

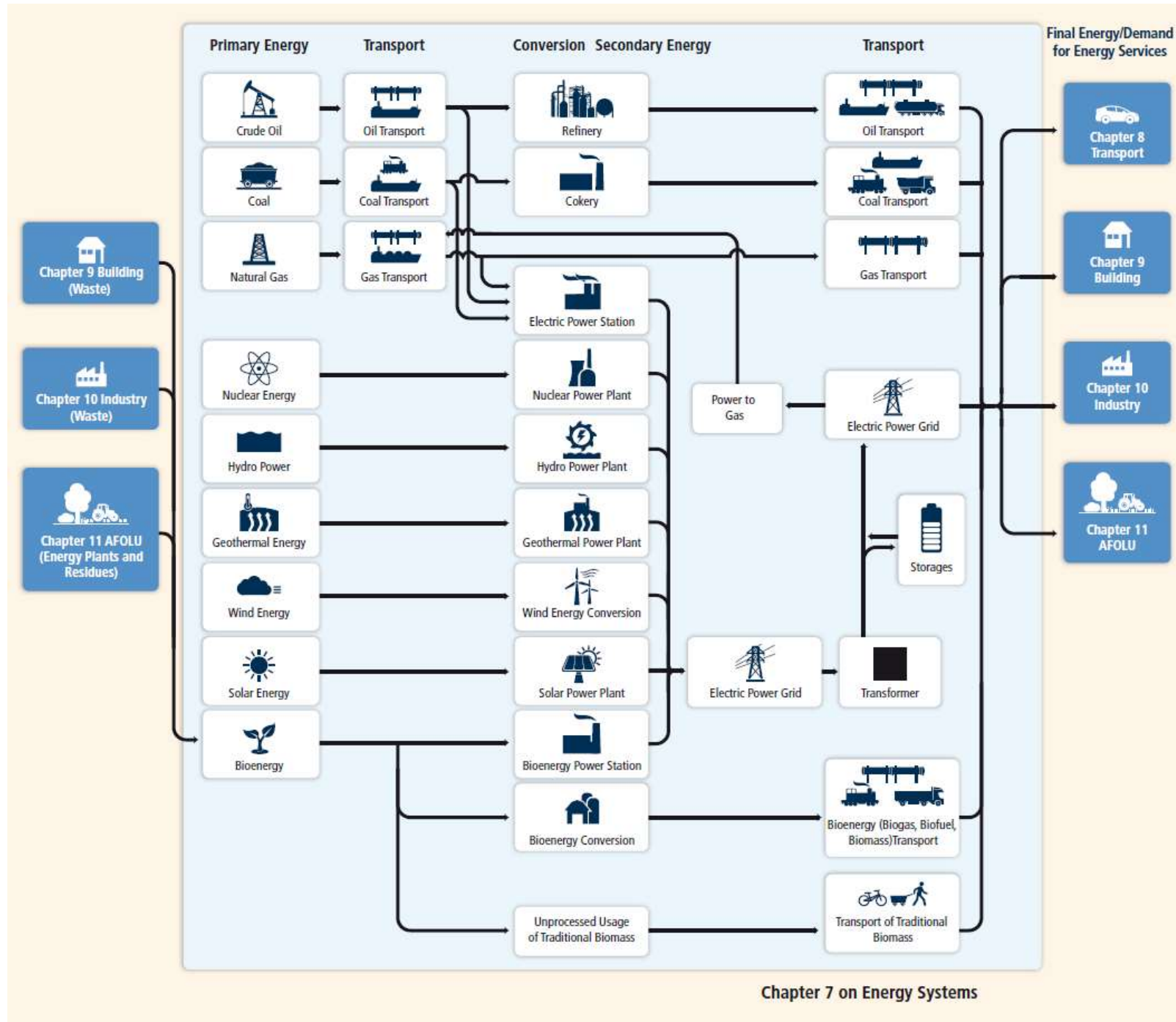
Supply, Demand, and the Implications of Increasing Subnational Action

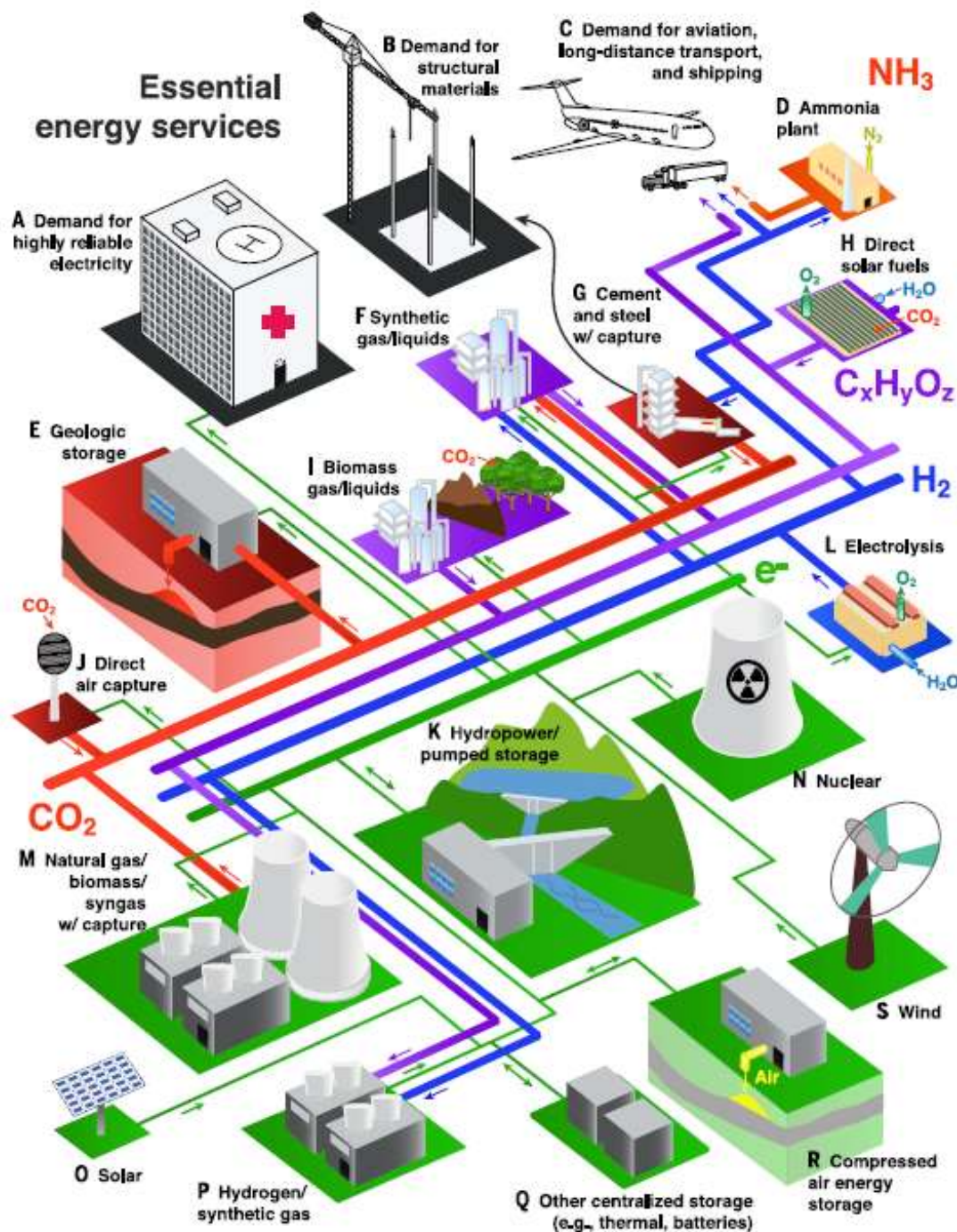
Leon Clarke

December 9, 2019

Energy systems are... systems

Source: Bruckner, et al., 2014





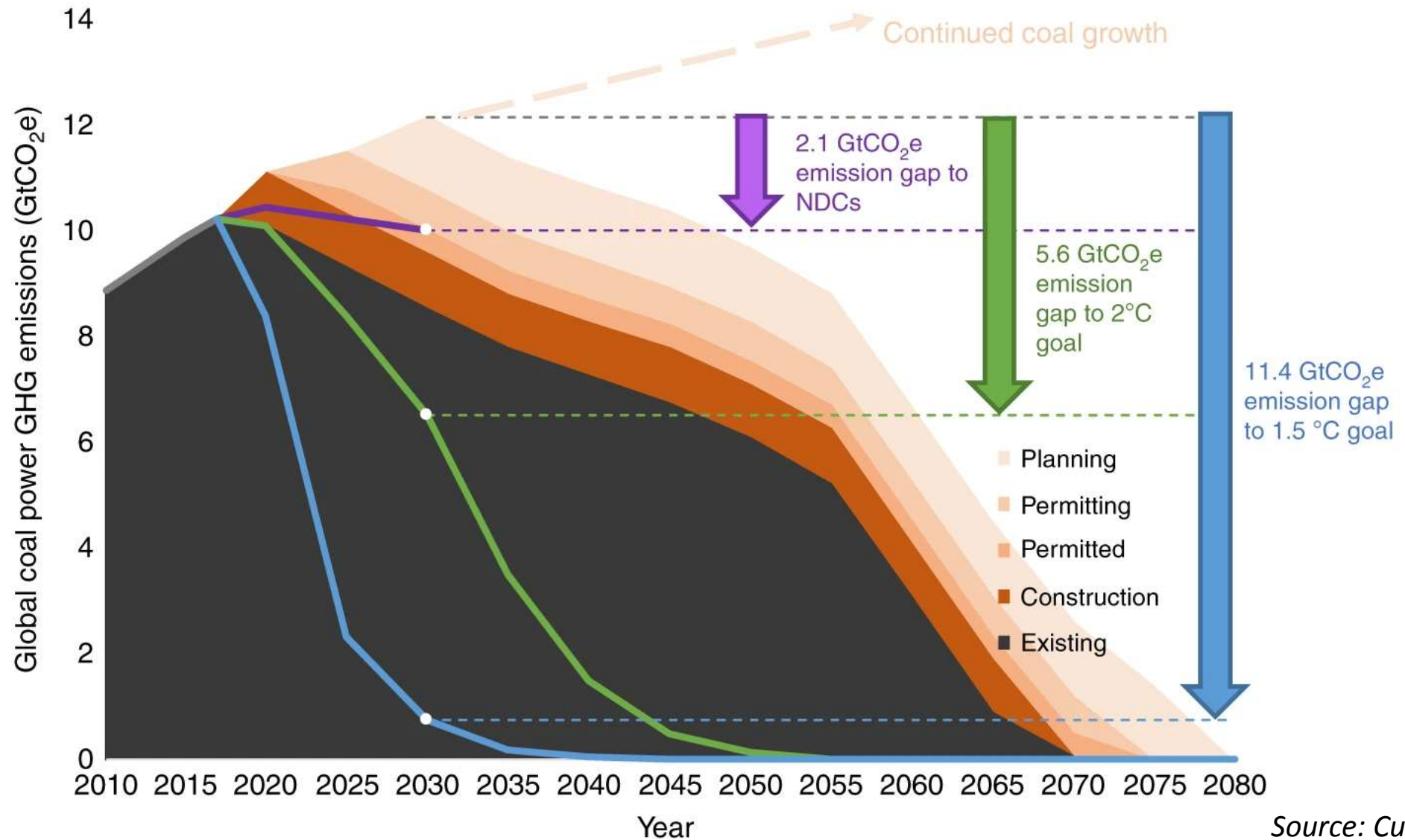
The long-term goal is zero or negative emissions

Major Challenges

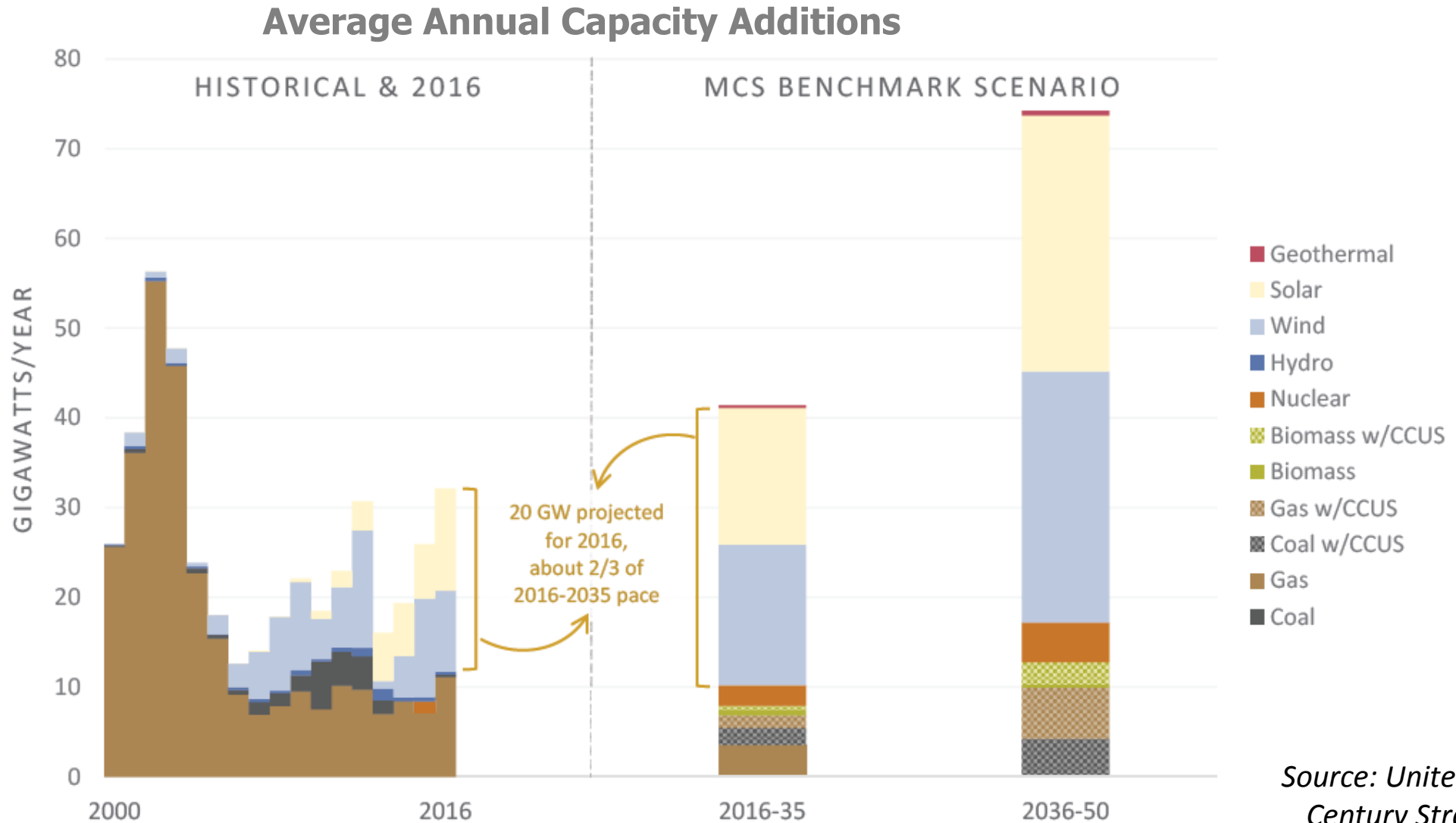
1. Aviation, long-distance transport, and shipping.
2. Structural materials (iron and steel, cement)
3. Load-following electricity



Coal retirements and 1.5C or 2.0C



Investment patterns need to evolve



Source: United States Mid-Century Strategy, 2016

Low Carbon Transition: Light Duty Vehicle Example (slide courtesy of Jim Williams)

Energy service demand (AEO)

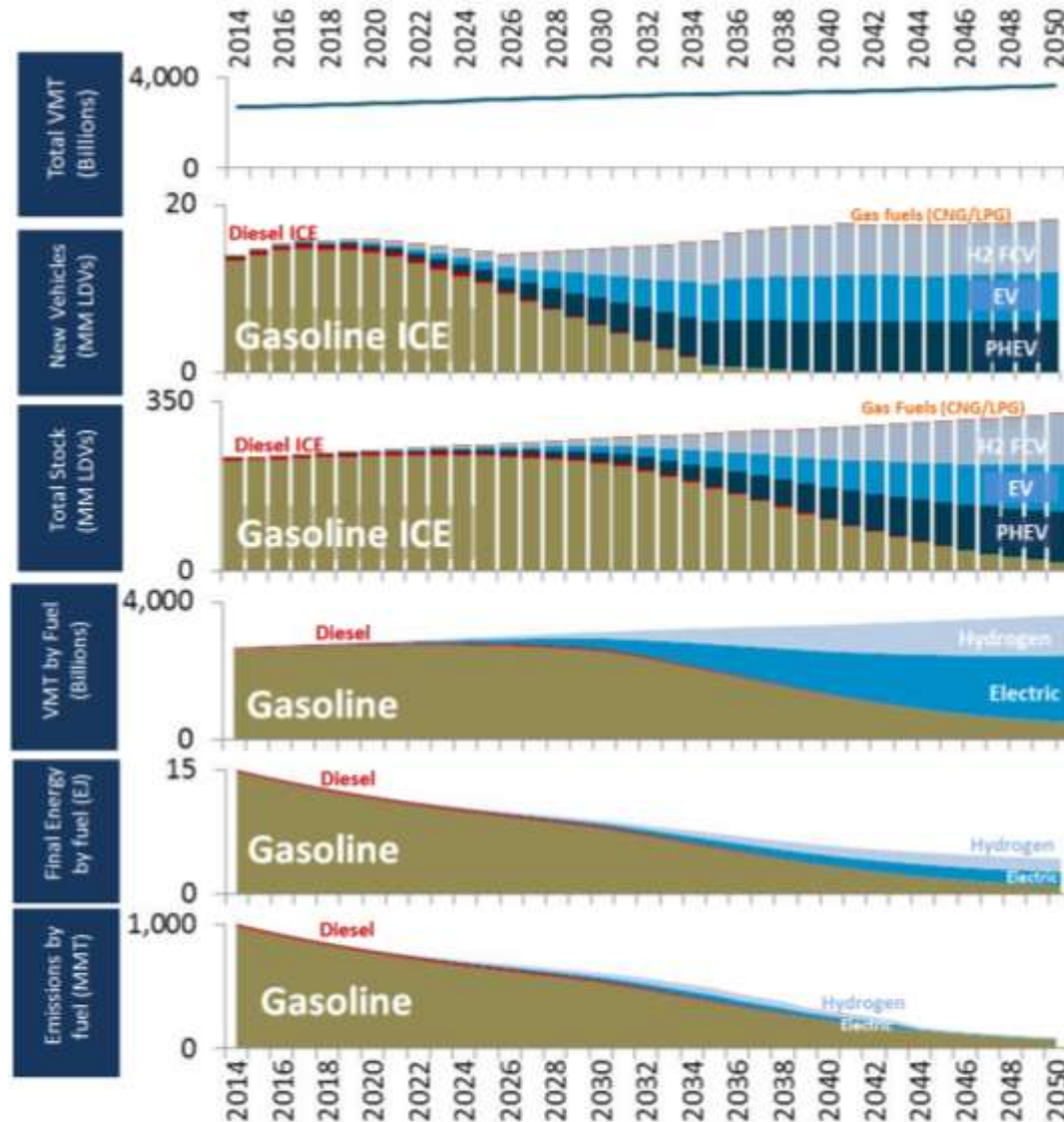
Annual LDV sales

LDV stocks by type

VMT by fuel type

LDV final energy by fuel type

GHG emissions by fuel type



Annual sales reach 100% low carbon vehicles in ~15 years

LDV stock ~300M low carbon vehicles in 2050

>90% of VMT from electricity or electric fuels

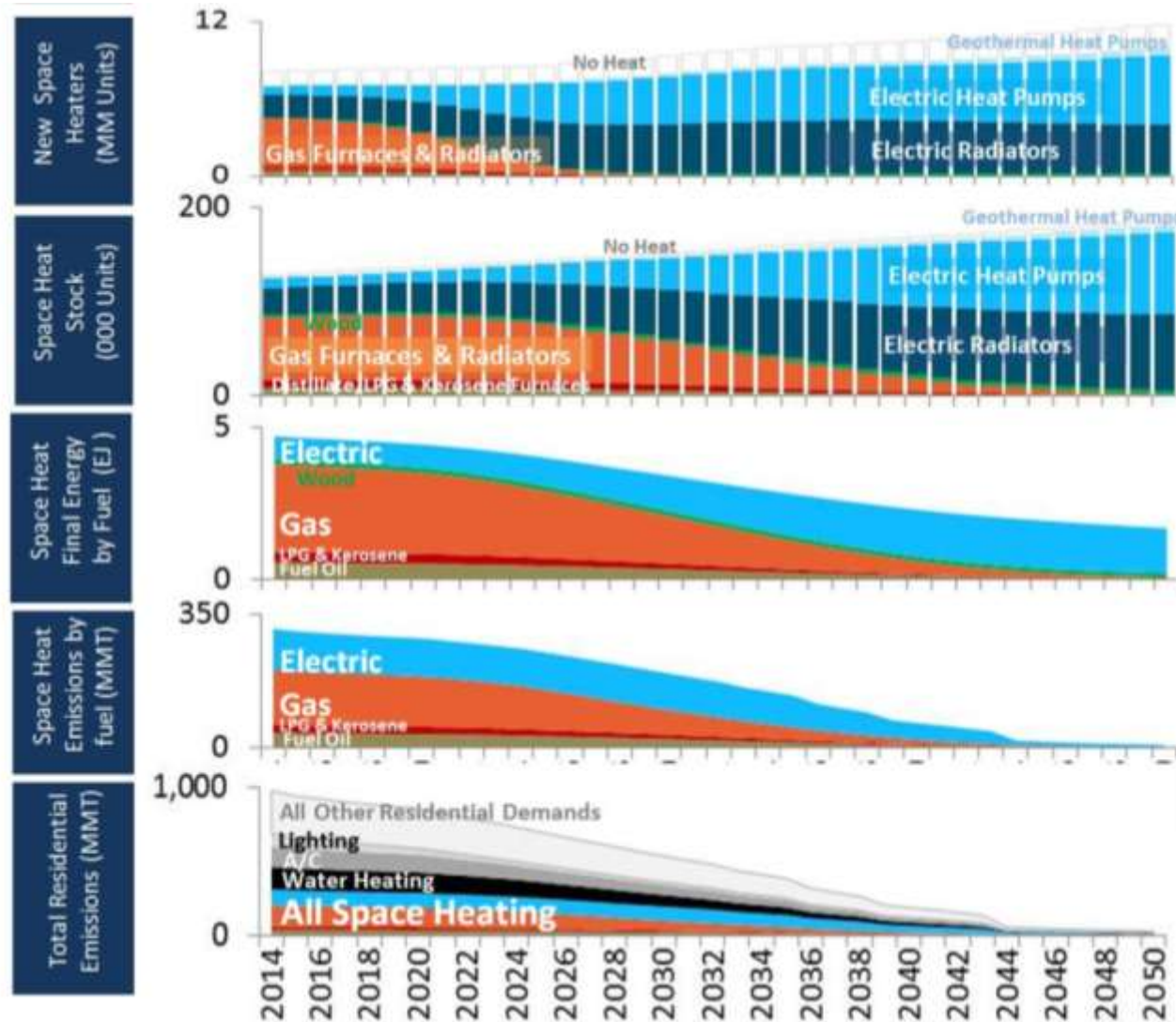
Electric drive train efficiency reduces final energy ~2/3

LDV emission reduced >95%



Space Heating and Building Applications

(slide courtesy of Jim Williams)



Annual sales reach ~100%
electric heating in ~10 years

Space heating ~100%
electrified by 2045

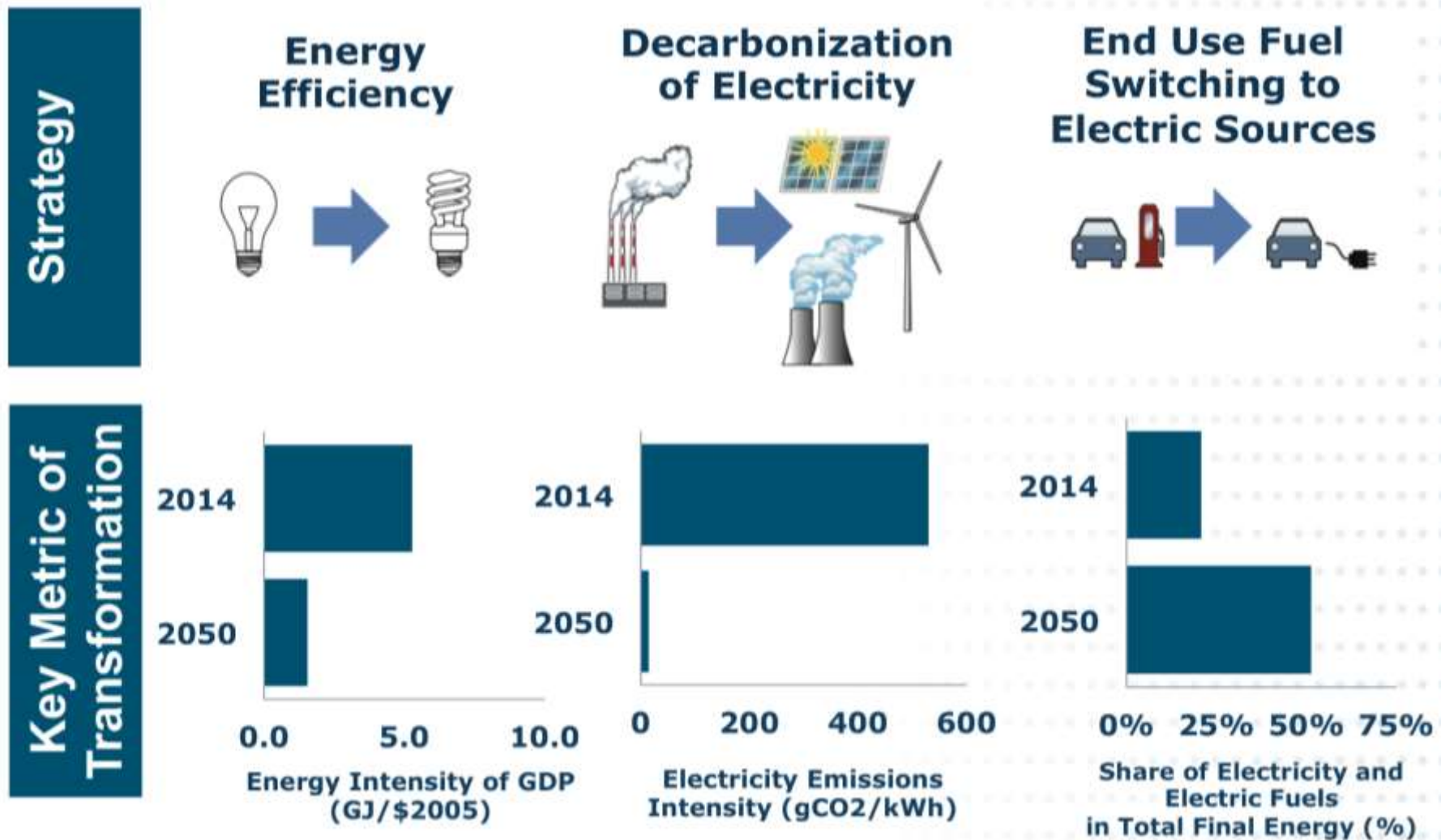
Electricity supplies all
heating in 2050

CO2 from heating almost
eliminated by 2050



Three Pillars of Deep Decarbonization

(Slide Courtesy of Jim Williams)

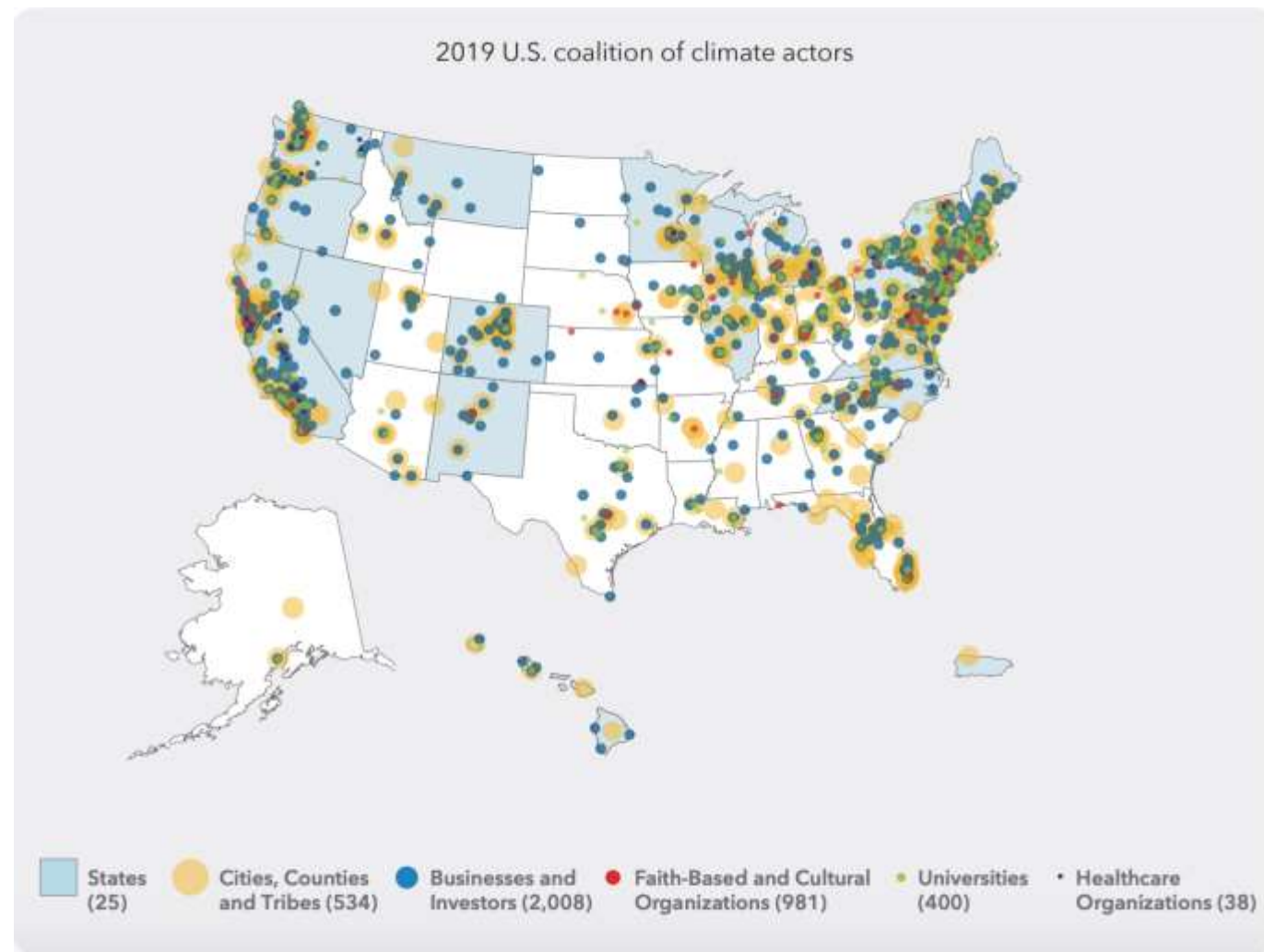


Non-federal actors are increasingly taking action on climate change

This group of actors represents:


- 68% of U.S. GDP
- 65% of the U.S. Population
- 51% of U.S. GHG Emissions
- And would be the second largest economy in the world, behind the United States

From: The America's Pledge Initiative on Climate Change (2019) "Accelerating America's Pledge: Going All-In to Build a Prosperous, Low-Carbon Economy for the United States." N. Hultman, et al.



Non-federal actors are increasingly taking action on climate change



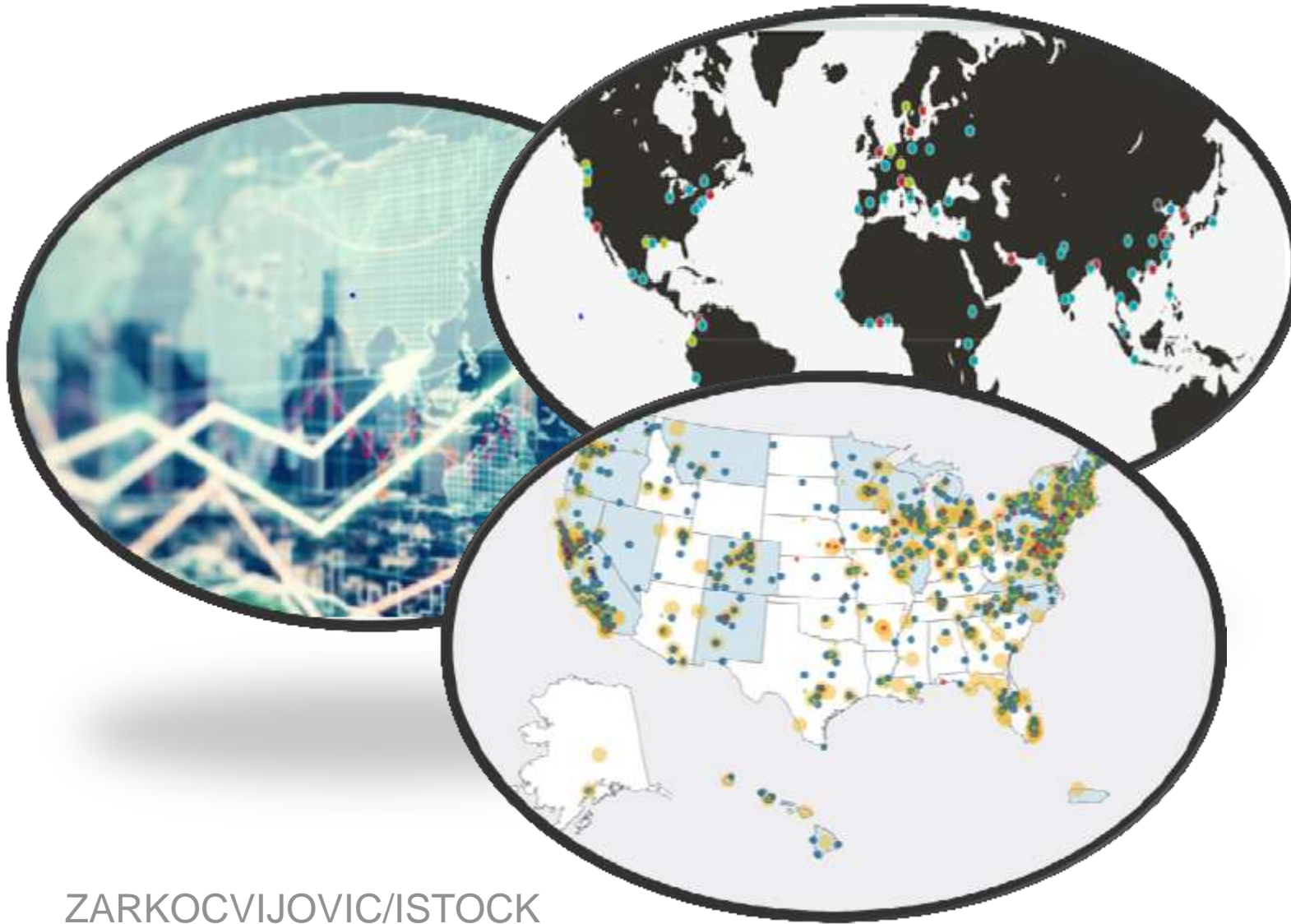
 Commitment

87 MAJOR COMPANIES LEAD THE WAY TOWARDS A 1.5°C FUTURE AT UN CLIMATE ACTION SUMMIT

These companies are taking action to align their businesses with what scientists say is needed to limit the worst impacts of climate change.



Each of these different actors has a different role to play in climate mitigation



Actions: renewable portfolio standards, zoning, public transit investments, basic and applied R&D, carbon prices, border-tax adjustments, building permits, vehicle standards, higher-efficiency processes, ZEV mandates, emissions targets, renewable targets, oil and gas methane, nuclear fleet retention, coal power plant retirement, public education programs,.....

Thank You