

Sustainable Transportation Energy Pathways (STEPS)

Making the Transition to Light-duty Electric-drive Vehicles in the U.S.: Costs in Perspective

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Joan Ogden and Lew Fulton
Institute of Transportation Studies
University of California, Davis
USA

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TRANSITION COSTS FOR ELECTRIC DRIVE?

- How much does it cost to launch electric drive fuel/vehicle pathways?
- National US perspective on required investments in vehicles and fuels
  - to reach breakeven "competitiveness" with incumbents
  - to fully build out fuel infrastructure
- How do long term costs and benefits compare to BAU (energy system without transition)?

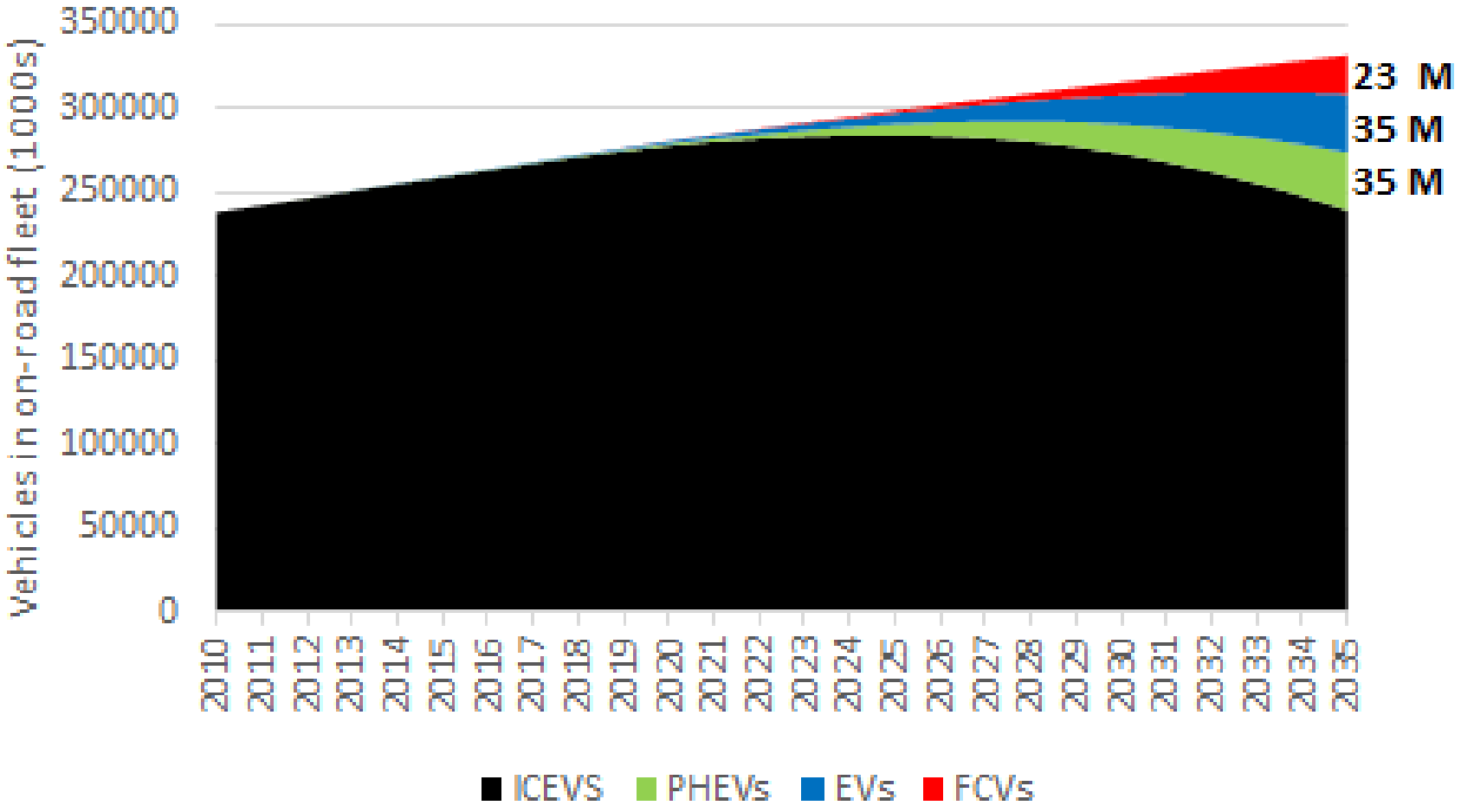
SCOPE*

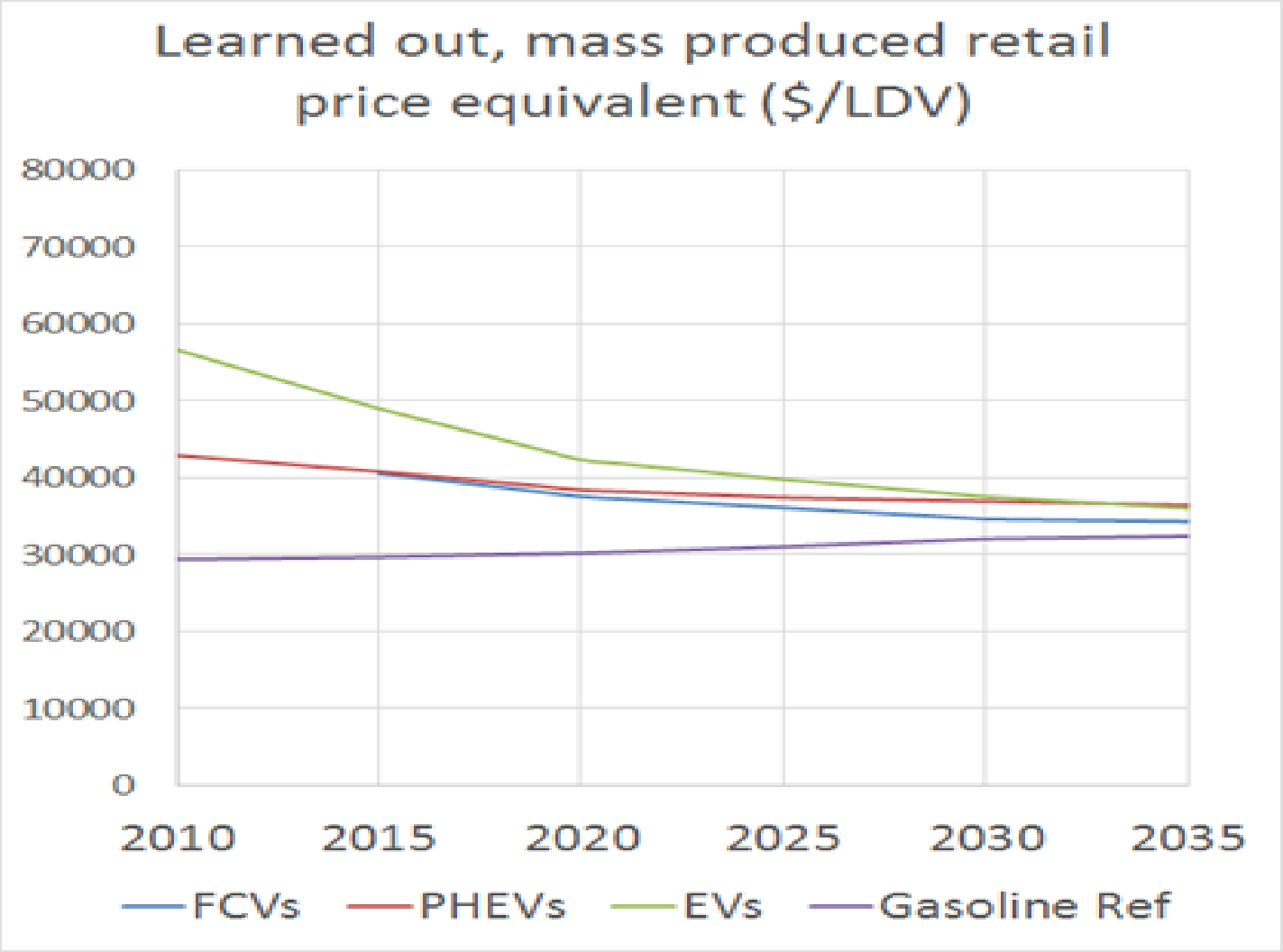
- **Analyze range of scenarios to 2035 for large scale adoption of plug-in electric & H2 fuel cell light duty vehicles in the US.**
- **Estimate transition costs of these scenarios taking into account the vehicle cost increment and fuel infrastructure costs, and associated subsidy costs of achieving these scenarios.**
- **Compare these costs with expenditures that are routinely made by Americans every year for new cars and fuels.**
- **Analyse several policy options for launching an EDV transition**

GOAL: Provide sense of transitional costs that society (and/or stakeholders within society) might have to pay to achieve a major role for light duty electric-drive vehicles by 2035.

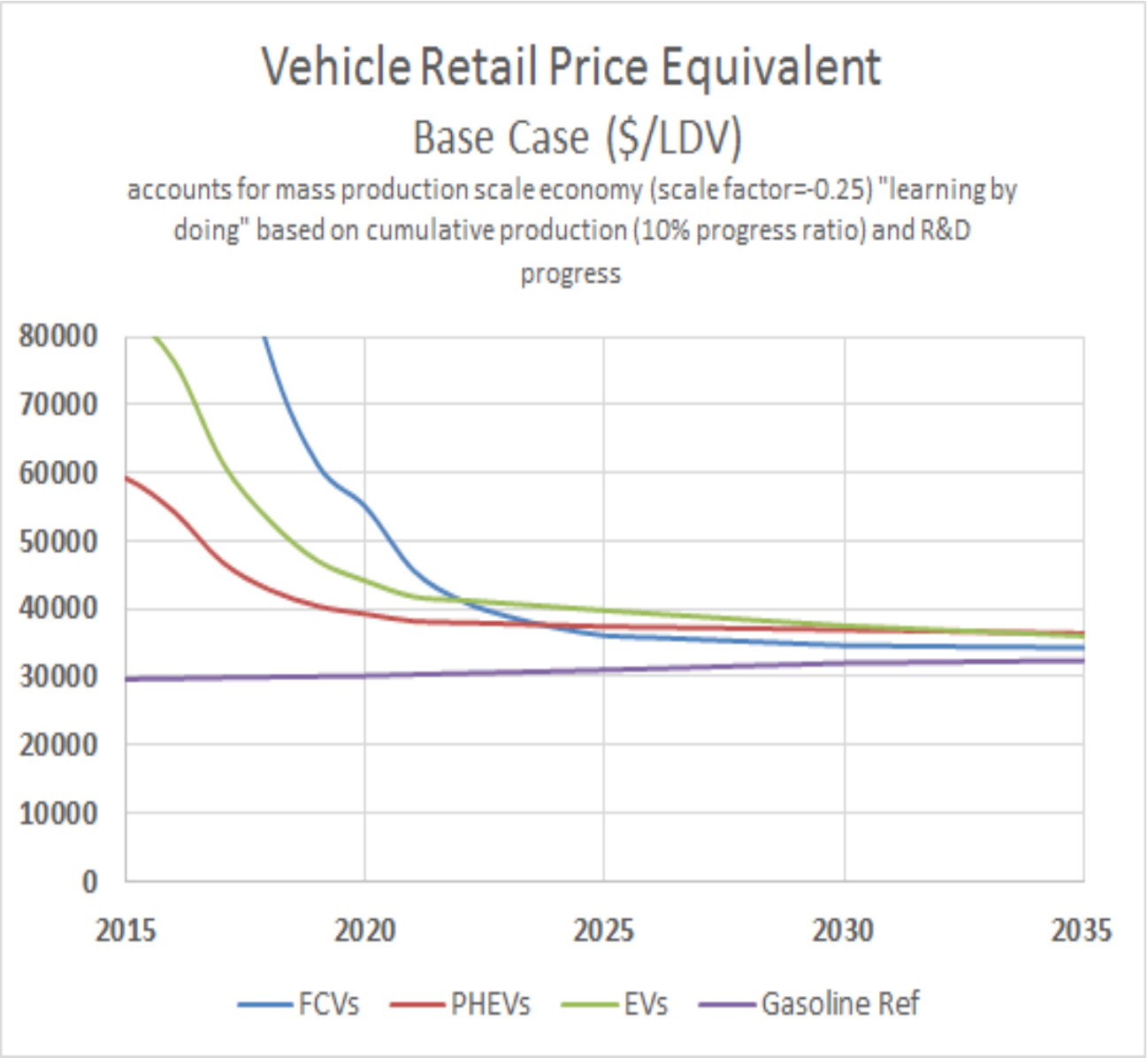
** This is a partial analysis; it does not include transition to very low carbon heavy-duty vehicles, nor does it include other potential low-carbon fuels besides electricity and hydrogen, such as biofuels. We also do not address a transition to low carbon primary sources for electricity and hydrogen*

Scenario for U.S. Light Duty Vehicle Fleet Mix (1000s vehicles on-road) Base Case

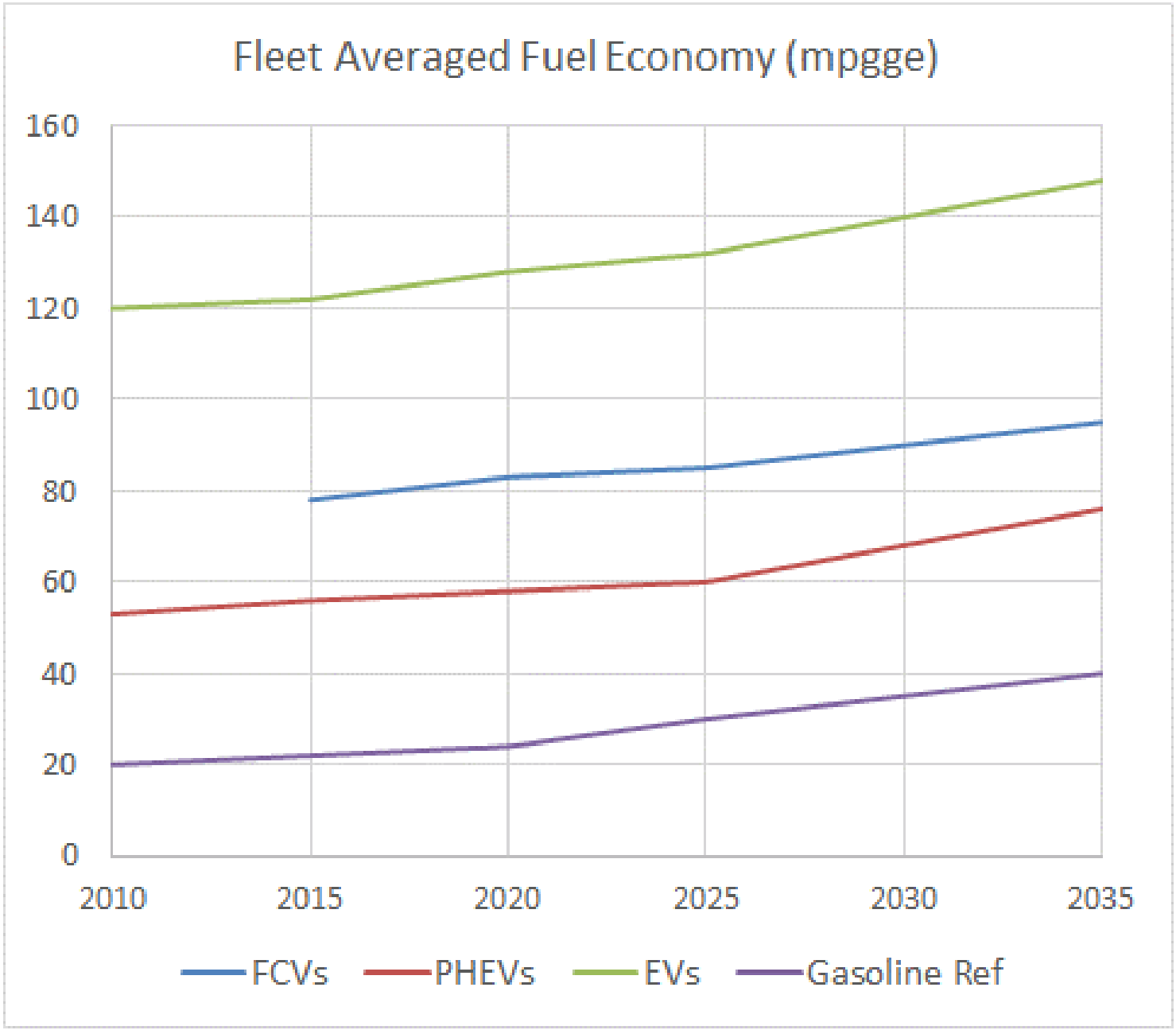




Based on NRC 2013 vehicle costs



Based on NRC 2013 vehicle costs, accounting for dis-economies of small-scale, early vehicle production (scale elasticity = -0.25)

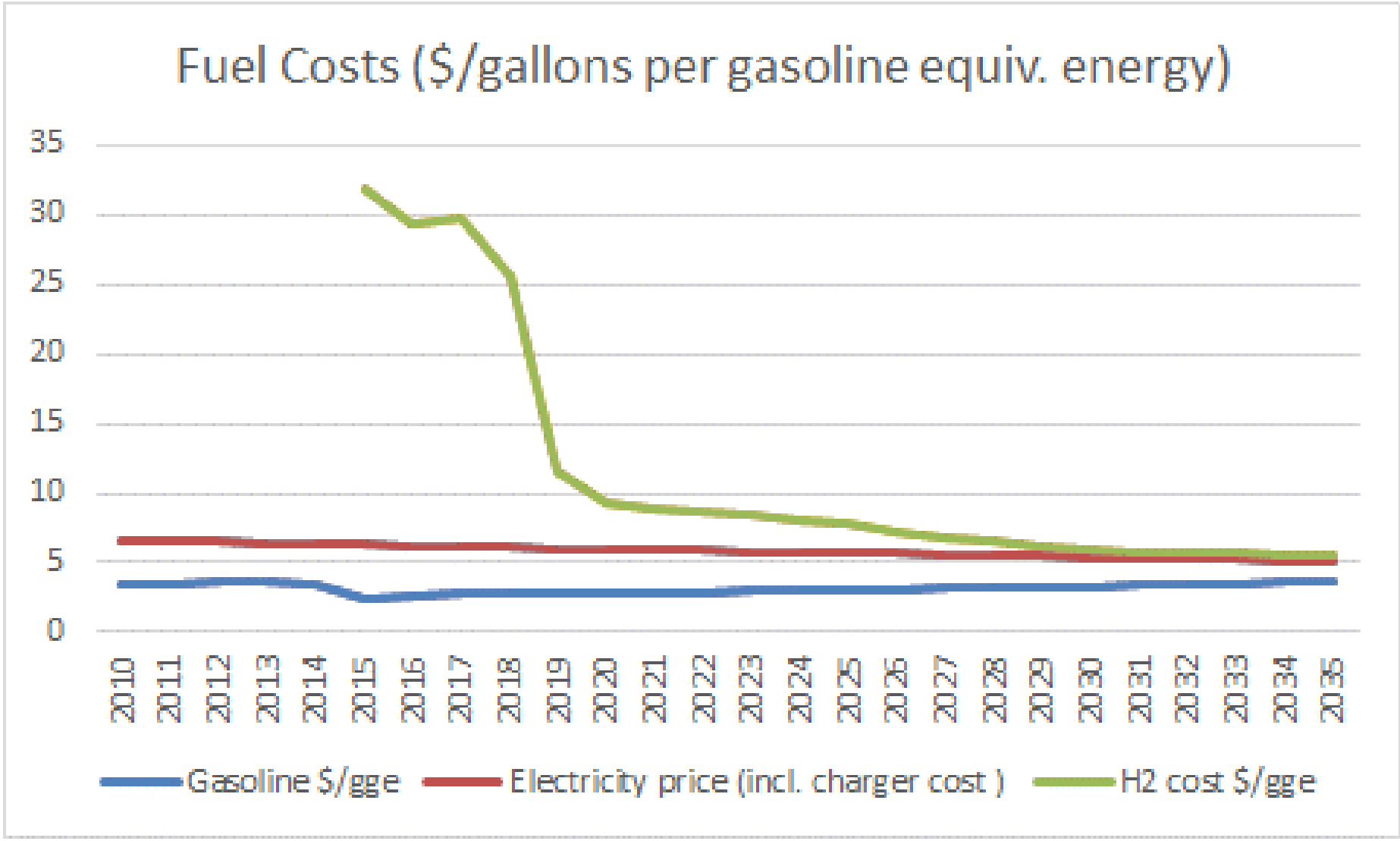


Adapted from NRC 2013 "Transition" report "Efficiency" Case, Figure 5.16

Infrastructure Assumptions
Plug-in Vehicles (PEVs) & H2 Fuel Cell Vehicles (FCVs)

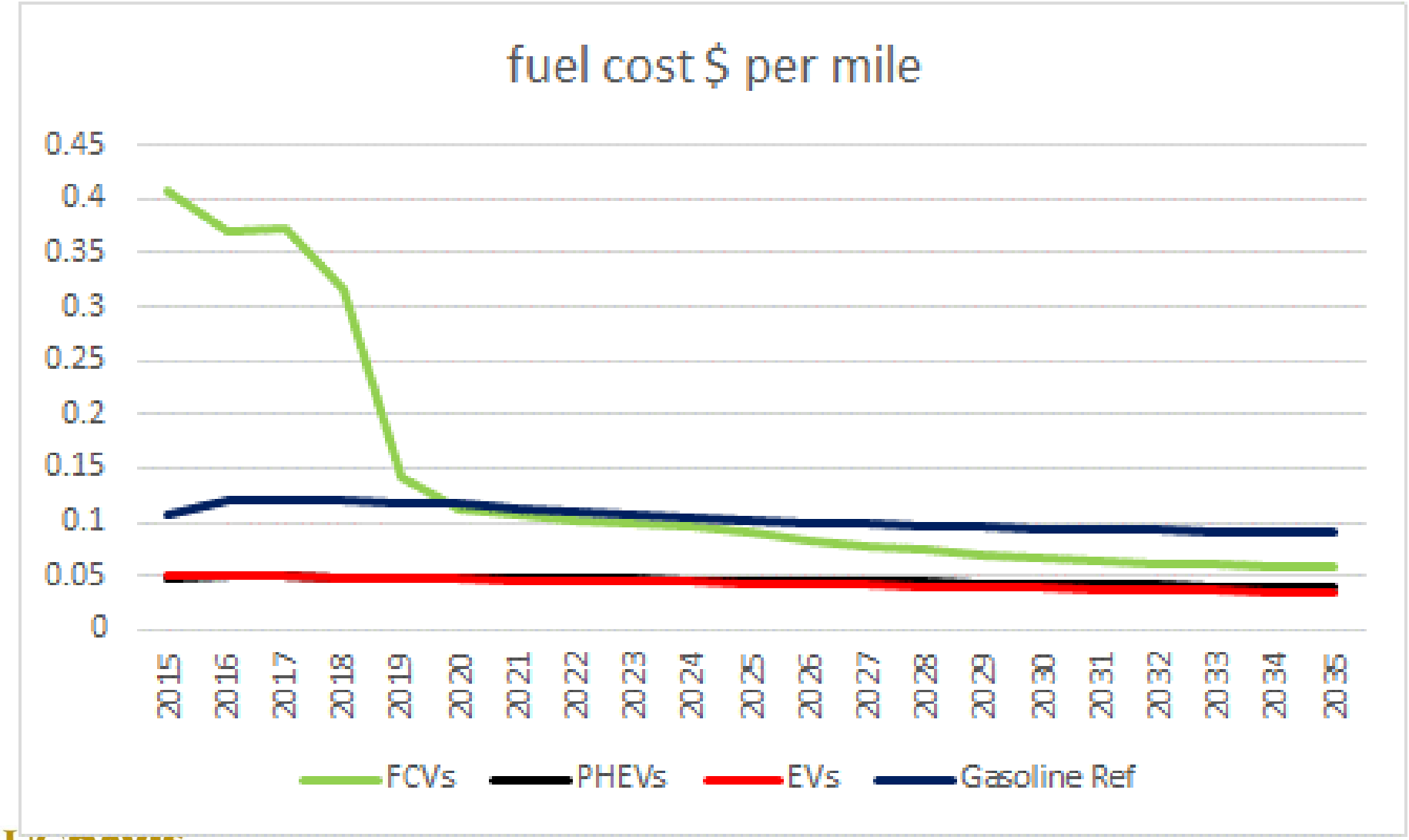
- Home chargers cost $ 2500->1600. 1 per PEV
- Public chargers cost $20,000. 1 per 100 PEVs
- H2 stations are built as FCVs are rolled out in a series of “Lighthouse cities” between 2015 and 2035, starting with California. Stations use truck delivery and onsite production, network designed using regional “cluster strategy”.
- Gasoline costs based on EIA Annual Energy Outlook 2015 ref case

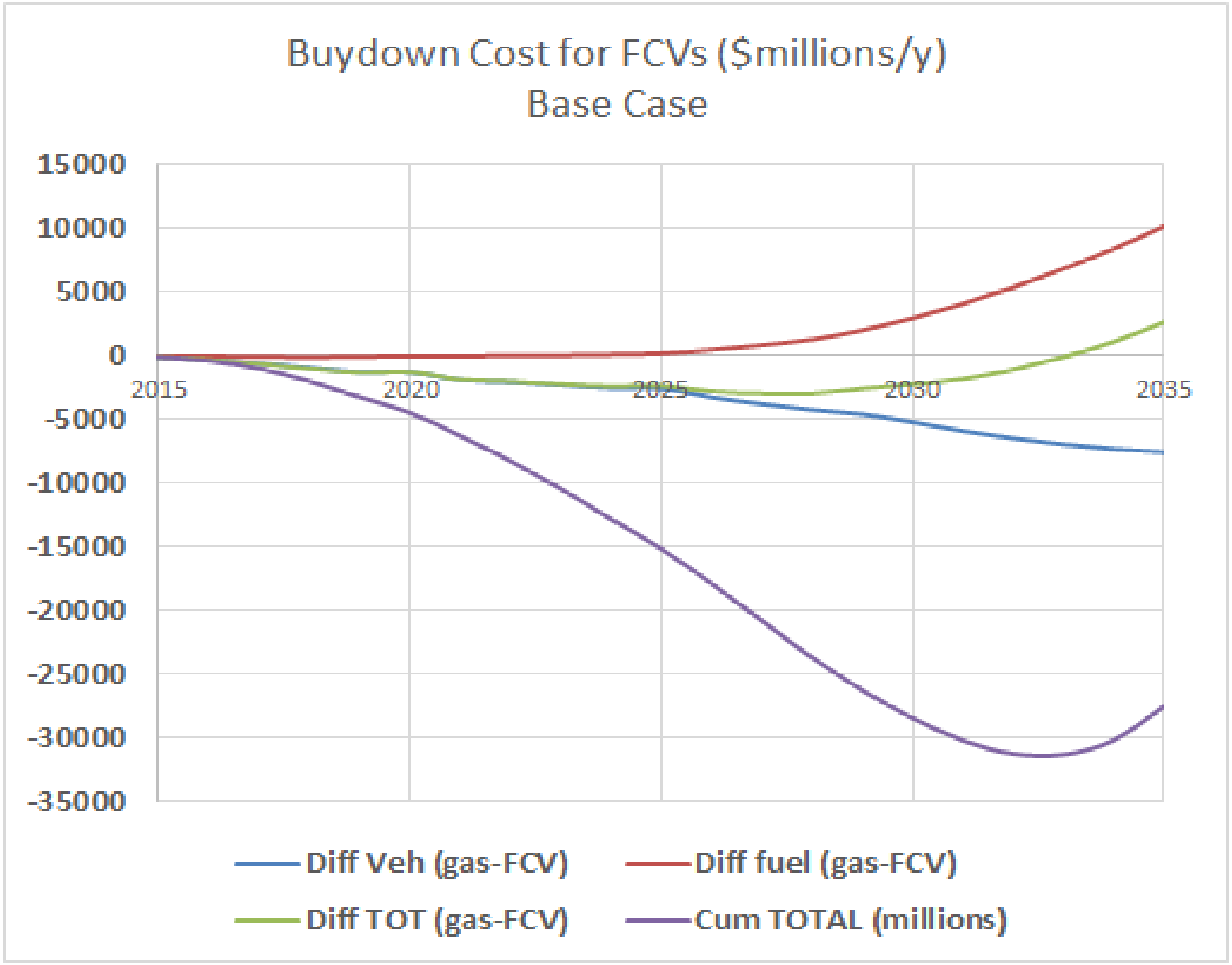
Estimated Fuel Cost ($/gallon gasoline equivalent)

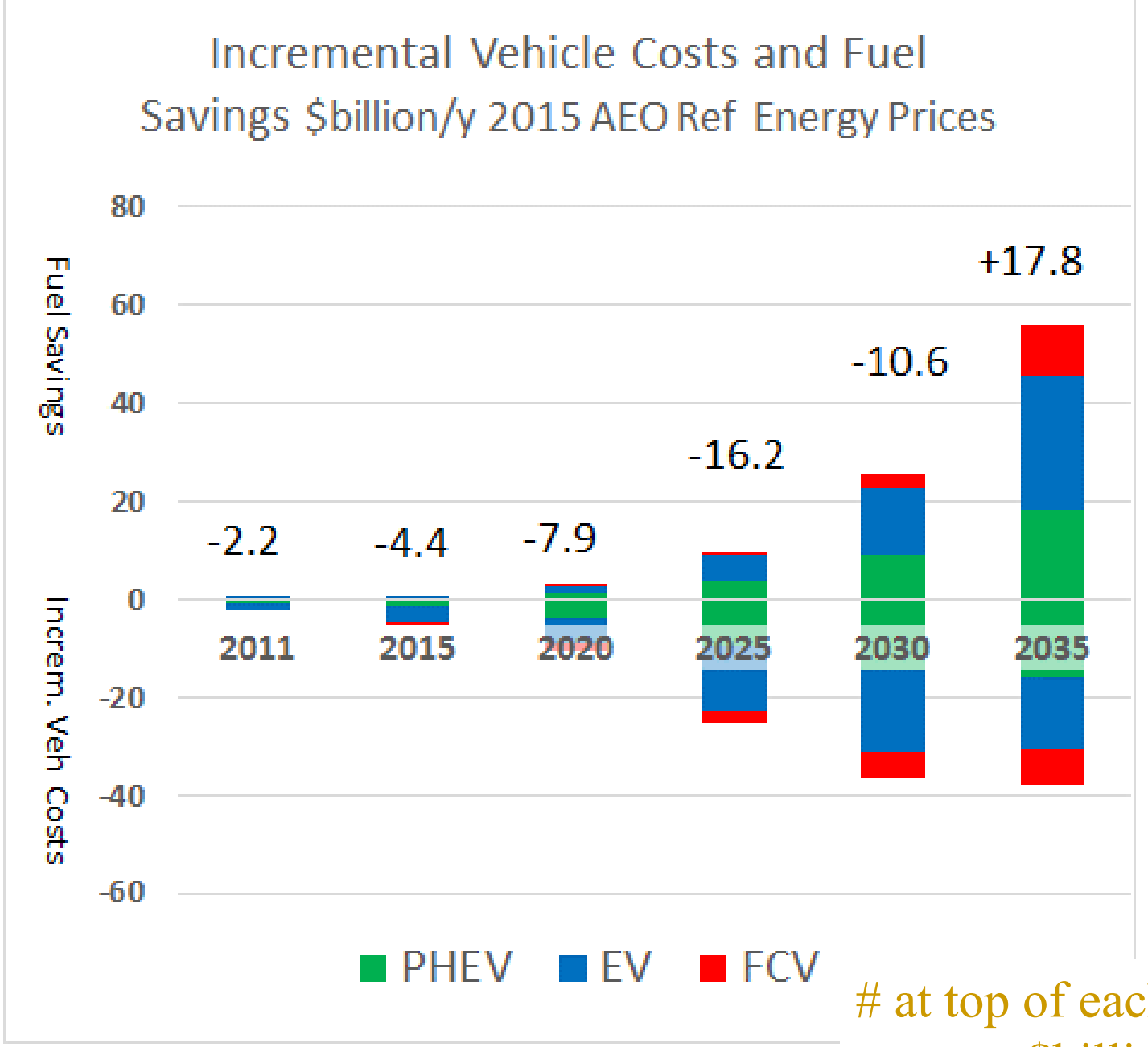


Estimated "Fuel Cost Breakeven" ($/mile)

Plug-in EVs.< gasoline ICEV throughout
FCV (H2 US ave.) < gasoline ICEV after ~2024

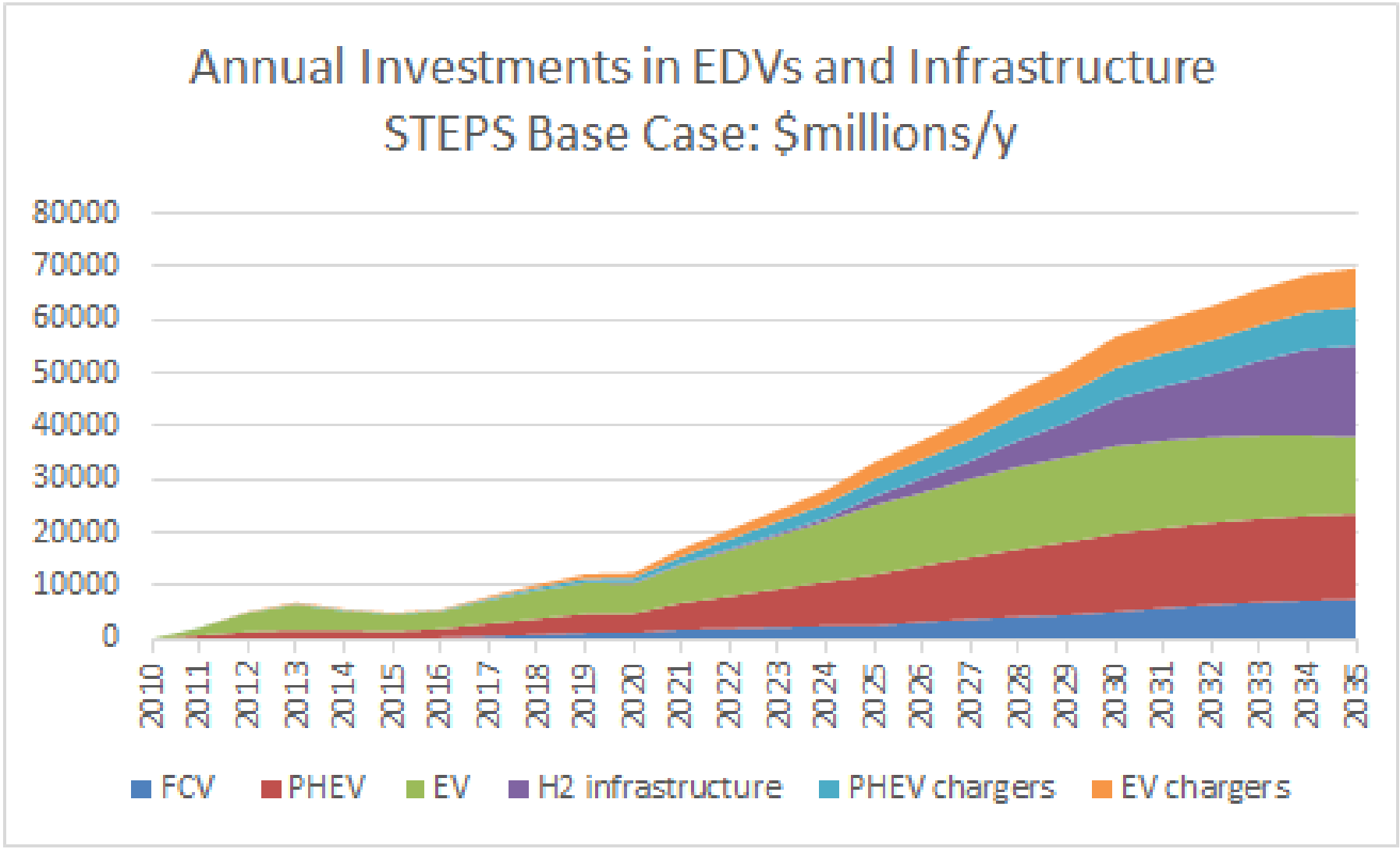



Buydown Cost for FCVs ($millions/y)
Base Case
15000
10000
5000
0
-5000
-10000
-15000
-20000
-25000
-30000
-35000
2015
2020
2025
2030
2035
Diff Veh (gas-FCV)
Diff fuel (gas-FCV)
Diff TOT (gas-FCV)
Cum TOTAL (millions)

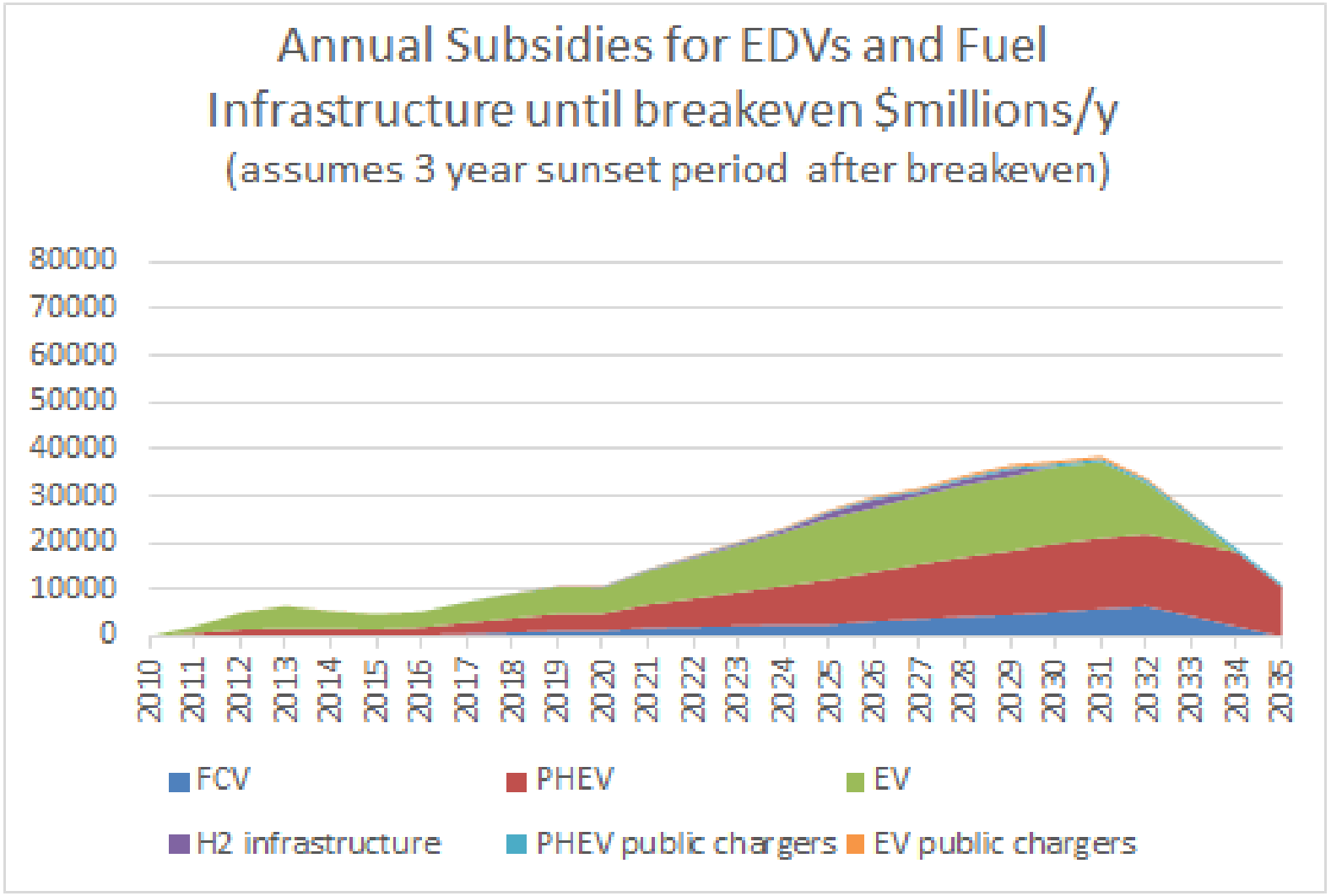


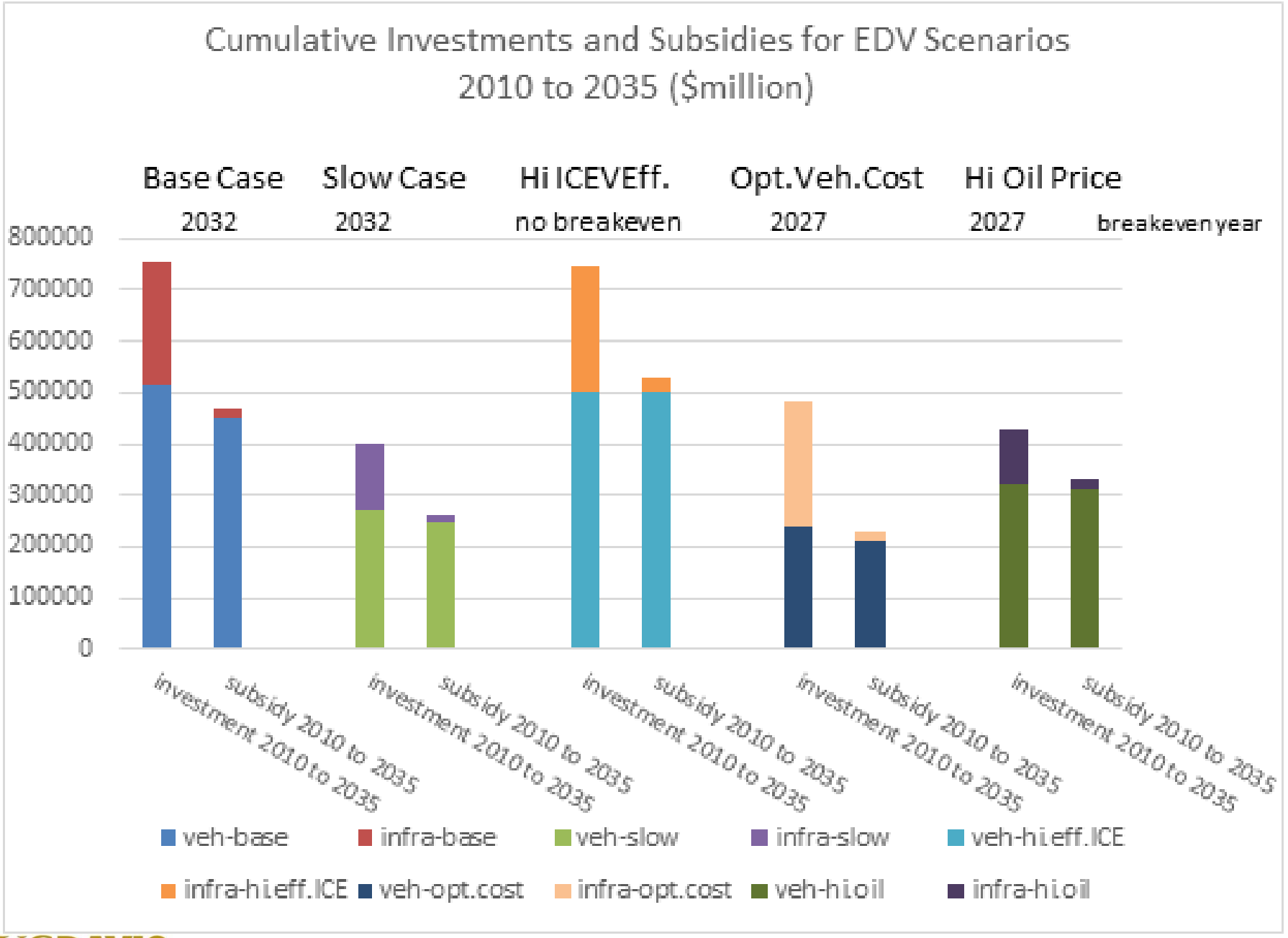
at top of each bar is net cost $billion/y

Incremental INVESTMENTS for Alt Fueled Vehicles and Infrastructure ($M/y) Ave ~$30 B/y



SUBSIDIES for Electric drive Vehicles and Infrastructure w/ 5-yr phase out after Breakeven ($M/y) Ave ~$18 B/y



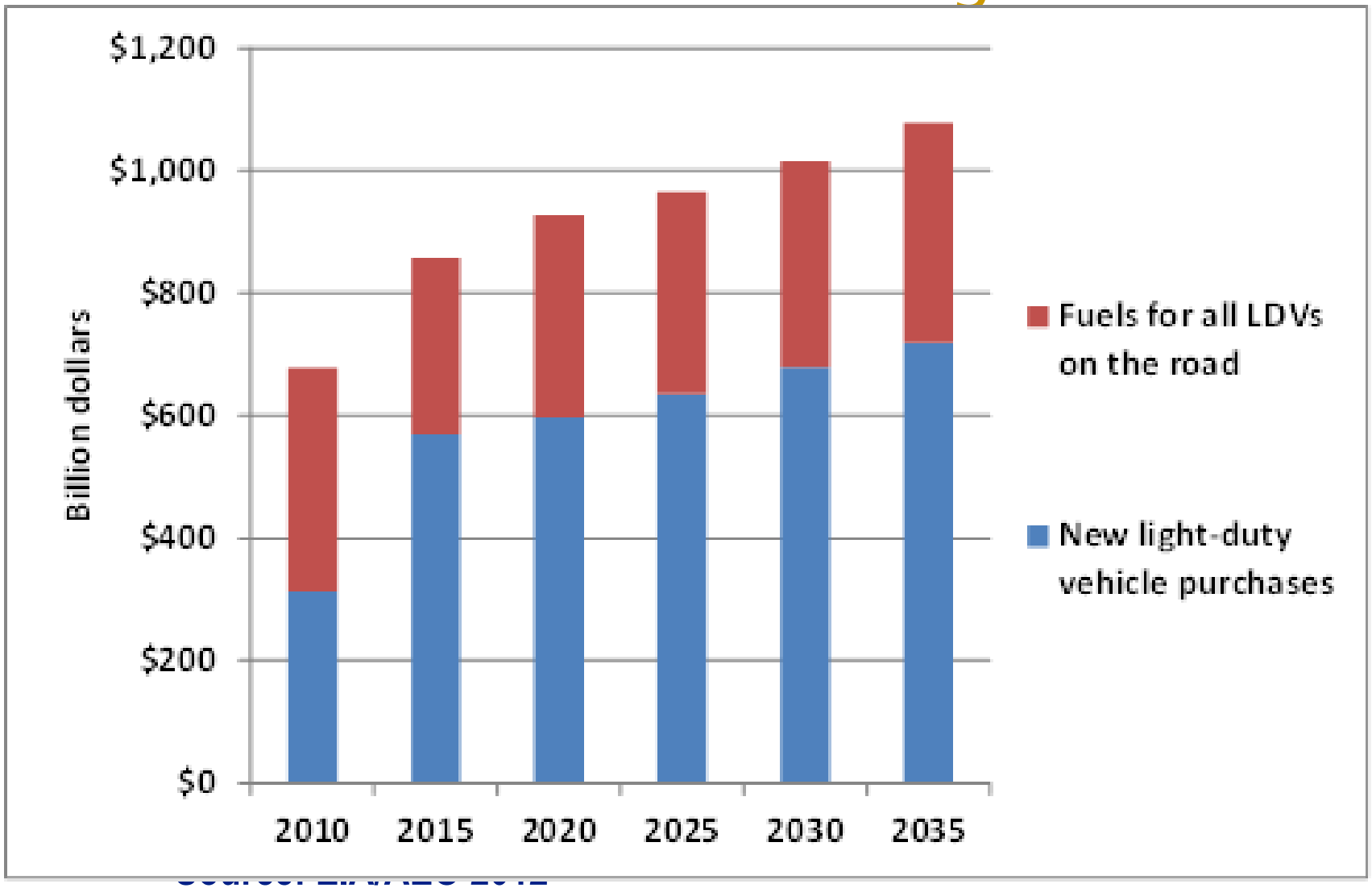

Cumulative Investments and Subsidies for EDV Scenarios
2010 to 2035 ($million)
Base Case
Slow Case
Hi ICEVEff.
Opt.Veh.Cost
Hi Oil Price
2032
2032
no breakeven
2027
2027
breakeven year
800000
700000
600000
500000
400000
300000
200000
100000
0
investment 2010 to 2035
subsidy 2010 to 2035
investment 2010 to 2035
subsidy 2010 to 2035
investment 2010 to 2035
subsidy 2010 to 2035
investment 2010 to 2035
subsidy 2010 to 2035
investment 2010 to 2035
subsidy 2010 to 2035
veh-base
infra-base
veh-slow
infra-slow
veh-hi.eff.ICE
infra-hi.eff.ICE
veh-opt.cost
infra-opt.cost
veh-hi.oil
infra-hi.oil

Transition costs

- Our Base case PEV + FCV scenario breaks even ~2030.
- Beyond this, fuel savings outweigh incremental costs for vehicles.
- **Cumulative INVESTMENTS** to 2035 are about $400-750 B, the majority for incremental cost of EDV vehicles.
- **Cumulative SUBSIDIES** (to breakeven w/3-yr phase out) are about $250-450 B. Required infrastructure **SUBSIDIES** are only about 5-10% of the total.
- The results are sensitive to a lot of assumptions

IS THIS A LOT OF MONEY?

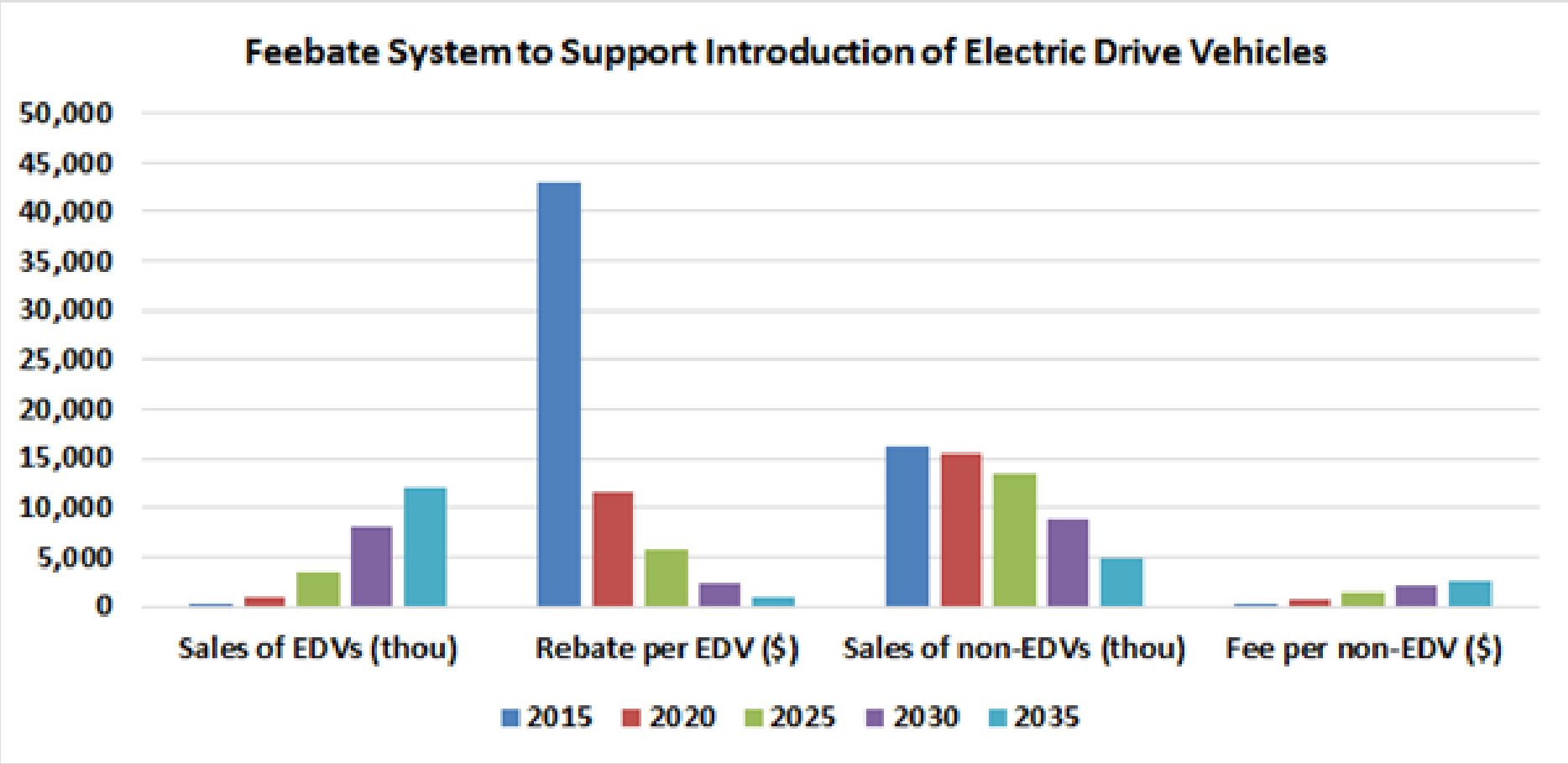
In the US we will spend around $19 trillion on new cars and fuels through 2035



Investments And Subsidies For EDVs << Expected U.S. Expenditures On Cars And Fuels

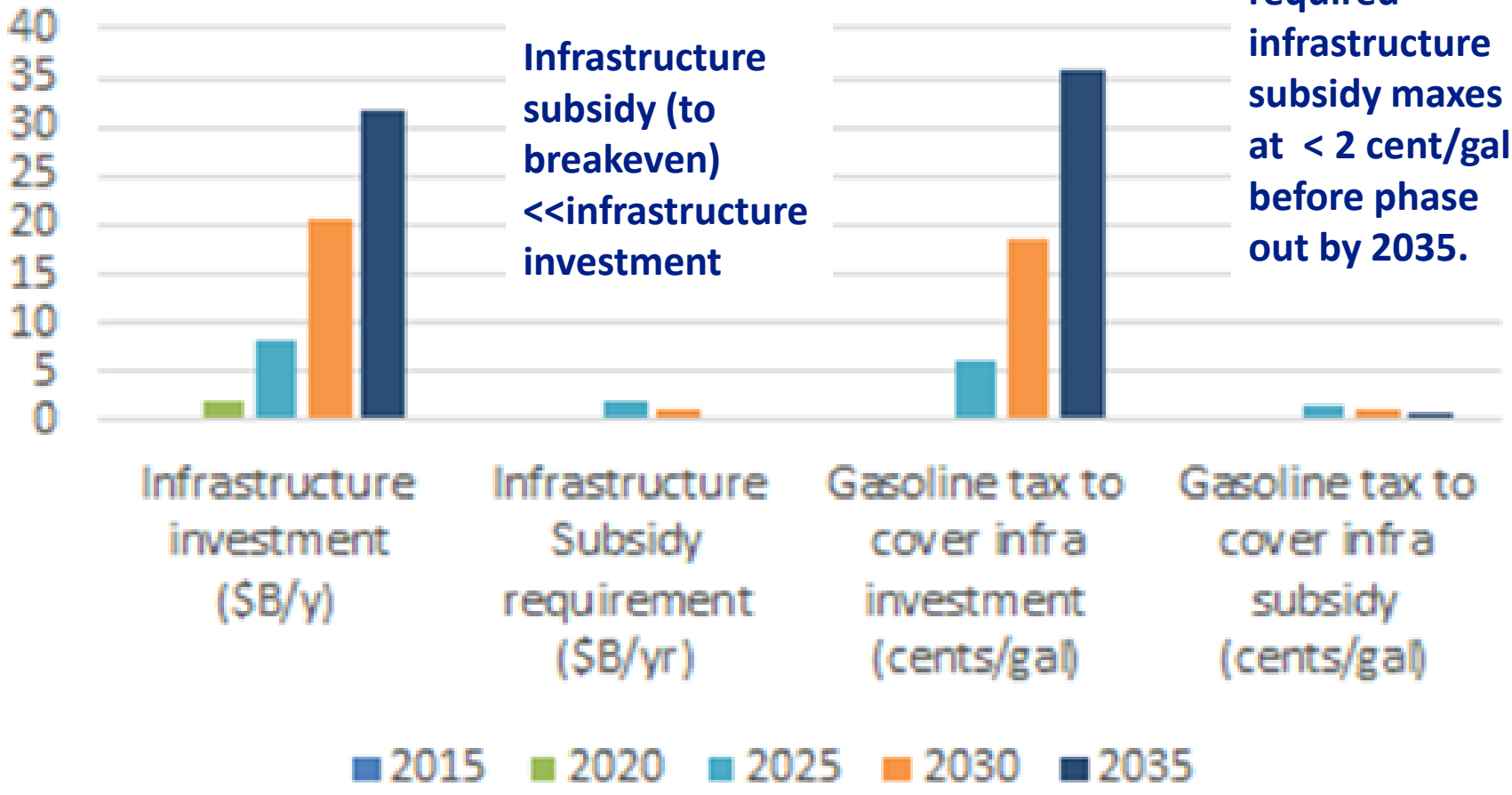
- investment costs of $400-750 billion for EDVs and their fuels to 2035 are ~2-4% of this $19 trillion total, with the estimated subsidy costs ~ 1-3%.
- On an annual basis, the Base Case investment costs range from about $6 billion to $70 billion with subsidies ranging from $6 billion to $37 billion, in a vehicles/fuels market with nearly $1 trillion spent annually.

POLICY OPTIONS



The fee for non-EDVs sales starts at about $300 and maxes in 2030 at $2200 before phase out.

Gasoline tax to cover fuel infrastructure investments and subsidies



Infrastructure subsidy (to breakeven) <<infrastructure investment

Gas tax to cover required infrastructure subsidy maxes at < 2 cent/gal before phase out by 2035.

Conclusions (1) Transition Cost Results

- EDVs “break even” economically with incumbent gasoline vehicles in the 2027-2032 time frame for a range of scenarios with varying assumptions about technology, vehicle adoption rate and fuel costs.
- Cumulative Transition investment costs for light-duty electric drive vehicles and fuels are estimated to be in the range of $400 to $750 Billion (2010-2035).
- Cumulative Transition subsidy costs (investments needed to breakeven c. 2030) for light-duty electric drive vehicles and fuels are estimated to be in the range of $200-500 Billion (2010-2035).
- The majority of transition costs are for vehicle incremental costs. Required subsidies are 10-20% lower than investments for vehicles, and Required subsidies are 80-90% lower than investments for fuel infrastructure
- Net transition costs over the next 20 year period of several hundred billion dollars would be quite small in comparison to the $19 trillion expected to be paid overall for new light-duty vehicles and for fuels for all LDVs in this time frame.
  - investment costs of for EDVs and their fuels to 2035 are about 2 to 4% of this $19 trillion total, with the estimated subsidy costs about 1-3%.
  - On an annual basis, the Base Case investment costs range from about $6 billion to $70 billion with subsidies ranging from $6 billion to $37 billion, in a vehicles/fuels market with nearly $1 trillion spent annually.

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Conclusions (2) Policy Options

- A range of policies is available that could serve to leverage the needed funding, including fuel and vehicle taxes along with rebates for EDVs.
- The costs of these policies would be quite small through 2025, and can be kept relatively modest, if they are focussed on subsidies to reach "breakeven" with incumbent technologies (e.g. we phase out subsidies once fuel supply and vehicle ownership become economically competitive).

For example, we analysed a combination approach that imposes fees on conventional (non-EDV) cars to subsidize new EDV purchases, and a gasoline tax to support EDV fuel infrastructure development. These policies would be ramped down during a 3-year "sunset period" after "breakeven" and largely phased out by 2035.

- Imposing a fee on sales of non-EDV vehicles to support new EDV purchases would require less than $2200 per non-EDV.
- If a gasoline tax were imposed to pay for EDV infrastructure investments (PEV chargers and H2 stations), this would be less than 30 cents per gallon even under conservative assumptions about infrastructure profitability.
- Basing the gasoline tax solely on the infrastructure subsidies needed to make EDV fuel prices competitive, reduces the amount of tax required to less than 2 cents/gge especially after 2025.