Promoting Plug-in Electric Vehicles

(It's much more than internalizing externalities)

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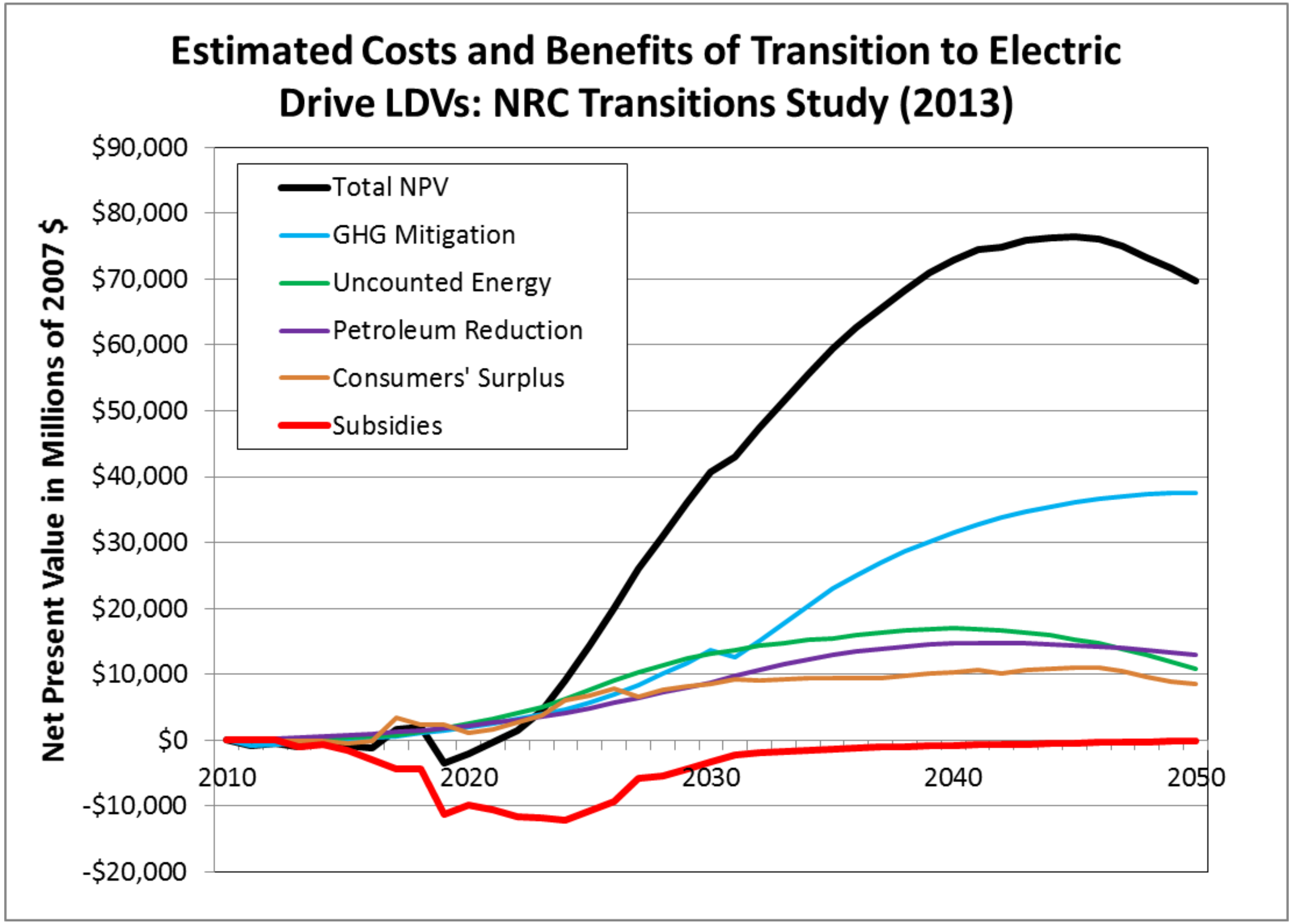
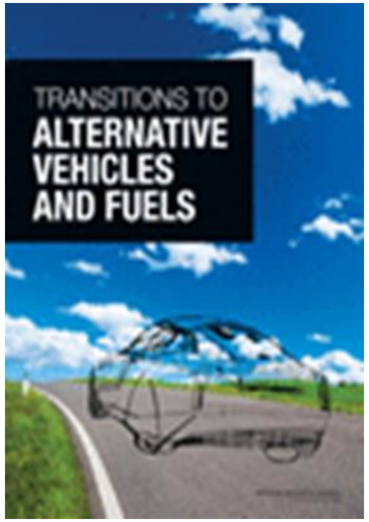
The transition to zero-emission energy is not a simple environmental externality problem.

- Urgent, long-term energy transition requires a new policy paradigm: (internalizing externalities is not sufficient.)
  - Long time constants (≈50 years) → Deep uncertainty
  - Transition barriers → + feedbacks → tipping points & path dependency
    - Cost: Scale economies, learning by doing, technological advances
    - Majority risk aversion and lack of knowledge
    - Lack of make/model choice diversity
    - In adequate charging infrastructure
    - Institutional and regulatory infrastructure to support markets
- What policies can be effective, durable and adaptable?
  - To overcome transition barriers
  - To manage the co-evolution of fuel and vehicle markets?

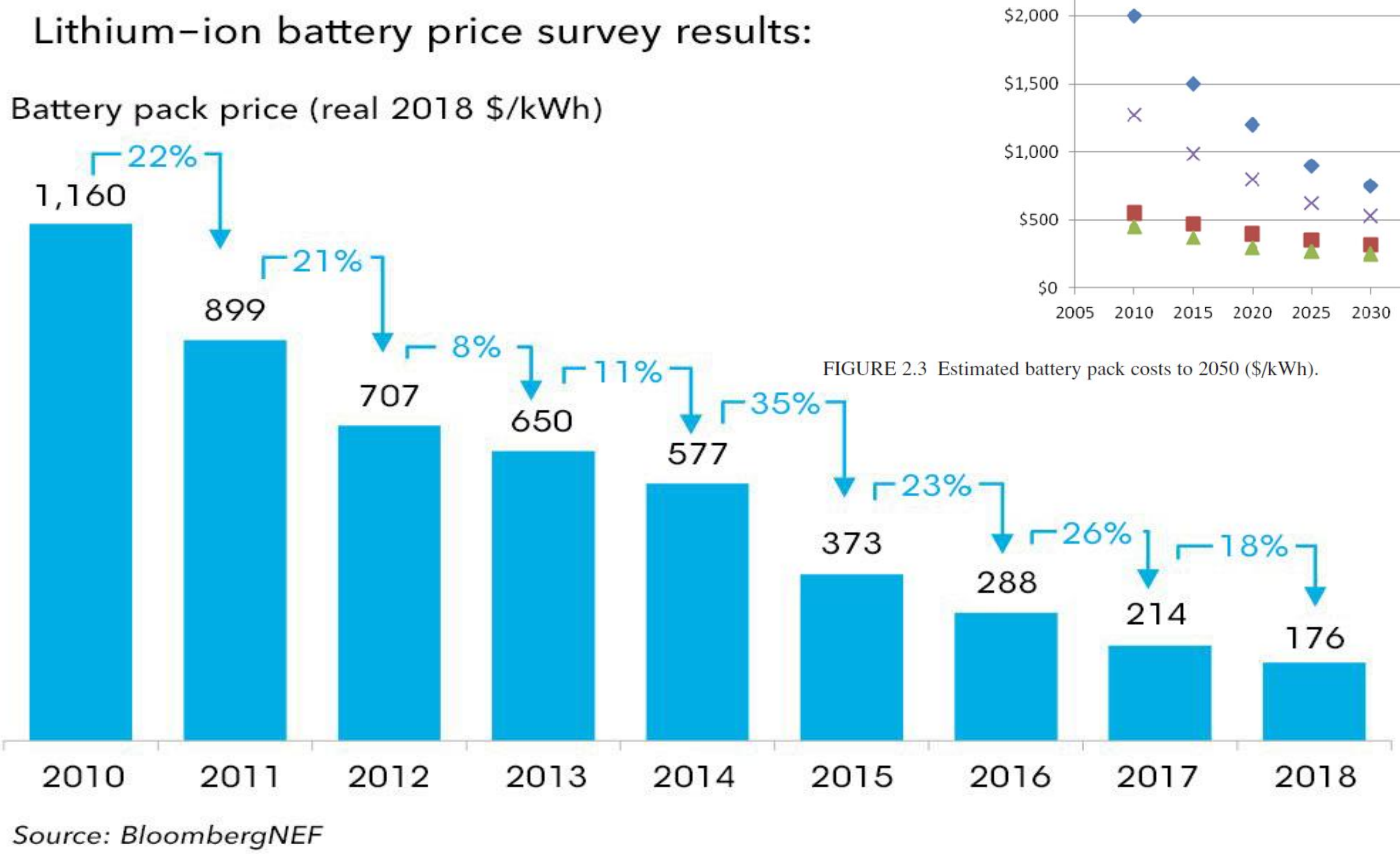
The NRC's 2013 assessment of how to achieve an 80% reduction in GHGs by U.S. light-duty vehicles by 2050 illustrates 4 key attributes of large-scale energy transitions for the public good.





1. Takes decades
2. Costs many $billions
3. Initially Benefits<Costs
4. Eventually B >> C

Things are going great…



ALTERNATIVE VEHICLE TECHNOLOGIES: STATUS, POTENTIAL, AND BARRIERS

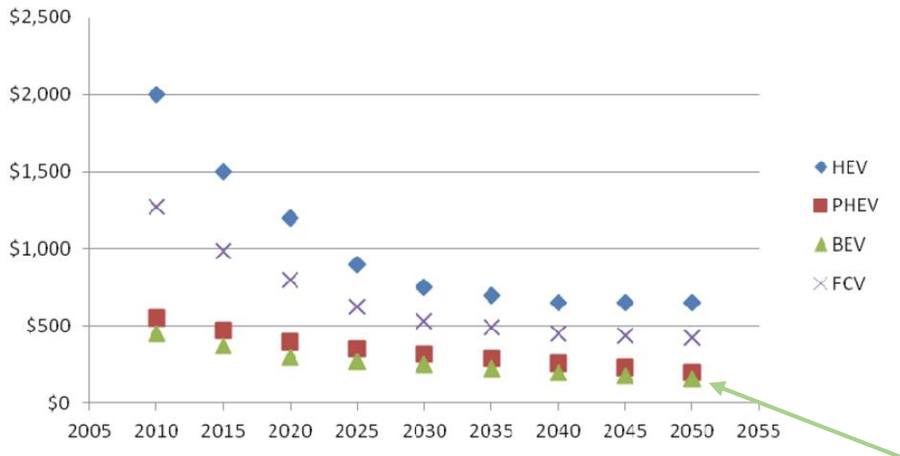
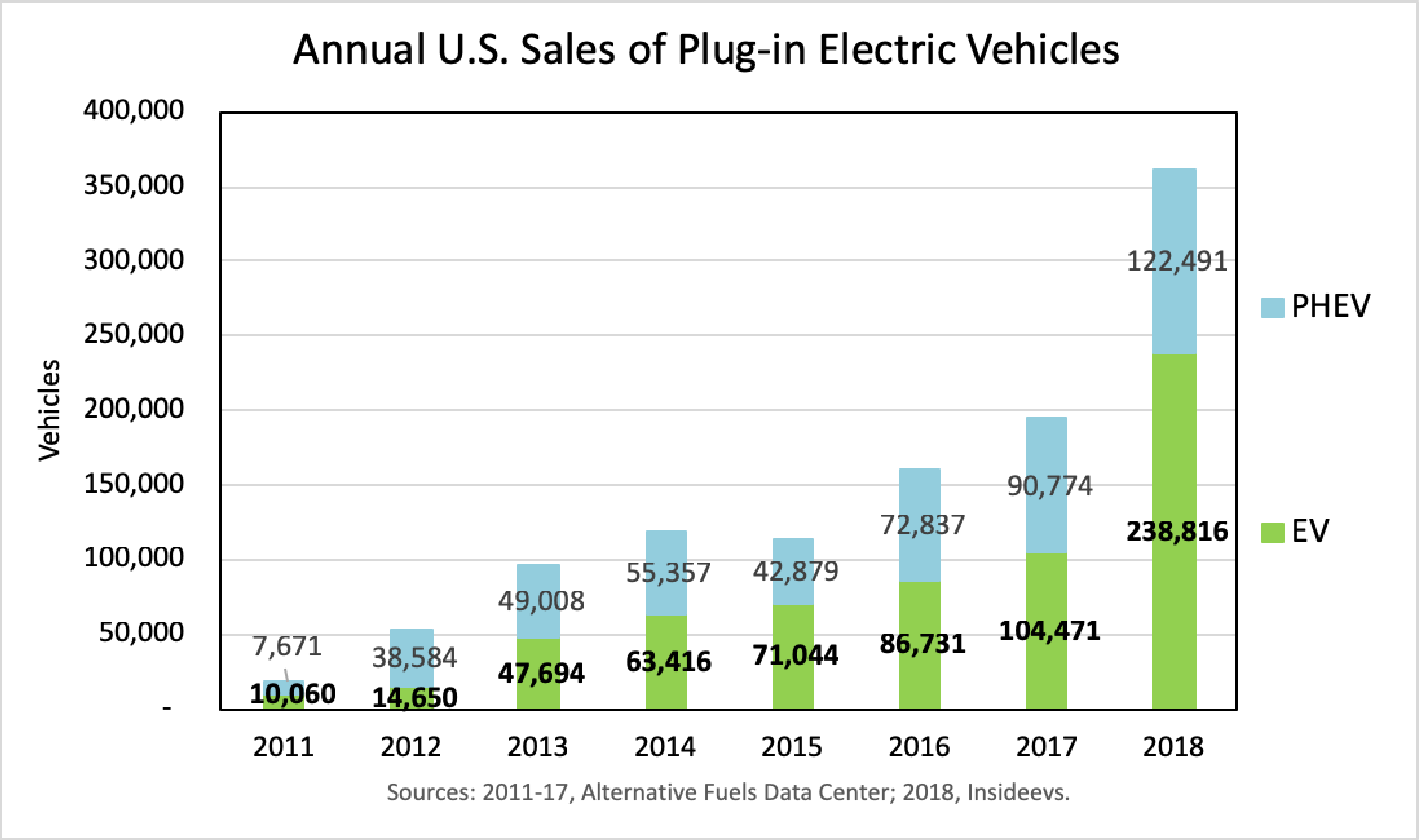


FIGURE 2.3 Estimated battery pack costs to 2050 ($/kWh).

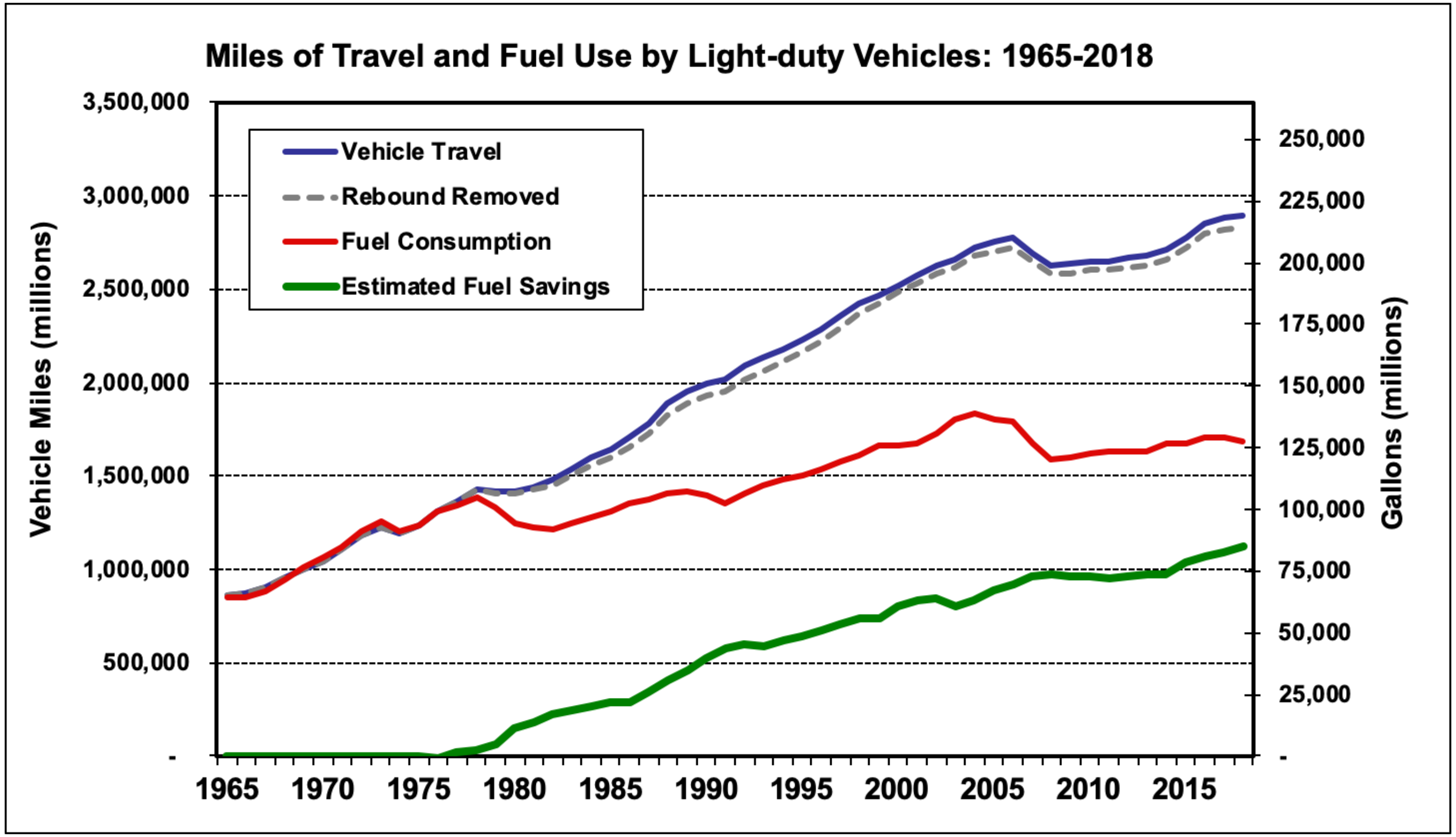
NRC, 2013:
$160/kWh
$150/kWh "optimistic"

PEV sales are booming but it's early days. 1.4% of sales. 0.4% vehicles on road.



Regulations: ZEV and CAFE/GHG

- **ZEV** (29 years)
  - Drives the market
  - Half of US PEVs in CA
  - “The ZEV mandate.”
- CAFE/GHG (44 years)
  - 2 Trillion gallons saved since 1975.
  - Credits for PEVs
    - 0 ghg emissions
    - 0.15 energy for MPG



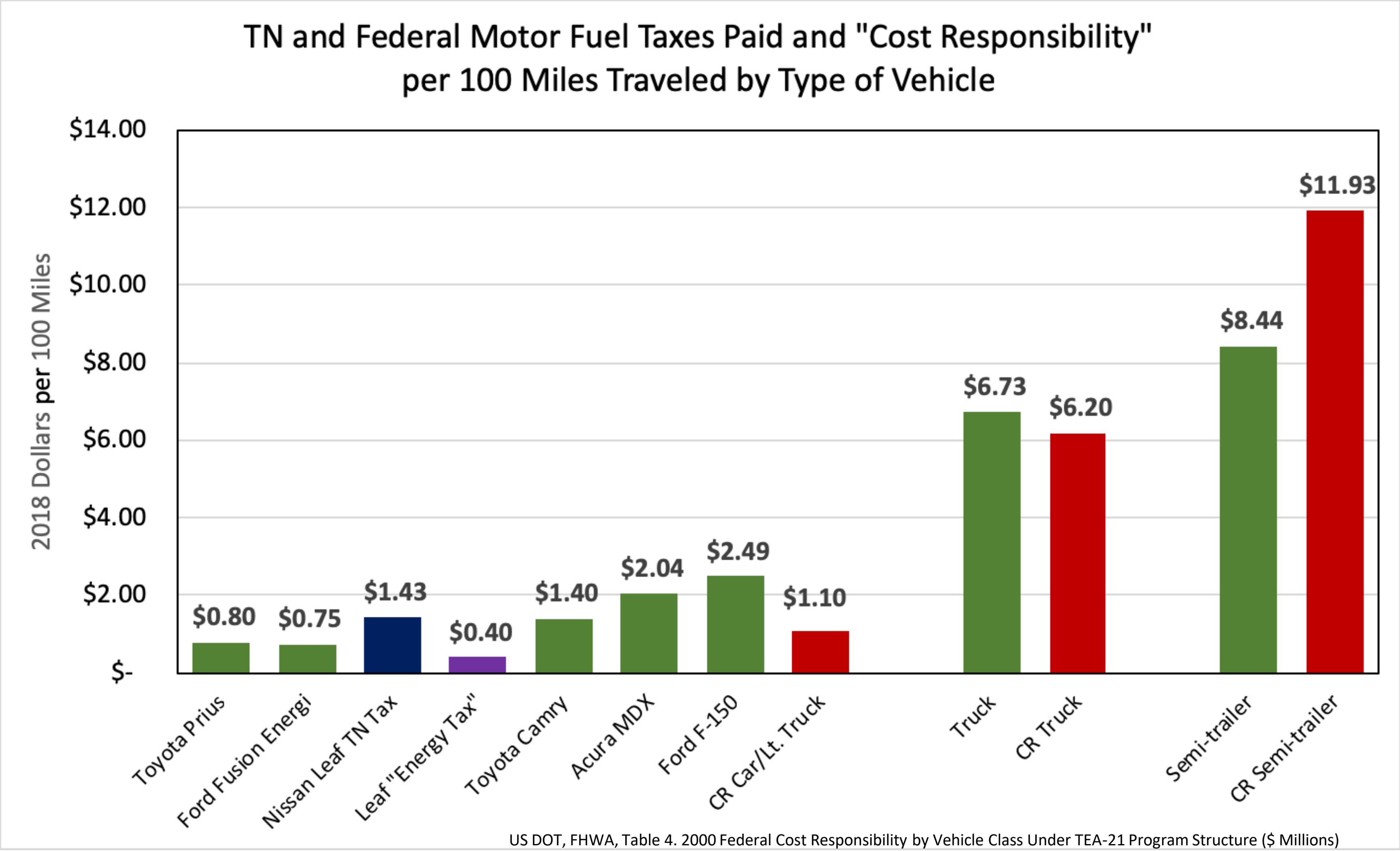
Pricing: Tax credits, rebates, taxes, electricity rates.

- $7,500/vehicle tax credit (9 yrs.)
  - Phase out after 200k BEVs: too soon.
  - 10 mfgrs. X 200,000 < 1% of 250 million LDVs on U.S. roads.
- State and local incentives also important.
- Motor fuel taxes! (72 years)
  - A $0.50/gge energy tax
  - A tax on transportation WORK (forceXdistance)
  - What about PEVs?
- Electricity pricing for PEVs

- CARBON TAX (Go for it!)
  - At 12,500 miles/yr a 25 MPG light-duty vehicle consumes 500 gallons of gasoline.
  - 8 kg CO_2 per gallon means 4,000 kg per year.
  - A tax of $50 per metric ton of CO_2 equals $200 per year.
  - Discounted over 15 years at 6% equals about $2,000.
  - Compare to CA + federal BEV incentive of $10,000.

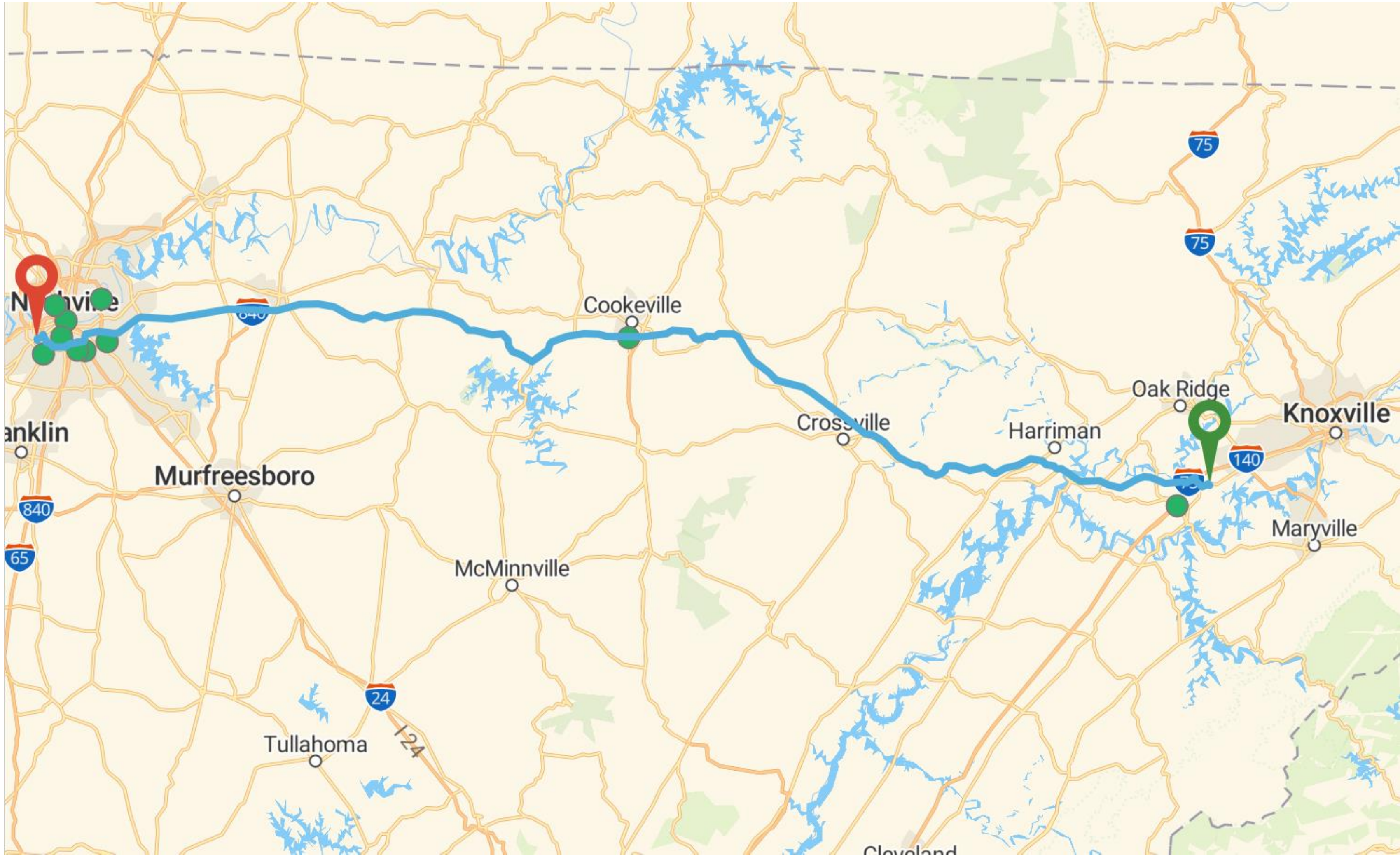
Who pays for the roads? Who should pay?

(cost responsibility estimates are ***fuzzy***) Avoided CO_2:(11,200/22.3)x(8.887/1000)x$50 = $223/yr.

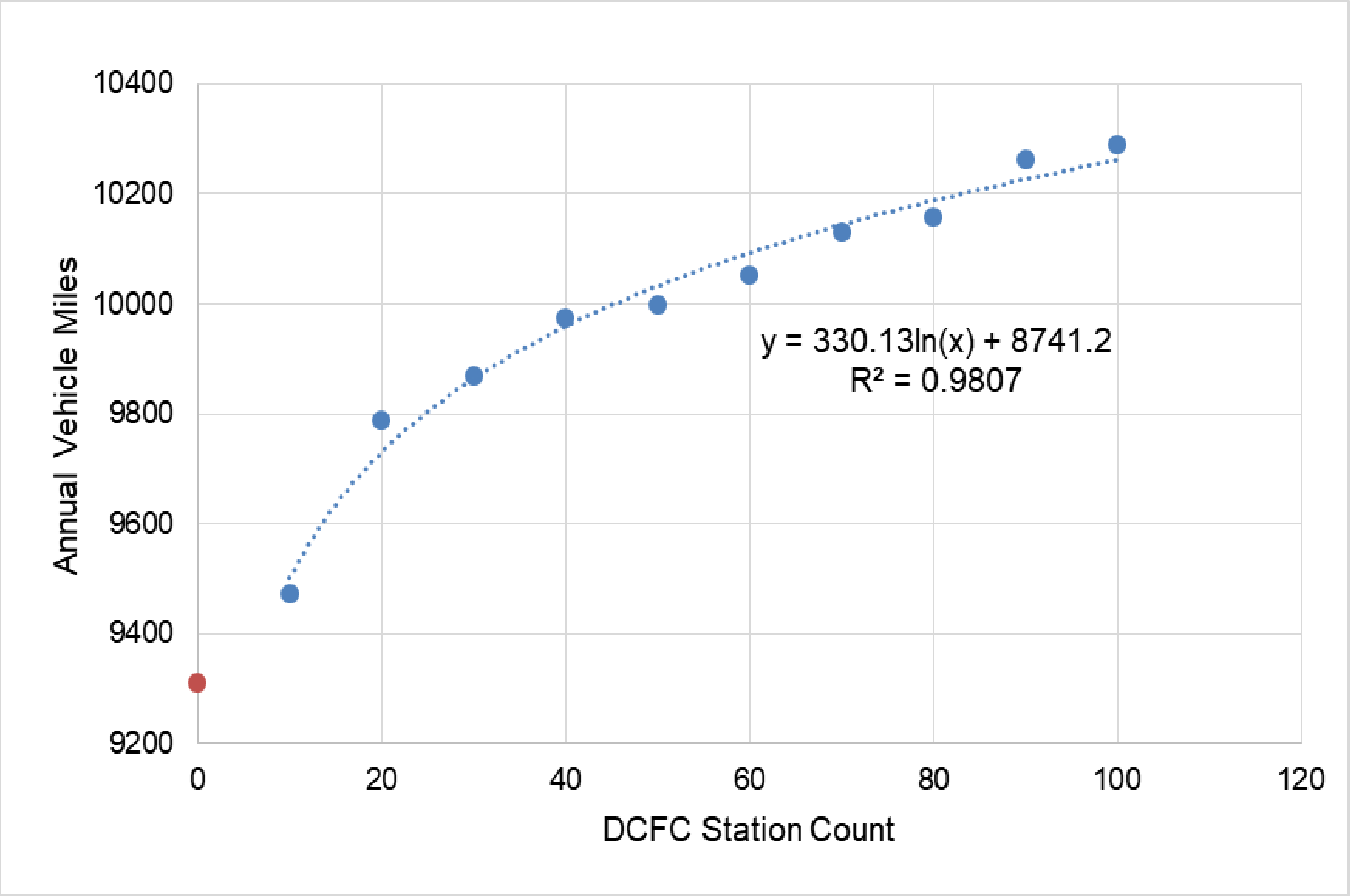


Infrastructure: What is it worth?

- The questions:
  - How much?
  - Where?
  - What type?
- The information:
  - Stated preference experiments
  - Usage data
  - Optimal location/allocation modelling
  - Simulation modeling

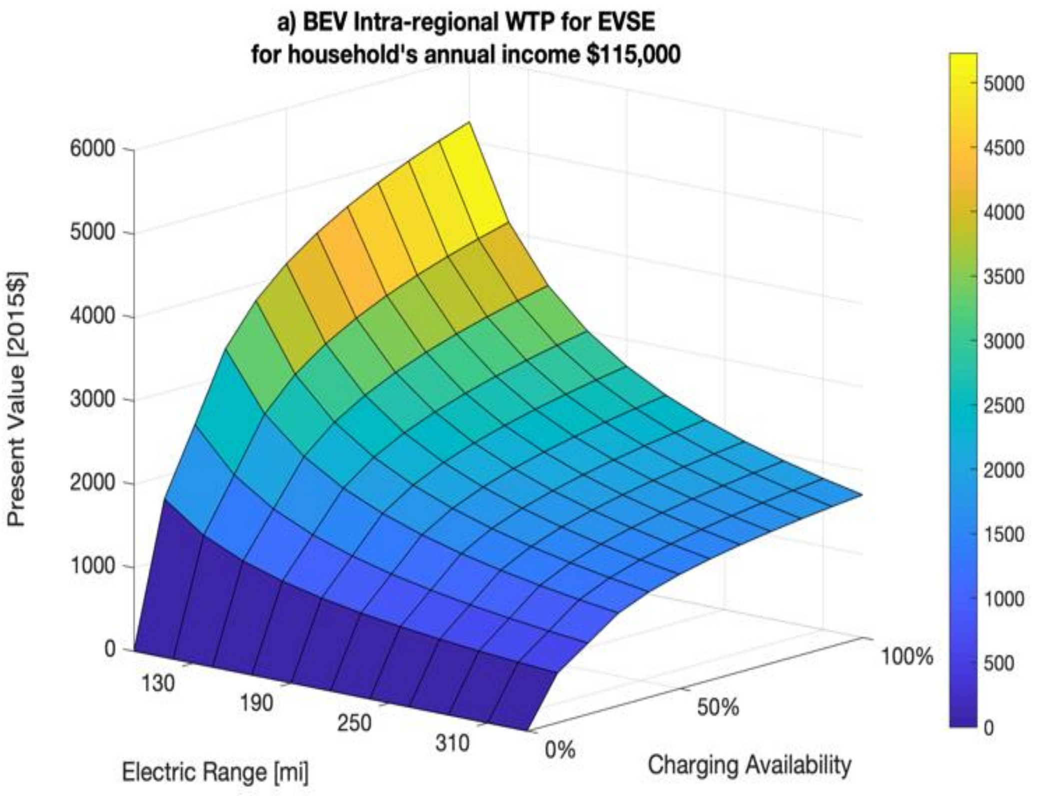


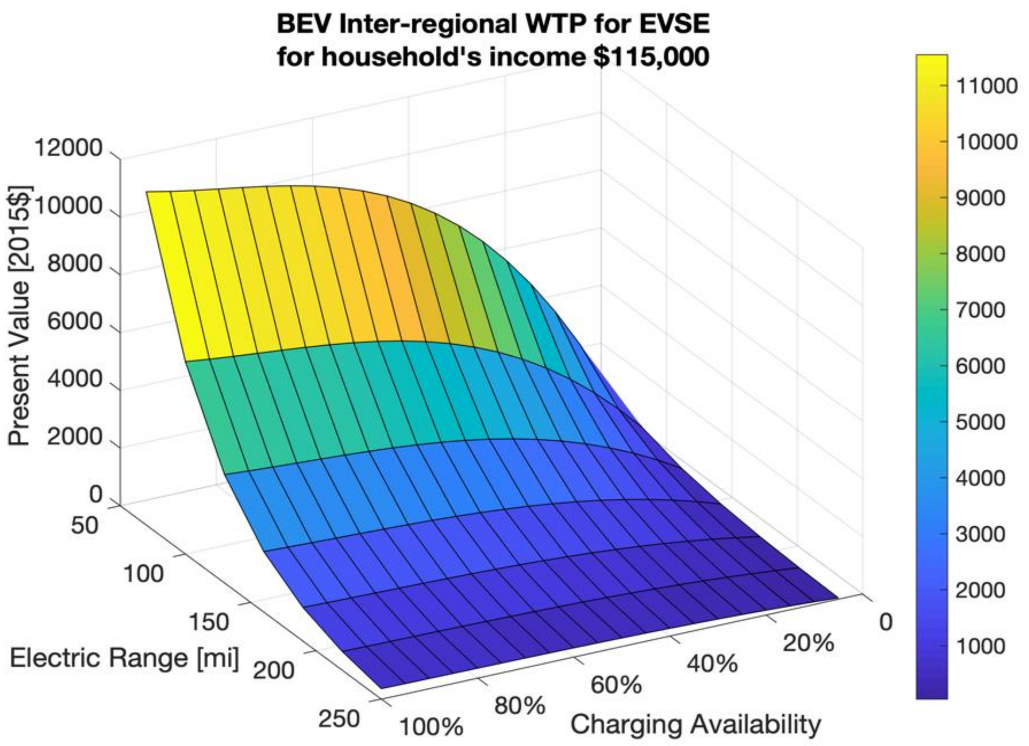
Geographically and temporally detailed vehicle use data, trip simulation modeling and optimal charger location algorithms have estimated additional electric-miles enabled by chargers.



Greene et al., 2019 (NREL/CEC) derived from Wood et al., 2015 analysis based on data from Seattle, WA.

Willingness to pay for an additional enabled miles can be inferred from the willingness to pay for BEV range and from the marginal cost of an additional mile of travel (both say about $0.40/mile). (CAVEATS!)





Greene et al., 2019. *Quantifying the Tangible Value of Public Electric Vehicle Charging Infrastructure*, CEC/NREL, forthcoming.

For BEVs with ranges of about 100-150 miles, adequate infrastructure is roughly as valuable as existing financial incentives.

- WTP for chargers decreases rapidly with vehicle range.
  - Will range increase over time or will consumers prefer different ranges?
  - Consumers are heterogeneous: high mileage drivers will want both.
  - Caveats: Multi-day long-distance trips missing, not all trips equal in value.
- How fast, how expensive?
- Will there ever be a viable business model?
- Who cares?
  - PEV owners
  - Society/government
  - Sellers of electricity

There's still a long way to go and a lot more to do but there are good reasons to be optimistic.

- Electrifying vehicles is a large-scale energy transition for the public good.
  - Multi-decadal time constants, large uncertainties, strong positive feedbacks, tipping points and path dependency.
  - "Getting the prices right by internalizing externalities" is the wrong paradigm.
- Overcoming the barriers to transition with effective, durable and adaptable policies that are likely to be very cost-effective in the long run is the right policy paradigm.
- Technological progress is ahead of schedule.
- Vehicle and infrastructure are co-evolving and benefiting from experience, analysis and learning.
- We have a portfolio of policies (under attack) that needs to be sustained and adapted as we learn more about the market for PEVs.

Thank you.