



Harvard Kennedy School Energy Policy Seminar

“Implications for the Oil and Gas Industry
During the Energy Transition”

28 March 2022

Prof. Donald L. Paul

Executive Director of the USC Energy Institute

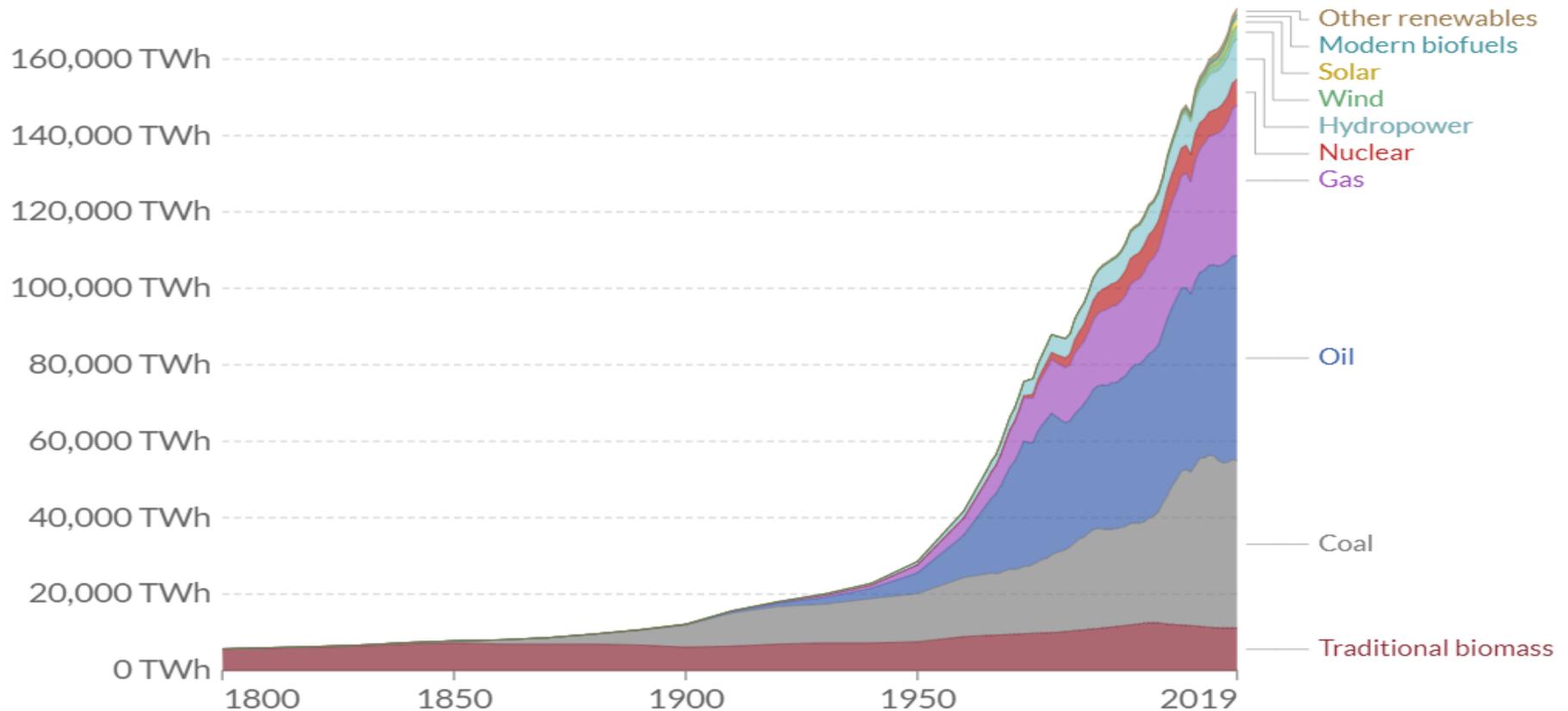
William M. Keck Chair of Energy Resources

The History of Energy Transitions: 1800 to the present

Global primary energy consumption by source

Primary energy is calculated based on the 'substitution method' which takes account of the inefficiencies in fossil fuel production by converting non-fossil energy into the energy inputs required if they had the same conversion losses as fossil fuels.

□ Relative

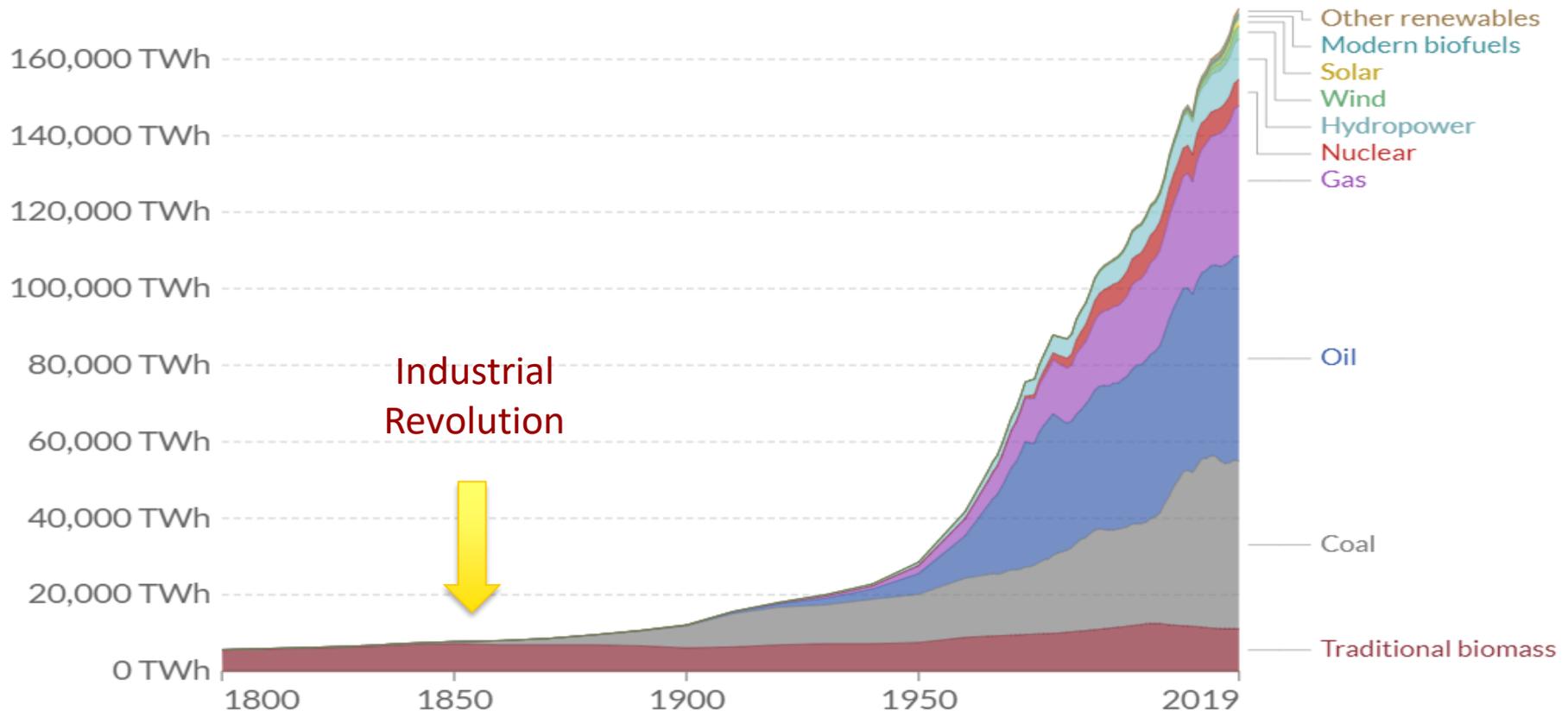


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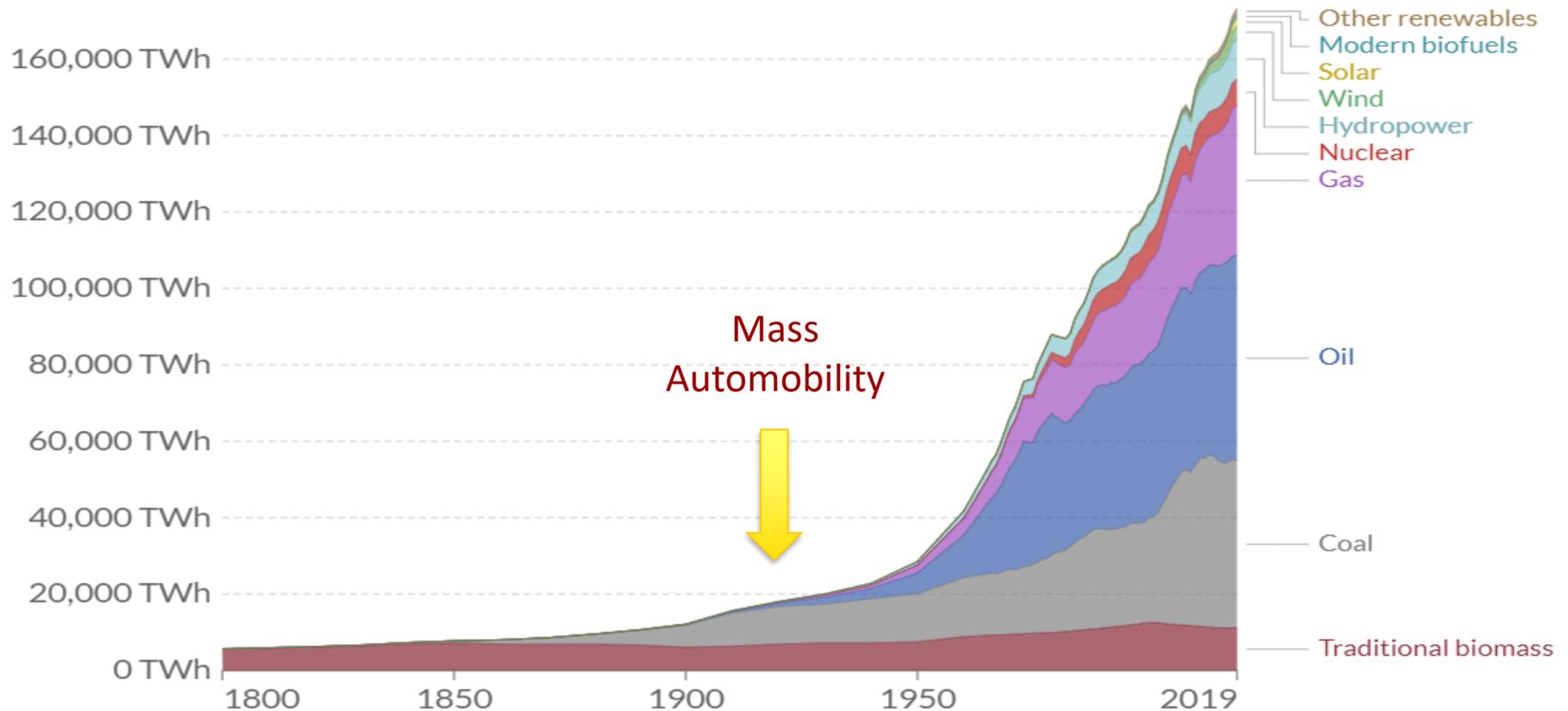


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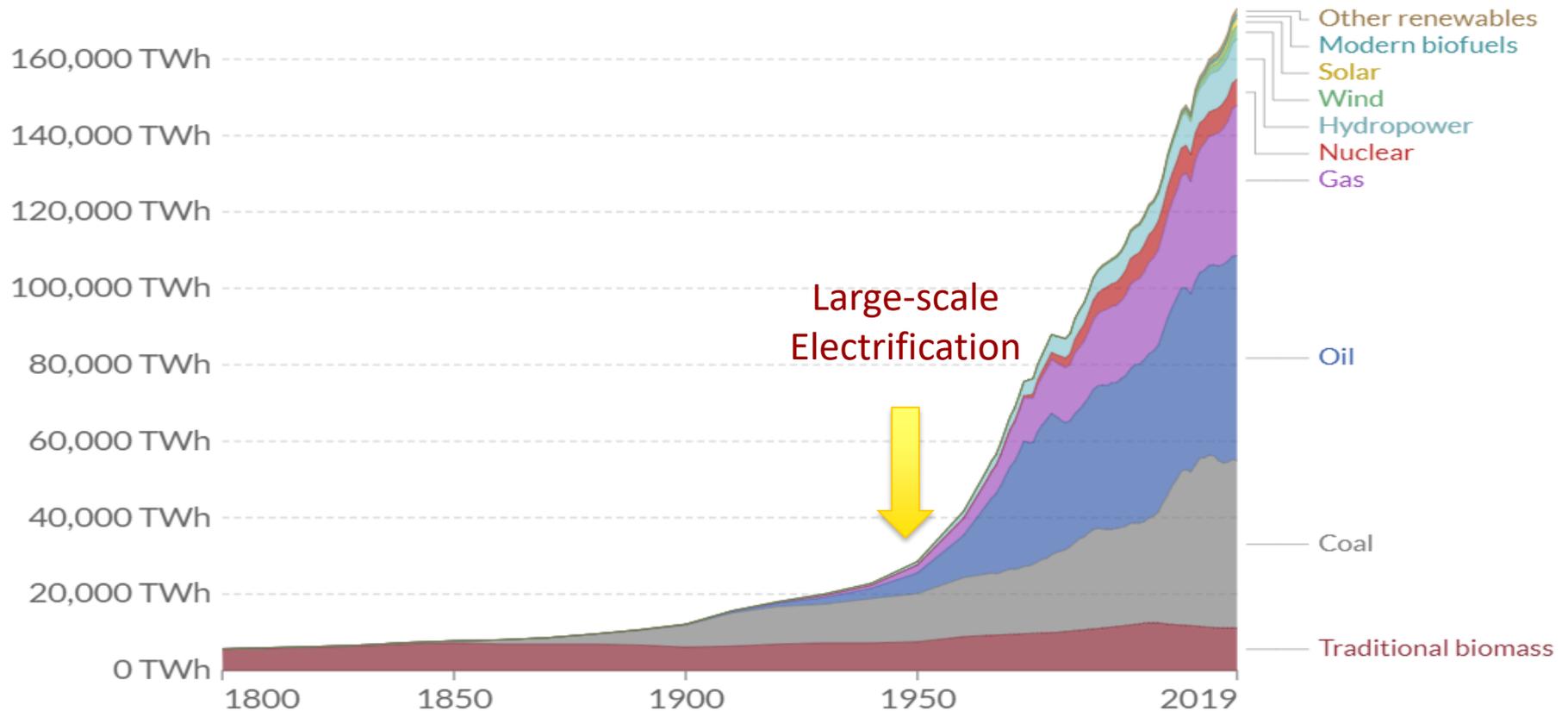


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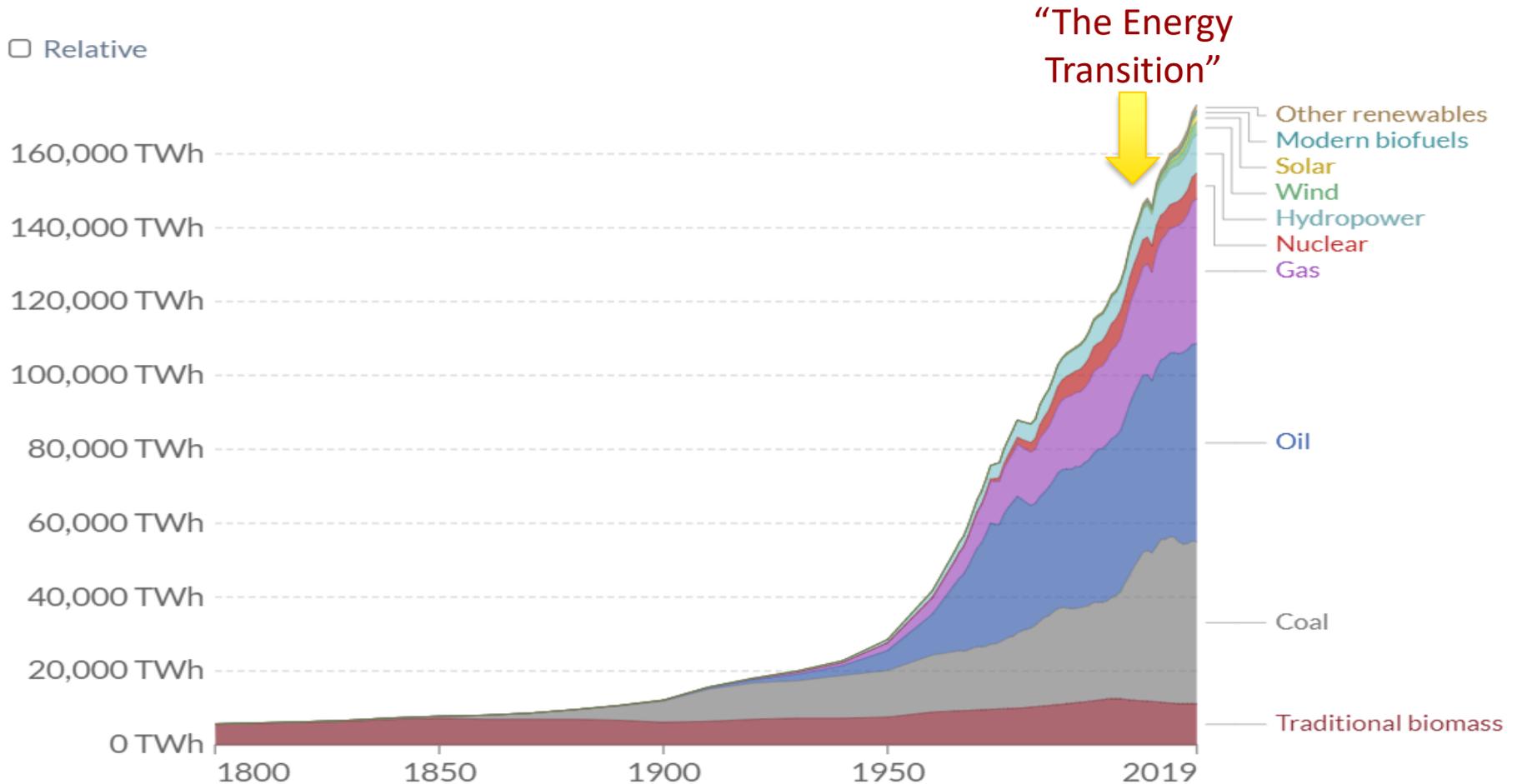


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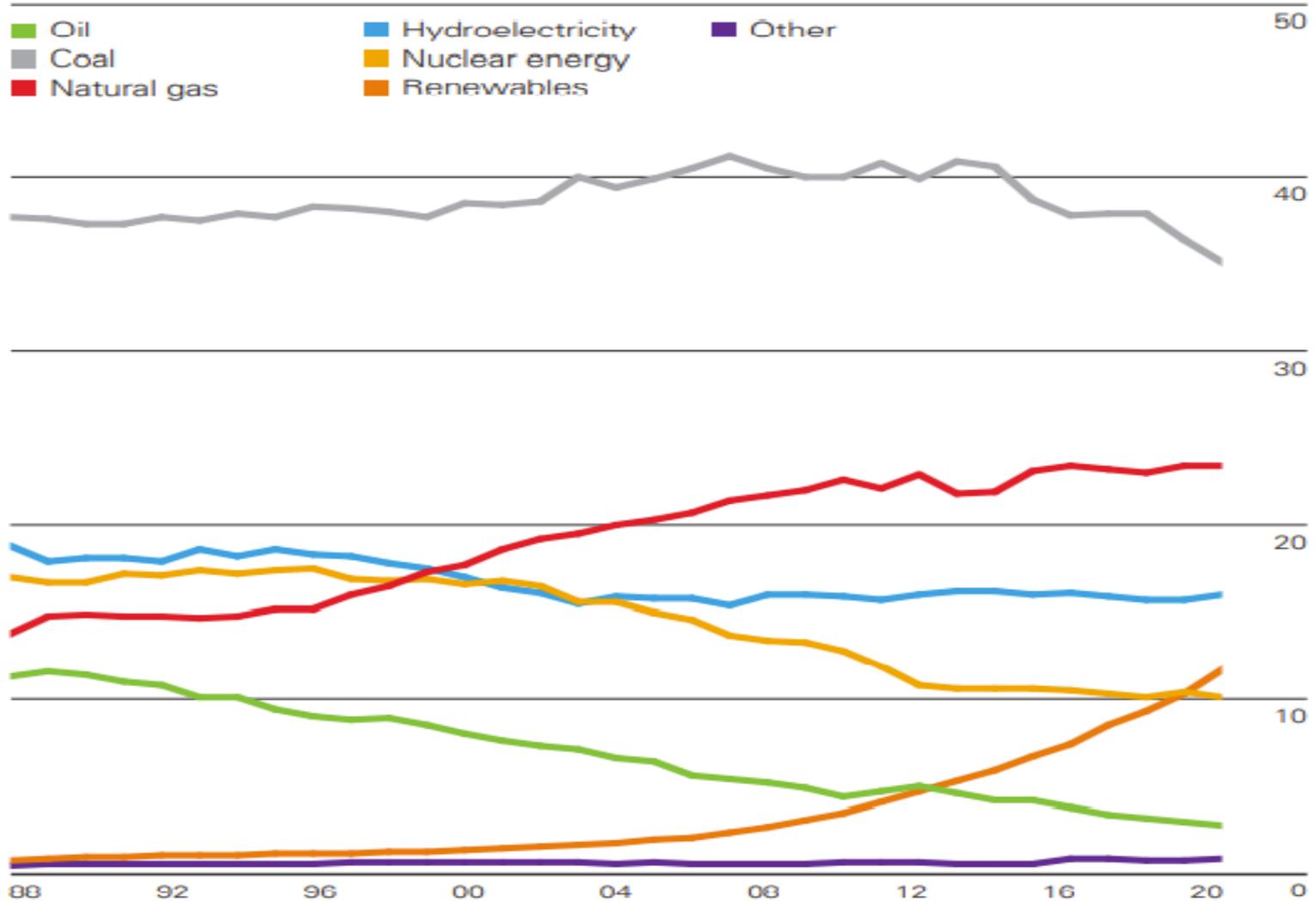
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Energy Transition: electricity generation by source (1990+)

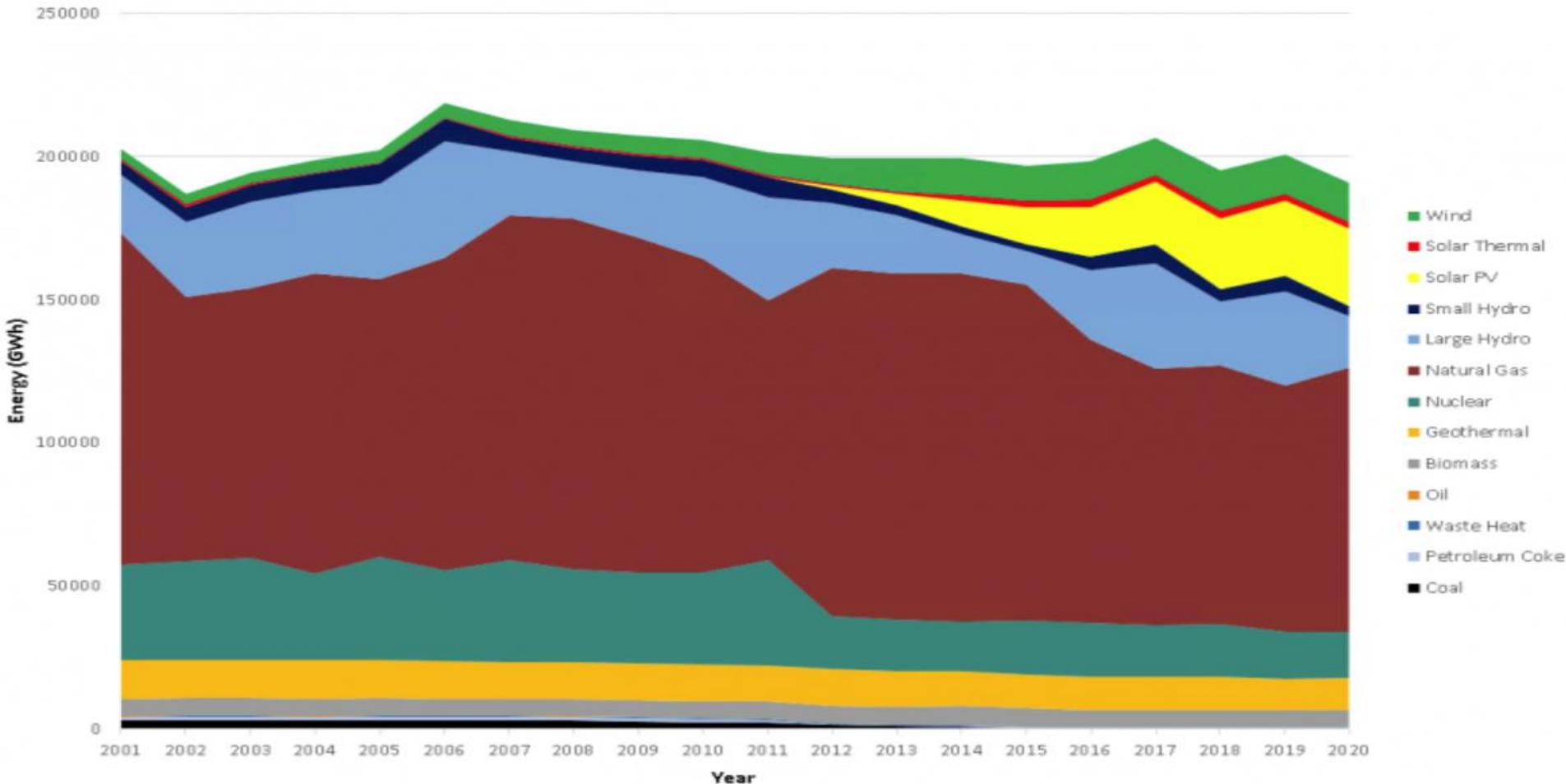


Ref. BP Statistical Review 2021

Transition example: California's power system

In-State Electric Generation by Fuel Type

Source: Quarterly Fuels and Energy Reporting Regulations



Ref. CA Energy Commission

Historical drivers of energy transitions

- New energy resources and technology deployable at scale
- Increases in energy demand from new applications and markets of scale (automobiles, aircraft, computers, etc.)
- Growth in available investment capital

Past Energy Transitions have been **additive** to supply to meet new growth in energy demand

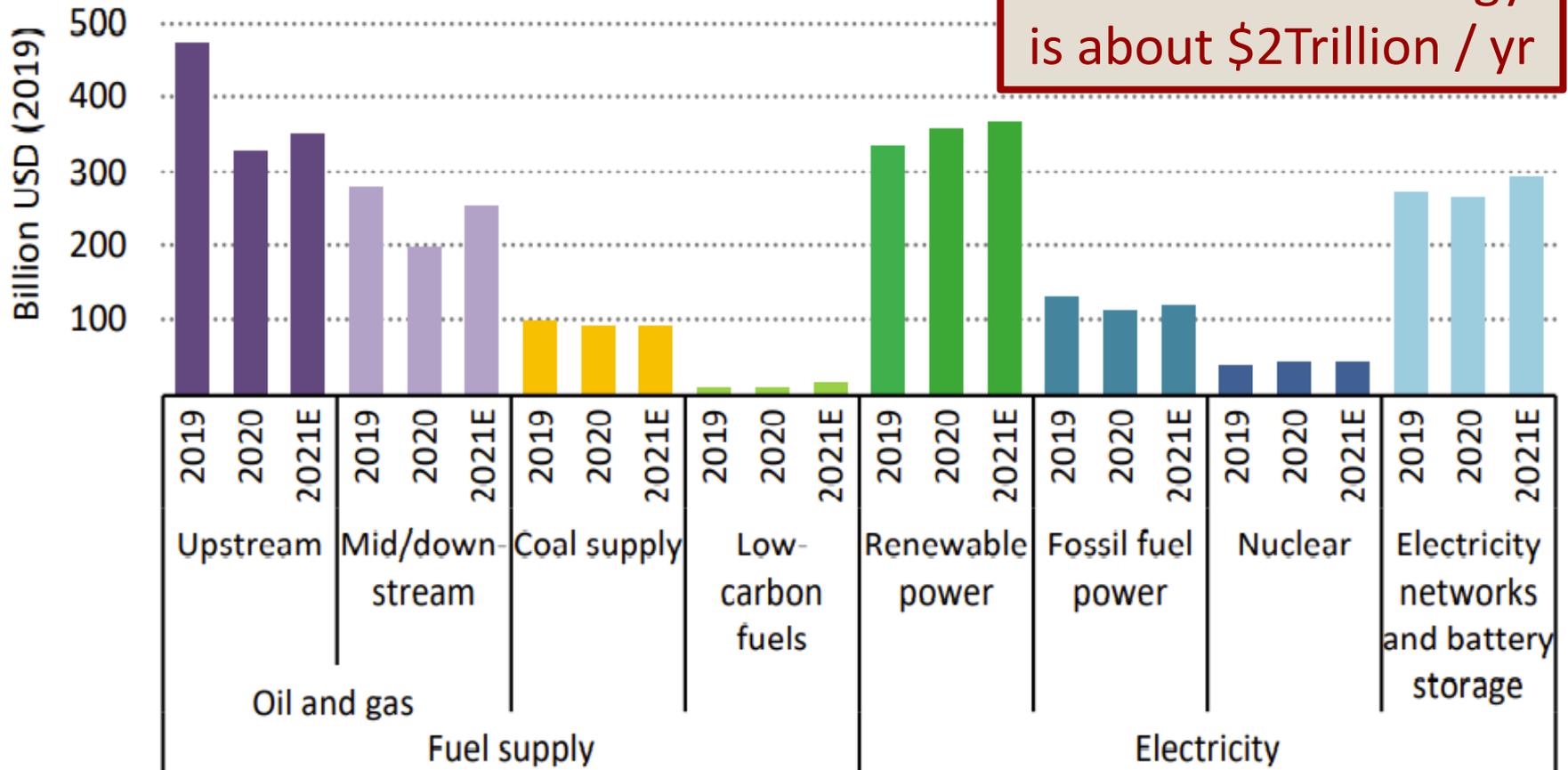
Drivers of the new Energy Transition

- Lower-carbon energy resources and technologies deployable at scale
- Growth in political and societal demands for lower-carbon energy sources
- Shifting investment capital flows

The new Energy Transition is **both additive and substitutive** to meet demand growth and displace higher-carbon supplies

The Energy Transition: indications from shifting global investments

Global energy supply investment by sector



Total Global Investment in Energy is about \$2Trillion / yr

The Energy Transition is about

Technology

+

Economics

+

Policy

+

Society

The Energy Transition is about

Technology

+

Economics

+

Policy

+

Society



SCALE
CAPITAL
TIME

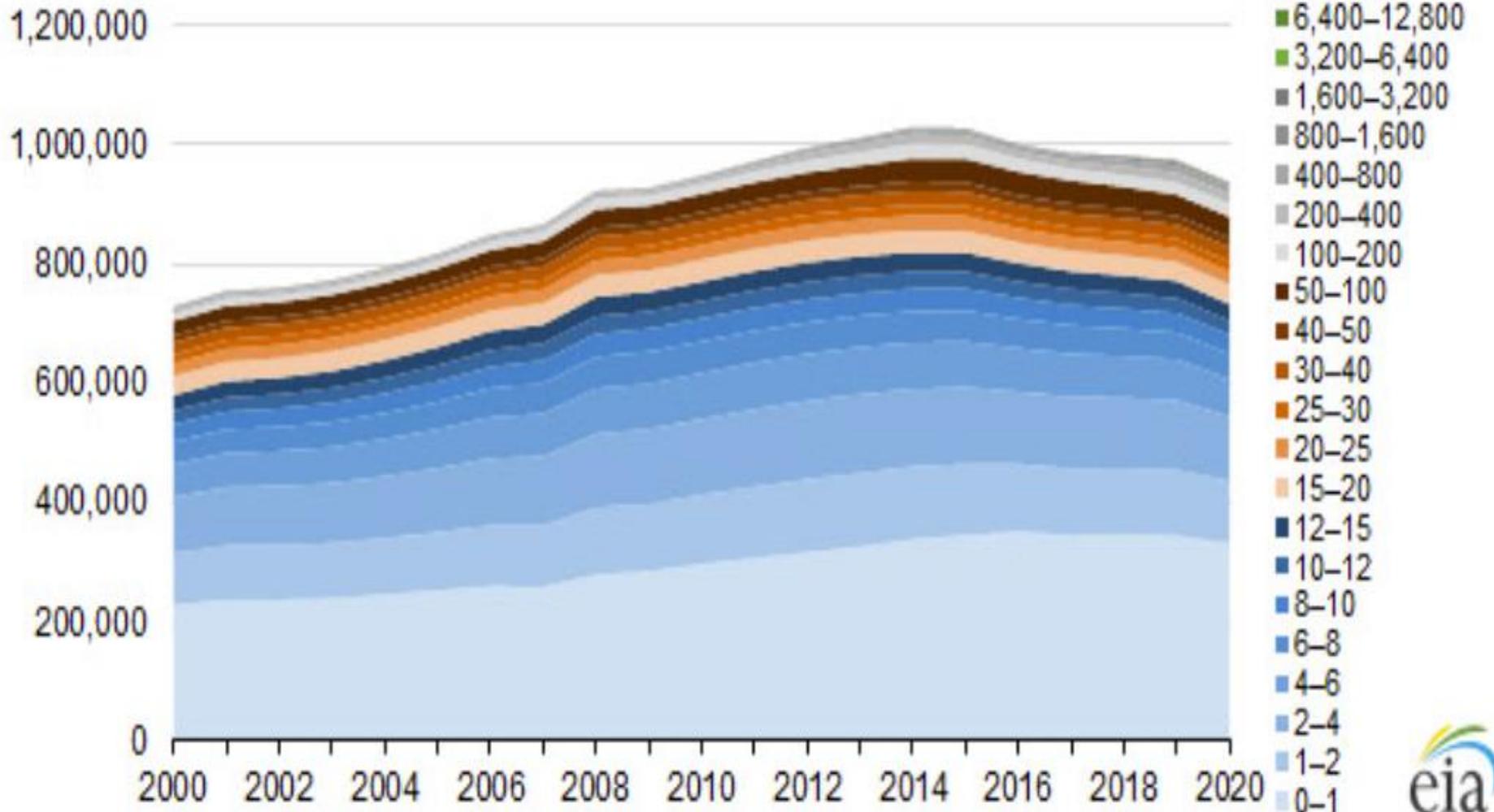
Challenges and opportunities from the Energy Transition

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Challenges:

- The scale of the Transformation
- Capital demands for the Transition
- The timeframe for the Transition
- Supply chain re-structuring
- Legacy asset management

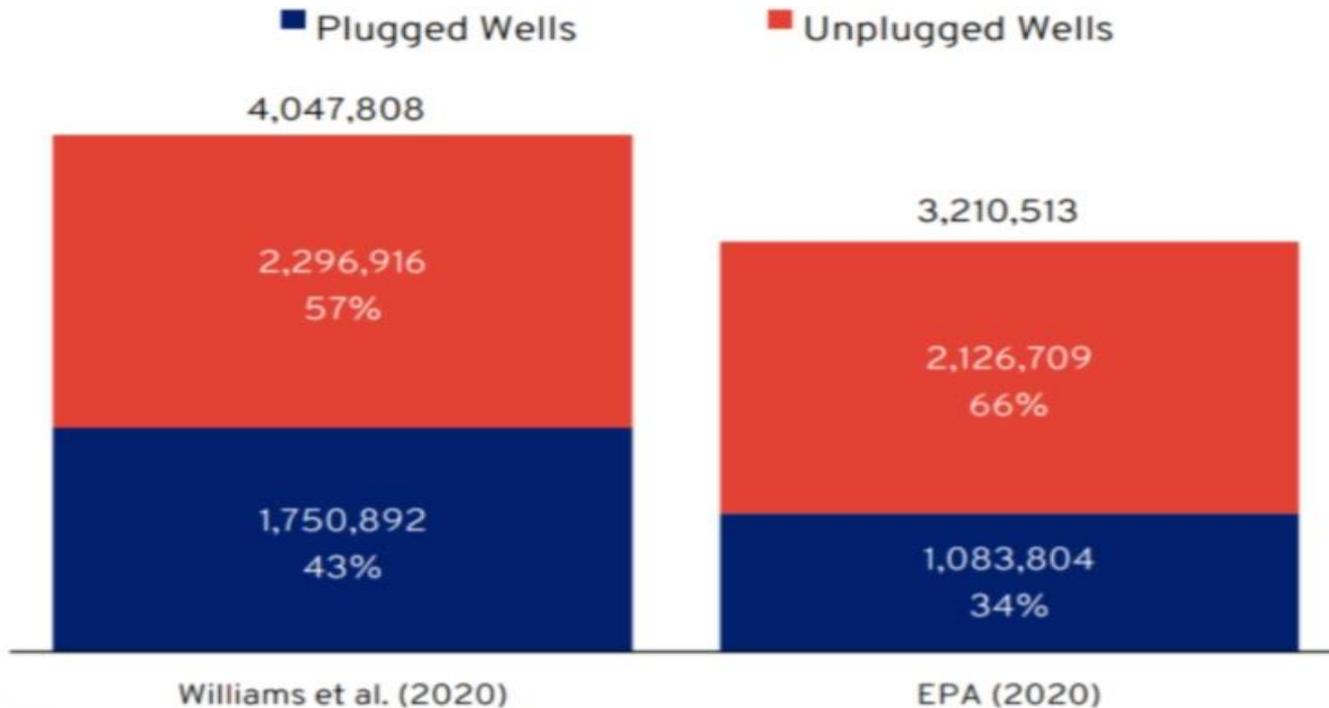
Figure 1. U.S. total wells by production rate brackets
wells



U.S. abandoned wells

I

Estimated Onshore Plugged and Unplugged Abandoned Oil and Gas Wells in the U.S.



Source: U.S. Environmental Protection Agency, "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018," Washington, DC, 2020 and James, P. Williams, Amara Regehr, and Mary Kang. "Methane Emissions from Abandoned Oil and Gas Wells in Canada and the United States," *Environmental Science & Technology*, 55 (1), 563-570

Los Angeles 1902: “An oil well in every yard”

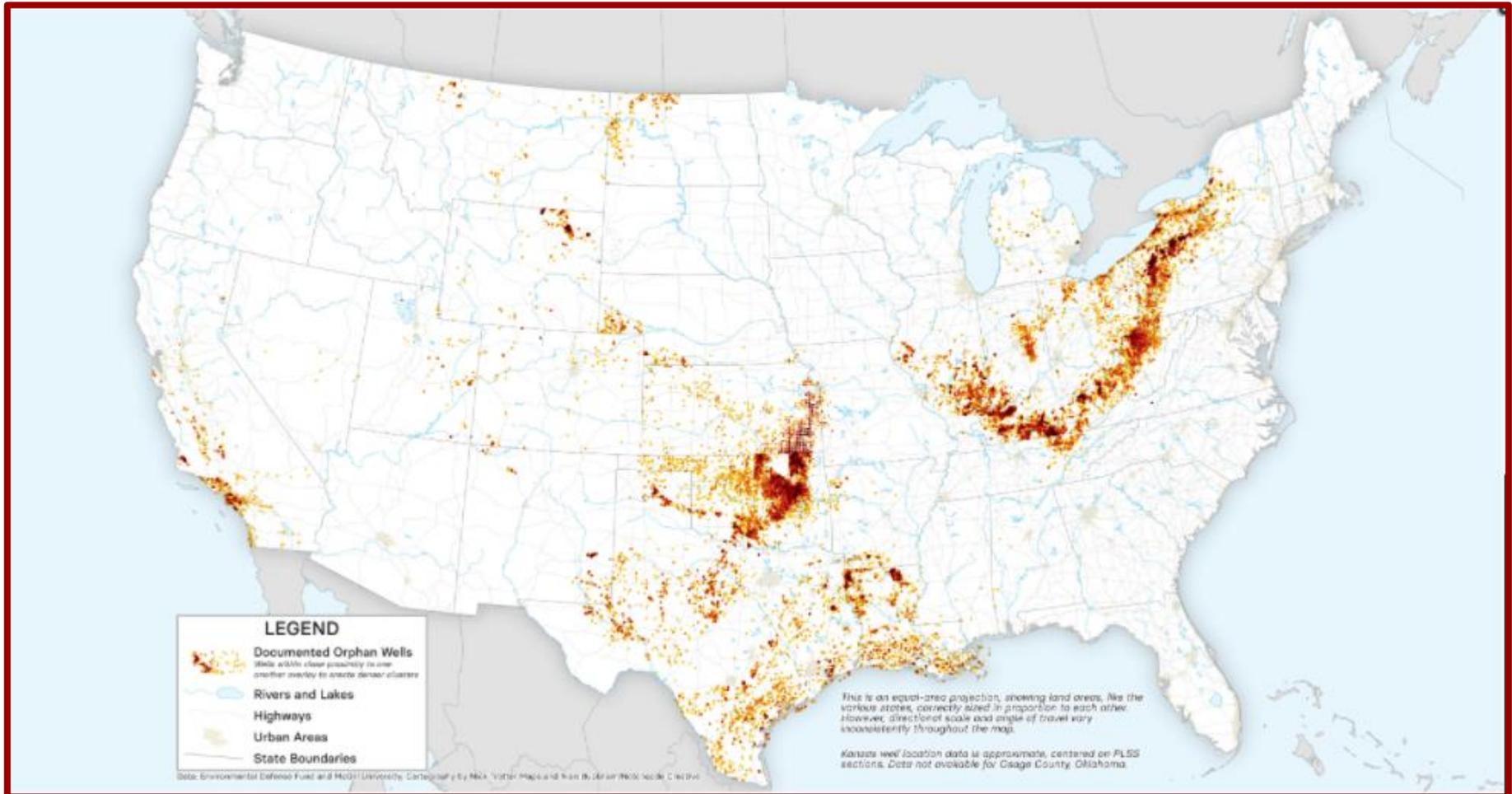


Los Angeles 1902: “An oil well in every yard”

The U.S. oil and gas industry is unique because of U.S. property rights and mineral ownership laws



Documented “orphan” wells in the U.S.

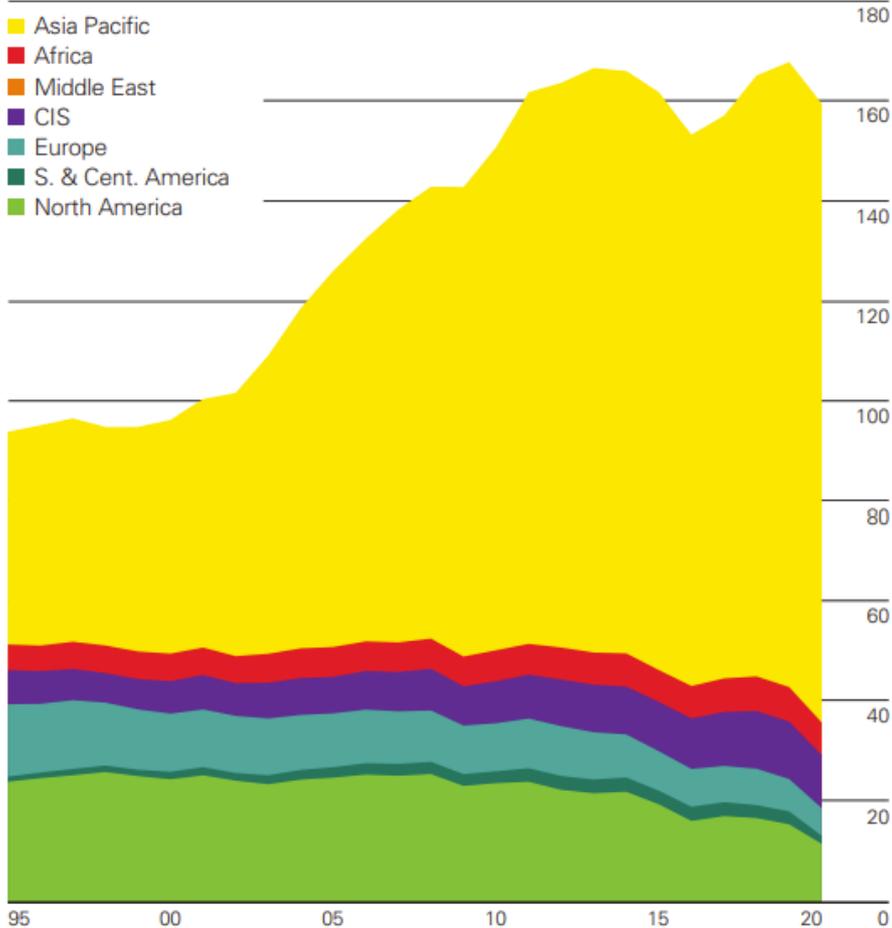


Limiting global CO2 emissions requires solving the coal problem, particularly in greater Asia

Coal: Production by region

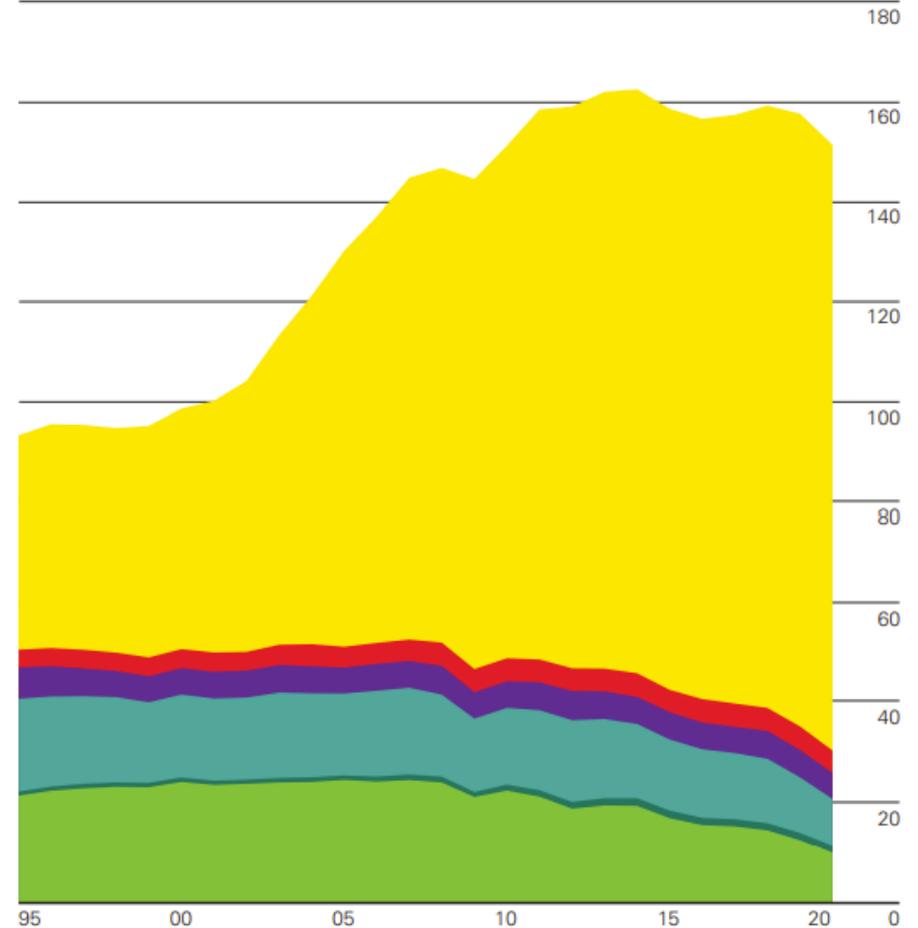
Exajoules

- Asia Pacific
- Africa
- Middle East
- CIS
- Europe
- S. & Cent. America
- North America



Coal: Consumption by region

Exajoules



Challenges and opportunities from the Energy Transition

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Opportunities:

- Significant investment growth in energy systems
- Globally displacing coal with natural gas
- Re-purposing legacy assets
- Re-engineering energy supply chains
- New natural resource developments

Structural impacts for the oil and gas industry

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- National Oil Companies
- Integrated Global Majors
- Major independents (“mini-majors”)
- US mid and small independents

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Diversifying capital structures

Consolidating assets

Reducing operational carbon footprints

Managing / re-purposing end-of-field life assets

Summary Observations

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Summary Observations

- The Energy Transition will be “uneven”
- Unforeseen events will intervene (as they always have)
- The Transition will take longer and may take form in ways which challenge current political goals
- The oil and gas industry will change its technology base and operational practices to reduce carbon footprint
- The oil and gas industry will diversify in its business models to adapt (notably in the U.S.)

Thank you for your attention