Paris Agreement Compatible Scenarios for Energy Infrastructure

What energy mix in a net-zero emissions world?

Scenario workshop, Brussels, 9 October 2019

Agenda

#PACscenarios

10:00 Introduction. Why infrastructure and scenarios matter.

10:15 Building a common scenario: our approach – your feedback

Deeper dive into the generation side

10:45 How grid operators build their scenario: Overview of generation side modelling for the Ten-Year Network Development Plan (TYNDP)

11:15 Coffee & tea break

Building our scenario: Phasing out fossil fuels and nuclear

11:30 Assumptions on fossil fuels (oil, coal, fossil gas) in the energy mix

12:15 Assumptions on nuclear in the energy mix

13:00 Lunch break

Agenda

#PACscenarios

13:00 Lunch break

Building our scenario: Reaching 100% renewables

14:00 Assumptions on variable renewables in the energy mix

14:30 Assumptions on dispatchable renewables in the energy mix

15:00 Assumptions on non-fossil gases in the energy mix

15:30 Coffee & tea break

Building our scenario: How to guarantee security of supply and flexibility?

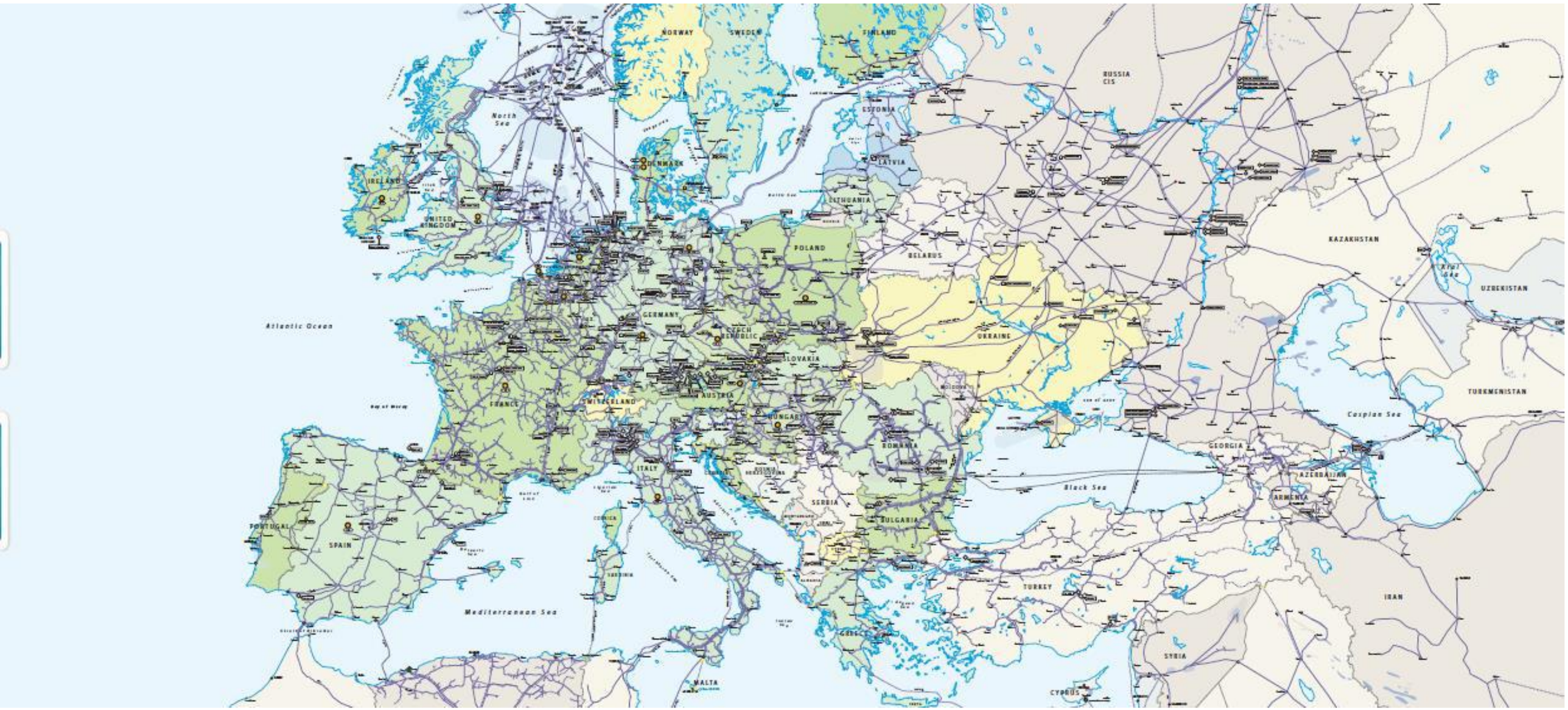
15:45 Assumptions on demand side response and flexibility options

Summary

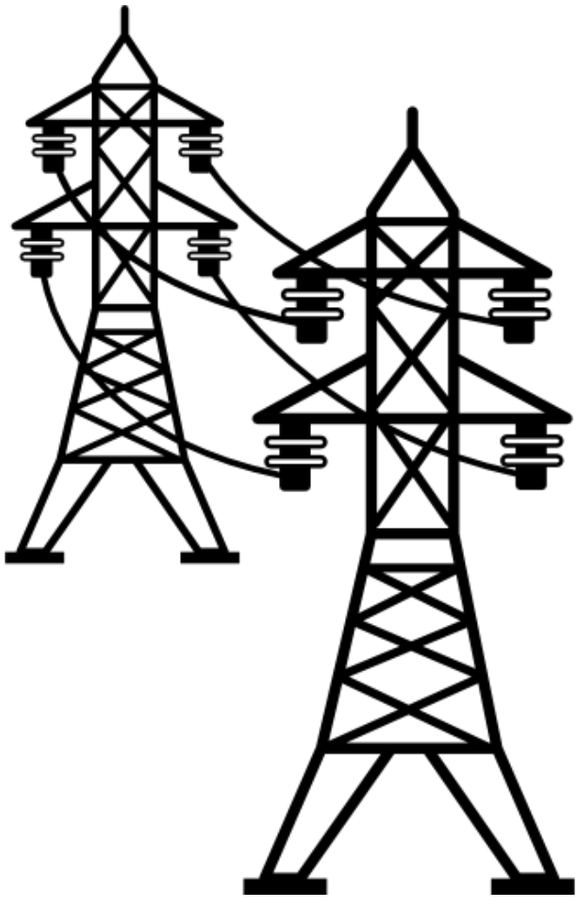
16:30 Identifying gaps and priorities, wrap-up, next steps

17:00 End of the workshop

Introduction. Why infrastructure and scenarios matter



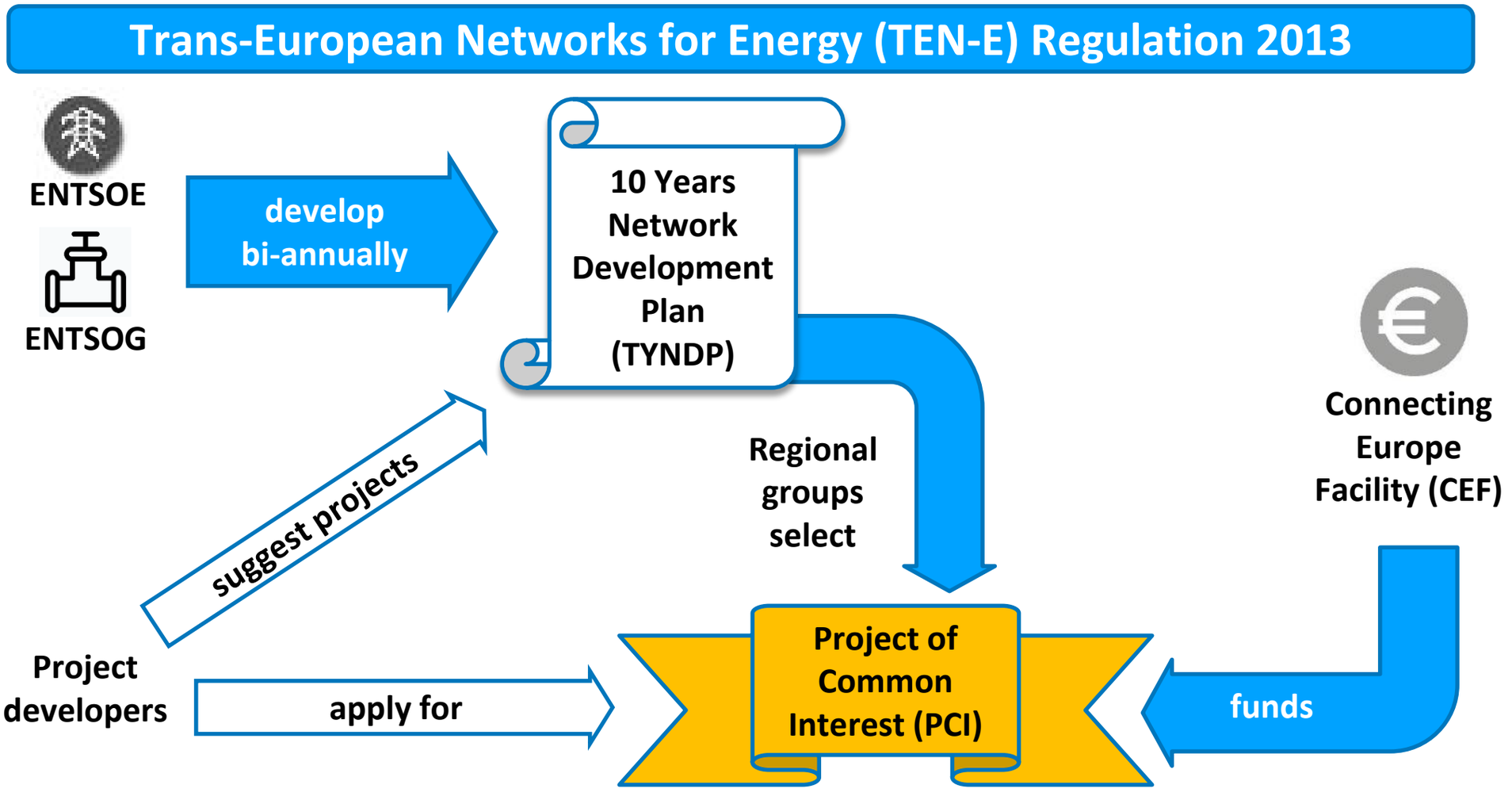
Introduction. Why infrastructure and scenarios matter



40 years

80 years

Introduction. Why infrastructure and scenarios matter



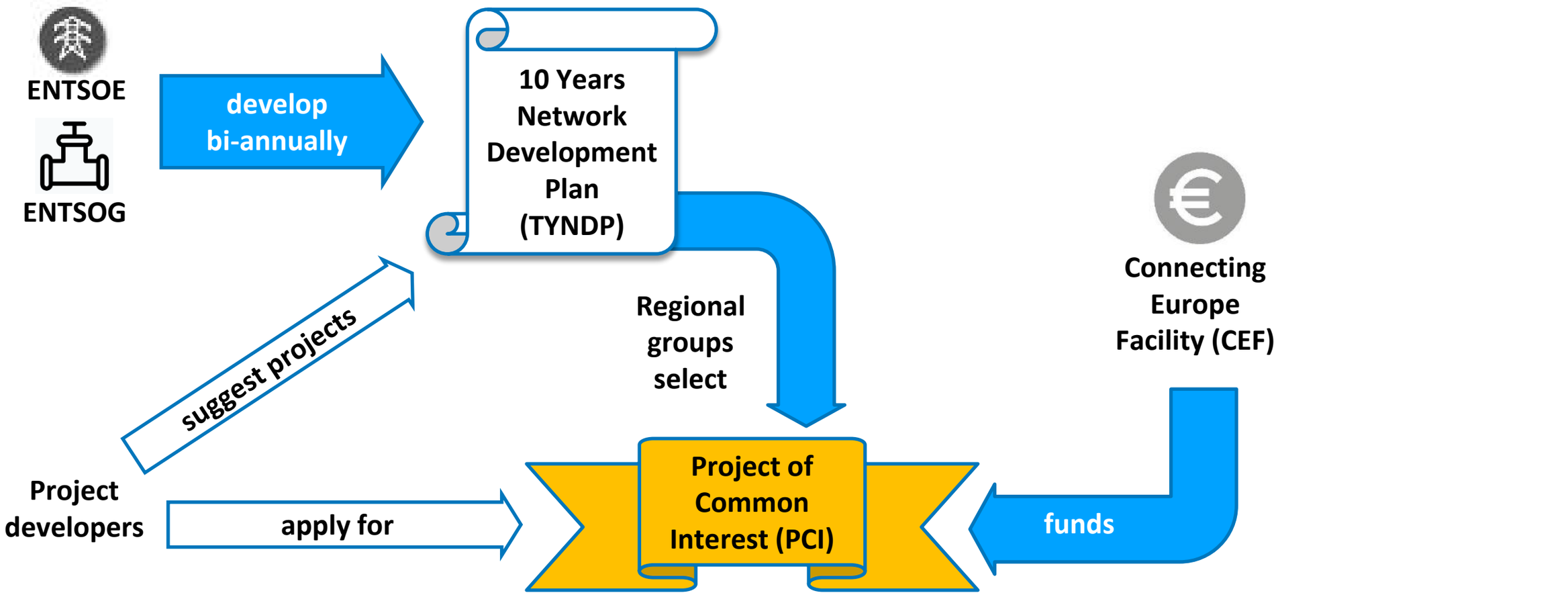
Introduction. Why infrastructure and scenarios matter

Paris Agreement 2015

Clean Energy Package 2018

?

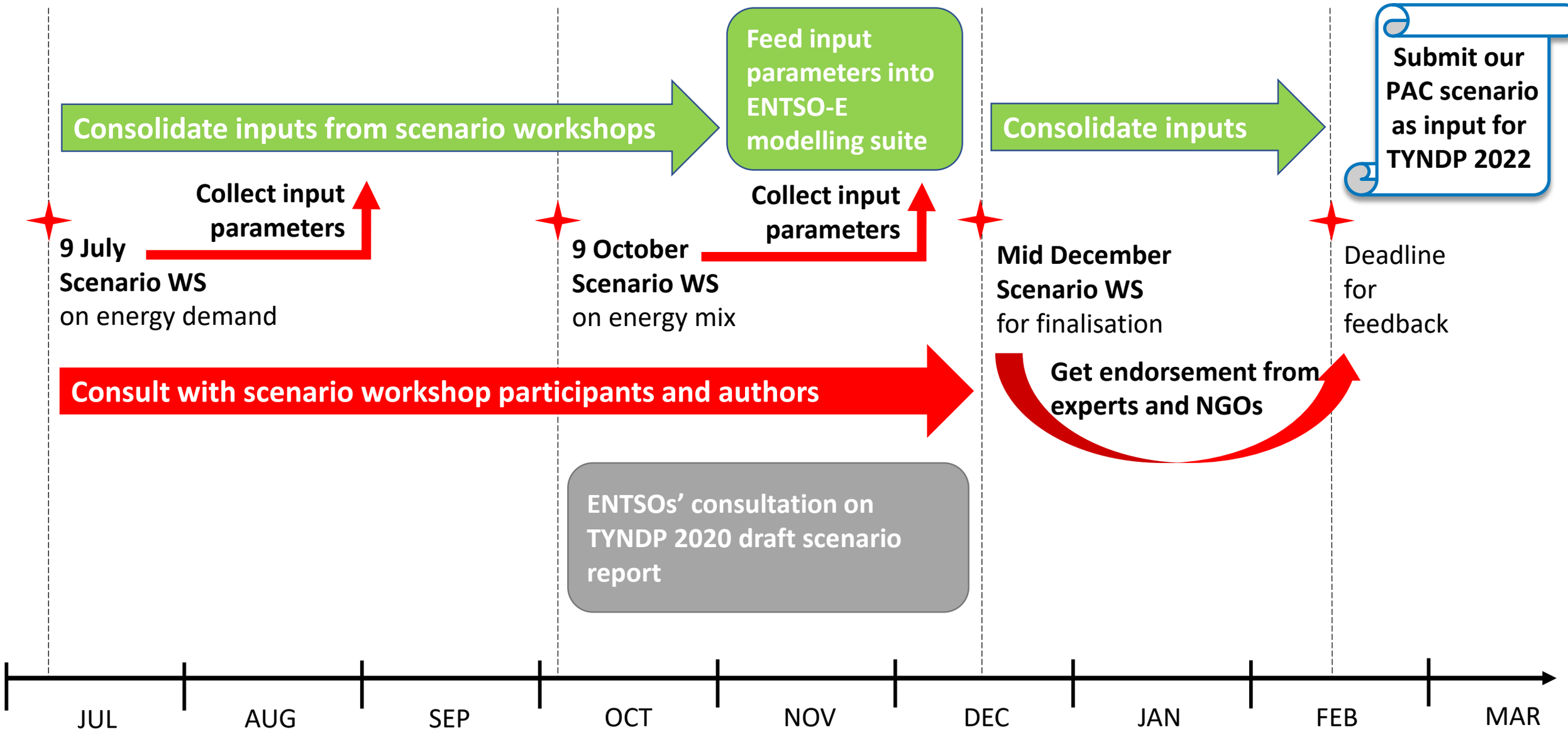
Trans-European Networks for Energy (TEN-E) Regulation 2013



Building a common scenario: our approach - your feedback

The project partners

Building a common scenario: our approach - your feedback



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Building a common scenario: our approach - your feedback

- **Net zero emissions by 2040**
- **100% renewables by 2040**
- **65% GHG reduction by 2030**

Submit our PAC scenario as input for TYNDP 2022

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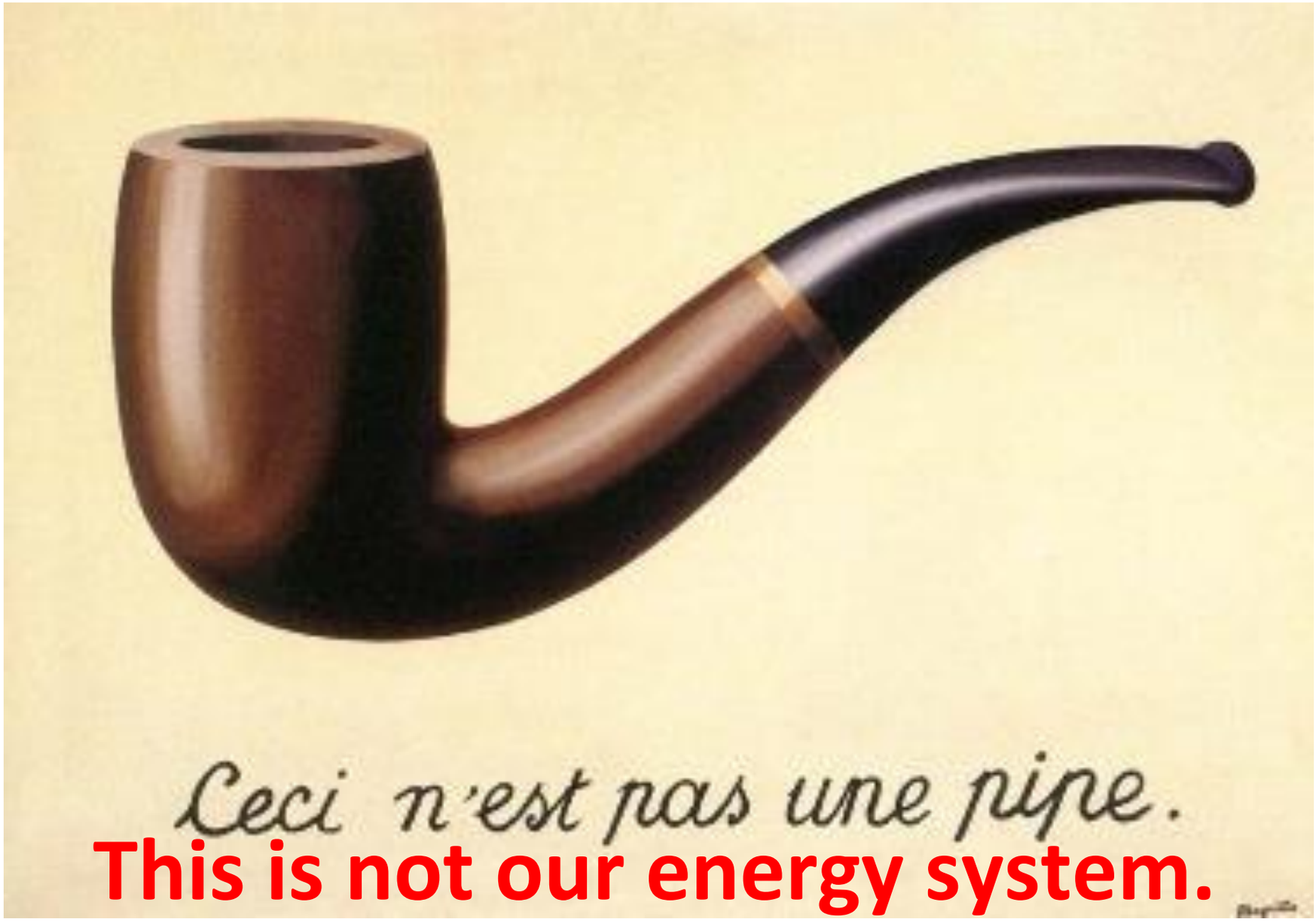
Building a common scenario: our approach - your feedback

Building a common scenario: our approach - your feedback



This is not our energy system.

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Deeper dive into the generation side

How grid operators build their scenario: Overview of generation side modelling for the Ten-Year Network Development Plan (TYNDP)

Dante Powell, ENTSO-E

Building our scenario: Phasing out coal

- National phase-out plans will be implemented or even anticipated (DK, EL, FI, FR, HU, IE, IT, NL, SK), announced retirements as of Sep. 2019 will be implemented.

- If no national phase-out plan exists, expected retirement is based on assumption of 50y lifetime. CHP capacities will be retired later. Country-specific analysis for DE + PL.

- By 2030, all EU coal capacities have higher long-run operating costs than renewables (Carbon Tracker, Nov. 2018), e.g. DE lignite uneconomic during half of all hours in Q2/2019 and will remain uneconomic (Sandbag, July 2019).

- Full load hours are likely to decrease strongly. Current carbon price trends drive an earlier retirement of capacities. Investors prefer to avoid stranded assets risk.

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Building our scenario: Phasing out lignite

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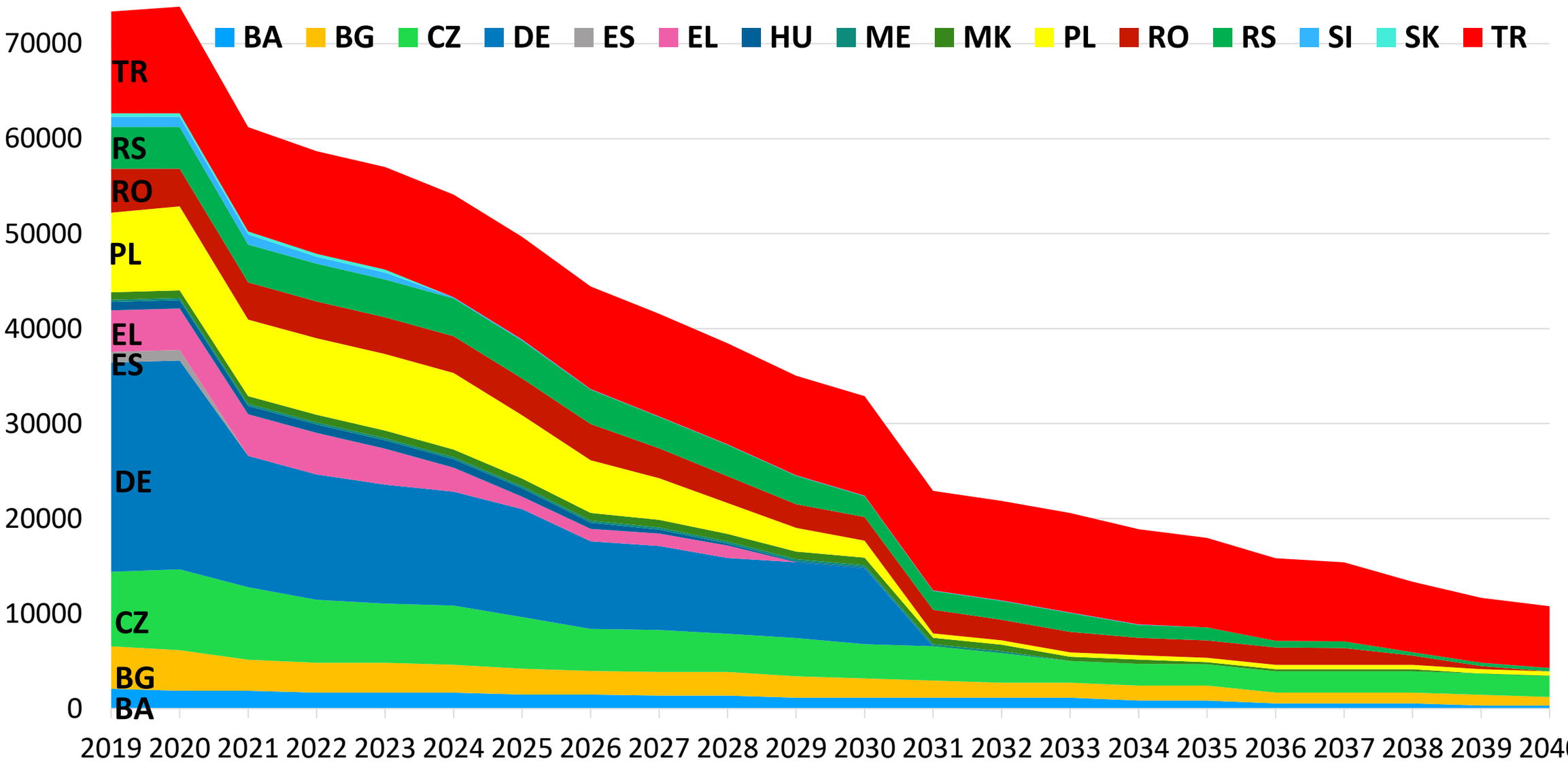

Building our scenario: Phasing out hard coal

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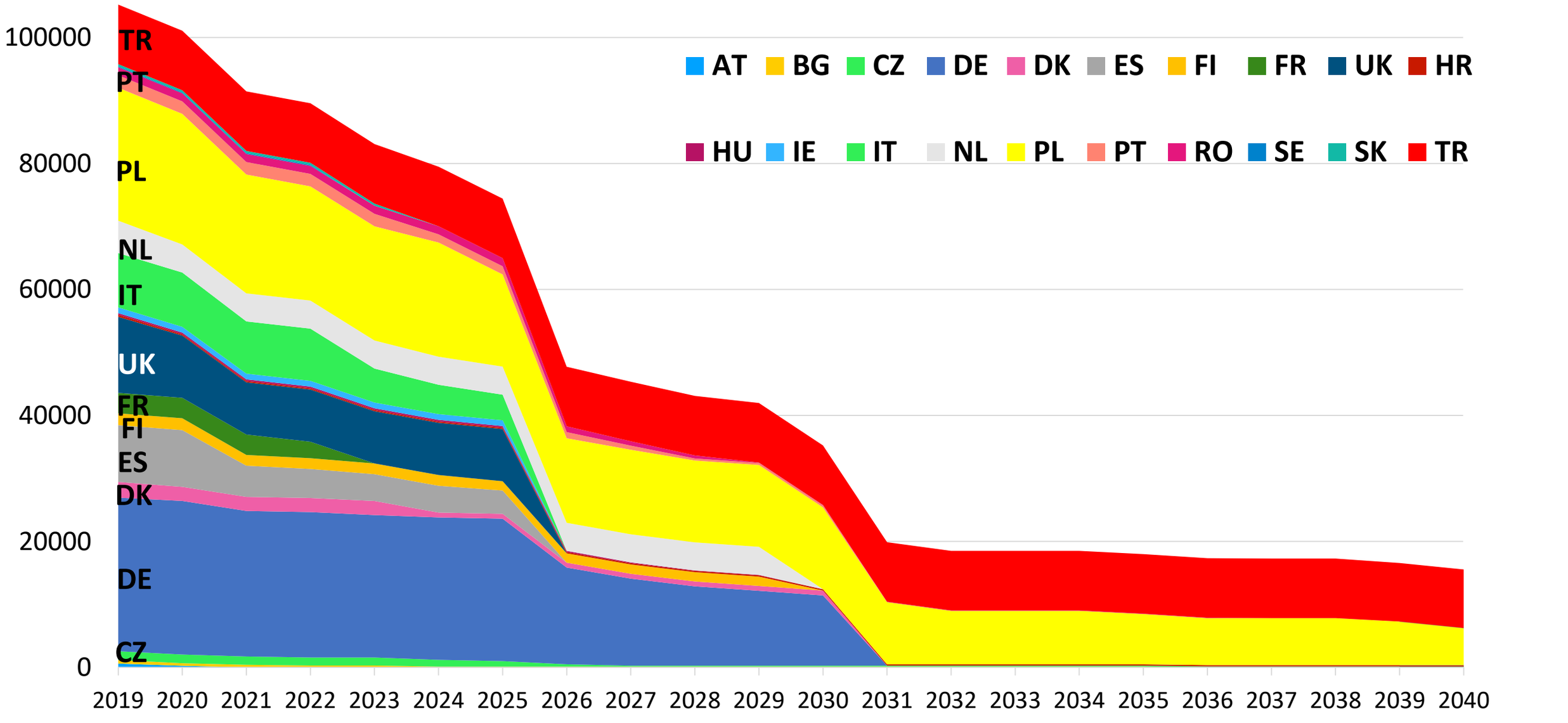

Building our scenario: Phasing out coal

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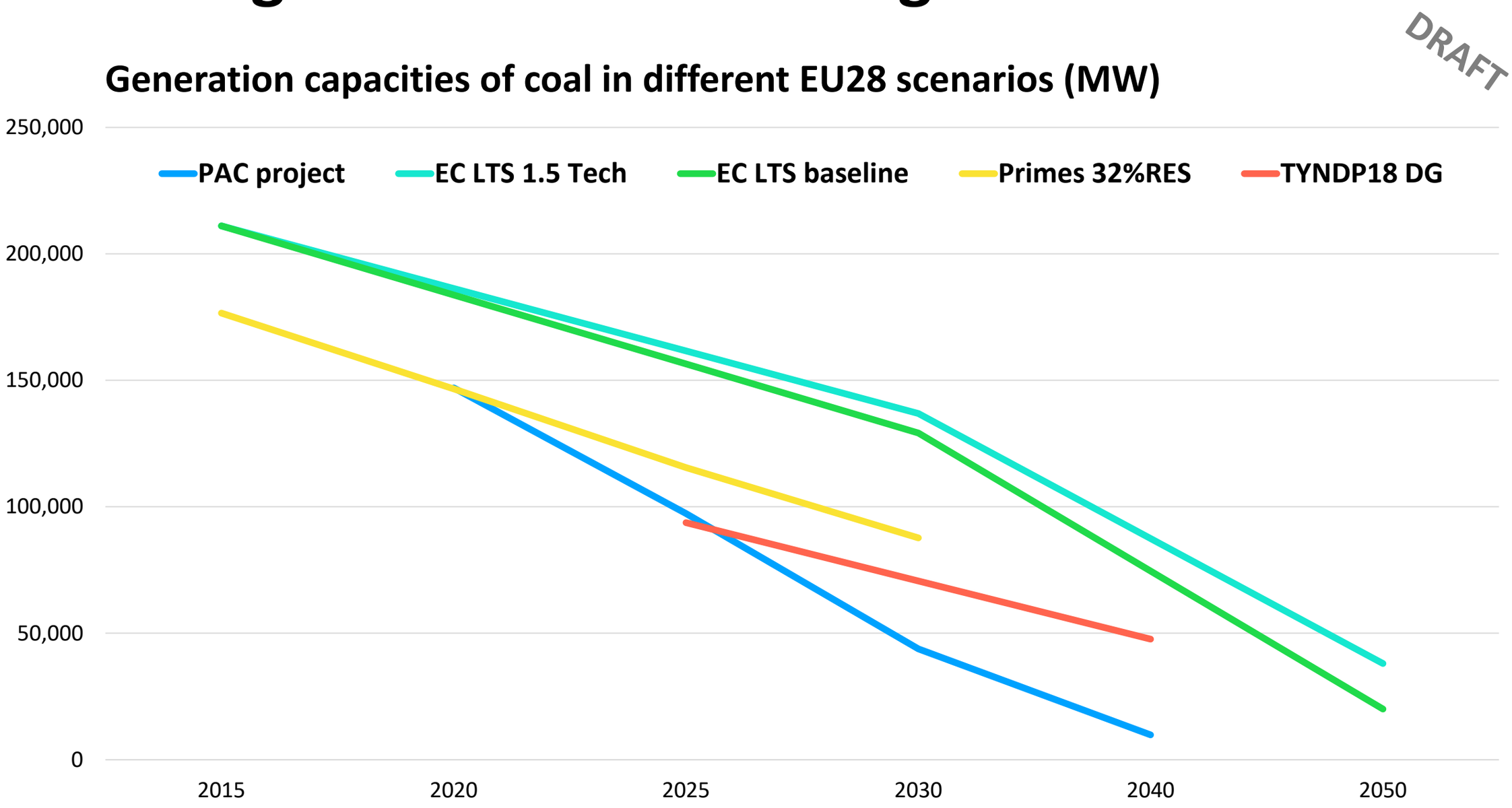

Building our scenario: Phasing out oil

Main assumptions (for net-zero 2050)

- No more fossil fuels in transports by 2050
- Full electrification of private cars by 2050
- Freight covered in priority by electrification, then H2 and/or PtL
- Aviation demand mostly covered by e-fuels and marginally biofuels
- Shipping covered by a mix of electricity and fuel cells
- Slight but constant increase of passenger activity in all sectors

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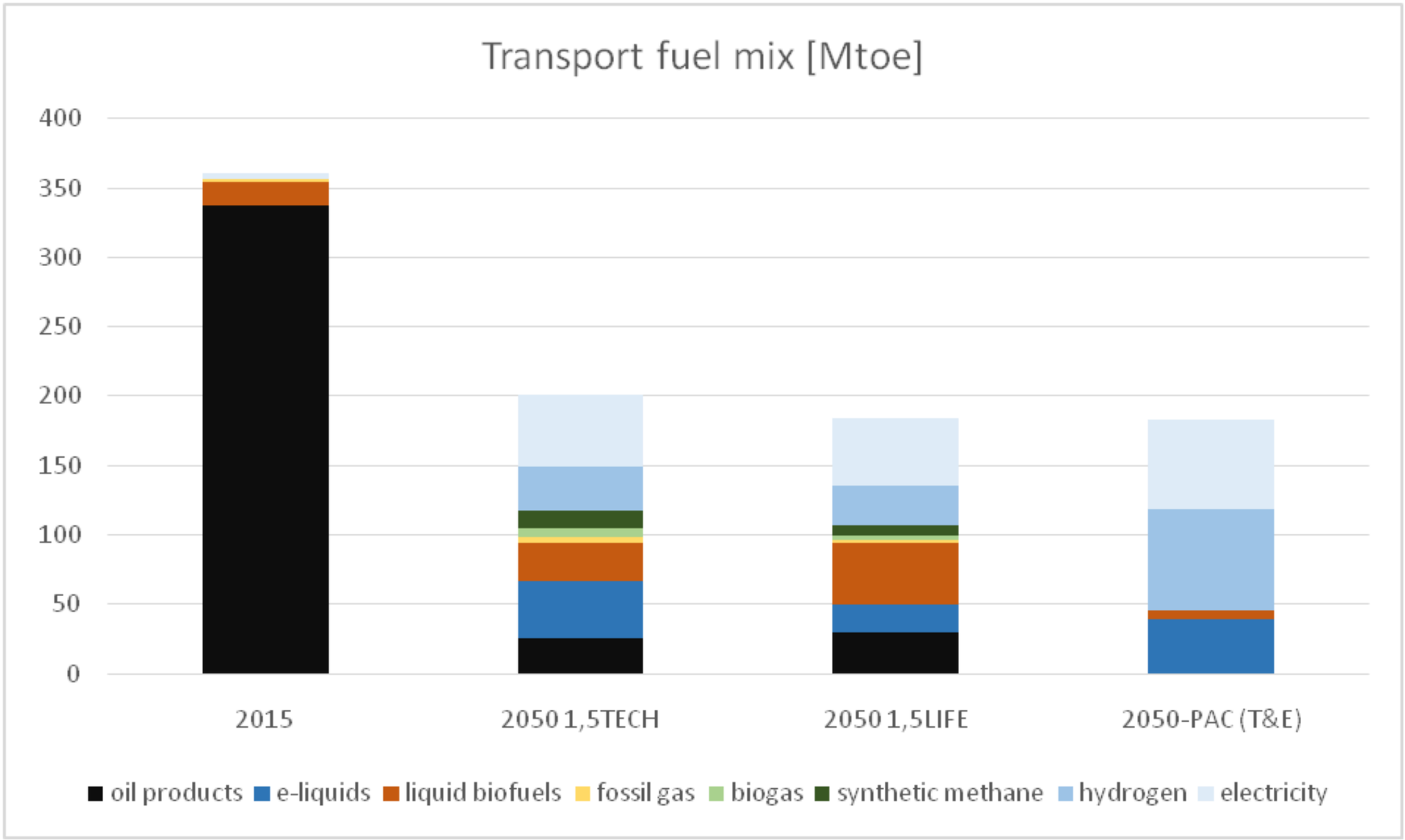
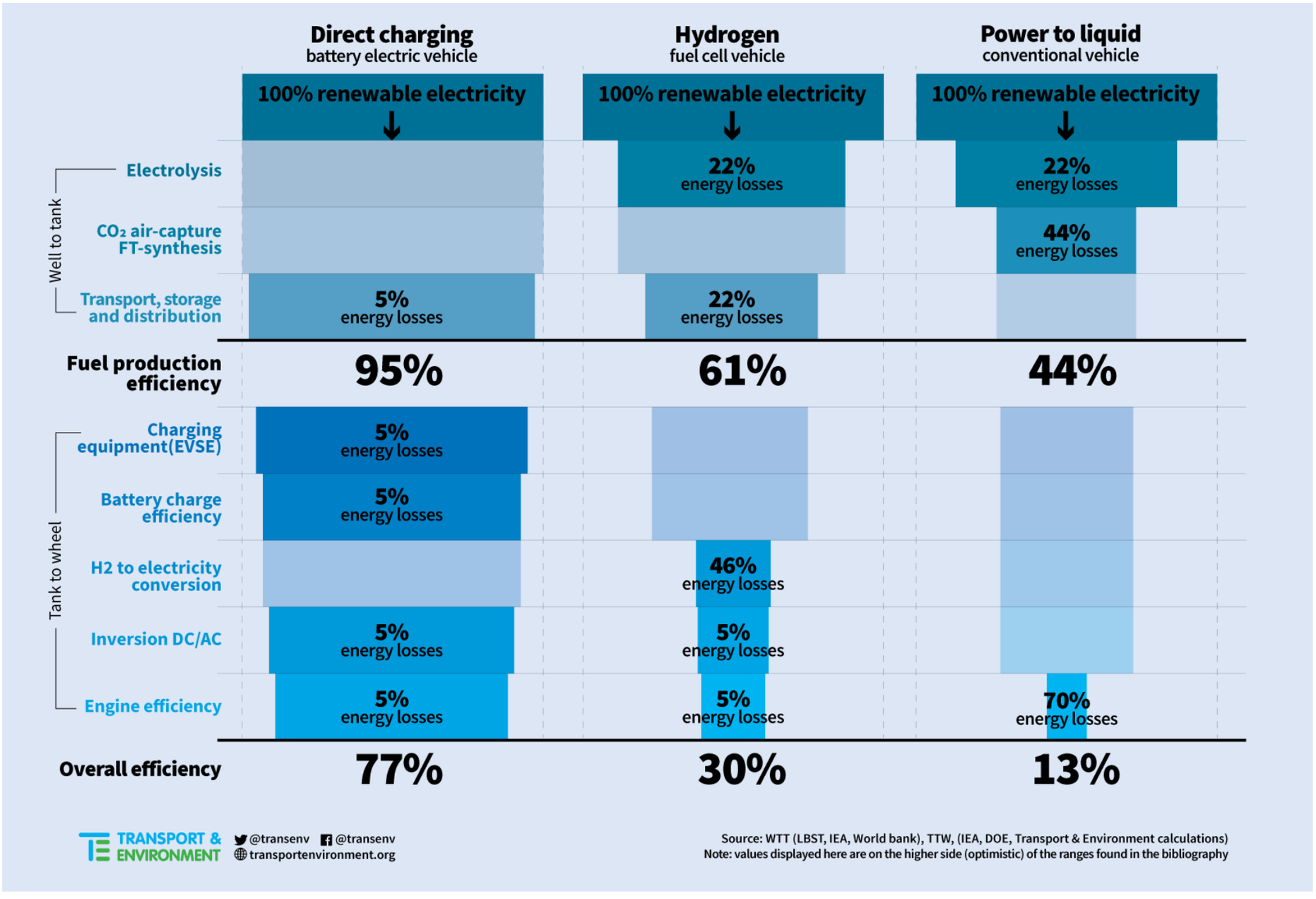
Results (for net-zero 2050)



Efficiencies



Building our scenario: Phasing out fossil gas

- CAN Europe policy demand to phase out fossil gas by 2035 to maintain the EU‘s chances to deliver on climate objectives in line with the Paris Agreement.
- Implementing energy efficiency measures in buildings and electrification of the heating sector will massively reduce fossil gas demand.
- A substitution of coal in electricity and heating by fossil gas would mean Europe remains on emission levels that make a net-zero emissions target by 2040 unlikely.
- Climate impact of methane leakage has been underestimated and might turn into driver for fossil gas phase-out.
- Fossil gas demand apparently has been overestimated in previous scenarios.

Building our scenario: Phasing out nuclear

- Newly added capacities are not realistic due to high investment costs and competition of renewables. Currently planned capacities (UK: Hinkley Point, SK: Bohunice, HU: Paks, BG, CZ, PL) won't be built. Replacement of FR capacities with EPR is not realistic.

- Capacities at an advanced stage of construction will be completed (FI: Olkiluoto 3, FR: Flamanville, SK: Mochovce 3&4).

- Expected retirement of specific units is based on country profiles of the World Nuclear Association, but limited to ca. 40 years of lifetime unless national governments endorsed any explicit lifetime extension.

- Increasing costs of maintenance, of the nuclear fuel chain and decommissioning costs need to be assessed as potential drivers of retirements.

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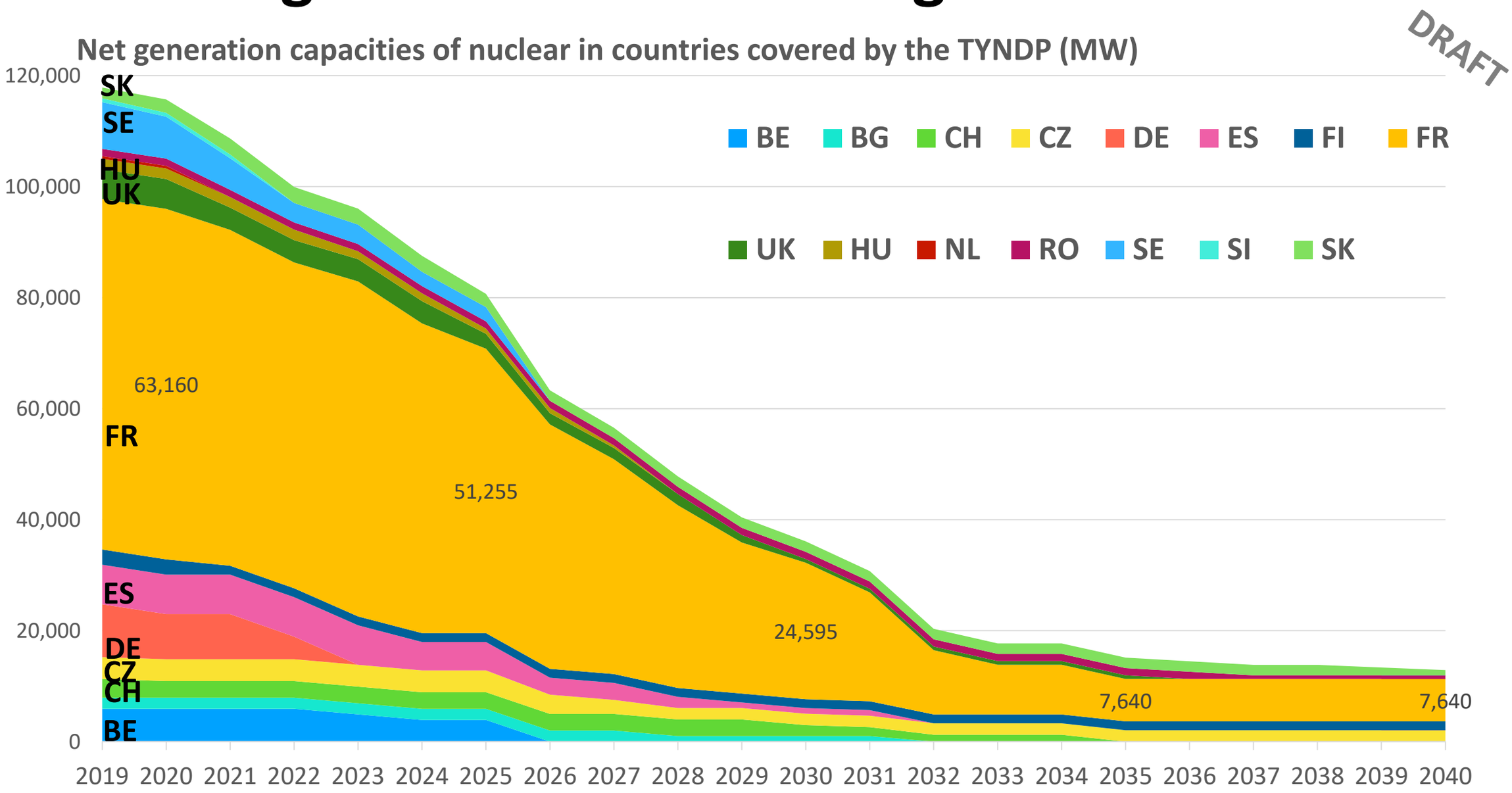
Building our scenario: Phasing out nuclear



Building our scenario: Phasing out nuclear

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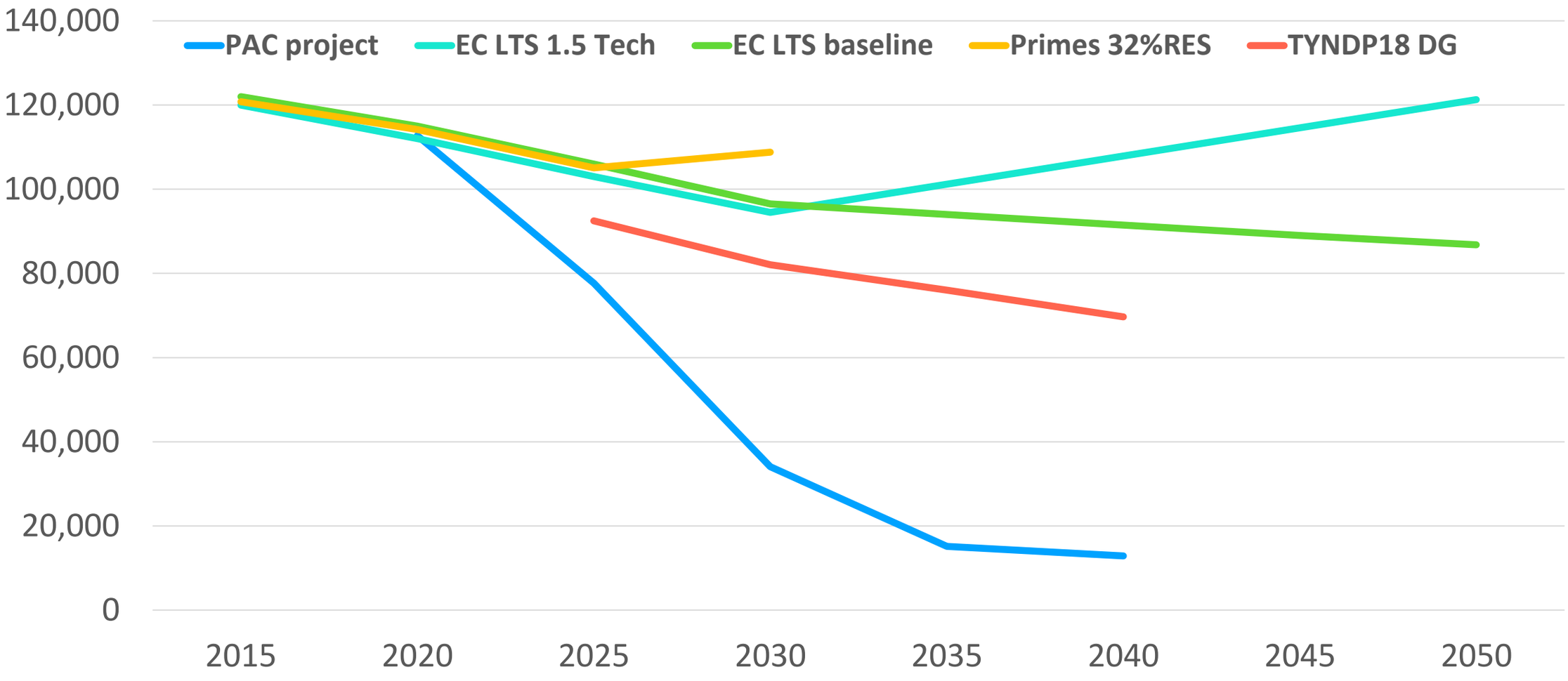
Net generation capacities of nuclear in different EU28 scenarios (MW)



Building our scenario: Reaching 100% renewables

- Adopting variable renewables potentials from LUT Energy System Transition model, based on an integrated assessment of renewable energy potentials in electricity, heat and transport sectors, including optimisation with different storage technologies.

- **Wind onshore**: Capex 2020: 1,150€/kW; 2030: 1,000€/kW; 2050: 900€/kW; 25y lifetime.

- **PV** optimally tilted: Capex 2020: 680€/kW; 2030: 480€/kW; 2050: 300€/kW;
  PV prosumers: Capex 2020: 1,090€/kW; 2030: 760€/kW; 2050: 500€/kW;
  2020: 30y lifetime; 2030: 35y lifetime; 2050: 40y lifetime

- **Wind offshore**: adopting scenario with LCOE 5.6 to 6.0 ct/kWh (BVG Associates/WindEurope, June 2019)

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Building our scenario: Solar PV

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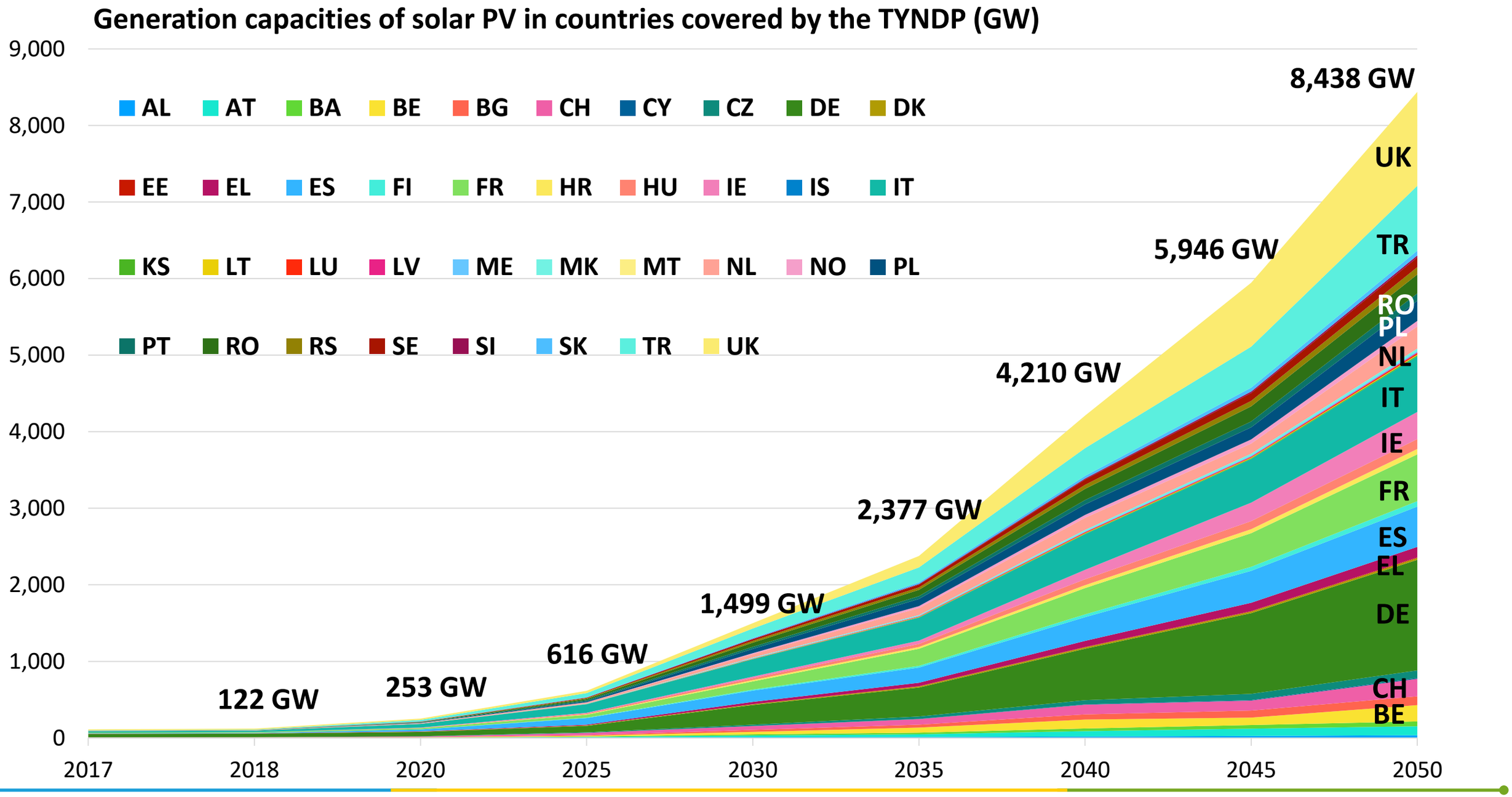

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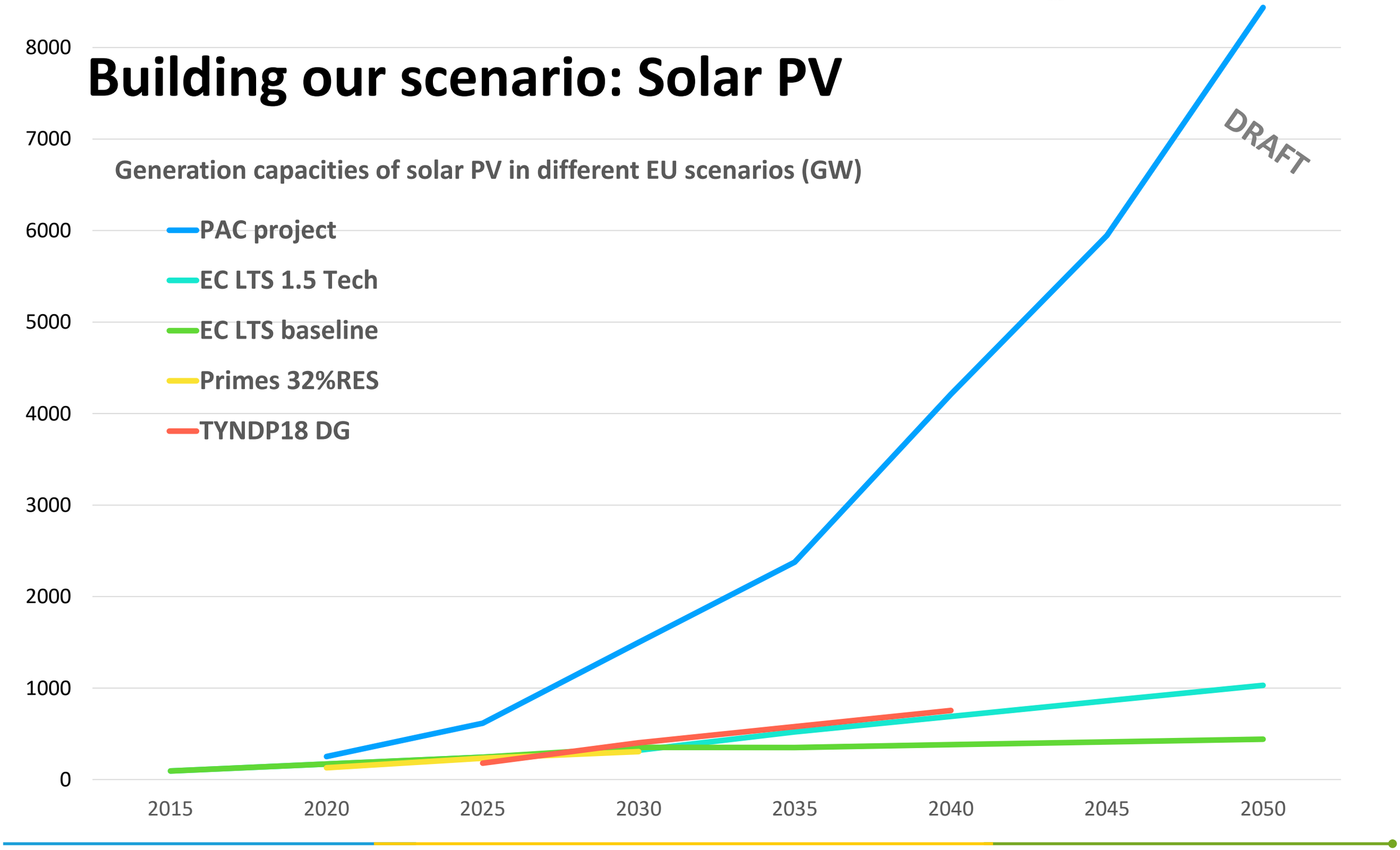
Building our scenario: Solar PV



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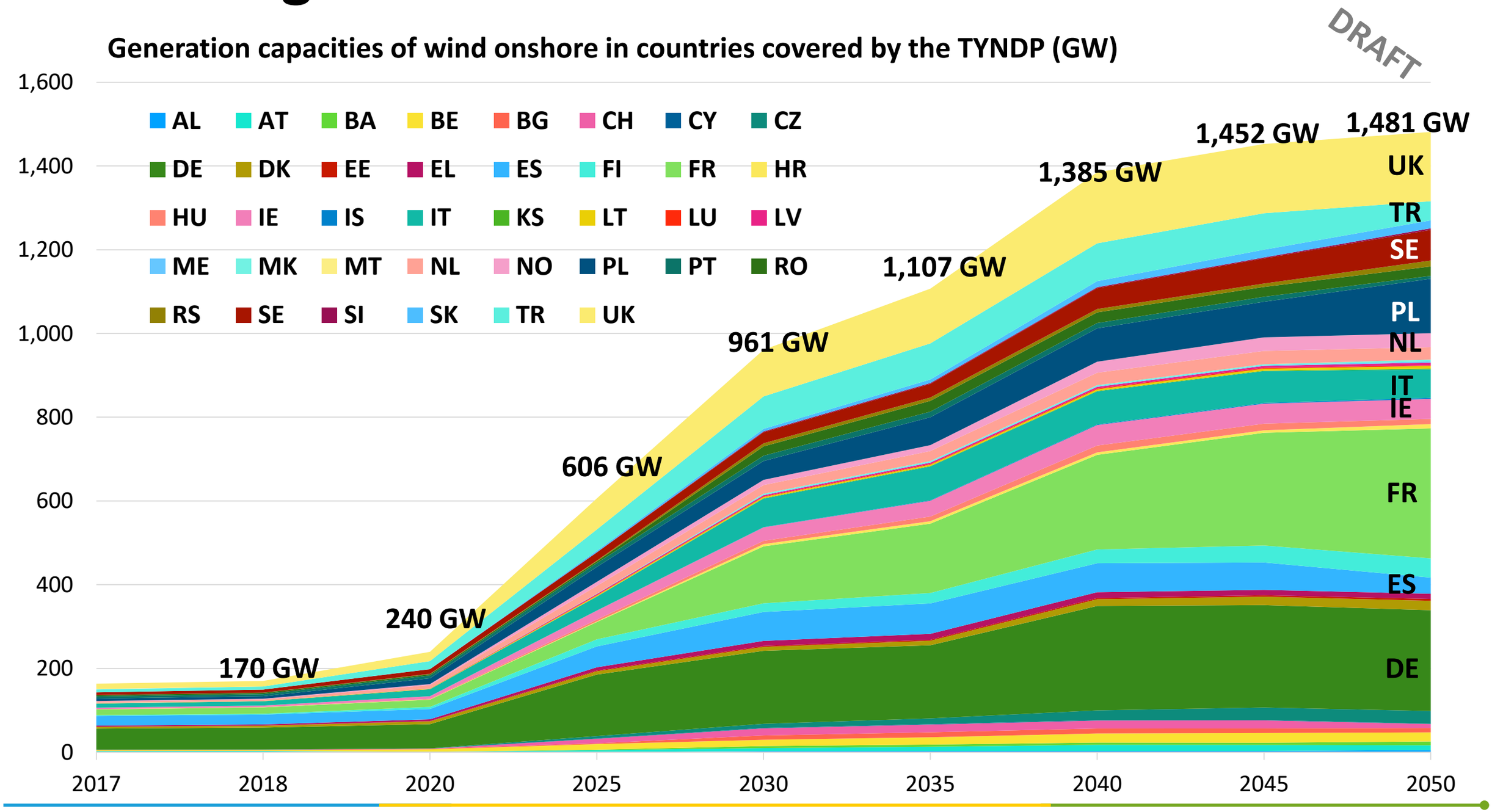
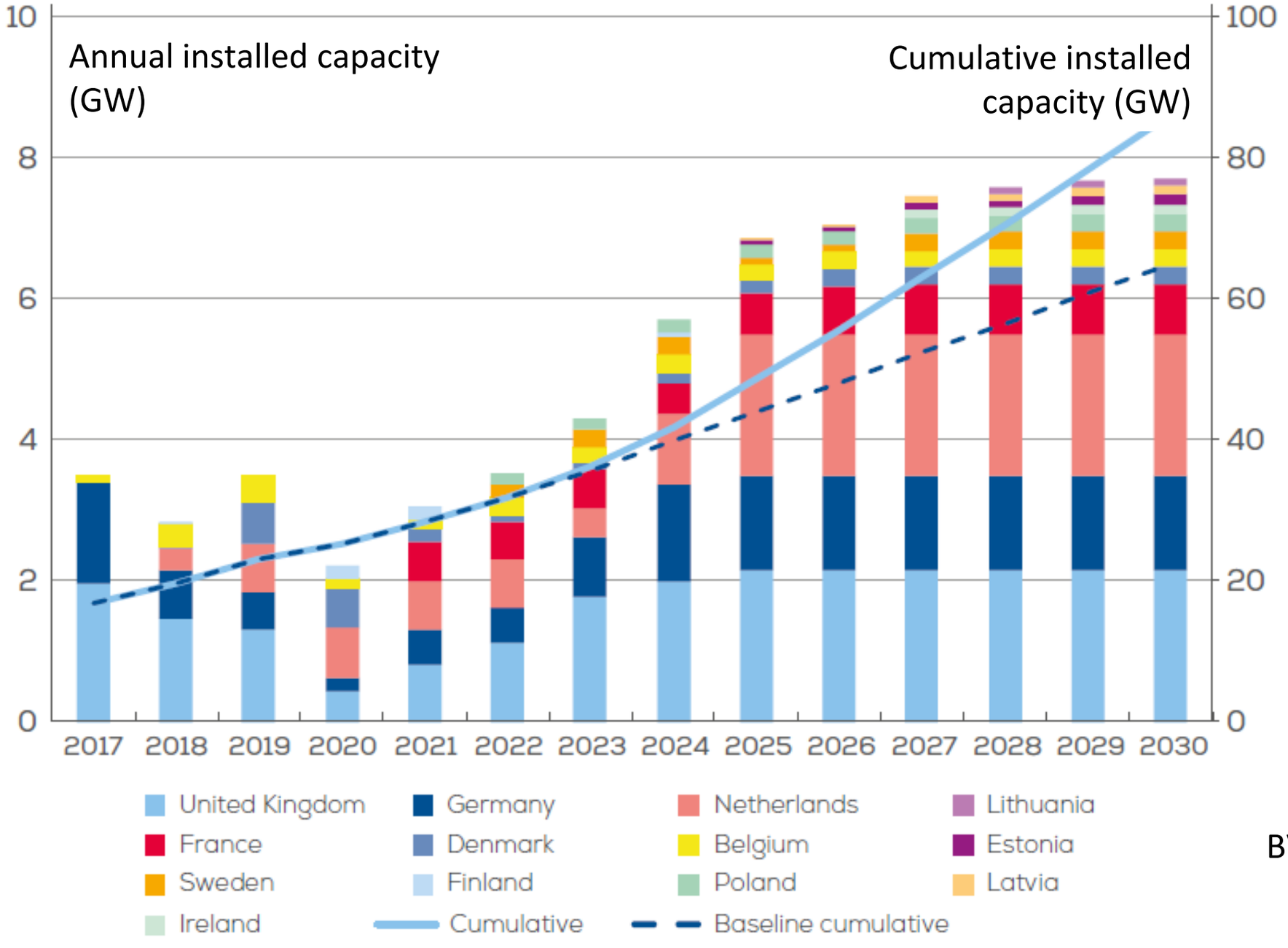
Building our scenario: Wind onshore



Building our scenario: Wind offshore



BVG Associates

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Building our scenario: Wind on/offshore

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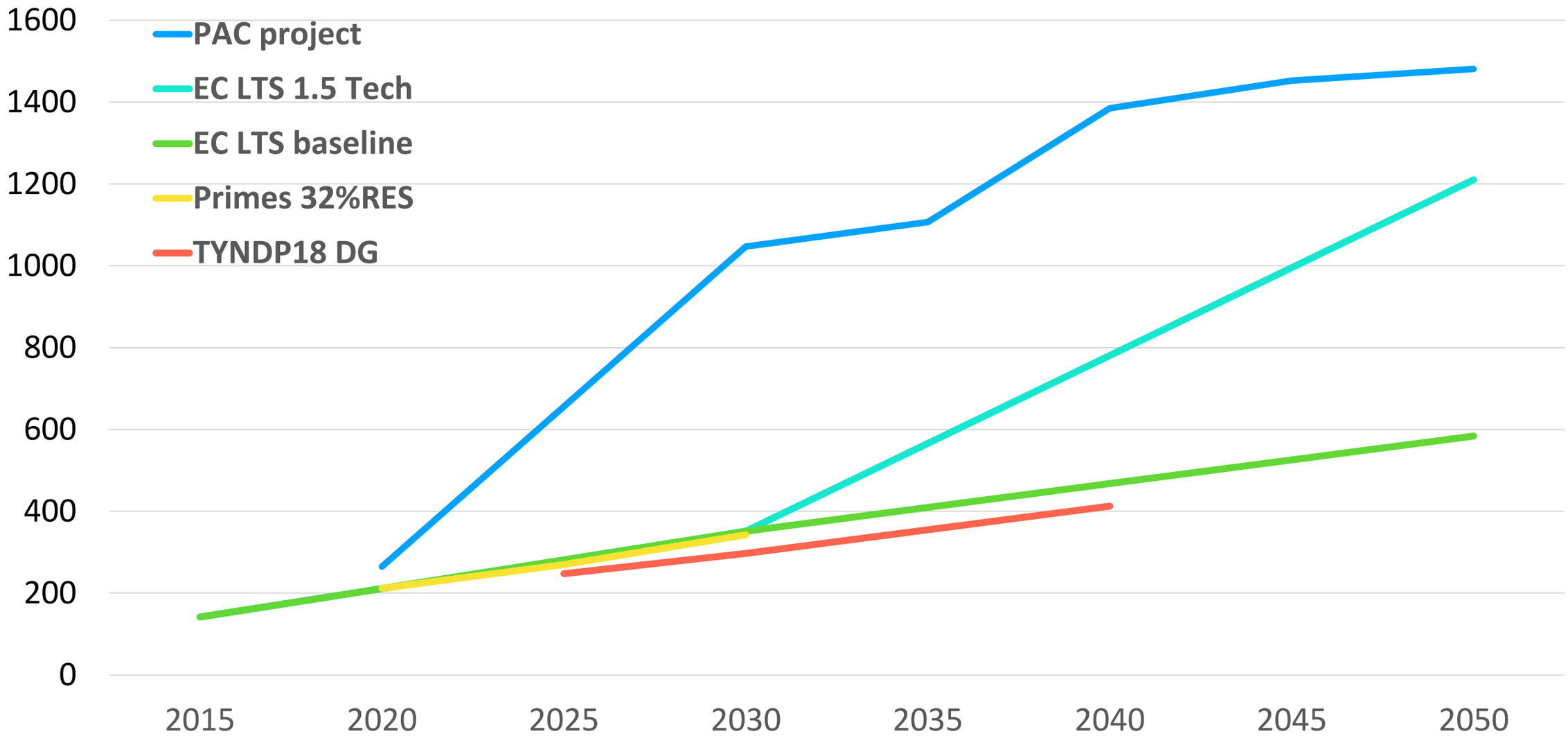
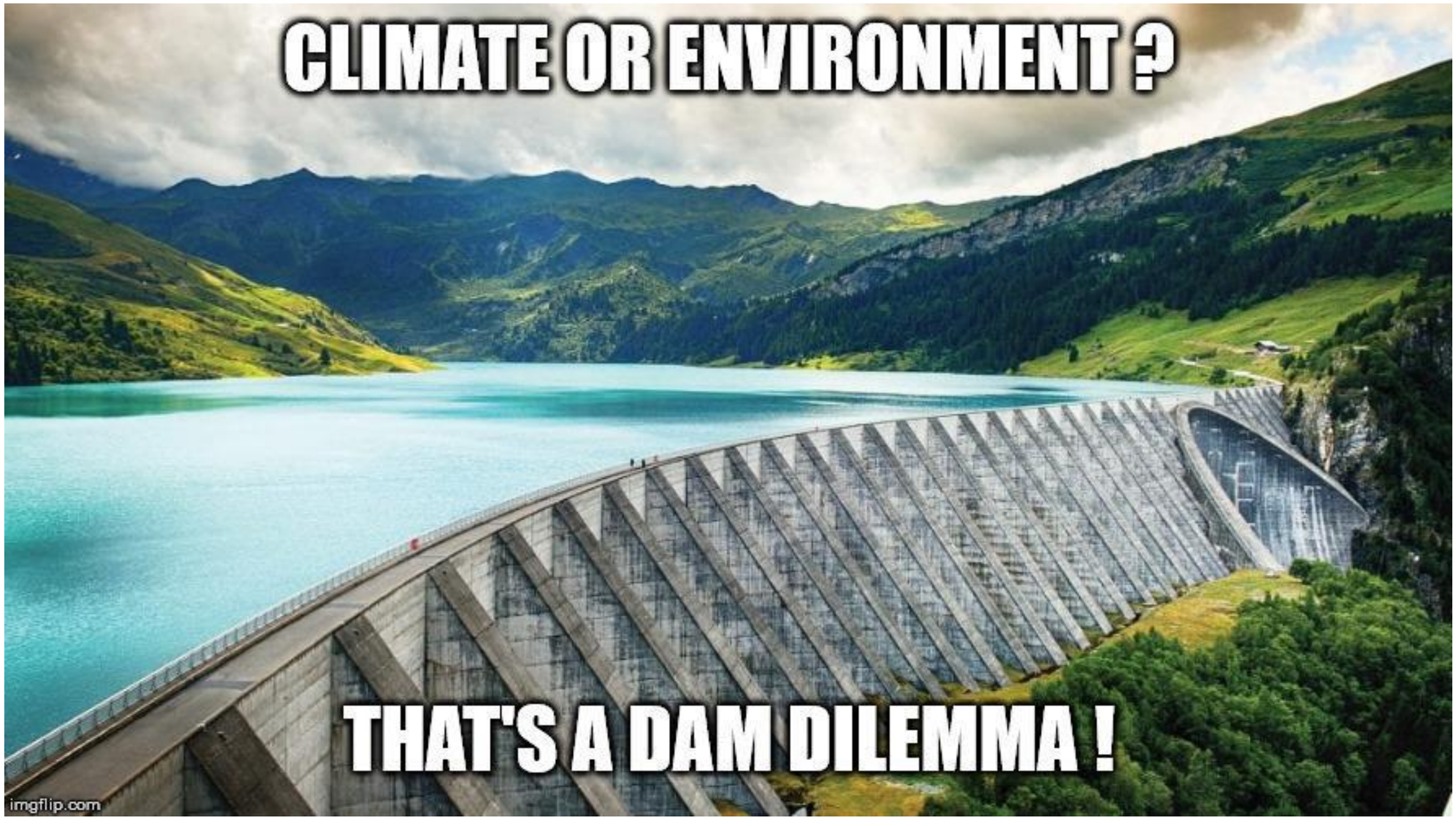
Generation capacities of wind on/offshore in different EU scenarios (GW)



REN21 EEB European Environmental Bureau Renewables Grid Initiative CAN Climate Action Network Europe

Building our scenario: Reaching 100% renewables

- Assumptions on dispatchable renewables (hydropower, biomass)
- We will integrate the potential of geothermal energy and heat pumps but we do not cover these energy sources and technologies in this workshop yet.


CLIMATE OR ENVIRONMENT ?
THAT'S A DAM DILEMMA !
imgflip.com

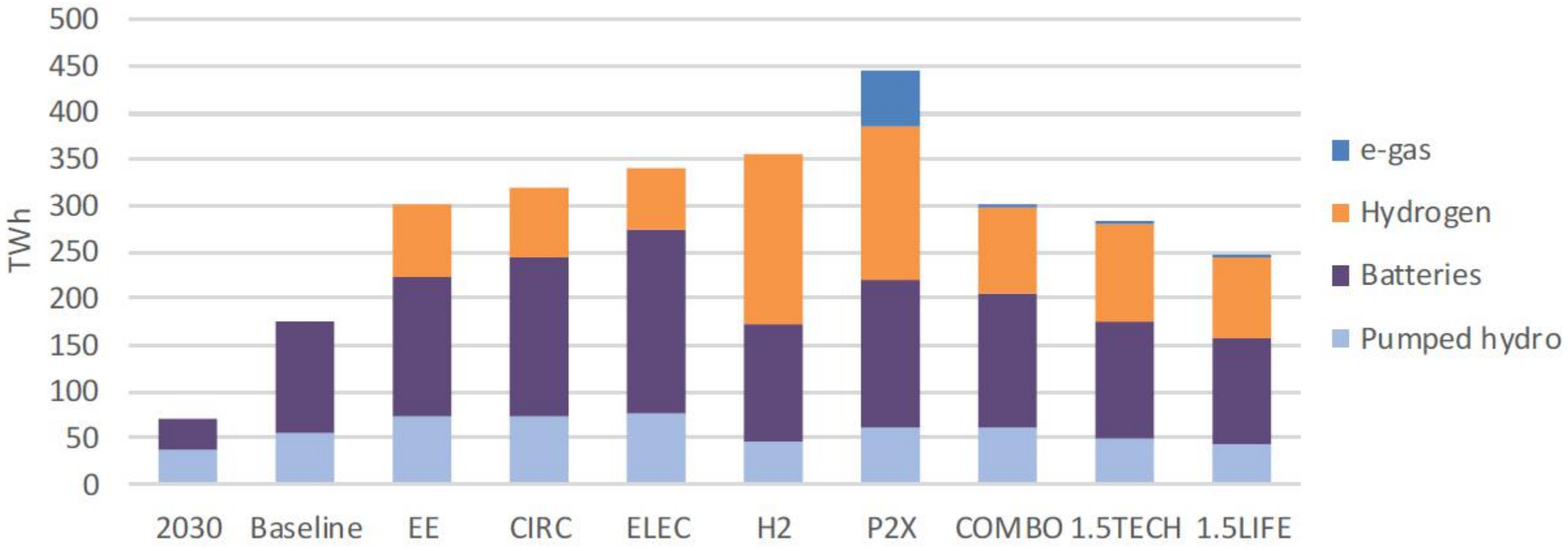
Building our scenario: Hydropower

Main assumptions:

- No more new hydropower capacity
- Potential decommissioning on a case-by-case analysis
- Potential refurbishment for increasing efficiency
- Pumped storage : upgrade of existing facilities possible
- New pumped storage : case-by-case ?

Results

Figure 26: Electricity storage in 2050



Source: PRIMES.

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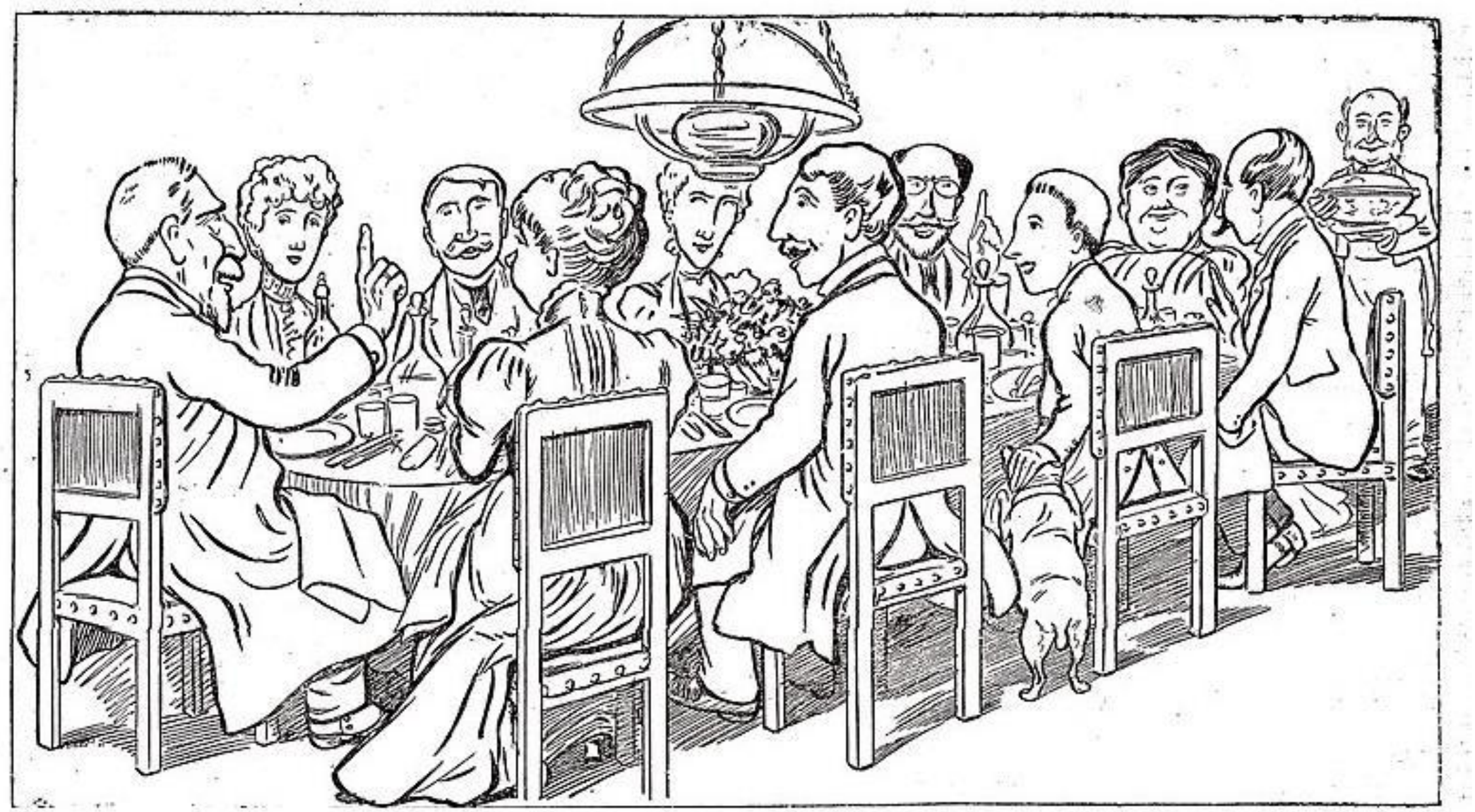

Today, let’s not talk about bioenergy!

REN21 EEB European Environmental Bureau Renewables Grid Initiative CAN Europe

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Scenarios for Energy Infrastructure

…and they talked about it…

REN21 EEB European Environmental Bureau Renewables Grid Initiative CAN Europe

Main assumptions

- Biomass-electricity only phase out by 2030
- Incineration phase-out by 2040
- Crop-based biofuels constant until 2030, then phased out
- District heating biomass following EU LTS 1.5LIFE slope from 2030 to 2050
- Individual heating biomass following EU LTS 1.5LIFE slope from 2030 to 2050

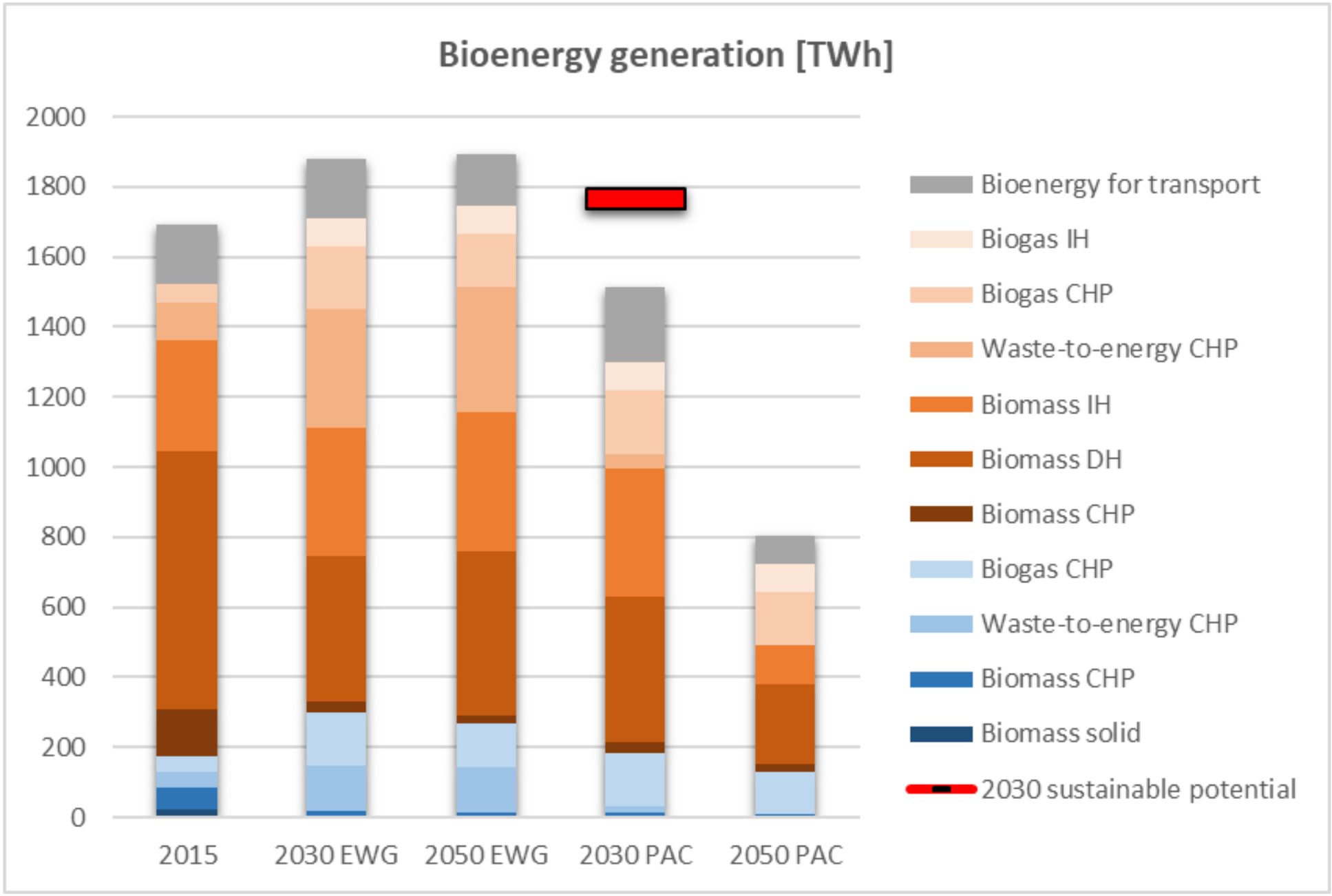
Potentials

Biomass source	Low risk quantity suitable for energy use (Mtoe) in 2030
Agricultural waste	52.4
Non-forest / industrial woody residues	42.6
Manure	18.9
Forest harvesting residues	10.4
Ligno-cellulosic waste	8.1
Forest stemwood	7.6
Energy crops[43]	*7.4 (equivalent to 1.34 Mha of land used for energy crops)*
Sewage	3.0
Used Cooking Oil	1.2
Landfill gas	0.5

Potentials

POTENTIAL (Mtoe)	2020	2030
Technical potential of biomass for energy (after excluding the demand by other sectors)	318	287
Low environmental risk potential of biomass for energy according to the aforementioned study and associated assumptions	172	152
DEMAND (Mtoe)	**2020**	**2030**
National Renewable Energy Action Plans 2020	140	-
EU 2050 Roadmap Reference Scenario (2013)[45]	153	163
Commission 2030 impact assessment reference scenario	-	178
Commission 2030 impact assessment GHG40/EE/RES30 scenario	-	192
Greenpeace Energy [R]evolution scenario for EU27 (2012)	-	154

Results


Bioenergy generation [TWh]
2000
1800
1600
1400
1200
1000
800
600
400
200
0
2015
2030 EWG
2050 EWG
2030 PAC
2050 PAC
Bioenergy for transport
Biogas IH
Biogas CHP
Waste-to-energy CHP
Biomass IH
Biomass DH
Biomass CHP
Biogas CHP
Waste-to-energy CHP
Biomass CHP
Biomass solid
2030 sustainable potential

Building our scenario: Reaching 100% renewables

- **Non-fossil gases** = H_2 and synthetic CH_4 produced with renewable electricity or biogas/biomethane based on waste and residues, with genuine climate benefits, fossil H_2 combined with CCS/CCU is currently neither realistic nor desirable

- Strongly diverging ranges of the potentials of different non-fossil gases in the EU:
  14 bcm synthetic CH_4, 95 bcm biomethane, 162 bcm renewable H_2 (Navigant, Mar. 2019),
  32 bcm synthetic CH_4 and biomethane (ICCT, Oct. 2018) by 2050

- Need to (politically) prioritise the allocation of non-fossil gases to balancing the energy system, for long-term storage and sectors that are most difficult to decarbonise

- Imports of non-fossil gases are currently neither realistic nor desirable

Building our scenario:
How to guarantee security of supply and flexibility?

Assumptions on demand side response and flexibility options

Holger Loew, RGI

Summary:
Identifying gaps and priorities

- Which assumptions could you support? Which ones would you reject?
- On which elements of the energy mix should the PAC project focus more?
- On which topics would you like to engage in a bilateral exchange with the PAC project?

Thanks for coming!

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