Pathways to Carbon Neutrality

(slides courtesy of UNECE)

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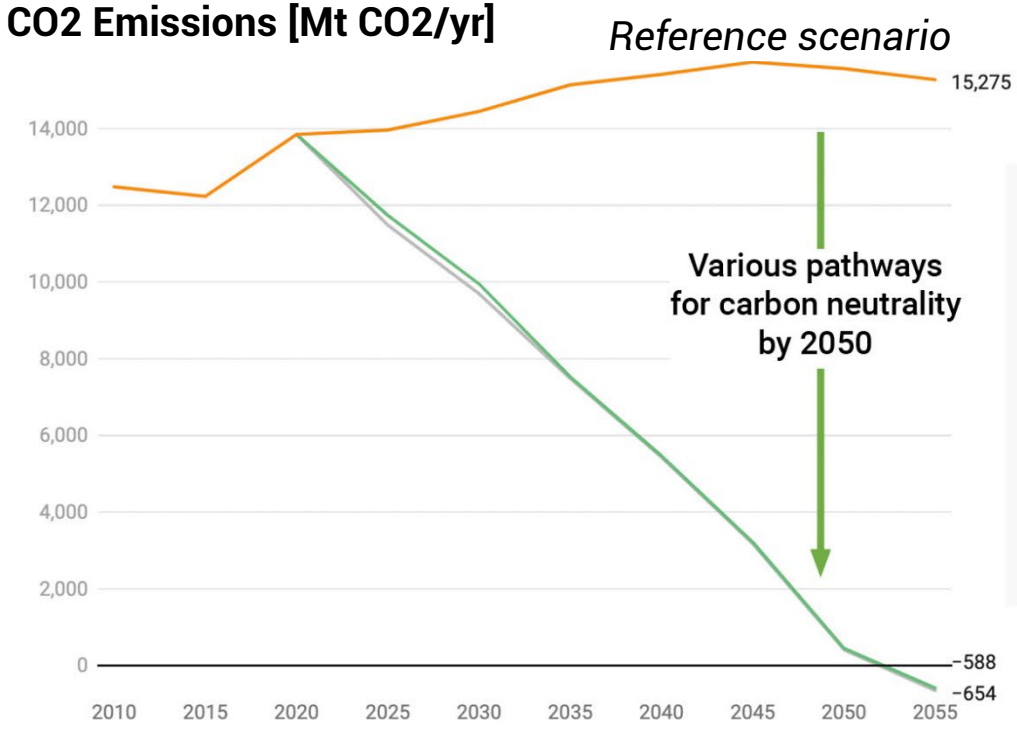
Actions fall short on delivering carbon neutrality

How big is the gap?

Size of Problem
– CO2 Emissions in the UNECE region
[Mt CO_2eq]

UNECE countries must cut/capture at least 90Gt of CO_2 by 2050 to meet 2°C. There are variety of pathways to attain carbon neutrality in the UNECE region.



Reducing the environmental footprint of the energy sector by

- Deploy low- and zero-carbon technologies
- Increase capacity of natural carbon sinks
- Scale-up negative carbon emissions technologies

Modelling of scenarios: a tool for informed decision making

Methodology

Modelling for policymaking climate policy implications for emissions, energy costs, supply security, storage needs, baseload requirement, and variable supply.

- **Modelling of global energy system linked with land use (MESSAGEix-GLOBIOM):** a model widely used for international policy assessment (IPCC reports, Network of Greening Financial Systems (NGFS), GCF Country Program, GIZ SPIPA India/China project, etc.)
- **Modelling based on minimum total discounted cost:** optimizing the global energy-land use system under various technology and policy scenarios to attain carbon neutrality by 2050
- **Modelling necessarily entails numerous assumptions** about various future developments based on *Shared Socio-economic Pathways* #2 (SSP2)

* SSP2 is known as “middle of the road”, resembling a business as usual scenario

** The scenario design in this study does not include the consequences of the Russian-Ukrainian conflict starting in 2022

More info about the model:

https://docs.messageix.org/projects/global/en/latest/

Modelling of scenarios: a tool for informed decision making

Scenario Design

Stakeholder workshops for informing scenario assumptions

Different working groups and stakeholders participated to identify technology market niches and prospects in each deep dive.

- **Reference scenario (REF)**

Based on SSP 2* as point of departure, i.e., without dedicated sustainable energy or climate policies (essentially the REF scenario of the Pathways Project)

- **Carbon Neutrality (CN)**

Normative scenario mandating carbon neutrality of UNECE's aggregate energy system by 2050 (and beyond until 2100)

- **Special technology deep dives**

Hydrogen – production options and markets (H2)

Carbon capture, utilization, and storage (CCUS), including direct air capture(DAC)

Nuclear energy – realizing its potential, new application and markets (NUC)

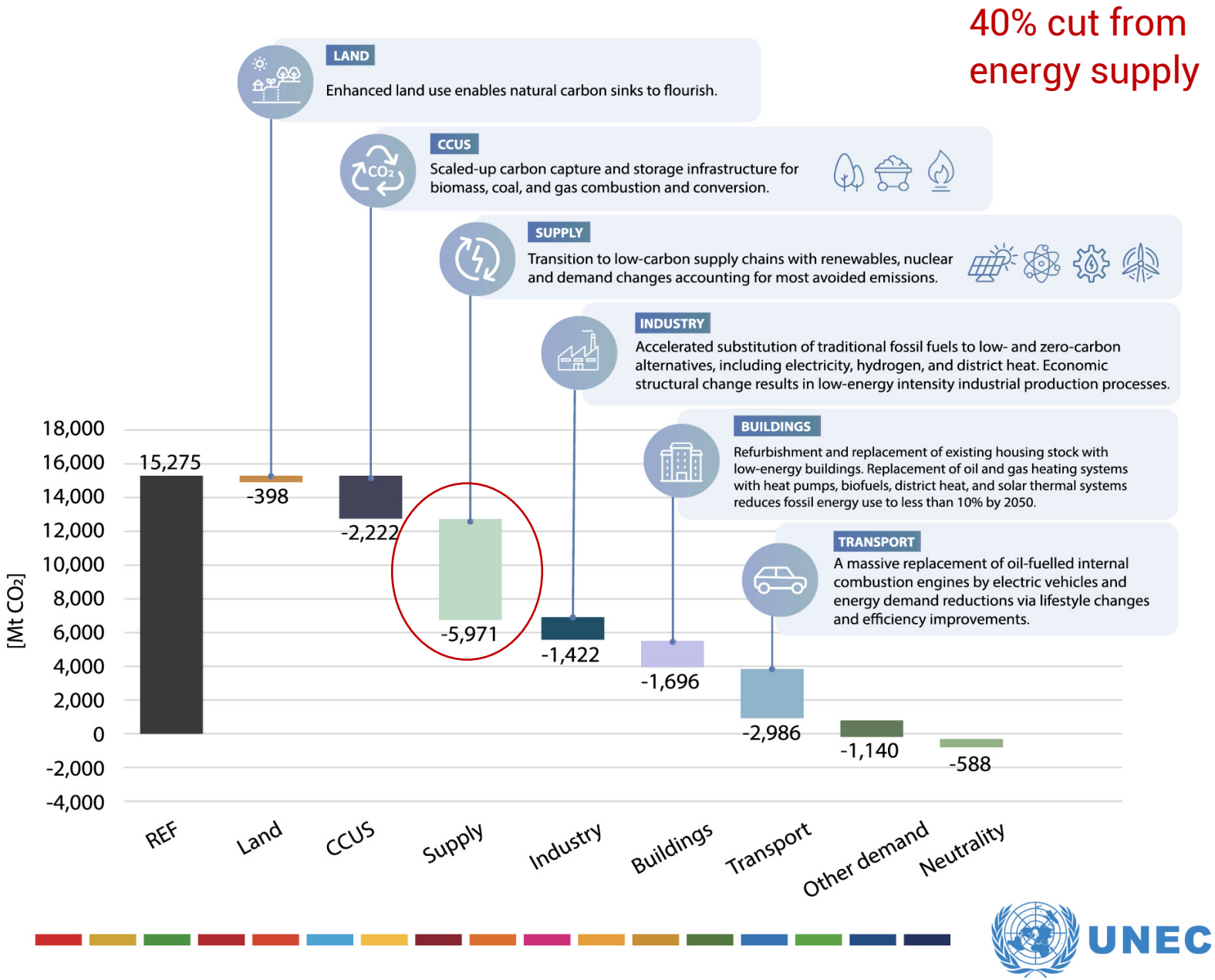
- **Carbon Neutrality Innovation**

All three technology deep dives combined: synergies and benefits

Actions are needed across sectors

How can different energy sectors be decarbonized?

CO_2 mitigation [$MtCO_2$/yr.] **in UNECE, Neutrality vs. Reference Scenarios**



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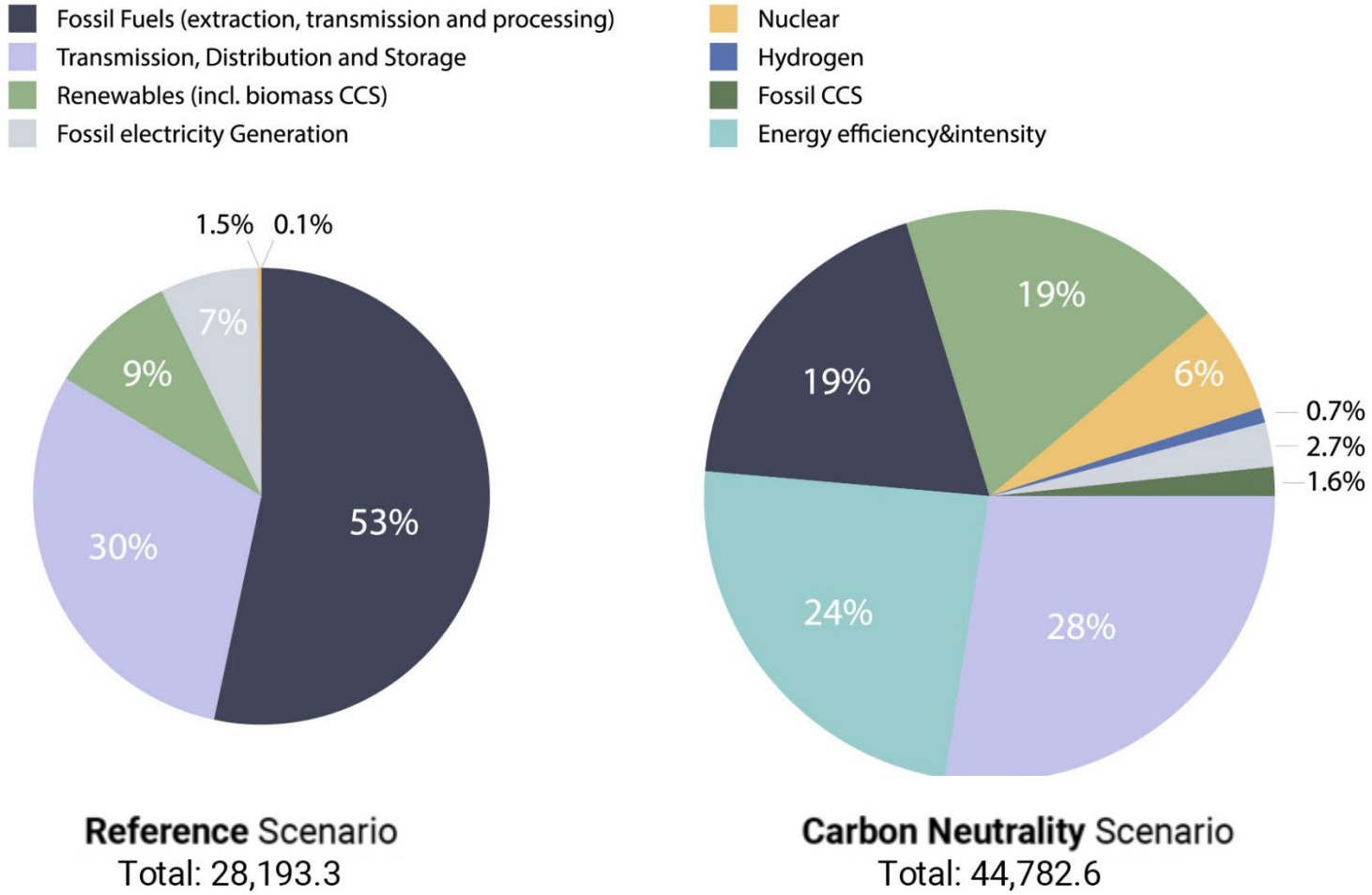
Investments are needed across all low- and zero-carbon technologies

What is the difference between current vs. required spending?



Total Investment Needs for UNECE Energy System Reference and Carbon Neutrality Scenarios [USD, Billion]

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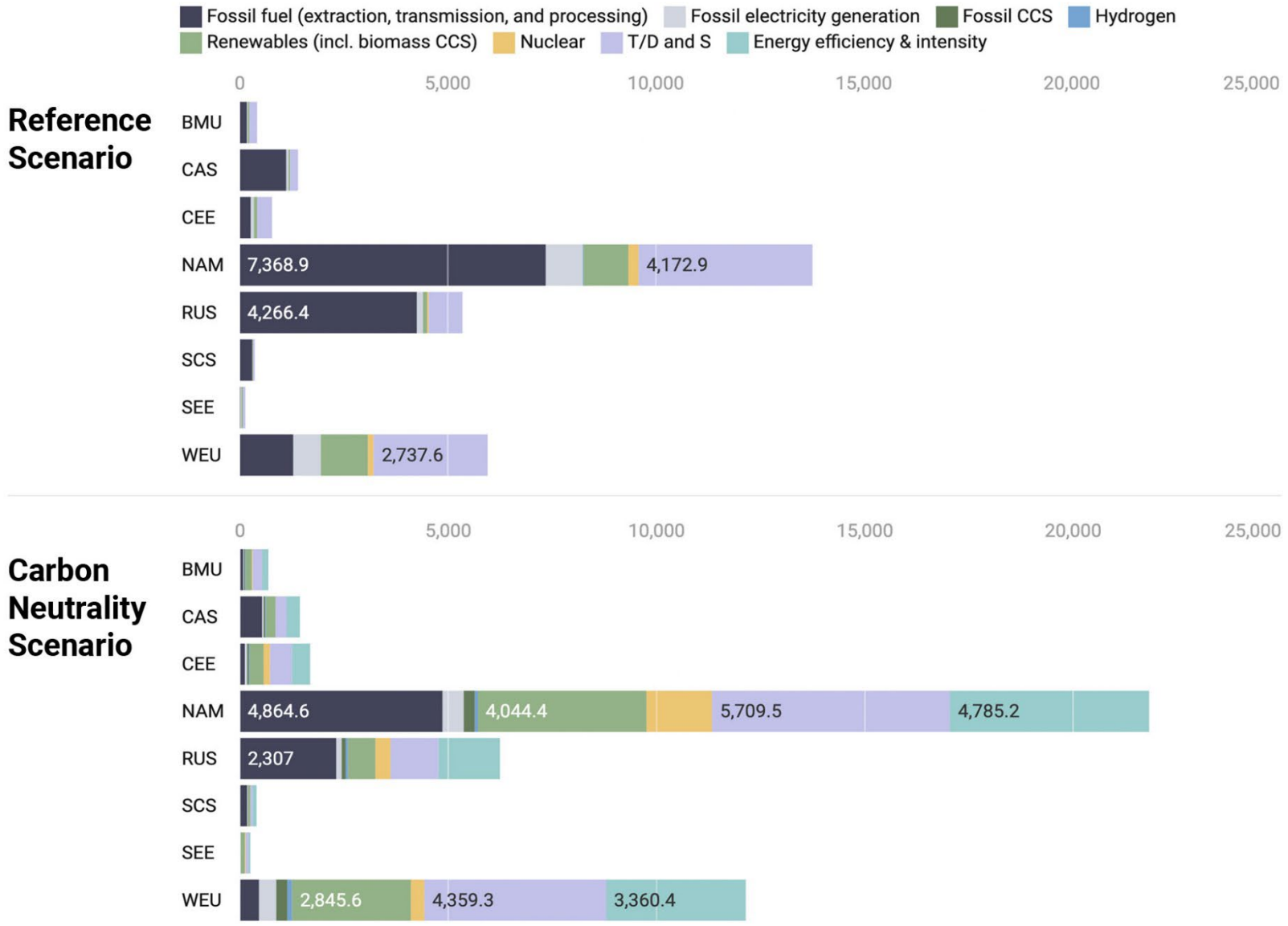
Investing into clean energy infrastructure across UNECE subregions

How do investments vary by subregions?

Total Investment Needs for UNECE Energy System Reference and Carbon Neutrality Scenarios [USD, Billion]



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Investment Dynamics

Reference vs.

Neutrality vs.

Neutrality Innovation

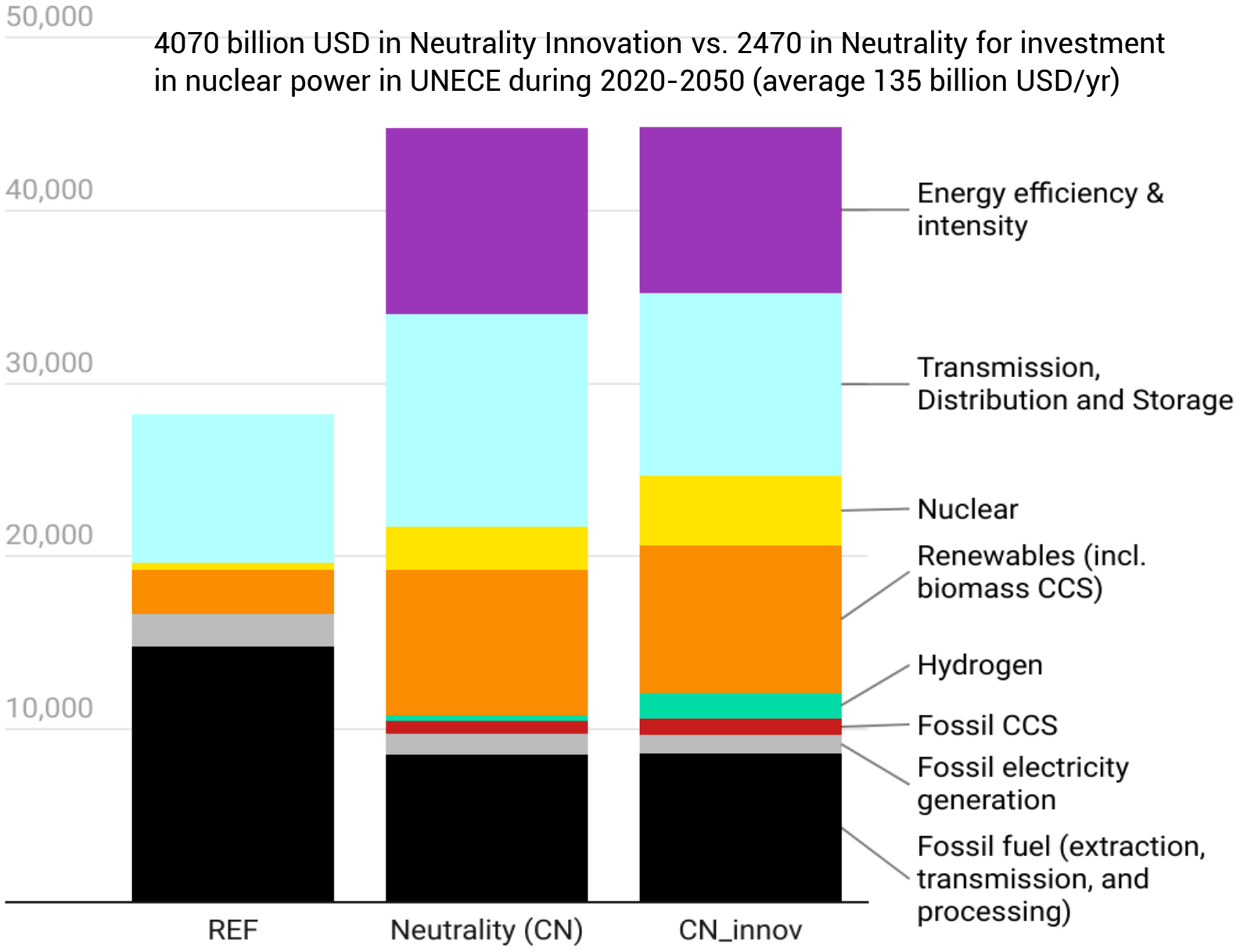
Neutrality Innovation:

64% growth in investment in nuclear power (incl. SMR)

960 GW nuclear power of which 450 GW SMR

Growth of hydrogen economy

4070 billion USD in Neutrality Innovation vs. 2470 in Neutrality for investment in nuclear power in UNECE during 2020-2050 (average 135 billion USD/yr)



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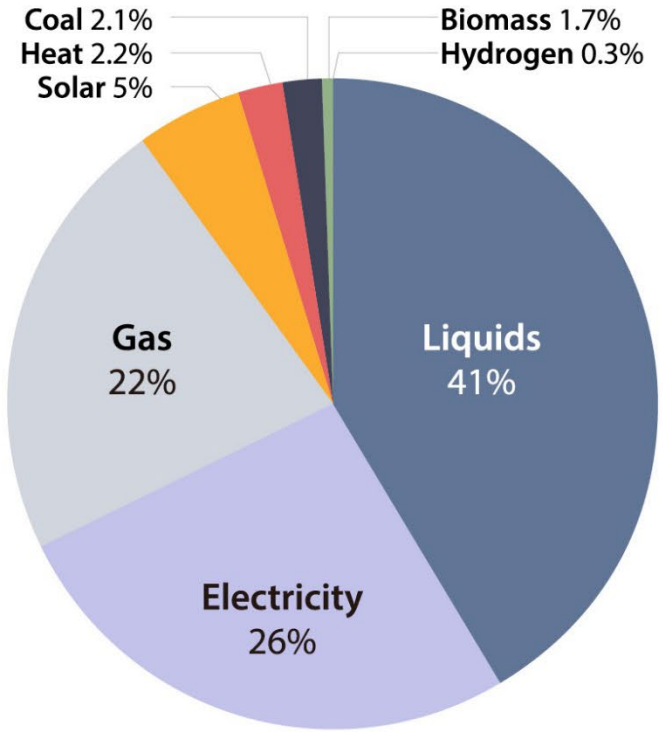
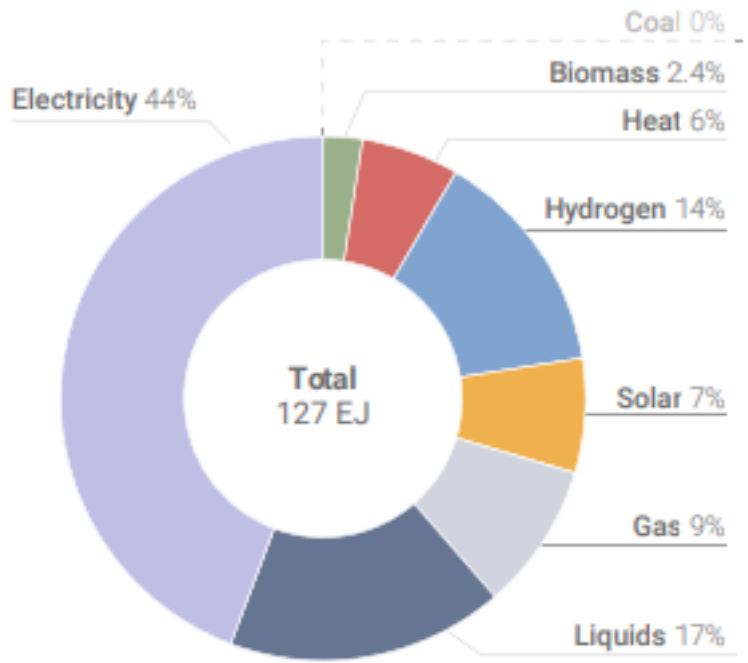
Diversifying resource base to attain a resilient energy system

What energy resources will be at the core of a future energy system?

Final Energy Supply [EJ]
Comparison between Carbon Neutrality and Reference Scenarios



Reference Scenario
Final Energy 2050



Carbon Neutrality Innovation Scenario
Final Energy Supply 2050

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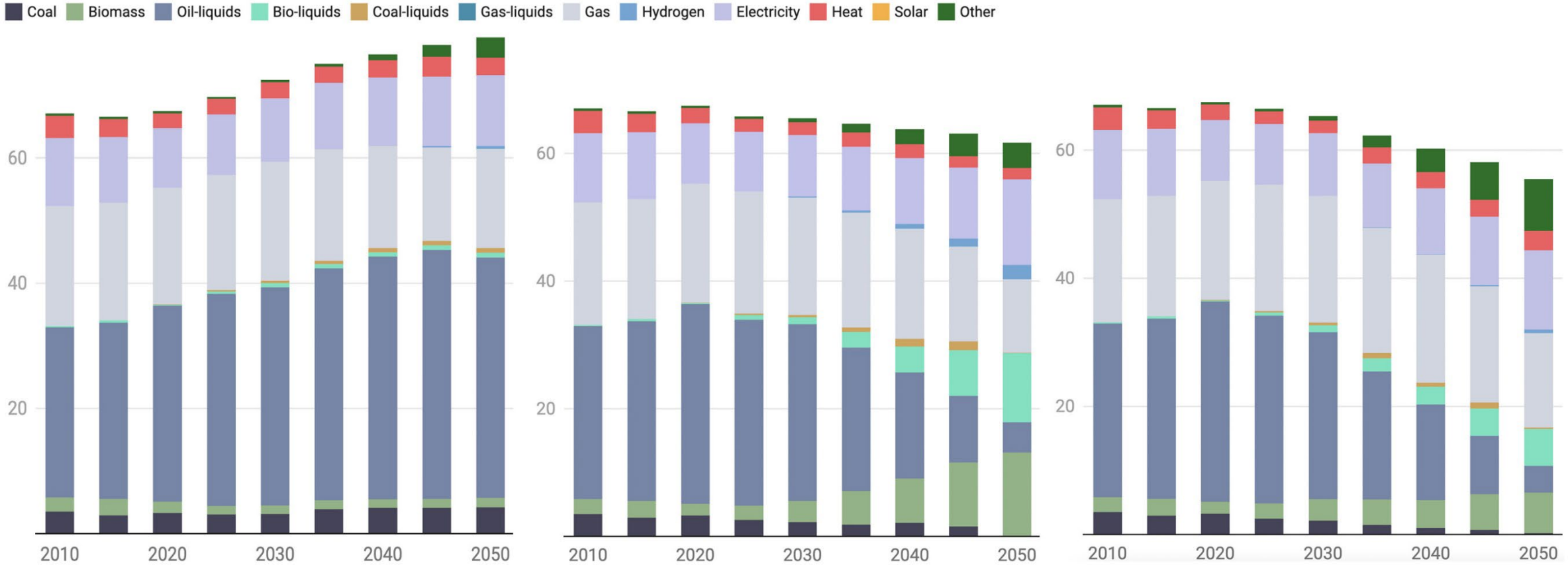
UNECE Industry (Final Energy [EJ])

Efficiency, Electrification, CCUS and H_2 in Industry, Intensive Industries



Total Final Energy Supply[EJ] Industry Reference Scenario

Total Final Energy Supply[EJ] Industry Carbon Neutrality Scenario

Total Final Energy Supply[EJ] Industry Carbon Neutrality Innovation Scenario

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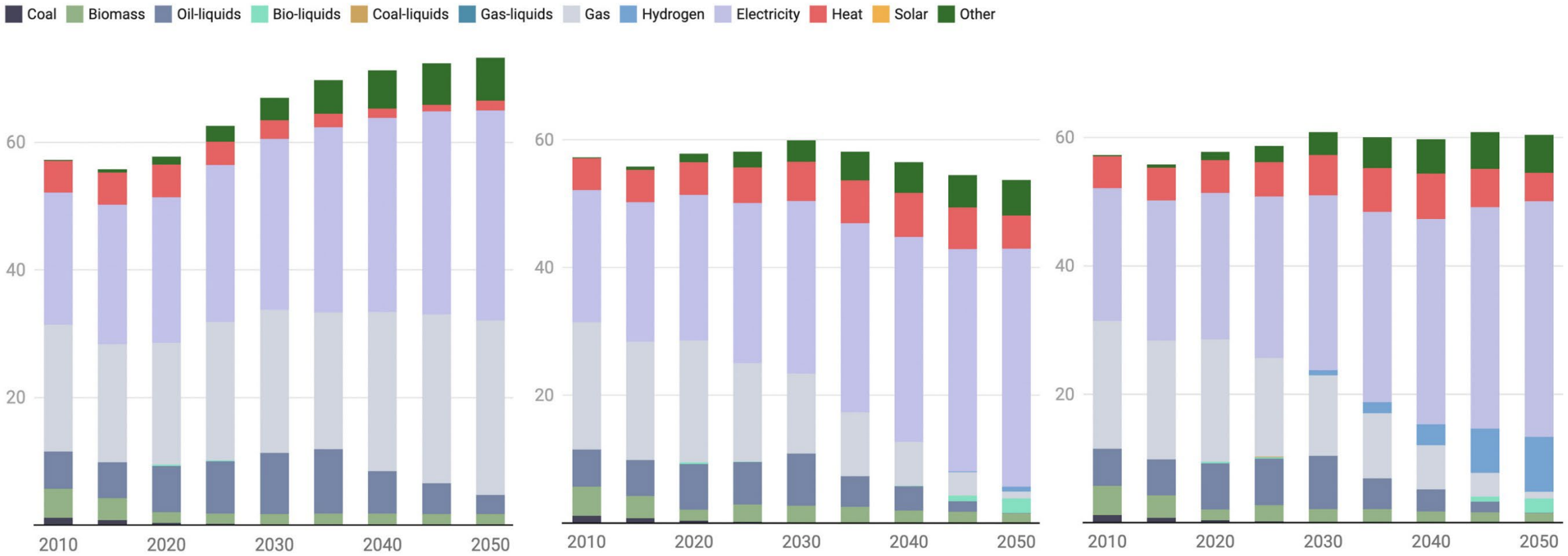
UNECE Buildings (Final Energy [EJ])

Efficiency, Electrification, Digitalization, Heat Pumps and Electricity



Total Final Energy Supply[EJ] Buildings Reference Scenario

Total Final Energy Supply[EJ] Buildings Carbon Neutrality Scenario

Total Final Energy Supply[EJ] Buildings Carbon Neutrality Innovation Scenario

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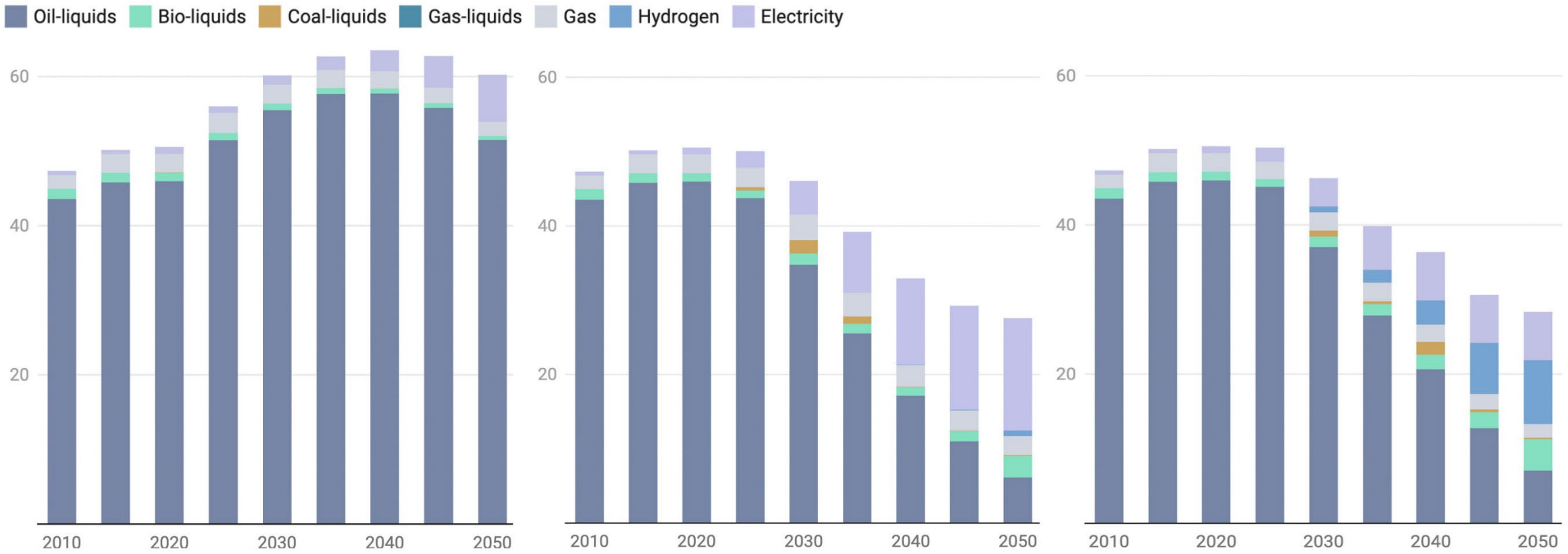
UNECE Transport (Final Energy [EJ])

Efficiency, Electrification, H_2 for Long-Haul Transport



Total Final Energy Supply[EJ] Transport Reference Scenario

Total Final Energy Supply[EJ] Transport Carbon Neutrality Scenario

Total Final Energy Supply[EJ] Transport Carbon Neutrality Innovation Scenario

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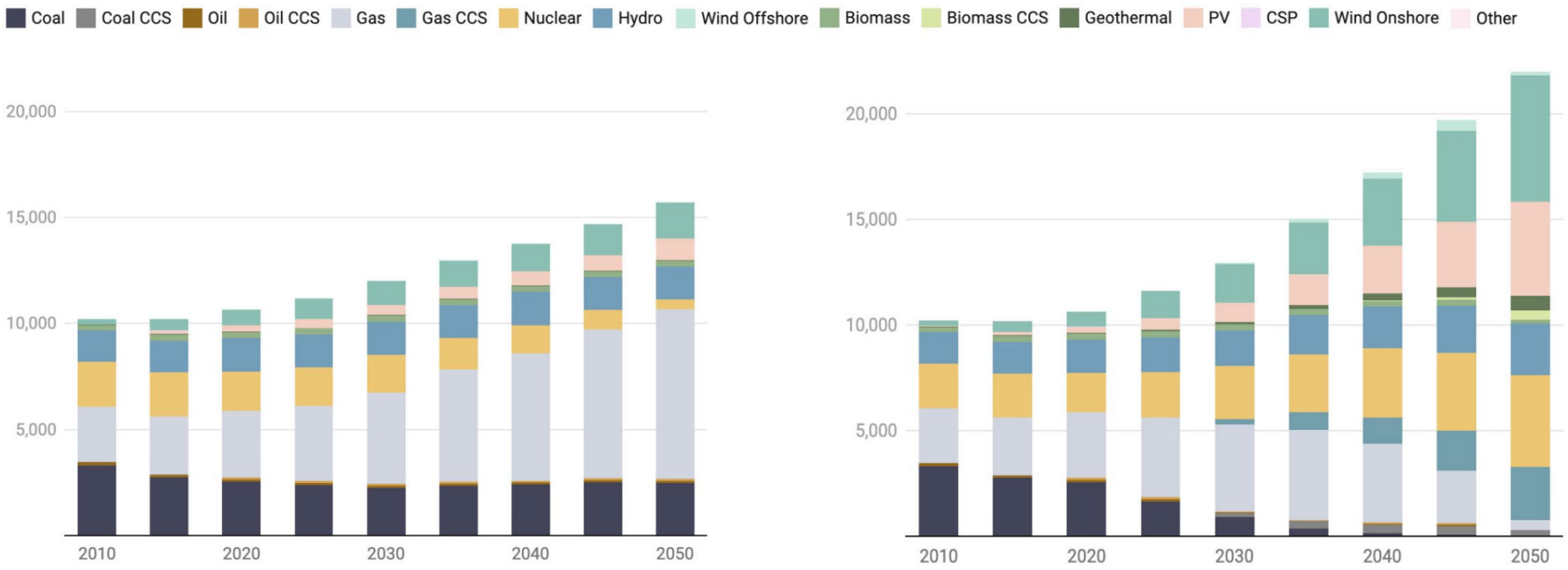
Electricity Generation Mix [TWh]

Technology Interplay

4300 TWh (600 GW) nuclear power in UNECE by 2050



Electricity Generation Mix [TWh]
Reference Scenario

Electricity Generation Mix [TWh]
Carbon Neutrality Scenario

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UNECE Key Takeaways

Technology Interplay

Problem
Climate models indicate that national actions and international climate targets set in the Paris Agreement and at COP26 fall short delivering on carbon neutrality and limiting global warming to 1.5 – 2°C.

Mission possible
There are achievable pathways for governments to design and implement a carbon neutral energy system through technology interplay.

How - Technology interplay
A carbon neutral energy system demands:
i) accelerated phase-out of conventional fossil fuels;
ii) electrification of all sectors through renewable energy and nuclear power;
iii) widespread innovation of low and zero-carbon technologies (incl. CCUS, hydrogen and next generation of nuclear power).

Implications for the UNECE region
The UNECE region must advance:
i) technology transfer and deployment;
ii) expanded institutional capacity;
iii) buy-in and adoption from all stakeholders to build a secure, affordable and carbon neutral energy system.

Immediate Actions
Action must start now to enable all zero- and low-carbon technologies to achieve carbon neutrality. Governments need to
i) raise awareness about the merits of all low and zero-carbon technologies;
ii) develop policy frameworks in support of carbon neutrality;
iii) create a level-playing field to finance a just transition towards the carbon neutral energy system

Role of UNECE
International cooperation will be essential to build resilience in the carbon neutral energy system. UNECE provides a much needed platform for developing rules, standards, and norms for systemic lifestyle and infrastructural changes. Supportive policies, incentives and regulatory frameworks encourage regional technical cooperation across industry, buildings, and transport for projects of common interest and public-private partnerships.

Thank you!

The slides and design by Iva Brkic & Walker Darke
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