



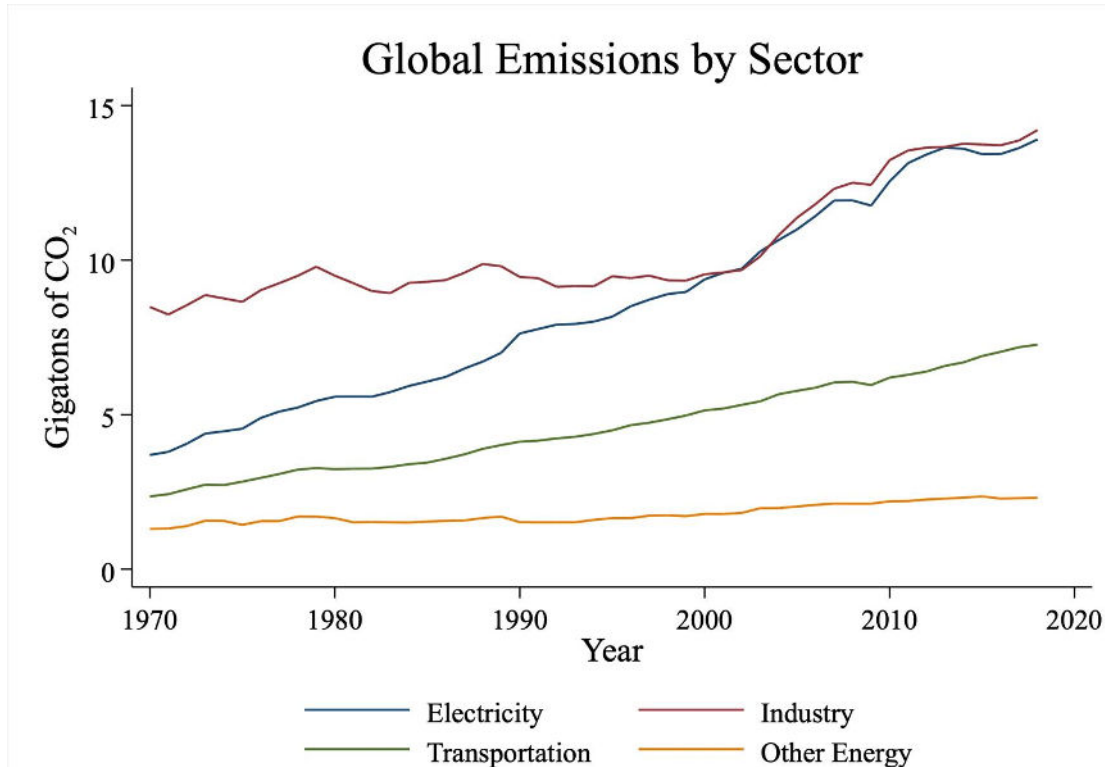
# THE ELECTRIC CEILING: LIMITS AND COSTS OF FULL ELECTRIFICATION

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FSR CLIMATE ANNUAL CONFERENCE  
DECEMBER 2, 2022

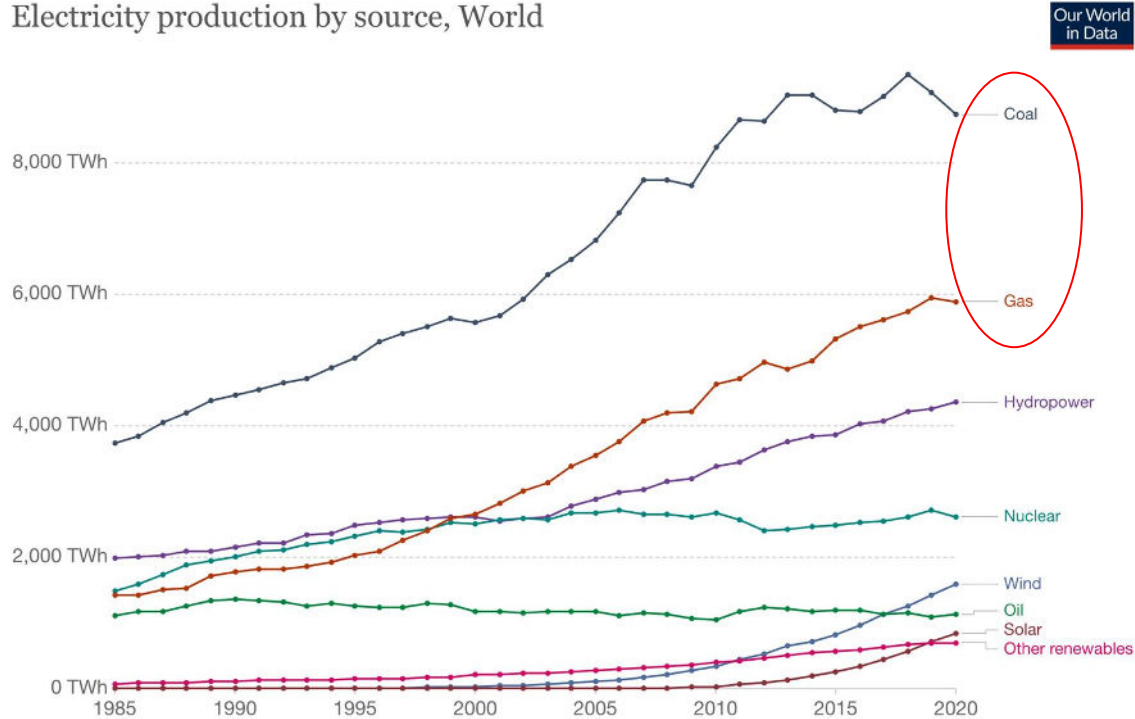
*THE VIEWS EXPRESSED HERE ARE MY OWN AND DO NOT NECESSARILY  
REPRESENT THE VIEWS OF THE FEDERAL RESERVE BANK OF DALLAS OR THE  
FEDERAL RESERVE SYSTEM.*

## Motivation: transportation emissions ~20% of total global emissions



## Motivation: load growth + coal

Electricity production by source, World



Source: Our World in Data based on BP Statistical Review of World Energy & Ember (2021)  
Note: 'Other renewables' includes biomass, waste, geothermal and wave and tidal energy.

## Electrification: centerpiece of the energy transition

- Yet reasons to be skeptical about inevitability, or at least optimal pace, of the transition.
- Several under-appreciated costs of full, or even deep, electrification
- 2 categories:
  - Private costs (incurred by potential EV owners)
  - Public costs (exacerbated by policies attempting to overcome private costs)
- Costs of attempting to mitigate GHGs via electrification may rise sharply at some as-yet-unknown level

## Can there be “too much” electrification?

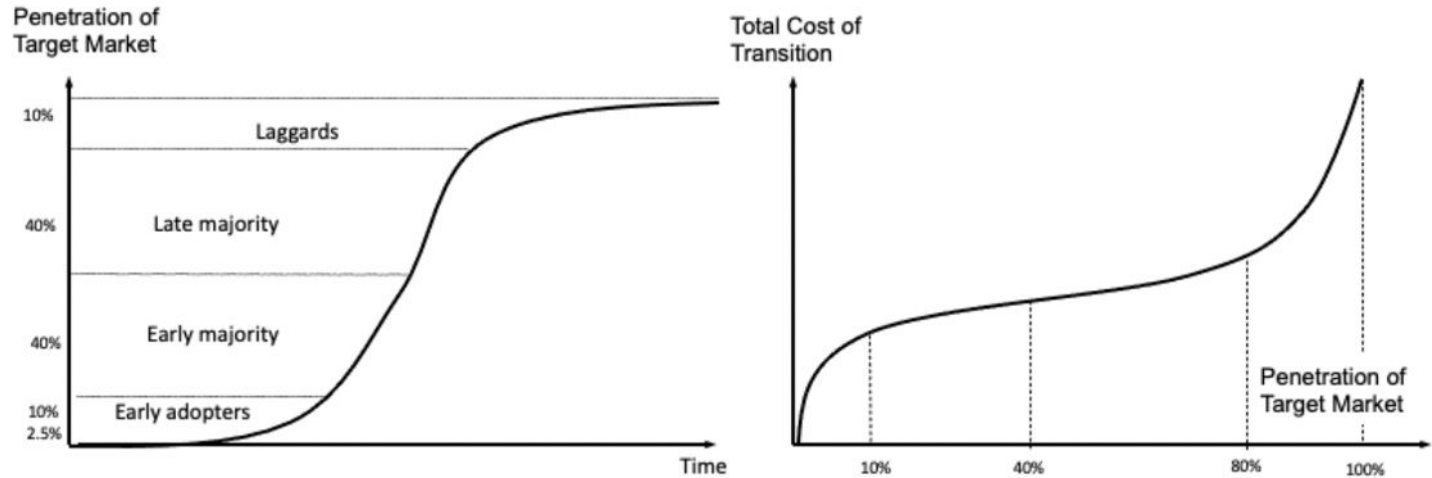
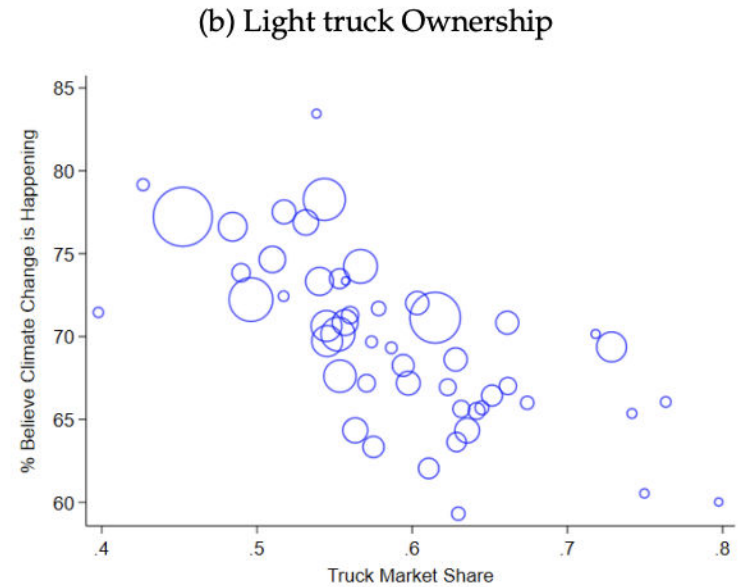
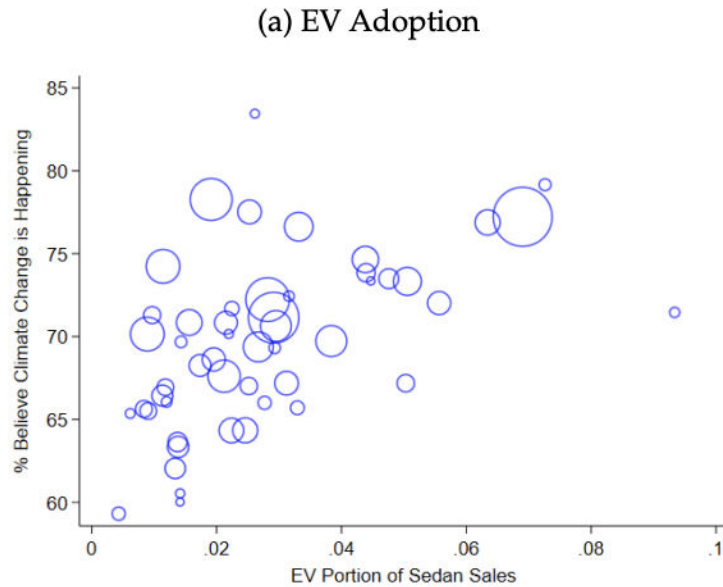


Figure 1: Adoption S-curve and marginal cost of adoption

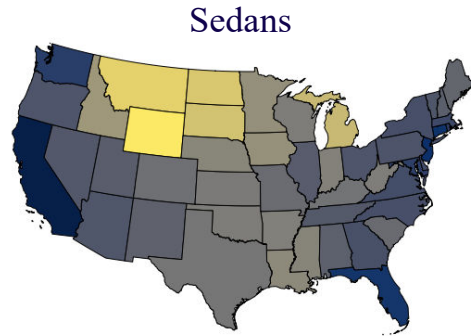
- Typically, electric alternative not (yet) dominant → mixed equilibrium
  - E.g. EVs, space heating

## Private costs: heterogeneous preferences

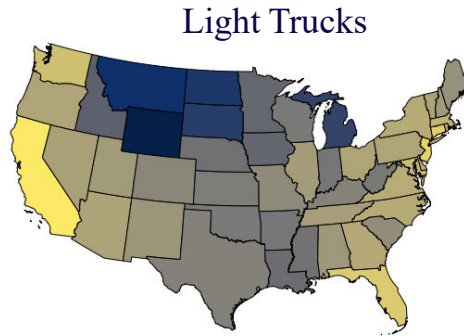
### *Climate Change Beliefs vs Vehicle Choice*



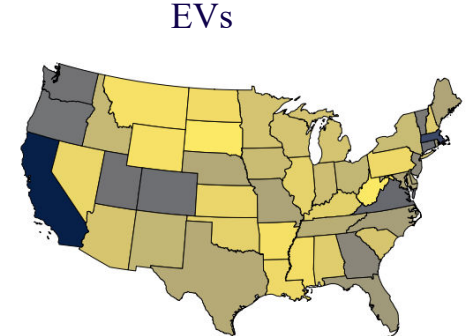
## Market share by vehicle type (2017-18, Maritz)



Market Share  
(% of all vehicles Sold)  
30% 40% 50%



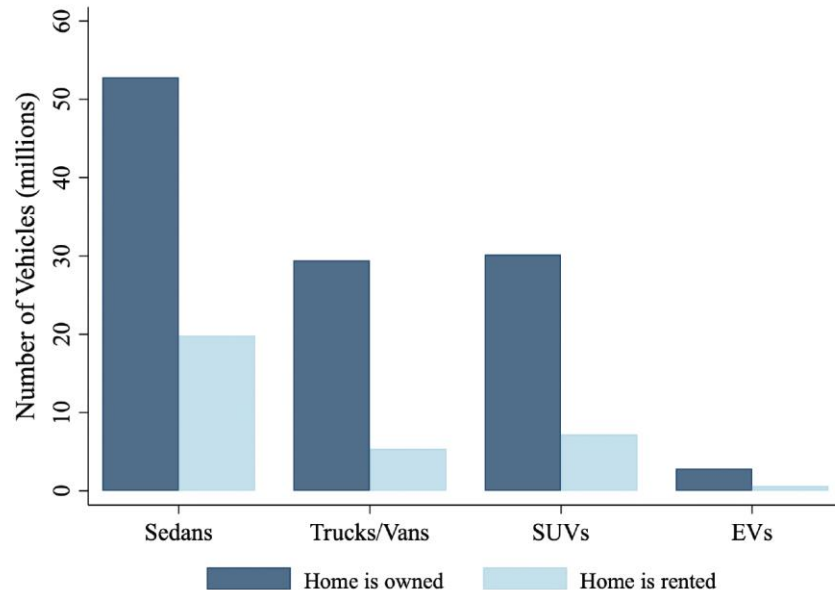
Market Share  
(% of all vehicles Sold)  
50% 60% 70%



Market Share  
(% of all vehicles Sold)  
1% 2% 3%

## Physical barriers

- At-home charging
  - MUDs comprise 31% of US housing
  - 1 in 6 EVs owned by renters
- Electricity service level
  - L2 charging requires >200amp service
  - ~20% of homes (est.) don't have this
  - Upgrade: \$1,000-\$2,500/hh
- Distribution system upgrades
  - \$200-\$2,000/hh (Brockway et al 2022)
  - Depends on ability to optimize demand over time and space

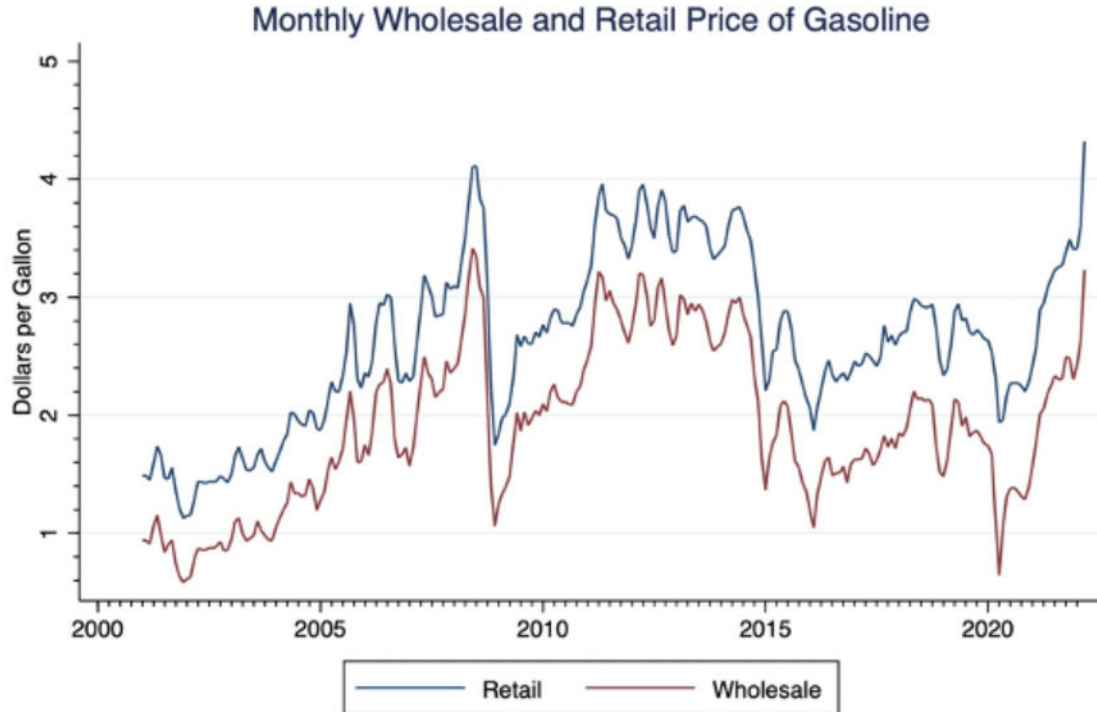




## Public costs

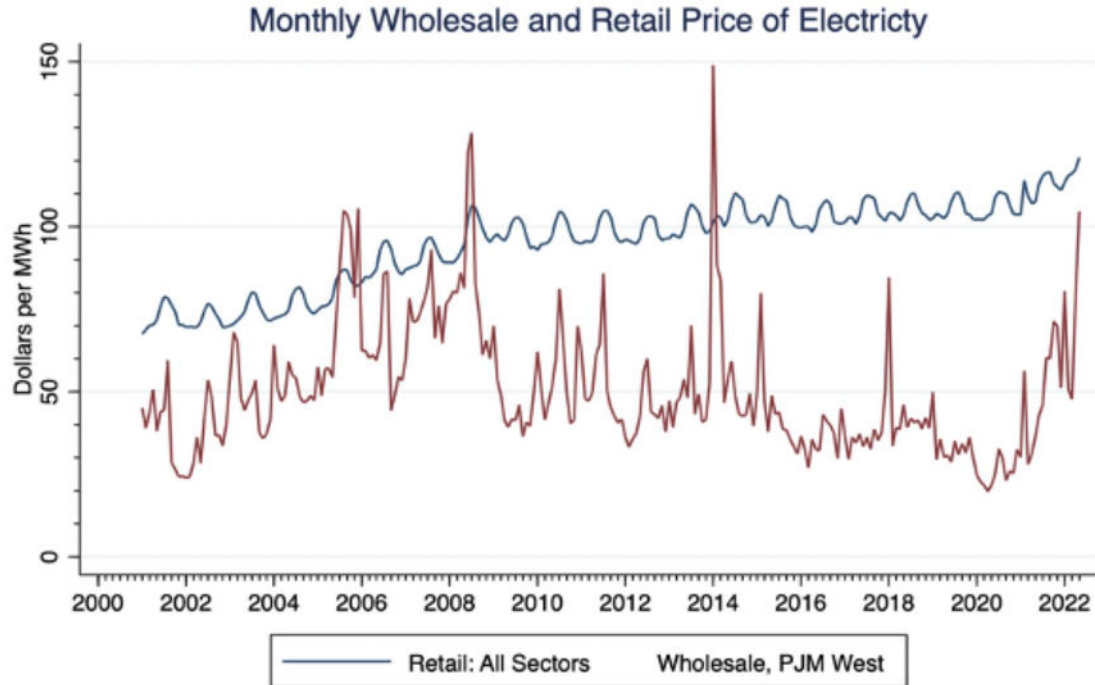
- Remaining CO2 & local pollutants in electricity sector
  - US 60% gas + coal
- Relative inefficiency of electricity sector
- Non-carbon externalities
  - Congestion, deaths, road taxes

## Electricity sector regulation shrouds price discovery



One segment of time = one quarter. Time: January 2001 - March 2022  
Values are national averages across all grades and formulations. Source EIA

## Electricity sector regulation shrouds price discovery

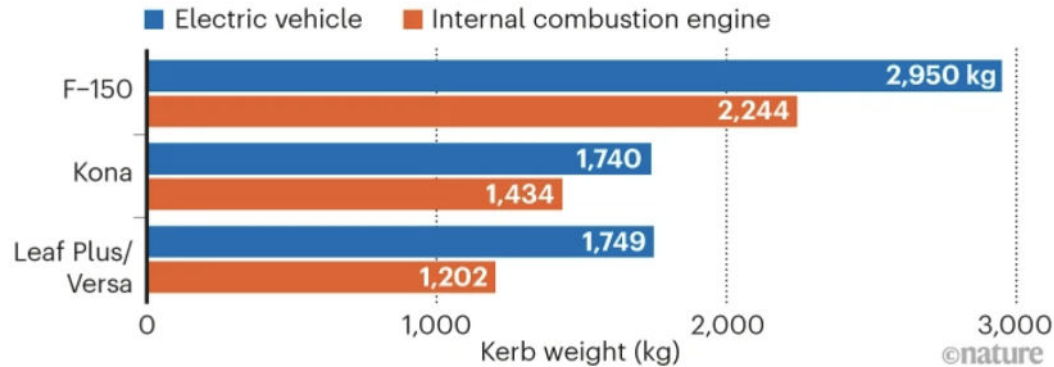


One segment of time = two months. Time: January 2001 - May 2022.  
Retail price is national average of all customer classes, Wholesale Price  
is from PJM West Intercontinental Exchange (ICE) trading hub.

## “Pounds that kill”

### HEAVIER ELECTRIC FLEET

Bulky batteries and their supports mean electric vehicles weigh more than petroleum predecessors.



- VSL of lives lost from +700lb weight ≈ climate benefits of avoided GHG

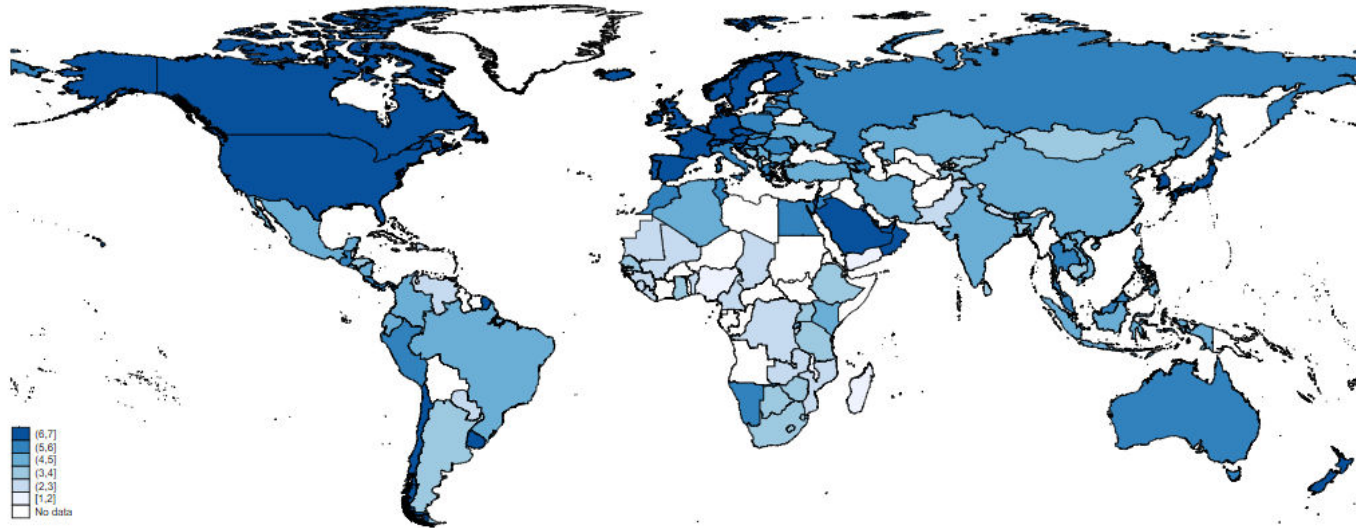
## What is the optimal mix of technologies?

- Full electrification requires changing the source of >80% of energy end uses in the US economy
- “All or nothing” mindset typically ignores optimality of  $MC = MB$
- Cost of 100% electrification using today’s tech would exceed even extreme forecasts of SCC
  - Commitments to full electrification are therefore a bet on sector-specific, future innovation
- More likely that the optimal scenario has a mix of technologies

## Rigid bans and mandates impose at least 2 risks

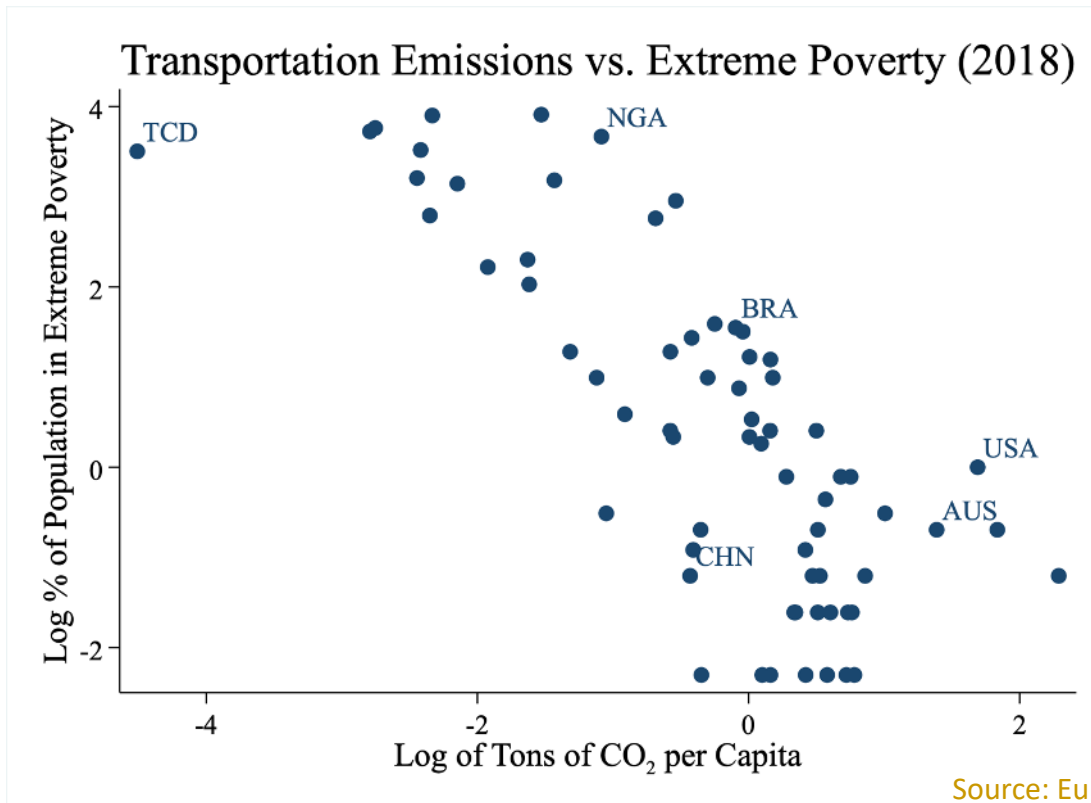
1. Drive up electricity costs rapidly, and risk undermining the electrification goal
  2. Foreclose more efficient, lower cost abatement pathways
- Important to retain flexibility
    - Cost containment
    - Alternative compliance mechanisms
    - Frequent re-evaluation
  - Market-based approaches likely to be increasingly important as electrification progresses

## Zooming out: electrification less promising in developing world



Survey Question: In your country, how reliable is the electricity supply (lack of interruptions and lack of voltage fluctuations)?  
[1 = extremely unreliable; 7 = extremely reliable]

## Zooming out: economic growth and transportation go hand in hand





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