Electricity, EVs, and More…

Batt Odgerel, Energy Policy Research Foundation

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Energy Policy Research Foundation

IEA Net Zero: Fossil % from 80% today to 16% in 2050

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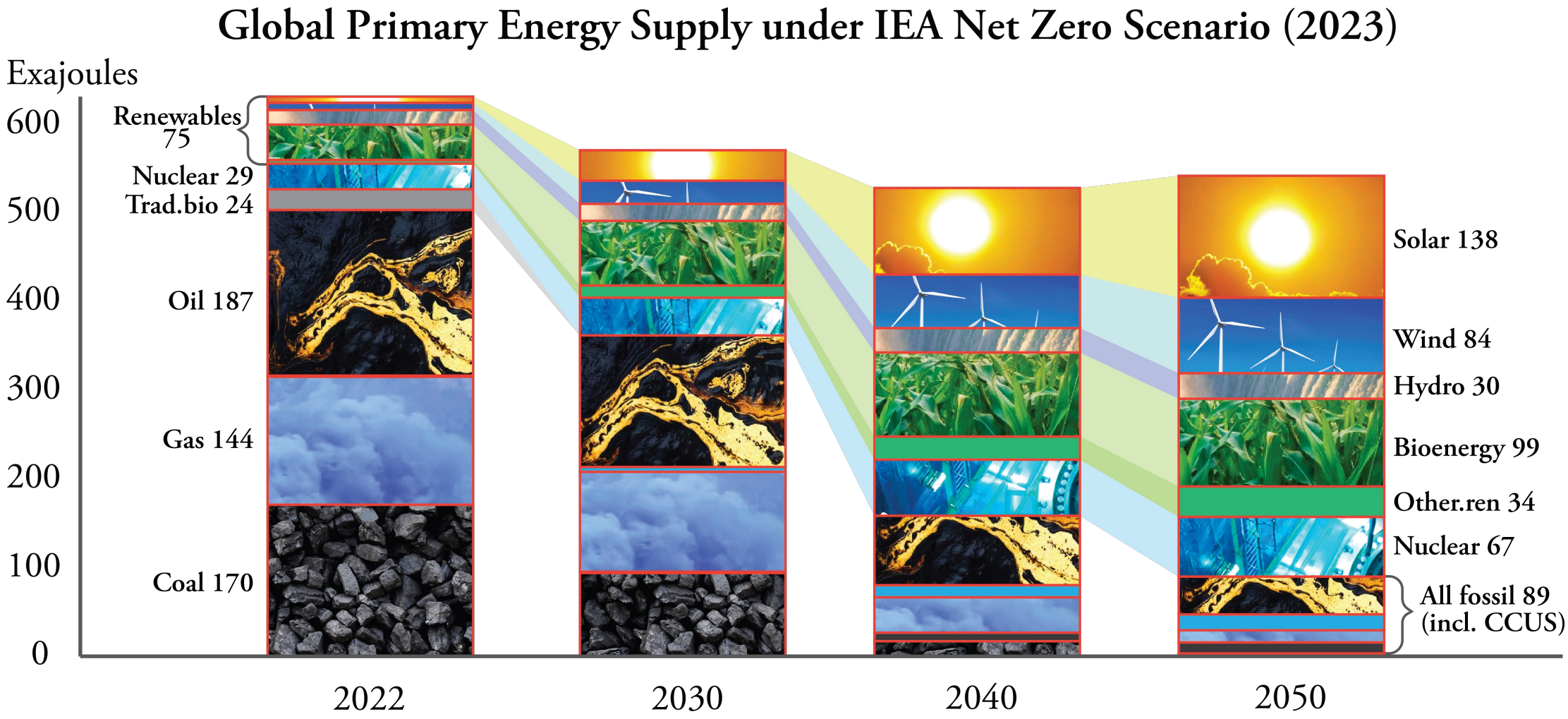

Source: IEA Net Zero Update 2023

Global Energy System

(Million tonnes of oil equivalent)

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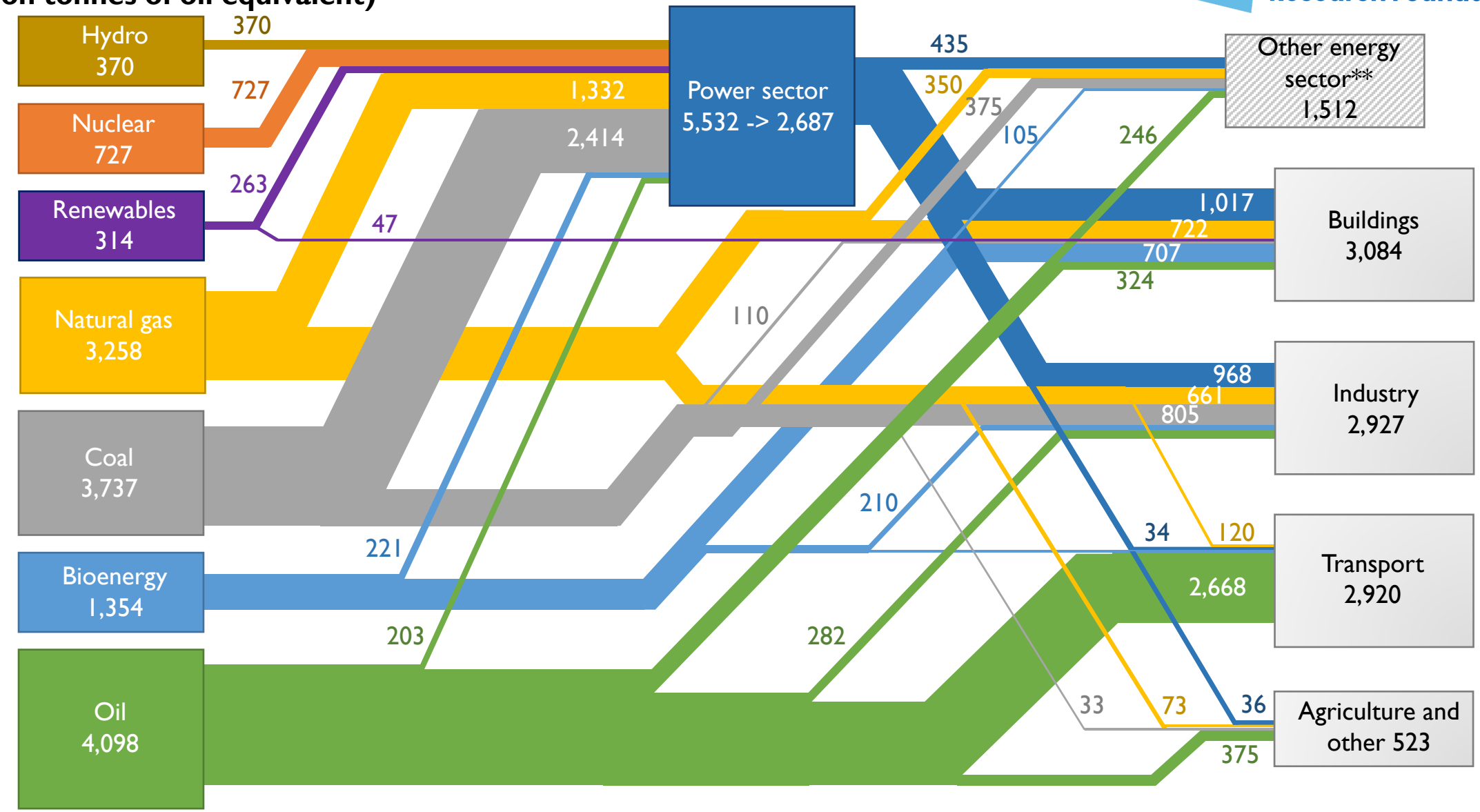


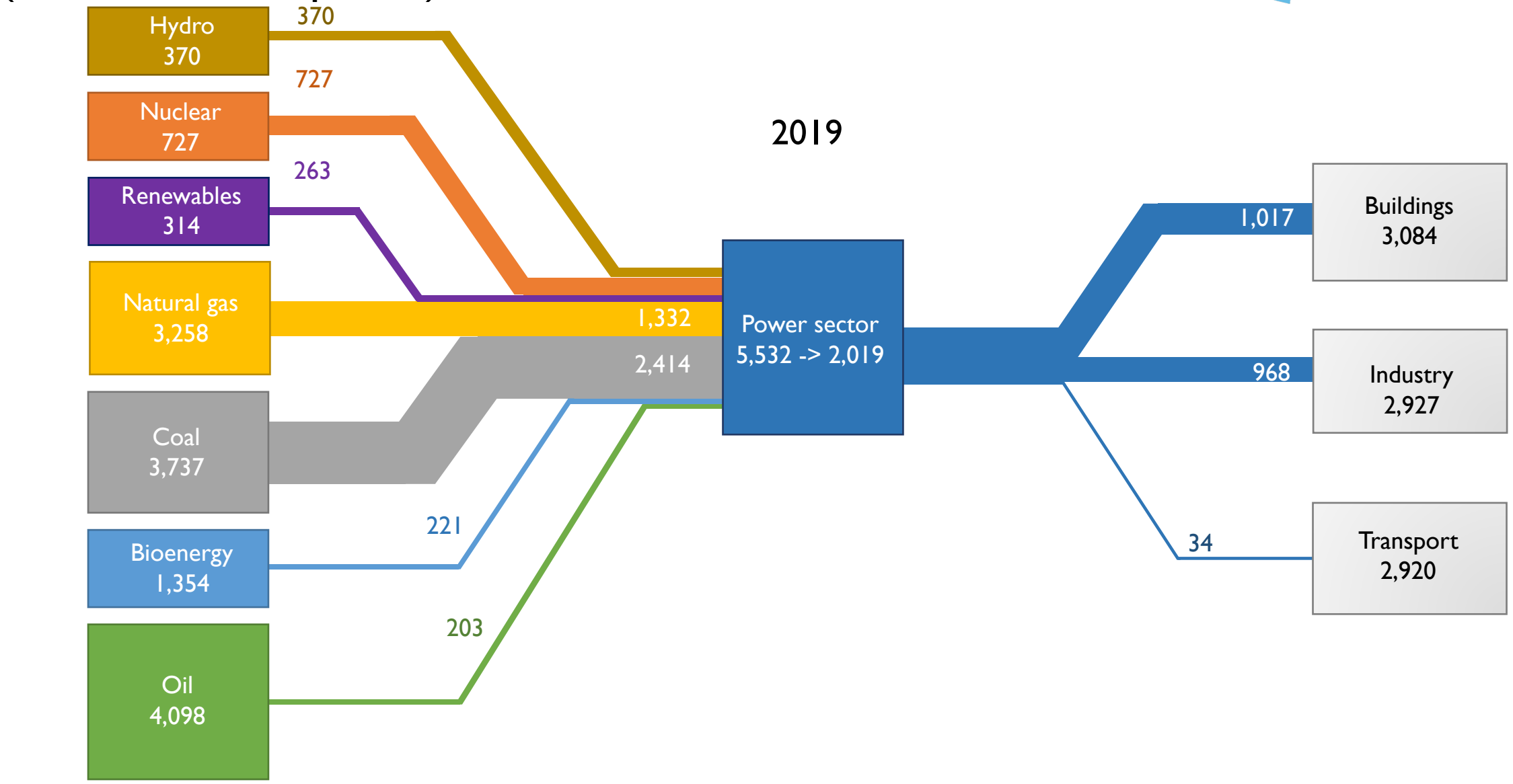
Source: Glen Sweetnam and Batt Odgerel, EPRINC analysis and figure based on IEA data

* Flows/values of less than 25 Mtoe are not shown.

**Other energy sector "covers the use of energy by transformation industries and the energy losses in converting primary energy into a form that can be used in the final consuming sectors." (IEA)

Role of Power Sector in Energy Transition

(Million tonnes of oil equivalent)



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Role of Power Sector in Energy Transition

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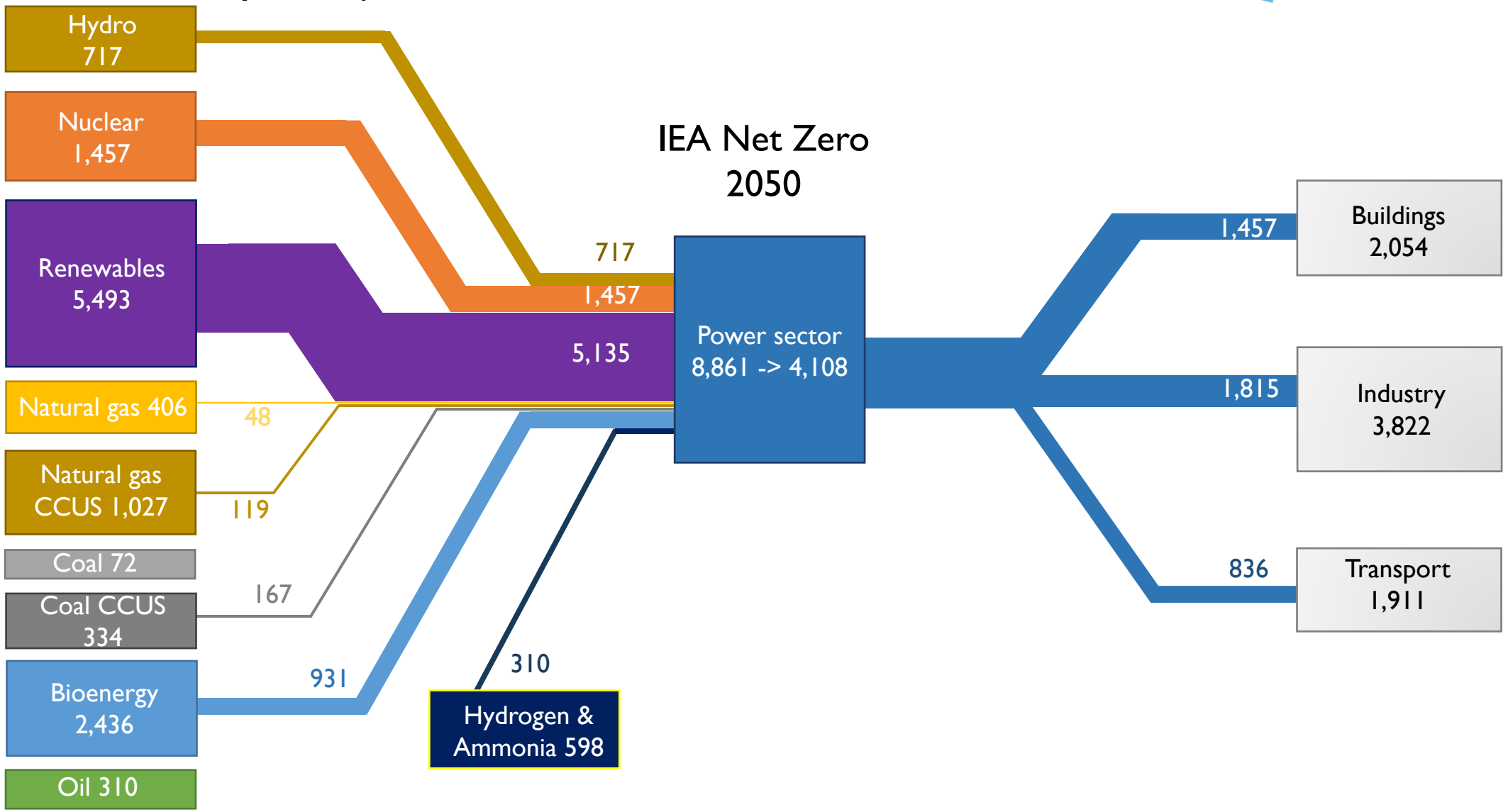

Source: Glen Sweetnam and Batt Odgerel, EPRINC analysis and figure based on IEA data

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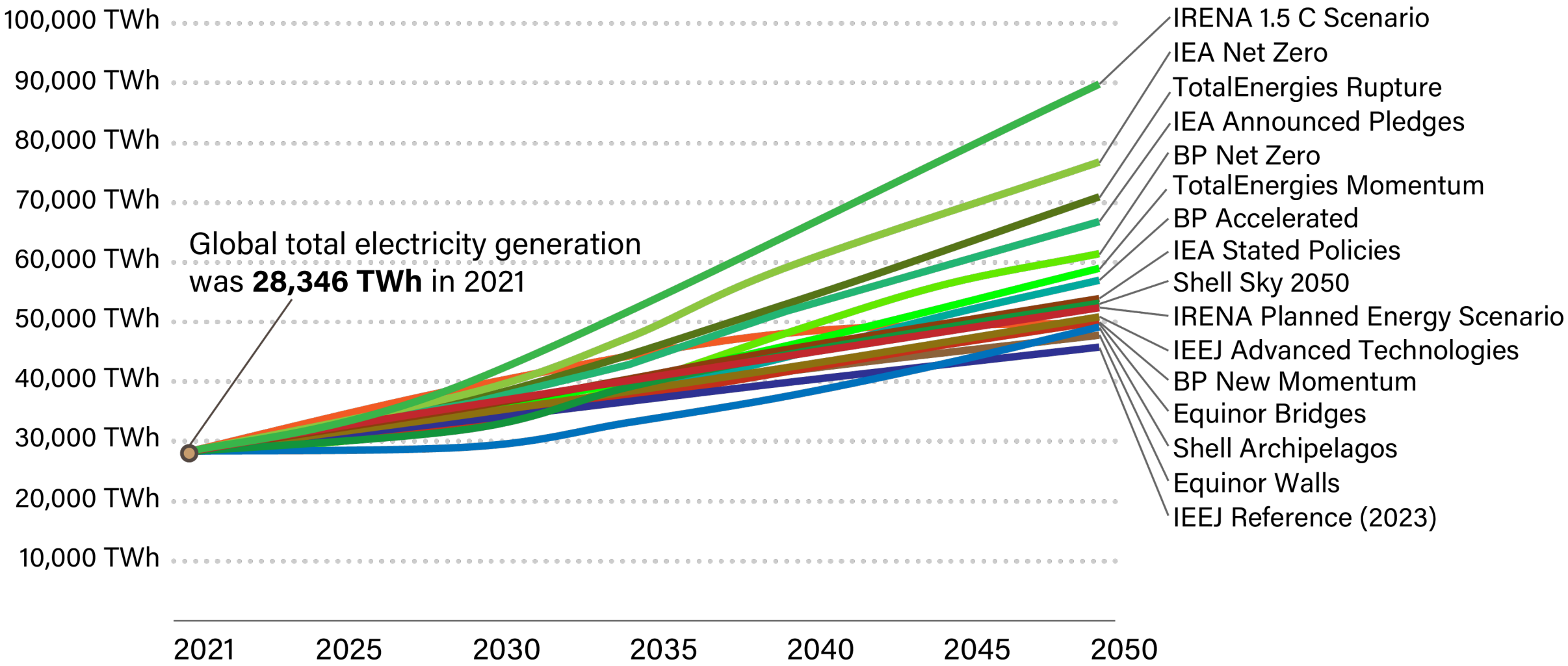
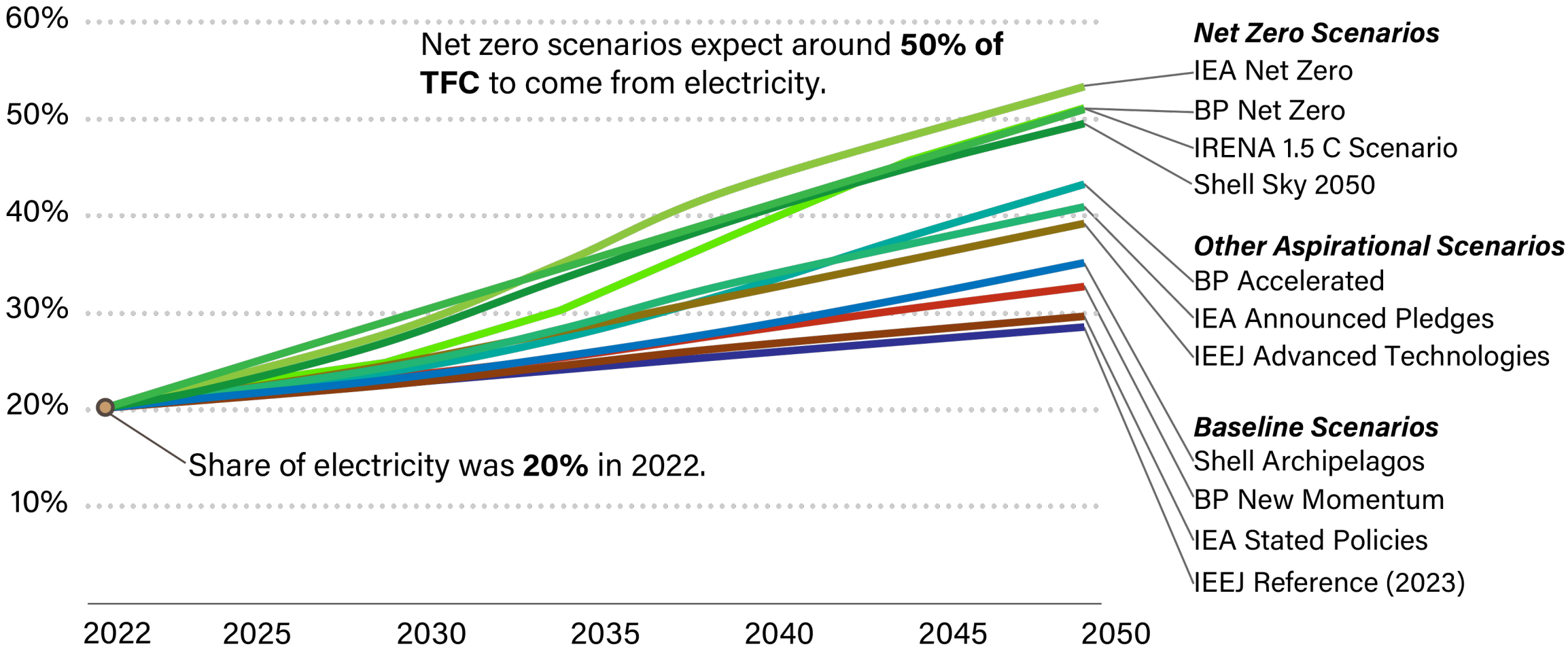
**Other energy sector "covers the use of energy by agriculture, transformation industries and the energy losses in converting primary energy into a form that can be used in the final consuming sectors." (IEA)

Global Electricity Generation Scenarios



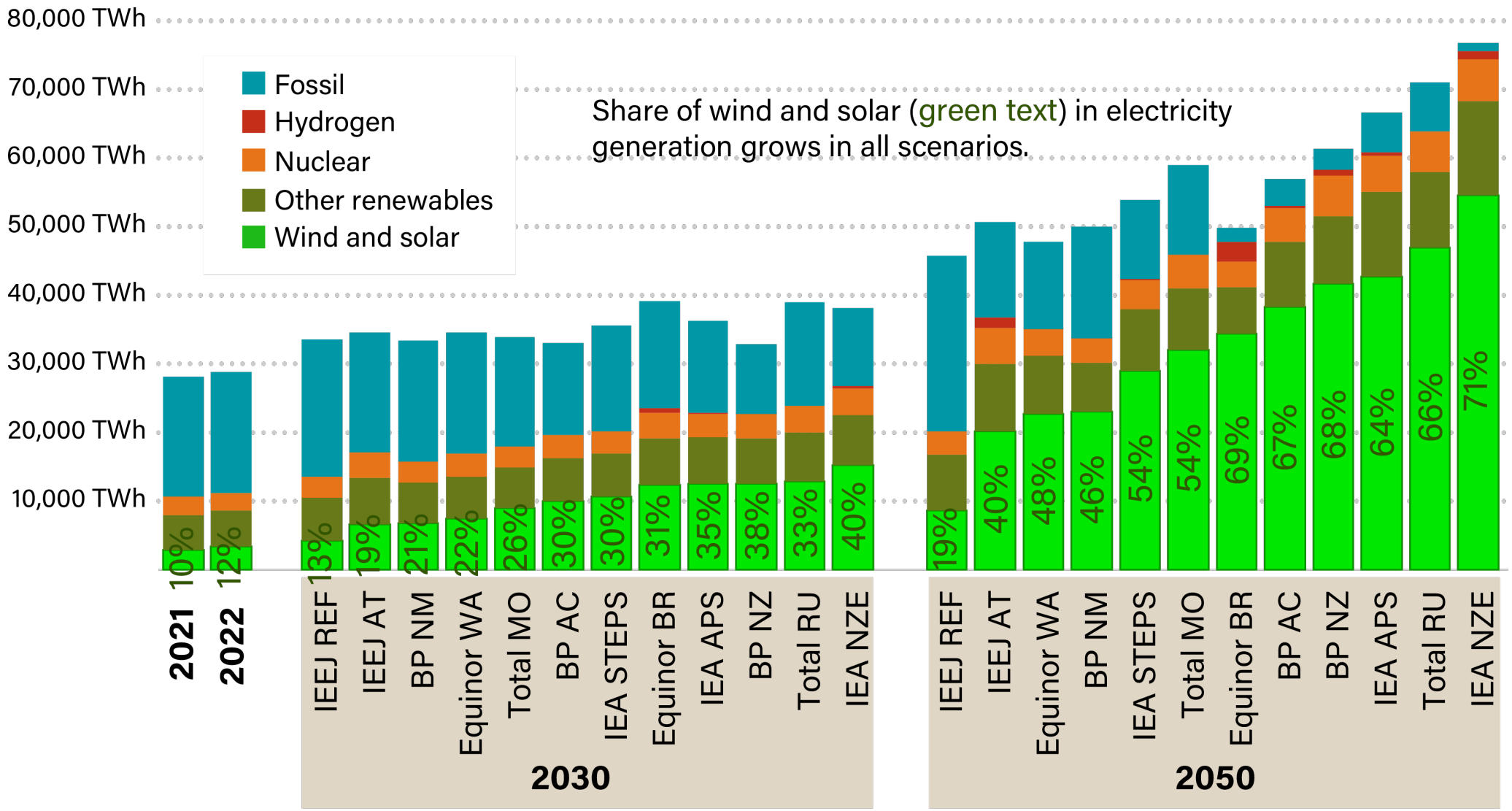
Source: Energy Policy Research based on most recent outlooks (except IEEJ) as of Nov 2023

Share of Electricity in Total Final Consumption



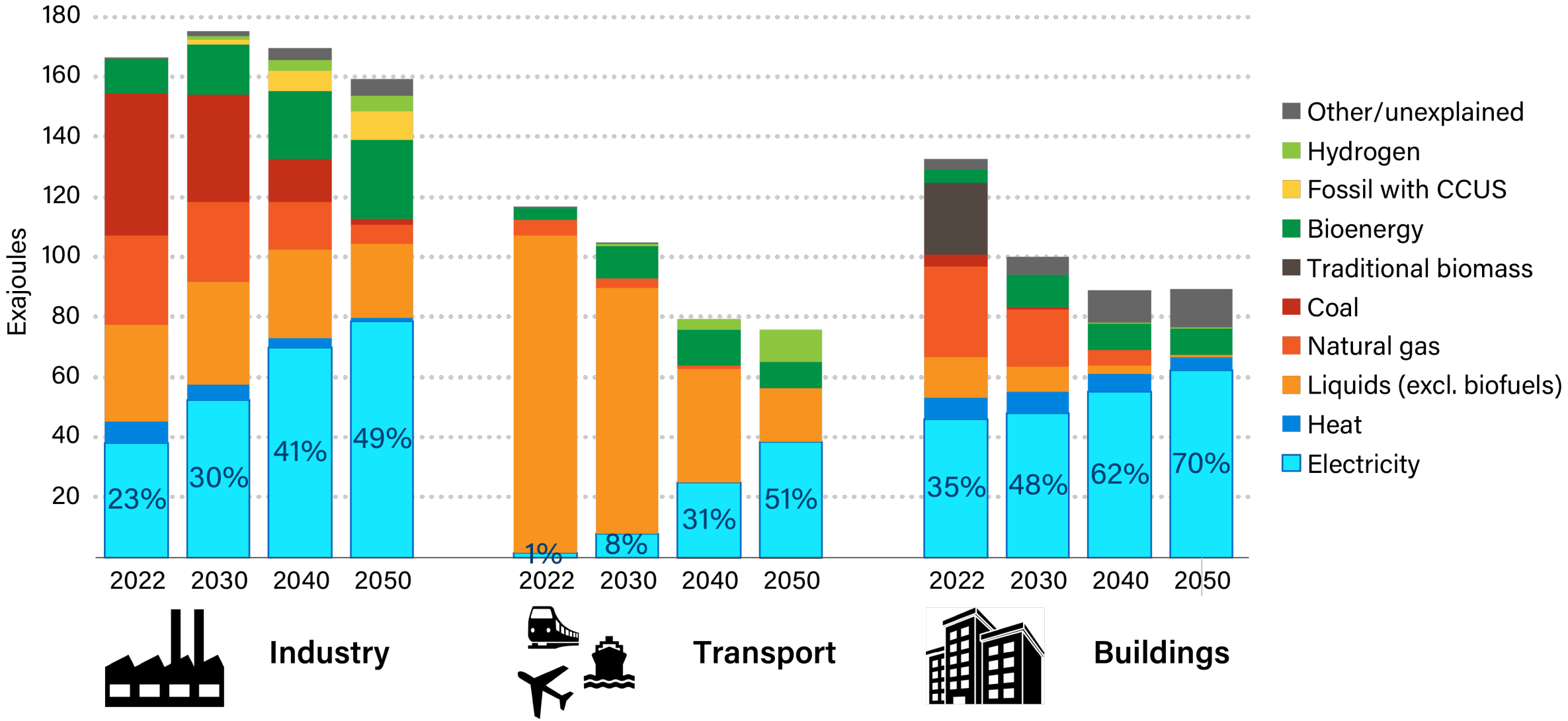
Source: Energy Policy Research based on most recent outlooks (except IEEJ) as of Nov 2023

Global Electricity Generation by Source



Source: Energy Policy Research based on most recent outlooks (except IEEJ) as of Nov 2023

IEA Net Zero: Final Consumption By Sector



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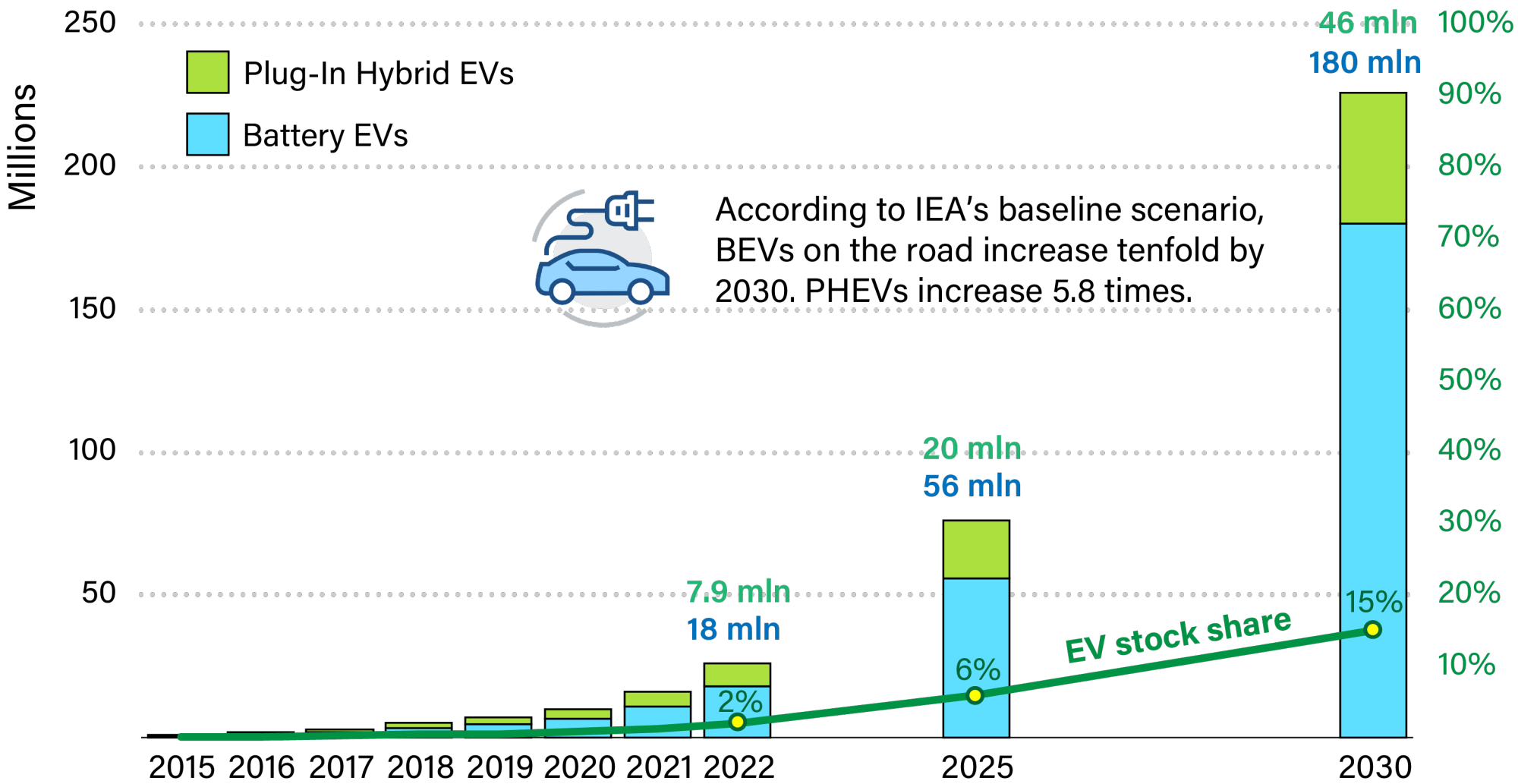
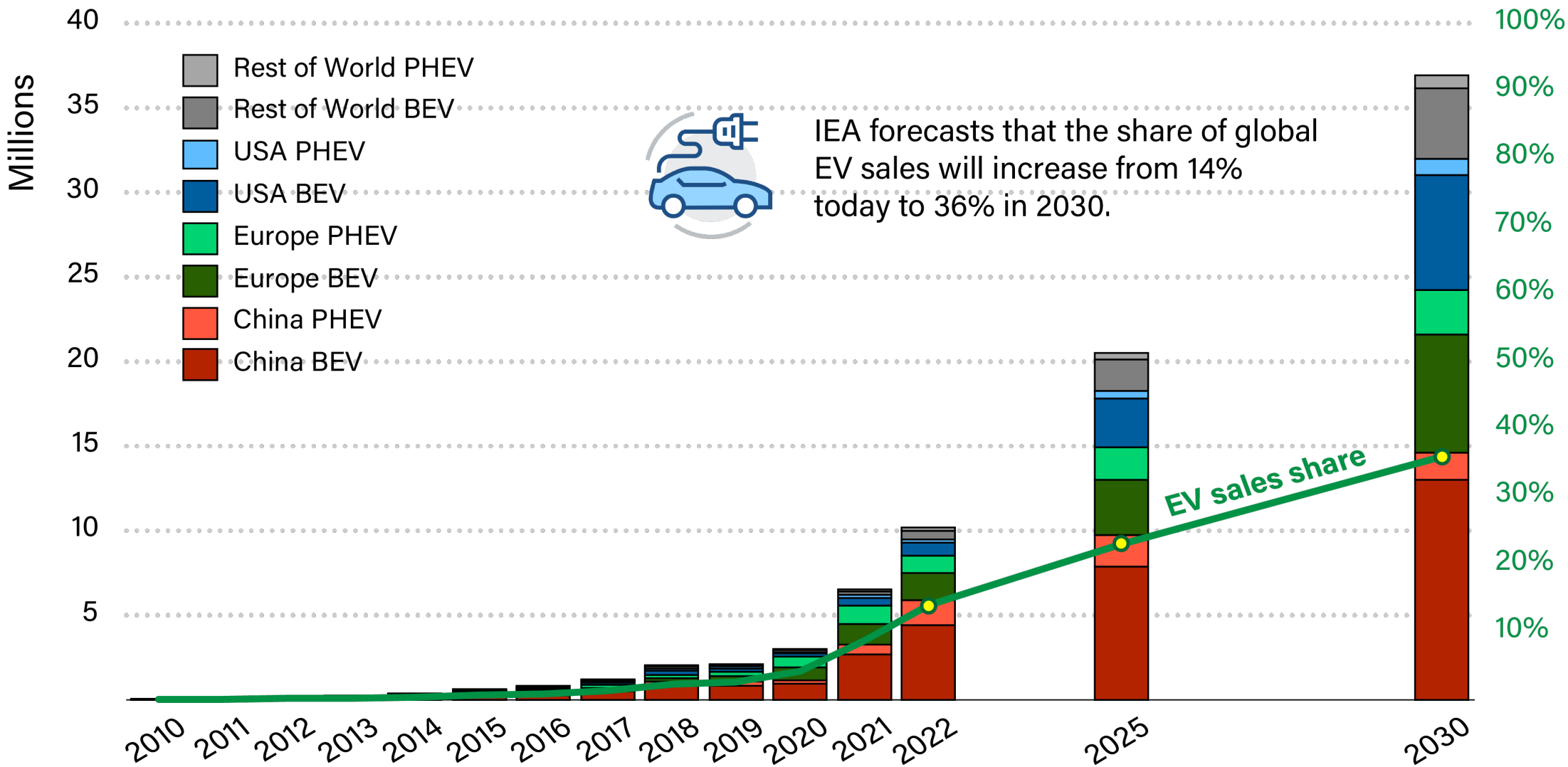
IEA EV Outlook: Historical and Projected EV (Cars) Stock



Source: Energy Policy Research's analysis of IEA EV Outlook 2023

IEA EV Outlook: Historical and Projected EV (Cars) Sales



Source: Energy Policy Research's analysis of IEA EV Outlook 2023

Data Centers, Internet, Crypto…

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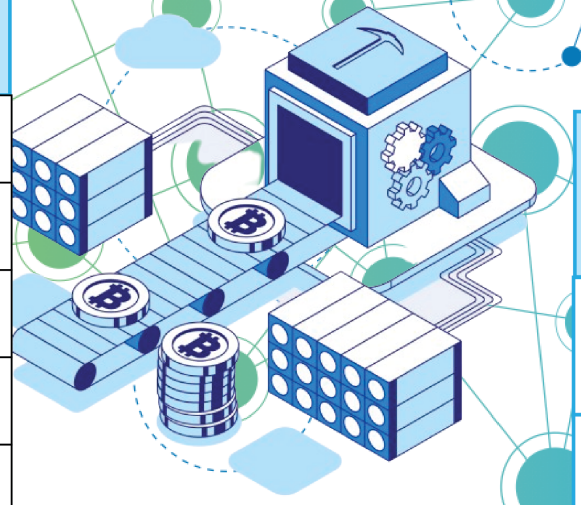
Top 10 electrcity consumers in 2022 (TWh)	
1. China	8,849
2. US	4,548
3. India	1,858
4. Russia	1,167
5. Japan	1,034
6. Brazil	677
7. Canada	660
8. S. Korea	620
9. Germany	577
10. France	468



Energy consumption in 2022 (TWh): IEA estimate	
Data centers	240-340
Data transmis-sion networks	260-360
Crypto mining	100-150
Total	**600-850**

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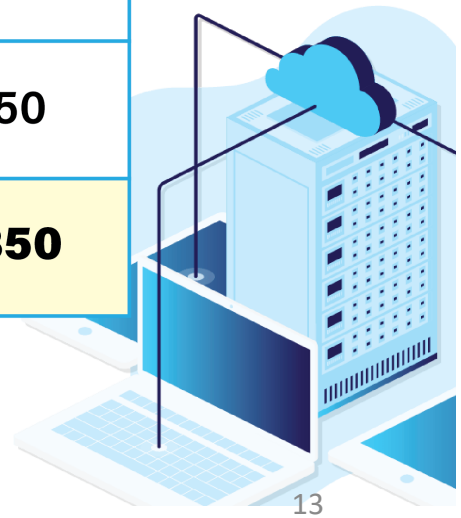
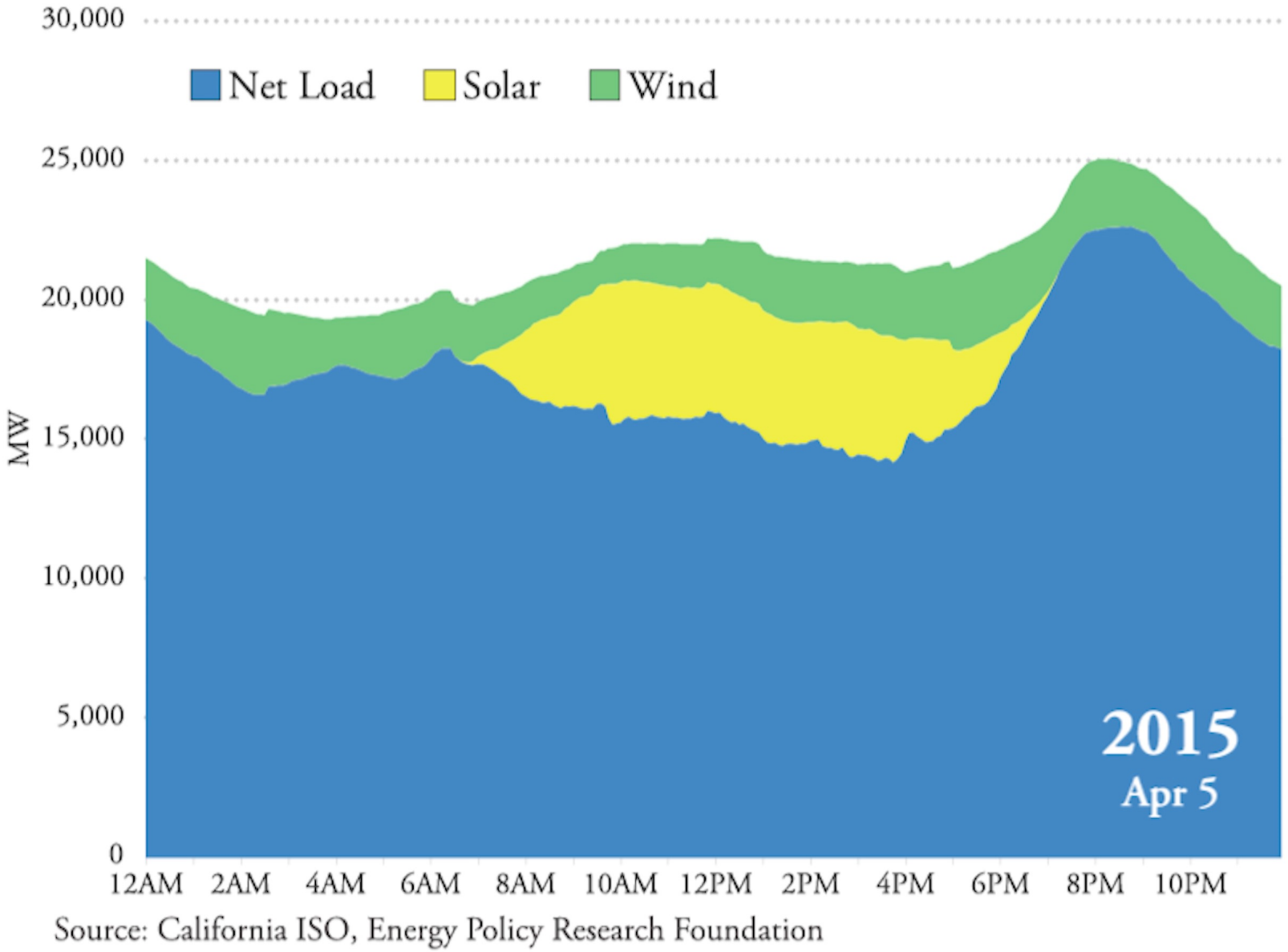
The combined electricty demand of data centers, data transmission networks, and crypto mining, when compared with countries.

Data: IEA, BP



From Duck Curve to Canyon Curve

CAISO's lowest annual net load day (2015-2023)



Source: California ISO, Energy Policy Research Foundation

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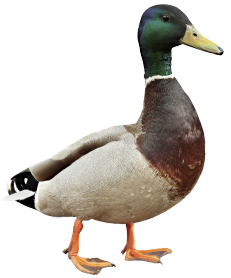
New challenges per CAISO:

- Short, steep ramps
- Oversupply risks
- Decreased frequency response



Massive Requirement for Critical Minerals

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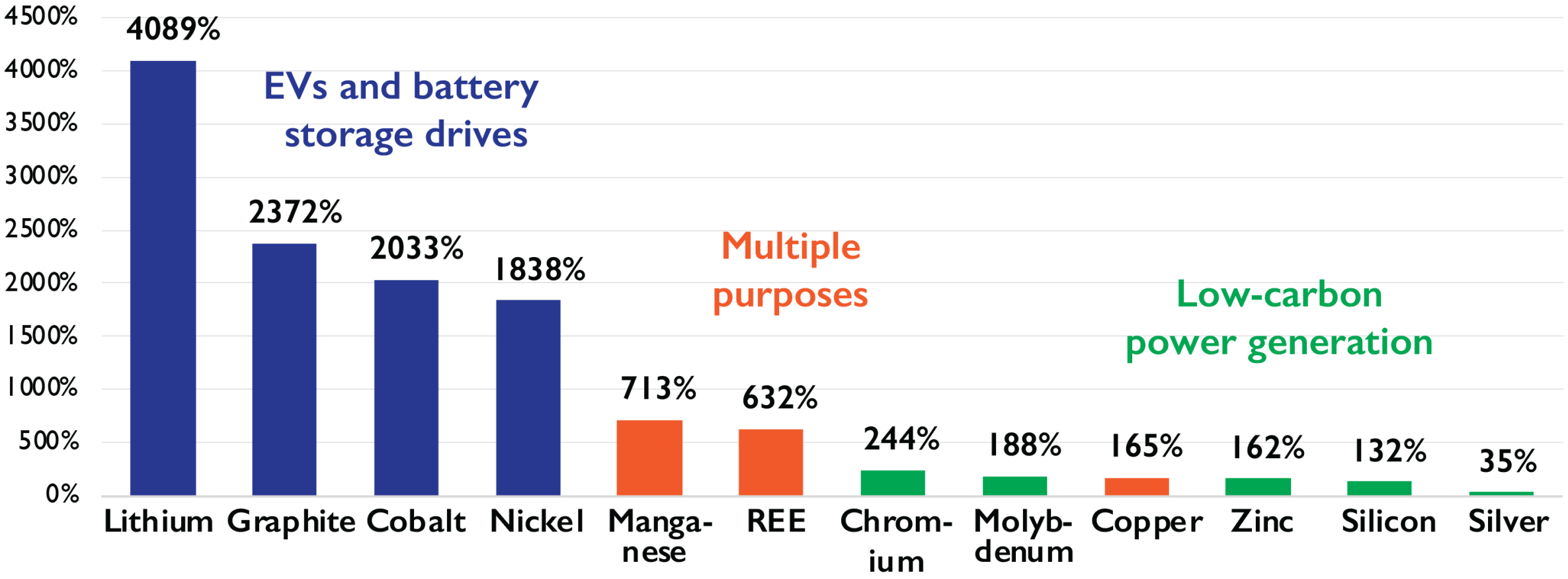
Required Growth of Select Minerals Supply in Energy Sector (2020-2040)

IEA's Sustainable Development Scenario



REE=Rare earth elements | Multiple purposes include EVs, battery storage, power gen, hydrogen, electric networks.
Data from IEA's Critical Minerals Report

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Power Gen Capacity (GW), 2021

Grid reliability

Cyber security

Charging infrastructure

Transmission network

Workforce impact

Reaching Net Zero in Electricity Generation:

- Advanced economies by 2035
- China by 2040
- Developing countries by 2045

Intermittency

Public acceptance

Technological barriers

Supply chain disruptions

Land use

Grid resilience

Material/mineral shortages

Affordability

Data: WRI

Additional Slides

Electricity Generation Capacity Scenarios