



A Brief History of Energy Transitions

Robert Balch

New Mexico Institute of Mining and Technology

November 7, 2024

CESAM, Socorro NM

What Is an Energy Transition?

An energy transition is a broad shift in technologies and behaviours that are needed to replace one source of energy with another (Jacard, 2020)

Has this happened before?: Sort of. Around 1750 the industrial revolution started in England, Biomass began to give way to coal. However... We still use biomass today, and in fact some coal power plants are being converted back to biomass

Arguably there has been only one Energy Transition which is still progress!

Biomass > Coal > Oil/Gas > Hydro > Wind > Nuclear > Solar PV > Modern Renewables

Pre 1750 1750 1850 1891 1895 1951 1951 1980

All of these power sources are still in use today

Energy Transitions are long-term processes, usually resulting from finding something better or cheaper: Early shifts in primary energy source driven by economics and capacity demand

So... **What** Is the Current Energy Transition?

A global or local shift in the world energy sector from Fossil based fuels to renewable [or carbon neutral] power sources.

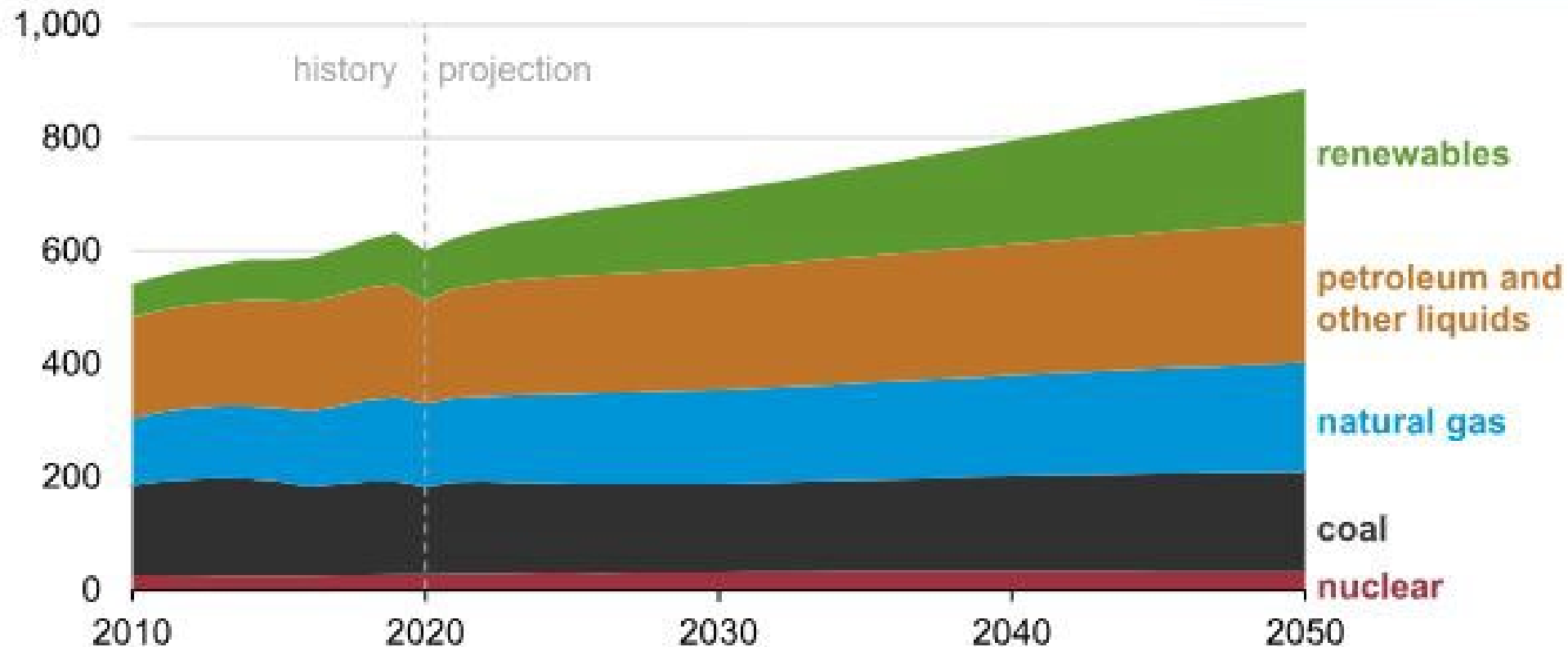
Where is this occurring: Some countries have already established ETA goals, primarily in the US, Europe, Australia, and parts of Asia (OECD Countries)

While some countries and US states are very aggressively changing policies to pursue these goals, often with phased approaches, many more are taking a much softer approach

Politics Matter: The most aggressive policies are at times outpacing the ability for renewables to be deployed, without full consideration of economics, materials, and energy balances

Global Energy Mix in 2050

Global primary energy consumption by energy source (2010–2050)
quadrillion British thermal units

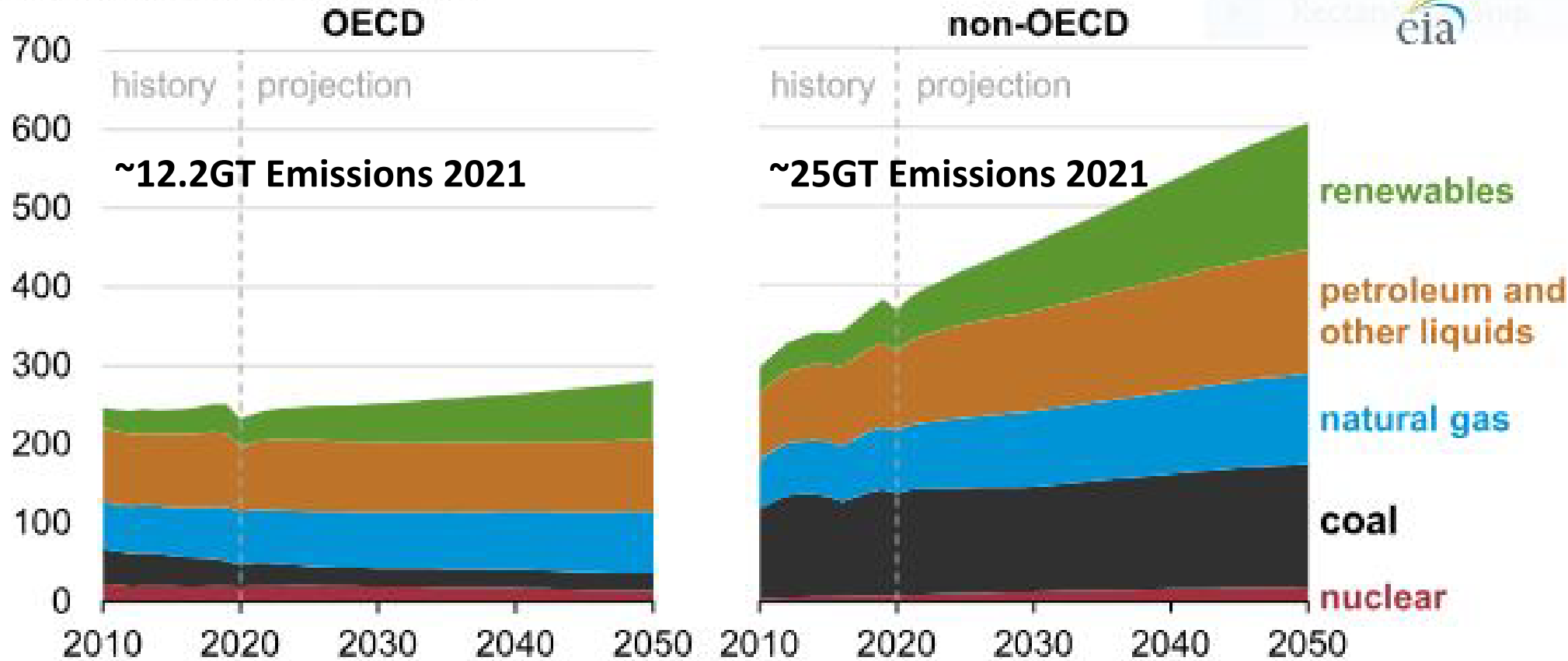


Source: U.S. Energy Information Administration, *International Energy Outlook 2021* Reference case
Note: Petroleum and other liquids includes biofuels.

- Renewables are the fastest growing category (45%)
- However, world energy demand is expected to grow by 50% in the same time period.
- Renewables are displacing, in part, new hydrocarbon demands, but all energy sources are increasing by 2050

Geopolitics Plays a Large Role...

Primary energy consumption by source, OECD and non-OECD countries (2010–2050)
quadrillion British thermal units



Source: U.S. Energy Information Administration, *International Energy Outlook 2021*

OECD Countries:

Primarily Europe, North America, Far East Asia are expected to slightly reduce Hydrocarbon use by 2050, and have modest growth in demand covered by renewables

Non-OECD Countries:

See rapid growth in every energy category, leading to a net increase in hydrocarbon use world-wide in 2050

How Do We Force an Energy Transition?

Simply stated this is an immense challenge

- **Hydrocarbon Energy:** Is pervasive and impacts every aspect of modern life
 - Coal-fired power (~30% of world CO₂ emissions)
 - Natural gas (~22%)
 - Vehicle Fuel (~9%)
- **Critical Building Materials:** Drive economic development
 - Cement (~8% world emissions)
 - Steel (~9%)
- **Strategic Minerals are Scarce:** Relative to new demands we lack sufficient supplies to meet demand for renewables, renewable power storage, and 0 emissions vehicles

While rapidly evolving, technology may not answer all of these needs in the time we have left to meet climate goals

Economics: Implications for New Mexico

NM has been an energy exporter since the 1930's

- Coal power mostly sent west
- Oil and Gas
- Now Renewables

Impacts on economics of current ET

- Can remain electricity exporter with renewables (to a point)
- People needed for grid buildups, power lines, wind and solar farms
- People not needed for long-term operations at the scale of current sources
- Transition leads to job losses in coal mining and power plant operation heavily impacting Navajo Nation

Important to consider economic implications and to adapt the transition to meet goals rather than ideals

References

- [Jaccard, Mark](#) (2020). "Chapter 11 – "Renewables Have Won"". [The Citizen's Guide to Climate Success: Overcoming Myths that Hinder Progress](#). [Cambridge University Press](#). [ISBN 978-1-108-47937-0](#). [OCLC 1110157223](#). [Archived](#) from the original on 2021-09-12.