# Policies for Electrifying the U.S. Light-Duty Vehicle Fleet

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# Introduction

**Decarbonization of light-duty vehicles (LDVs) is a major policy priority**

- LDVs generate 58% of U.S. transportation emissions
- Biden administration's stated goal: 50% of new LDVs are zero-emissions by 2030
- Chicken-and-egg problem: Electric vehicle (EV) sales vs. charging stations
- Two roles for government expenditures, both captured in the IRA: subsidizing EVs vs. subsidizing charging stations
- IRA EV tax credits cost $26.8B to raise the EV share of sales by 1 ppt in 2030. IRA investment EV infrastructure yields that same 1 ppt increase in EV sales for just $0.7B
- IRA + IIJA provisions double carbon emissions reductions from EVs in 2030 relative to baseline

# Research Questions

How do the Infrastructure Investment and Jobs Act (IIJA) and the Inflation Reduction Act (IRA) impact:

1) EV sales,
2) carbon emissions, and
3) government expenditures?

How do these two policies compare with other hypothetical allocations of government dollars between charging station subsidies and EV purchase subsidies?

# Outline

What does the IRA provide for light-duty vehicles?

Estimating policy impacts of the IRA & IIJA

What don’t we know that will be important for determining the IRA’s success?

Ongoing research: real-time data for DC-fast chargers

# IRA and IIJA Incentives for Consumer EVs

**EV tax credits (IRA):**

**New EV:**
**$3,750** if meets **battery components** requirements.

**$3,750** if meets **critical minerals** requirements.

**Used EV:**
**$4,000** for purchasing a used EV from a dealer.

MSRP and income caps apply.

Tax credit can be claimed at point of sale starting 2024.

**Charging station incentives:**

**IRA:** 30% subsidy for charging infrastructure built in low-income or non-urban census tracts.

99.6% of census tracts qualify!

**IIJA:** up to $7.5B for subsidizing DC-fast charging stations.

**Our goal:**

**Provide our best model of the impacts of the IRA, IIJA, and alternative policies based on current understanding of demand, EV and charging industries**

# Model: EV Demand and Charger Supply

**Consumers choose between EV and ICE versions of their vehicle** (car or light-duty truck) based on:

- relative prices,
- number of Level-2 and Level-3 chargers available
- the number of other EVs on the road and
- personal preferences.

**Firms choose whether or not to build charging stations** based on expected profits as a function of building costs and the stock of EVs on the road

**Two-way network effect between quantity of EVs and number of chargers** captures the “chicken-and-egg” problem

# Model Calibration & Simulations

**Use estimates from existing literature** to calibrate the parameters in our model.

**Assume the buyer saves $3,750 on purchase of the EV, plus $4,000 5 years later** upon selling the used vehicle.

**Assume an 80% subsidy to Level-3 chargers** until $5 billion IIJA budget is exhausted.

**Run Monte Carlo simulations with varied parameter values to estimate policy impacts**:

- EV penetration,
- emissions,
- cost per ton of emissions avoided, and
- fiscal costs.

# IIJA alone increases EV sales share by 7.6 percentage points in 2030

| | EV Share & Emissions | | Fiscal costs through 2031 ($B, not discounted) | | | |
|---|---|---|---|---|---|---|
| | **EV Sales Share by 2030 (1)** | Cost per ton CO2 avoided (2) | Total (3) | Chargers (4) | Rebates (5) | Ineffective Rebates (6) |
| **0** | **36.6%** | | - | - | - | - |
| **IIJA** | **44.2%** | 97 | 6 | 6 | - | - |
| IRA: chargers | 42.2% | 90 | 4 | 4 | - | - |
| IRA: rebates | 49.0% | 66 | 332 | - | 332 | 219 |
| IRA | 54.6% | 80 | 382 | 6 | 376 | 219 |
| IRA + IIJA | 57.7% | 95 | 451 | 11 | 440 | 219 |

**+ 7.6 ppts**

# IRA alone increases EV sales share by 18 percentage points in 2030

| | EV Share & Emissions | | Fiscal costs through 2031 ($B, not discounted) | | | |
|---|---|---|---|---|---|---|
| | **EV Sales Share by 2030 (1)** | Cost per ton CO2 avoided (2) | Total (3) | Chargers (4) | Rebates (5) | Ineffective Rebates (6) |
| **0** | **36.6%** | - | - | - | - | - |
| IIJA | 44.2% | 97 | 6 | 6 | - | - |
| IRA: chargers | 42.2% | [illegible] | 4 | 4 | - | - |
| IRA: rebates | 49.0% | 66 | 332 | - | 332 | 219 |
| **IRA** | **54.6%** | 80 | 382 | 6 | 376 | 219 |
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**+ 18.0 ppts**

# Dollar-for-dollar, charging station spending is substantially more effective than EV spending

| | EV Share & Emissions | | Fiscal costs through 2031 ($B, not discounted) | | | |
|---|---|---|---|---|---|---|
| | **EV Sales Share by 2030 (1)** | Cost per ton CO2 avoided (2) | **Total (3)** | Chargers (4) | Rebates (5) | Ineffective Rebates (6) |
| 0 | 36.6% | - | - | - | - | - |
| IIJA | 44.2% | 97 | 6 | 6 | - | - |
| **IRA: chargers** | **42.2%** | 90 | **4** | **= $0.7B per ppt** | - | - |
| **IRA: rebates** | **49.0%** | 66 | **332** | **= $26.8B per ppt** | 332 | 219 |
| IRA | 54.6% | 80 | 382 | 6 | 376 | 219 |
| IRA + IIJA | 57.7% | 95 | 451 | 11 | 440 | 219 |

# We estimate IIJA + IRA will cost $451 billion, in line with other studies

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- Bistline et al (2023): $390B for IRA clean vehicle credits
- Penn Wharton Budget Model (2023): $393B for IRA clean vehicle credits
- Goldman Sachs (2023): $393B for IRA EV policies

# We estimate $219B (49%) of $451B will go to EV buyers who would have bought EVs without the tax credit

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| 0 | 36.6% | - | - | - | - | - |
| IIJA | 44.2% | 97 | 6 | 6 | - | - |
| IRA: chargers | 42.2% | 90 | 4 | 4 | - | - |
| **IRA: rebates** | 49.0% | 66 | 332 | - | 332 | **219** |
| **IRA** | 54.6% | 80 | 382 | 6 | 376 | **219** |
| **IRA + IIJA** | 57.7% | 95 | 451 | 11 | 440 | **219** |

**= 48.6%**

# Every policy has a cost per ton of CO2 abated below the most recent estimate for the social cost of carbon

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|---|---|---|---|---|---|---|
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| 0 | 36.6% | - | - | - | - | - |
| IIJA | 44.2% | **97** | 6 | 6 | - | - |
| IRA: chargers | 42.2% | **90** | 4 | 4 | - | - |
| IRA: rebates | 49.0% | **66** | **< $190** | - | 332 | 219 |
| IRA | 54.6% | **80** | 382 | 6 | 376 | 219 |
| IRA + IIJA | 57.7% | **95** | 451 | 11 | 440 | 219 |

**Carbon emissions reductions from EVs in 2030 under IRA + IIJA are double baseline reductions!**

# Hypothetical Policy Combinations: Charging subsidies vs. EV tax credits

Moving $30 billion from EV tax credits to charging station subsidies without changing the overall budget **increases EV sales share of new vehicles in 2030 from 48% to 68%.**

Incremental spending on chargers is *much more cost effective* than incremental spending on EV tax credits.

Savings occur because nearly half (49.8%) of spending on tax credits goes to consumers who *would have bought EVs anyway.*

# Open questions around EV adoption

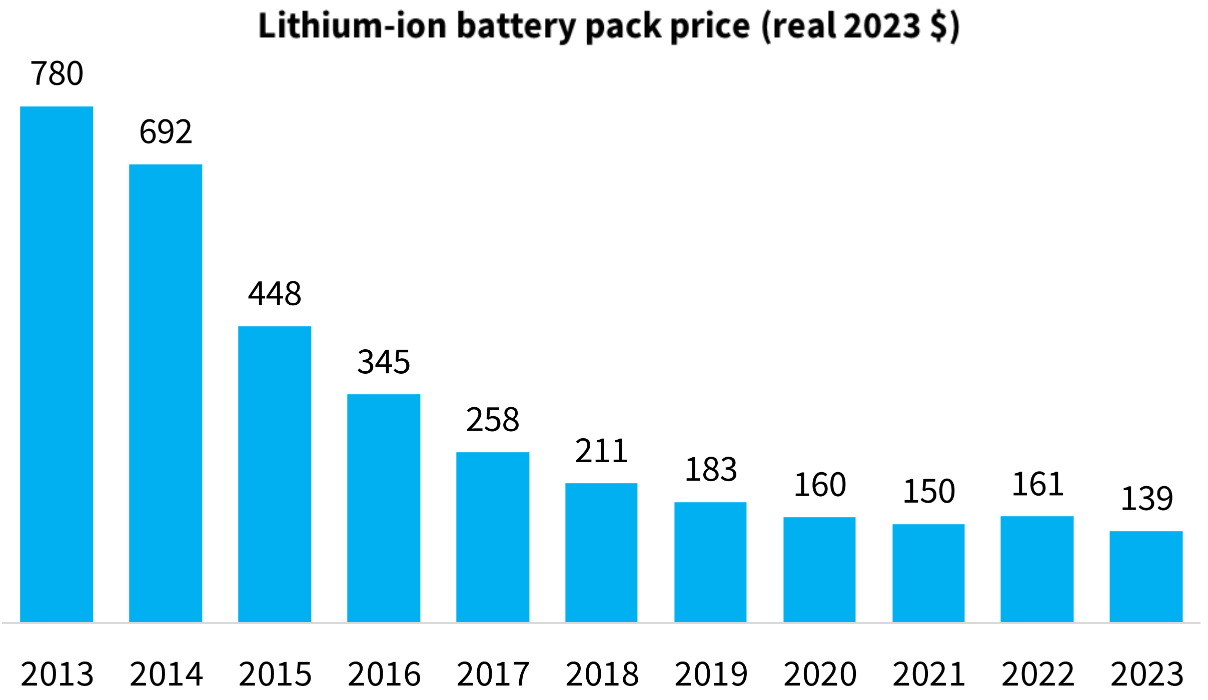
Will battery prices continue to fall?

Uncertainty about baseline EV adoption without the IRA – wide range of estimates

What fraction of EV models will qualify for IRA incentives over the long term?

Who will benefit from IRA incentives: sellers or buyers?

How will potential (lack of) interoperability between chargers and EVs, sufficient data on charger availability affect policy effectiveness?




Source: Bloomberg New Energy Finance, Lithium-ion battery pack prices hit low of $139 k/WH, November 26, 2023; BNEF survey results, volume-weighted average price.

# Current Work-in-Progress: Real-Time Charging Data

Joint work with Omar Asensio, Elaine Buckberg, Karina Chung, Luke Heeney, Christopher Knittel, Catherine Liang, James H. Stock

# Why does real-time data matter?

## What's an EV driver (or prospective EV driver's) charging nightmare?

**Running out of charge and needing a tow.** Which could happen if you go to one—or two—DCFC stations on a road trip and they don't work.

## How else is charger uncertainty costly?

**EV drivers need to allow for search time**—going to more than one charging station to successfully charge—on top of charging being slower than getting gas.

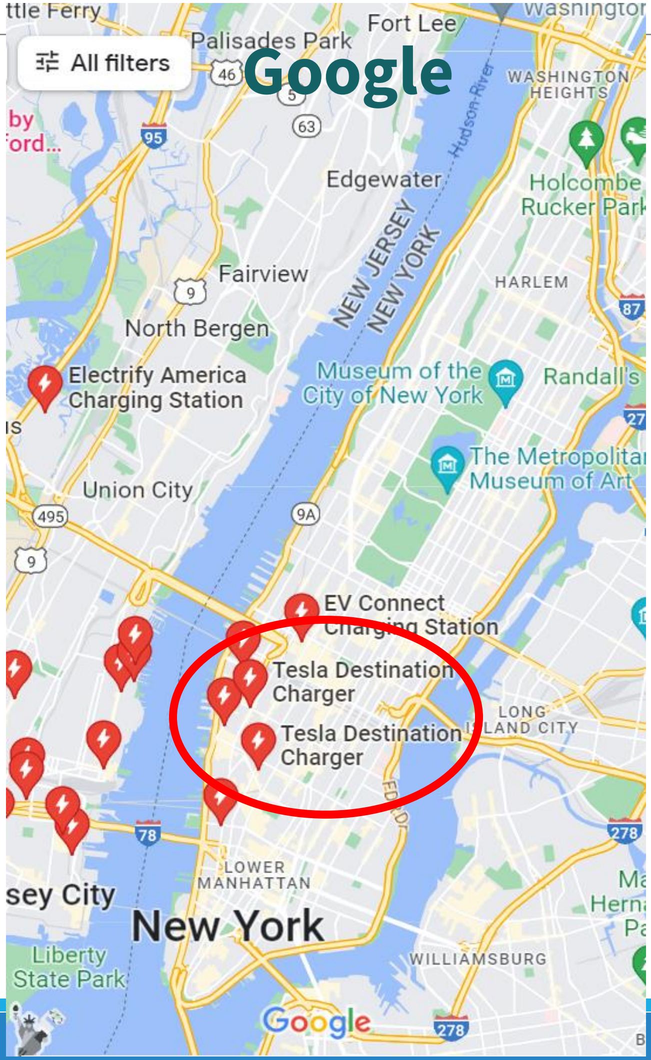
**Drivers value their time getting gas at an average of $27/hour**, based on recent research on gas buying patterns.[1]

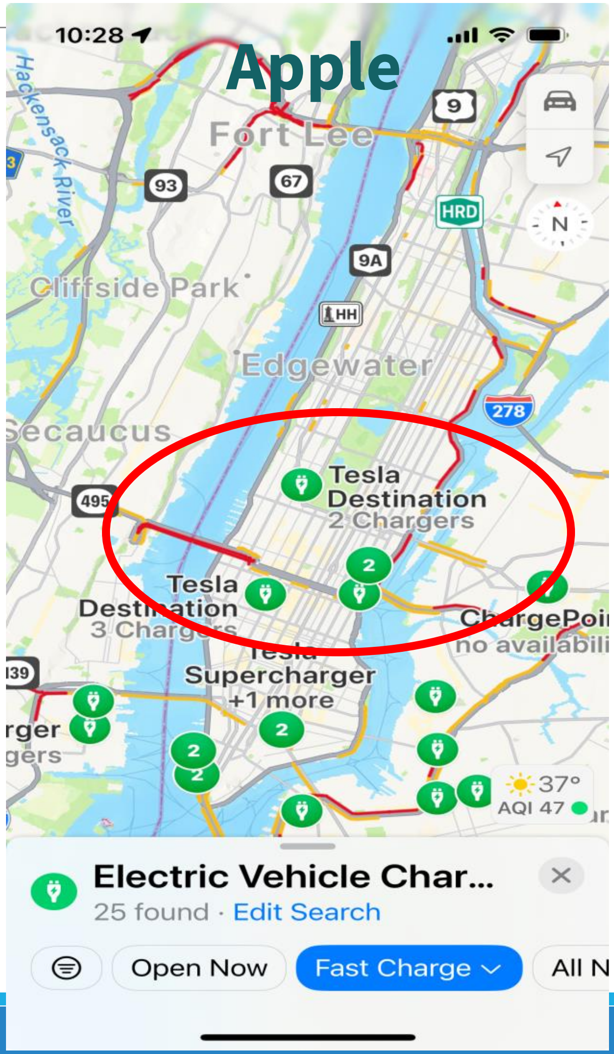
## Real time data can prevent failed charging attempts, alleviate range anxiety, and improve uptime through transparency.

# Drivers want to plan a route and find chargers in one app,

versus checking multiple charging networks' proprietary apps

**Results vary from 3 requests for DCFC, and include Level 2s**


Sources: PlugShare, Google Maps, Apple Maps.

# IIJA requires real-time data. What if *all* DC-fast chargers provide real-time data?

“***Third-party data sharing***. States or other direct recipients must ensure that the following data fields are made available, free of charge, to third-party software developers, via application programming interface [API]:…

- **Real-time status by port”** [e.g., whether in service and available/in-use]….
- **“Real-time price to charge** at each charging port.”

*--National Electric Vehicle Infrastructure Standards and Requirements under IIJA*

Preliminary results:
**Providing real-time data for all highway DC-fast chargers increases EV fleet by nearly 10% in 2028.**

Source: 23 CFR Part 680 as of 10/02/2023. Emphasis and brackets added.

# Conclusion

Our research indicates that **IRA and IIJA provisions substantially expedite the transition to ECs.**

**Charging station spending is more cost effective than EV subsidies**

- IRA charger provisions cost **$4 billion**, increase EV share by **5.6** percentage points
- IRA EV provisions cost **$332 billion**, increase EV share by **12.4** percentage points.
- **Chargers add 1ppt to U.S. EV sales share for $0.7B; purchase subsidies cost $26.8B for same 1 ppt.**

Much is unknown, both in the implementation of the IRA and in how consumers will respond.

Given the importance of charging stations to consumer choice, key path forward is understanding related factors – real-time data, uptime, interoperability, etc.