and power-to-X

Changing role of fossil generation. Fossil electricity supply will be gradually phased out and represent only ~5% of total supply by 2045. However, gas will still represent ~15% of total installed capacity to contribute to system reliability, especially in regions that don't have access to hydro or nuclear

Decreasing costs of carbon neutral technologies and innovation to abate the last tons of CO2 emissions (e.g. CCS, negative emissions) coming from the marginal use of the remaining thermal capacity such as negative emissions and CCS technologies

Significant investments will be required to decarbonize the power sector, but will also enable decarbonization of other sectors

Average annual capital investment cost 2020 - 2045[1], EUR bn



- Reaching 80 – 95% EU economy decarbonization will require a **significant ramp-up of investments** to accomplish
  1) large **increase in generating capacity to meet electricity demand growth** that is unprecedented in recent times
  2) **shift of the current generation stack** to carbon neutral electricity sources
- These investments will **compensate for investments needed to decarbonize other sectors** and are not for the power sector alone

1 Real cost linked to 2016 price level

A low cost, carbon neutral power sector must be supported by changing political, technological and market conditions

Political commitment to deep decarbonization across all sectors of the economy and regions. Continued efforts to integrate the European energy system

Active involvement of citizens e.g. through demand response and prosumers, and **increased social acceptance** for high renewables build out and new transmission lines

Synergies with other sectors. For example, P2X and H2 production enable decarbonization of other sectors while providing balancing capabilities to the power system. Existing gas pipeline infrastructure can be repurposed for power to gas and hydrogen transport and storage

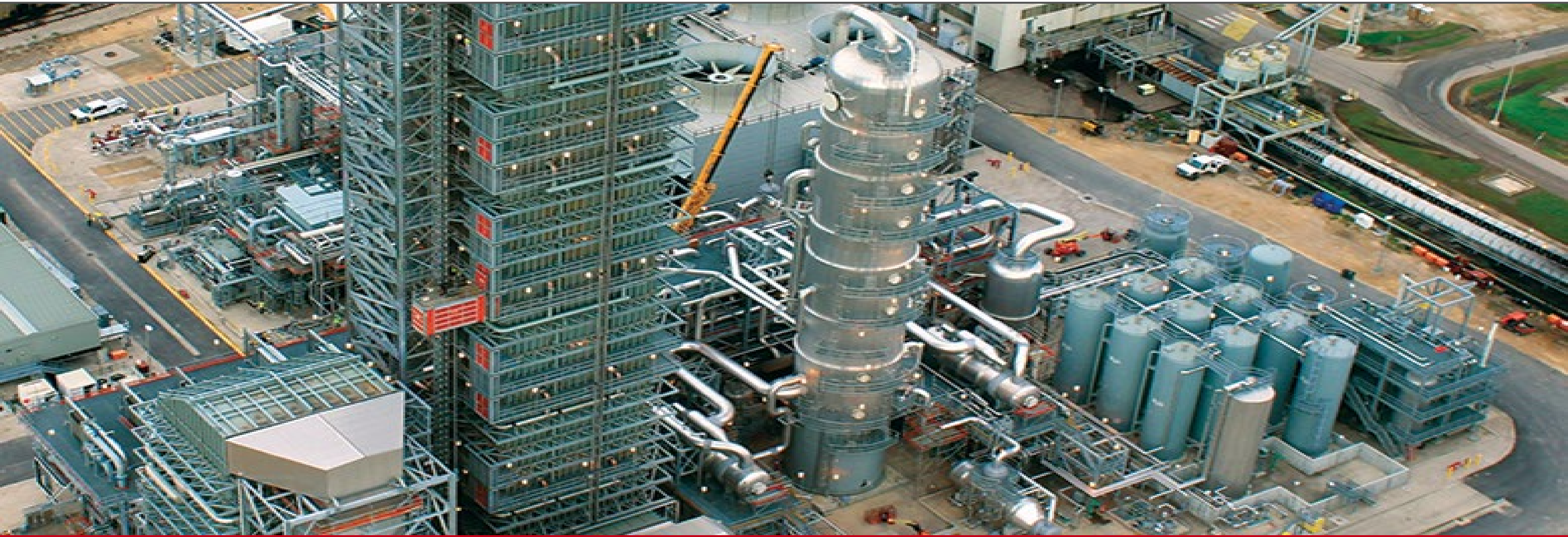
Efficient market-based investment frameworks and adequate market design to trigger investments in a high renewables-based system. For example, resources must to a larger extent be valued based on their contribution to system reliability. Meaningful CO_2 price signals will also be required to sufficiently incentivize full decarbonization

A smarter and reinforced distribution grid that integrates new market participants (e.g. decentralized solar PV and local flexibility sources), and plays a significant role in consumer empowerment through managing local congestions and redispatch, security of supply and grid resilience issues

The path and investments required to reach full decarbonization differs by country as European regions have different existing electricity mix and resources available. To ensure just energy transition **support and dedicated EU funding will be required** for Member States that face a more difficult starting point in the electrification and energy transition journey.

MHPS

Mitsubishi Hitachi Power Systems



Coal Regions in Transition
A Course of Action

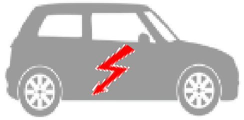
Prof. Emmanouil Kakaras
Senior Vice President
Energy Solutions and New Products

Platform for Coal Regions in Transition
Brussels, 15th July 2019

The World is changing rapidly…

Easy ⟵ complexity to decarbonise ⟶ Hard

Transport

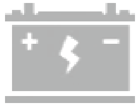


Battery (mostly) plus Hydrogen & eFuels

Hydrogen Fuel-Cell Trains & eFuels for Heavy Duty Vehicles

Liquid Hydrogen, eFuels and Fuel-Cells for long haul Big Ships

Power



Large Battery Systems for Daily Swing (hours)

Hydro-Power as Battery (days)

Backup-Power
- H_2 CCGT
- Biomass PP
- SOFC

Industry

Light Industry powered by Renewable

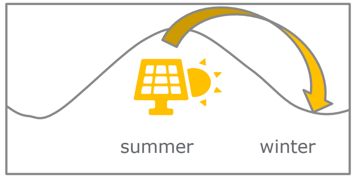
Heavy Industry powered by Hydrogen from Natural Gas + CCS

CC(U)S for Industry without other Alternatives

Heat

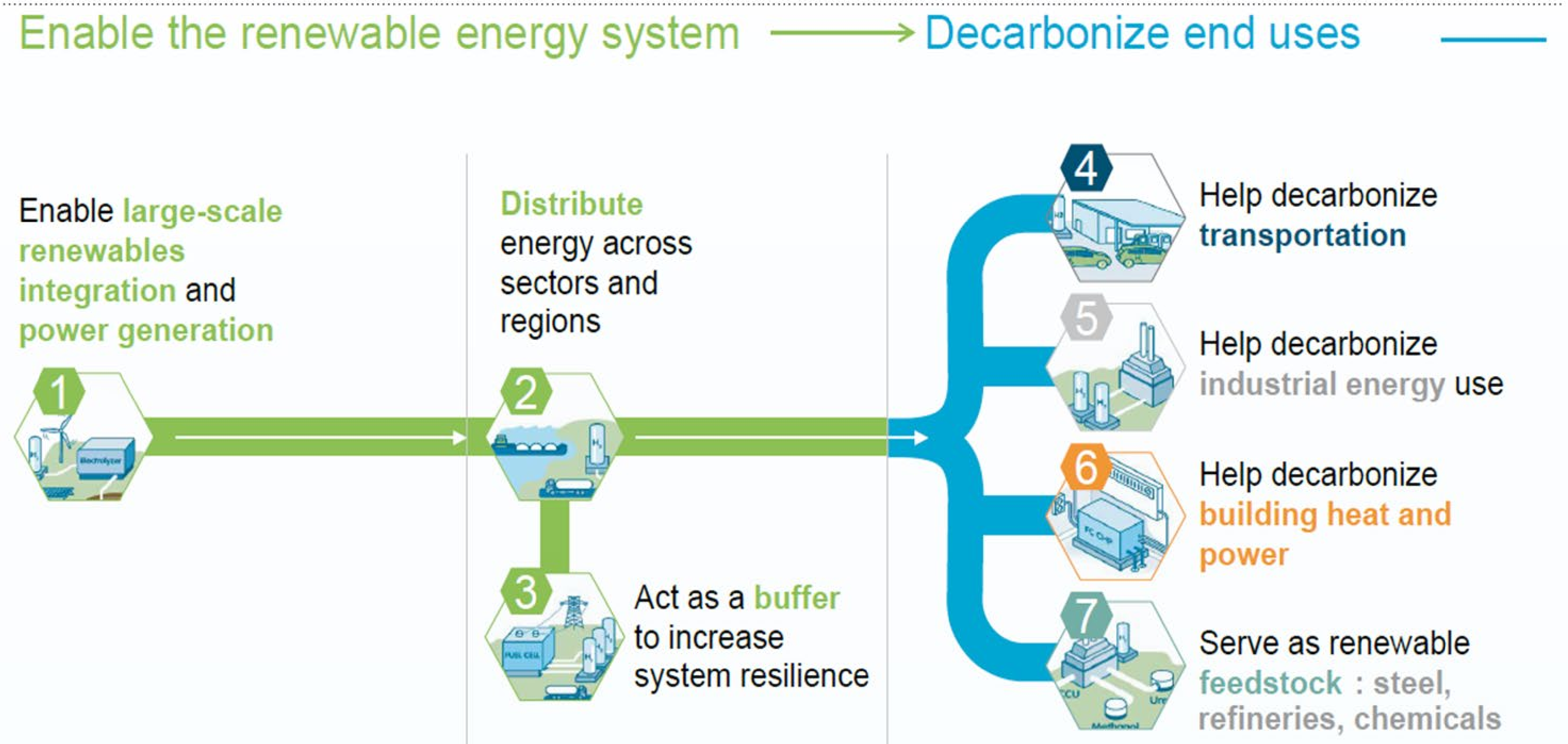
Heat Pumps For Efficient Use of Electricity in Homes and Industry

Hydrogen for Efficient Transfer of Energy from Production to End-Users



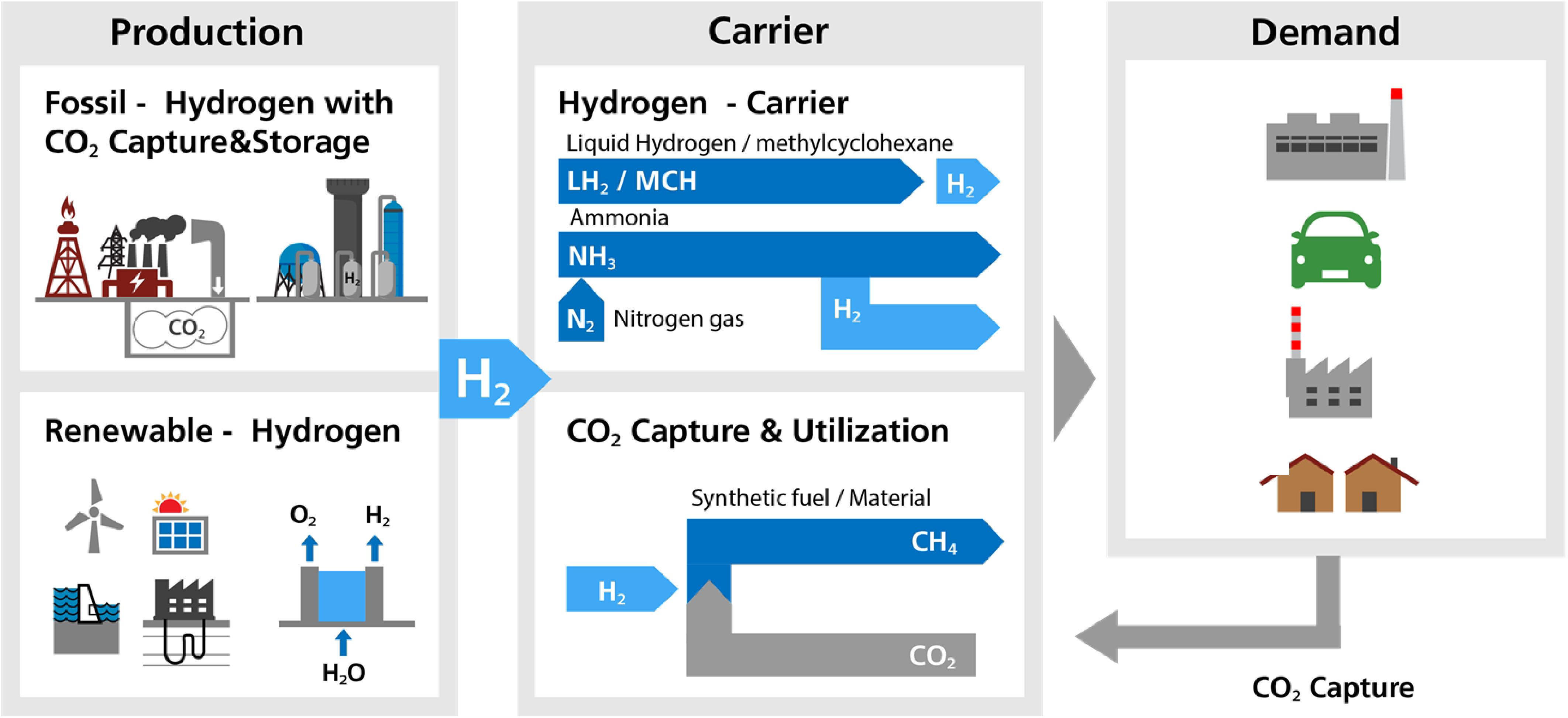
H_2 & biomass & CCU/eFuels for Seasonal Storage & Operational flexibility

Hydrogen is a decarbonisation enabler



SOURCE: Hydrogen Council

Hydrogen-related technologies in MHI group



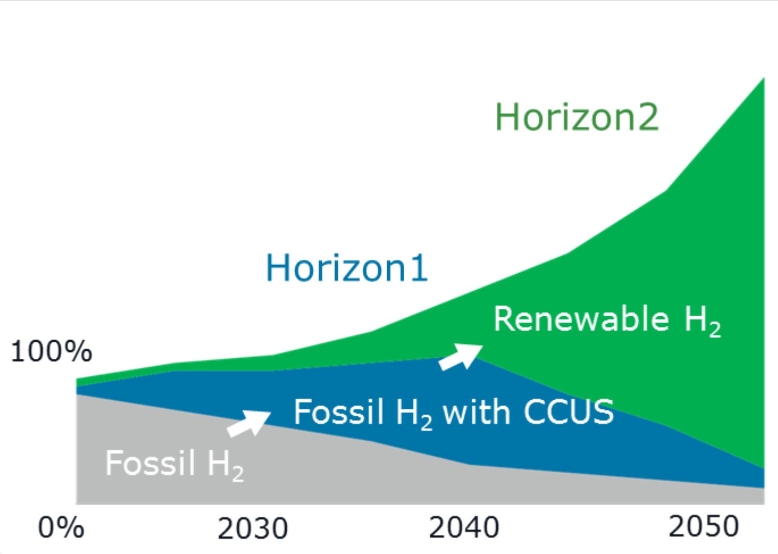
Global hydrogen supply chain is key to realise hydrogen society

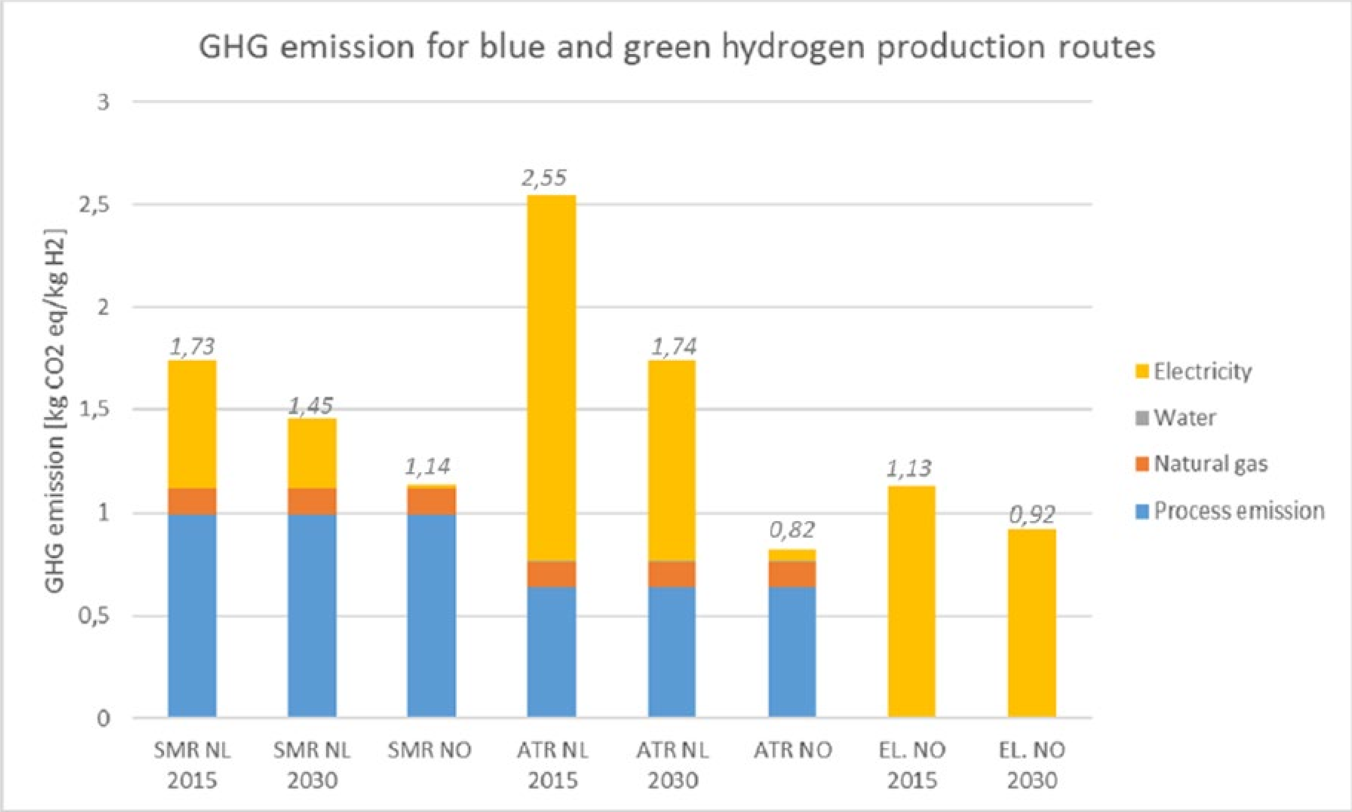
Hydrogen sourcing & related carbon footprint

Hydrogen sourcing

Horizon 1: Medium term
Fossil H_2 with CCUS to be the initiator and accelerator of the hydrogen society

Horizon 2: Long term
Renewable H_2 to become dominant through successive /disruptive innovation & significant cost reduction





Source: CE Delft, 2018

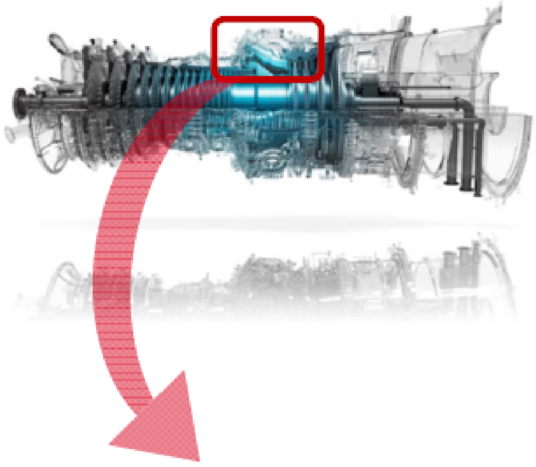
SMR: Steam Methane Reforming | ATR: Autothermal Reforming | EL: Electrolysis
NL: Netherlands | NO: Norway

Existing Gas Turbine can run with hydrogen by limited modifications to combustion parts

MHPS's "JAC"
Super High Efficiency GTCC
Efficiency : ~65%
Availability: 99.5%

H2 Gas Turbine

H2 Gas Turbine



Limited modification to combustion parts

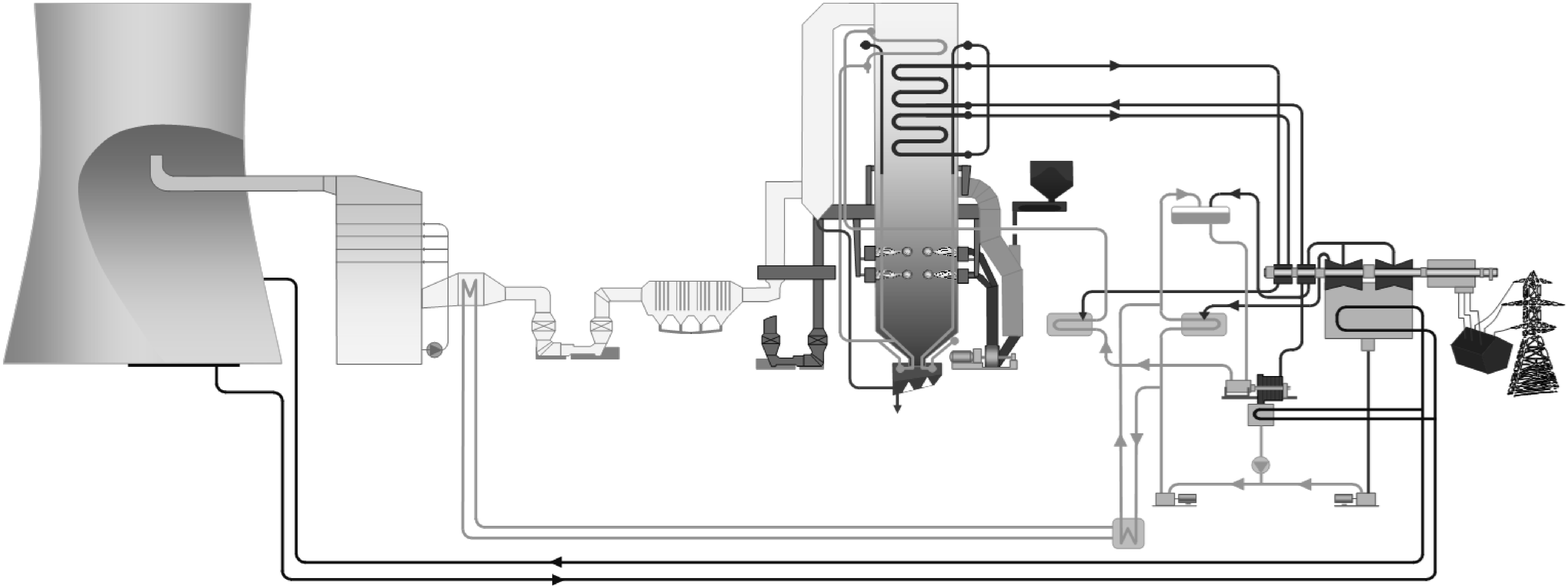
Fuels H2 infrastructure development

- Large H2 demand for power generation
- Straightforward repurposing of existing assets
- Gas Turbine can be fueled by H2 transported by Ammonia / MCH / LH2

Reduce CO2 at large scale

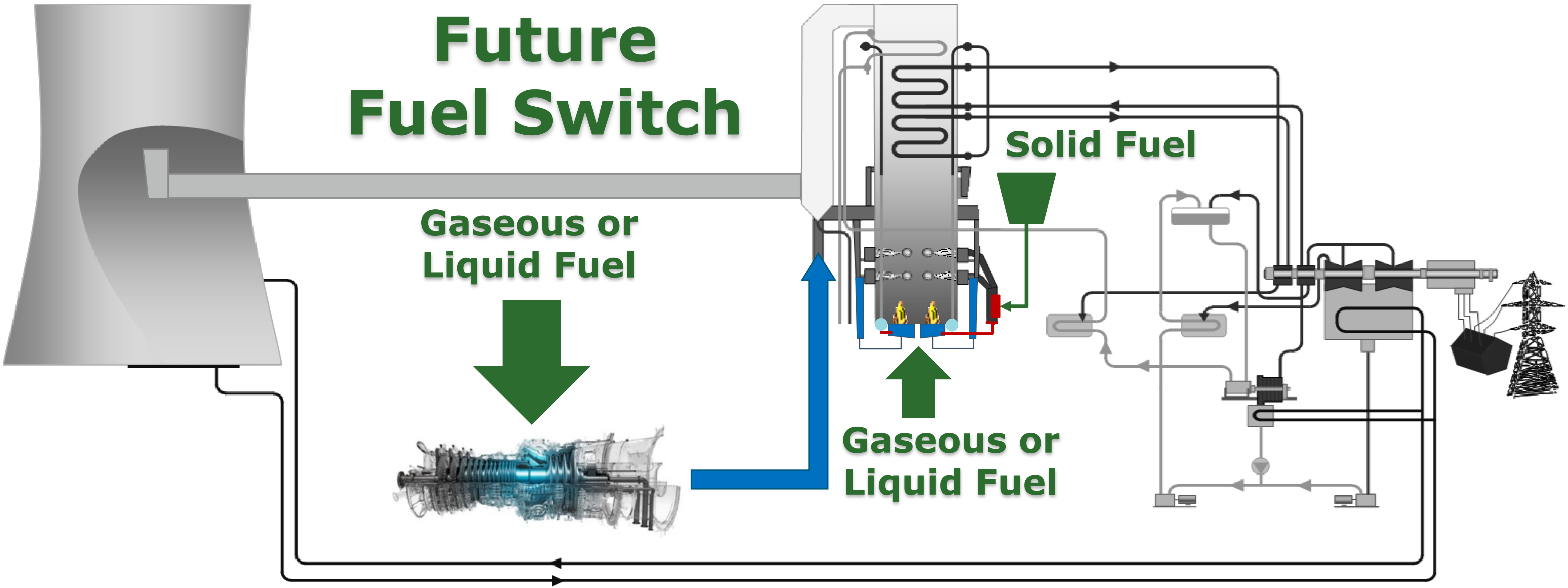
- Large CO2 reduction
  (1 CCGT (440MW) ≒ 2,000,000 FCV)

What can we do with “stranded” assets?



State of the Art Lignite Power Plant

What can we do with “stranded” assets ?



The distributed fuels can be 100% renewable

How do we go about it ?

1. Power Plant *retrofit* with a **toping gas turbine**

- ☑ Up to **+ 40%** power with higher efficiency
- ☑ Full low emission operation within **3 years**

– 20% GHG emissions

2. *Full fuel switch* to **NG** and **toping cycle**

- ☑ Up to **+ 40%** power with higher efficiency
- ☑ Full low emission operation within **3 years**

– 70% GHG emissions

3. *Co-firing* or *full firing* with **biomass and/or biogas**

- ☑ Up to **+ 40%** power with higher efficiency
- ☑ Full low emission operation within **4 years**

– 90% GHG emissions

4. *Integrate* **hydrogen** from **low carbon** and **renewable sources**

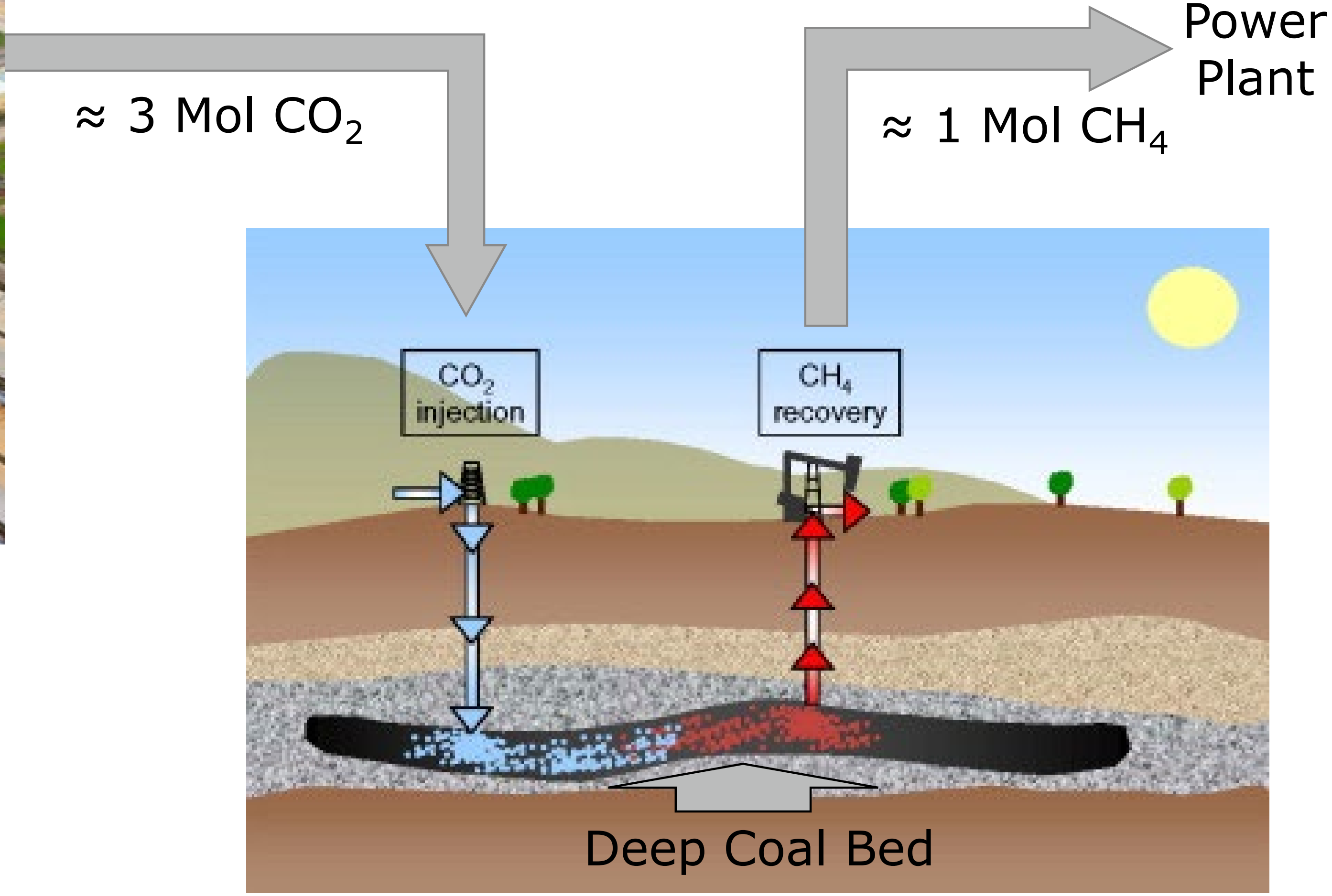
- ☑ Up to **+ 40%** power with higher efficiency
- ☑ Full low emission operation within **4 years**

– 95% GHG emissions

Carbon Capture can have a role to play

CO_2 - Scrubber Reference
Petra Nova: Texas – USA
World biggest CO_2-scrubber
Start up: end 2016
4.776 t/day CO_2-production
(flue gas of 240 MW hard coal)
90% CO_2 capture rate

The captured CO_2 can be either stored or for further use of the coal asset Enhanced Coal Bed Methane (ECBM) Production



No asset is really stranded until you decide !

Technology can turn today’s lignite power plants, but also hard coal power plants, into high efficient large scale gas fired and **“low carbon”** power plants with a **“green fuel option”** for the future.

The **first GHG reduction effect** can be reached **3 years after management decision** and order placement.

The **GHG savings steps** can be executed **one by one** for a better optimisation of the economics.

Power for a Brighter Future