The Macroeconomic Benefits of the EV Transition

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2035

GM aspires to eliminate tailpipe emissions from new light-duty vehicles.

2035

GM commits to 100% renewable energy for electricity to power global facilities.

2040

GM aspires to be carbon neutral in global products and operations.

EVerybody In: consumers want a no compromises EV

COST COMPETITIVE WITH ICE ENGINE

Lower operating costs expected to offset any premium in ~3 years.

COMPARABLE RANGE WITH ICE ENGINE

350+ miles of range.

UBIQUITOUS, CONVENIENT, AND FAST CHARGING

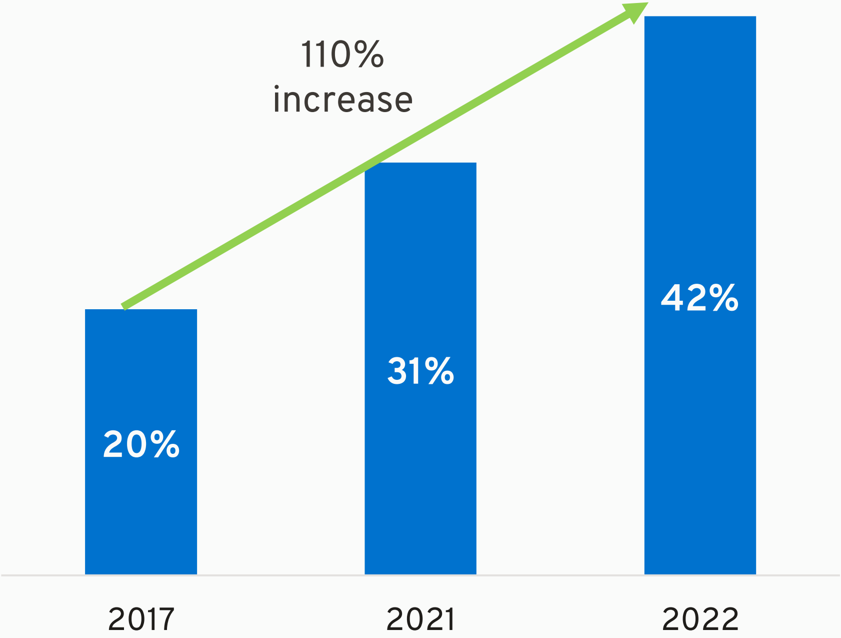
Fast charging required to spur adoption, but current owners prefer home charging.

BROAD BODY STYLE CHOICE

With strong interior and exterior styling.

U.S. consumer interest in EVs has grown 110% since 2017, with strong EV consideration across all segments

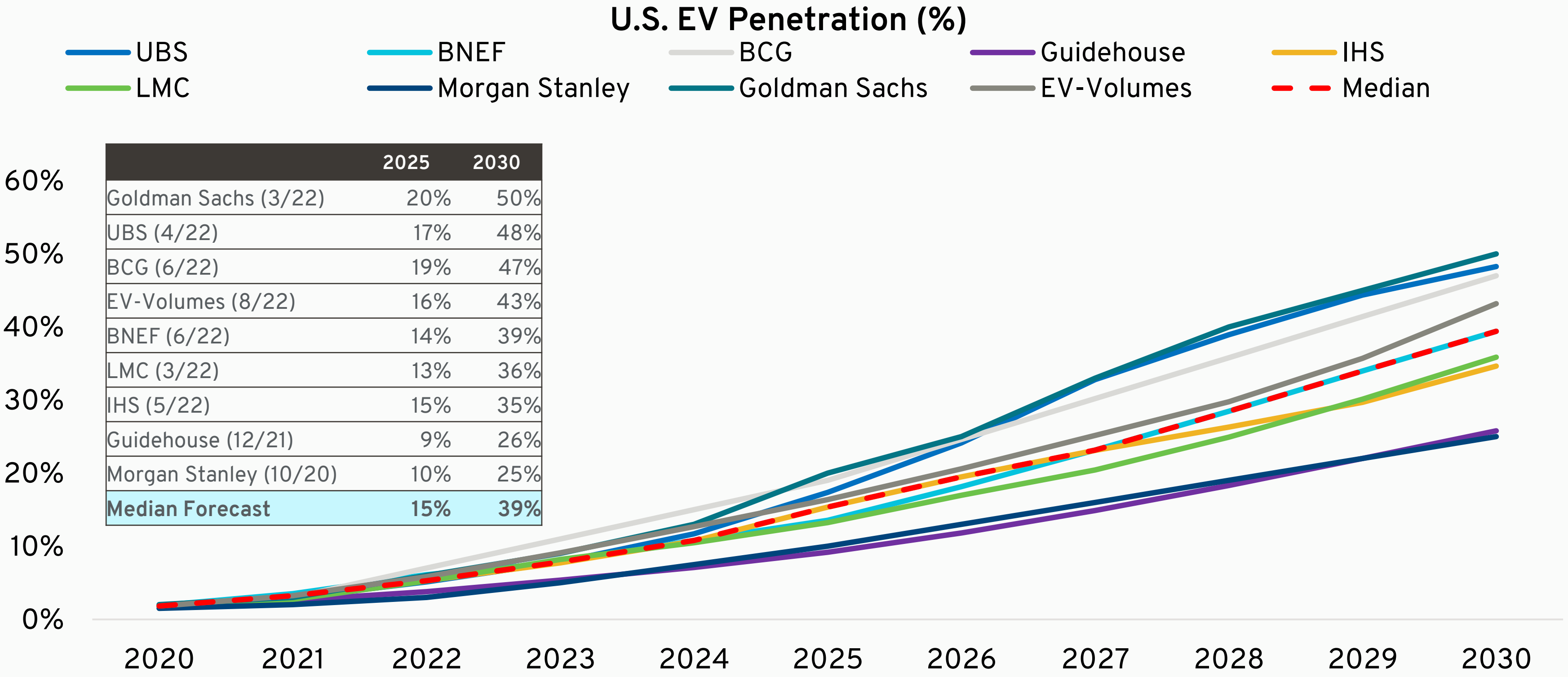
% of U.S. Consumers Who Rate Electric Propulsion As Appealing



Across All Segments, Consumers Indicate Strong EV Consideration

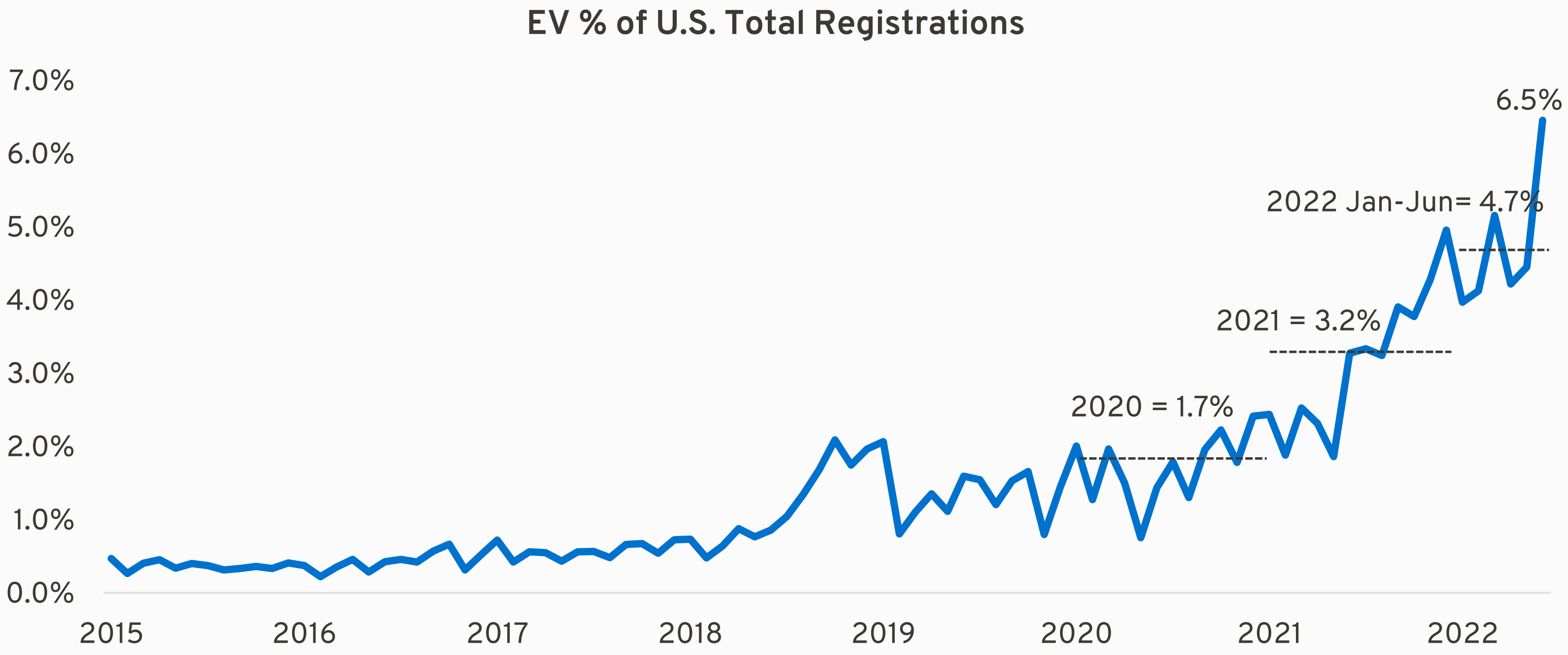
	U.S. EV Consideration
Total Market	50%
Luxury	64%
Pickups (Mid + Large)	44%
Mainstream Car	52%
Mainstream SUV	46%

Third-party forecasts of U.S. EV adoption range widely but center around ~40% in 2030



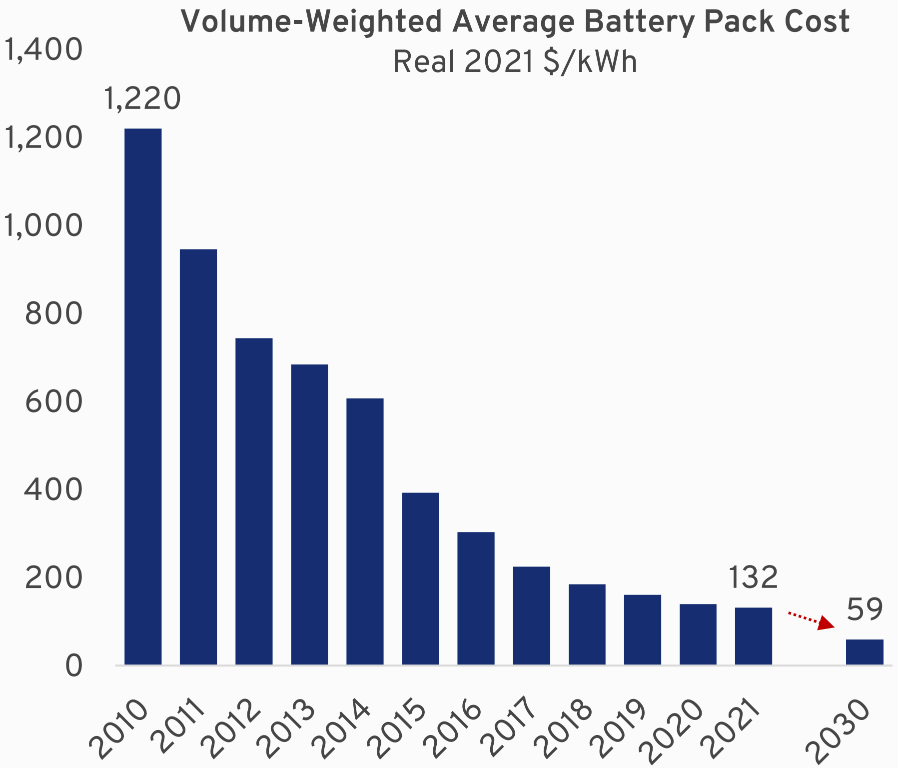
	2025	2030
Goldman Sachs (3/22)	20%	50%
UBS (4/22)	17%	48%
BCG (6/22)	19%	47%
EV-Volumes (8/22)	16%	43%
BNEF (6/22)	14%	39%
LMC (3/22)	13%	36%
IHS (5/22)	15%	35%
Guidehouse (12/21)	9%	26%
Morgan Stanley (10/20)	10%	25%
Median Forecast	**15%**	**39%**

EV industry penetrations are 4.7% for CYTD 2022, more than doubling 2020 levels

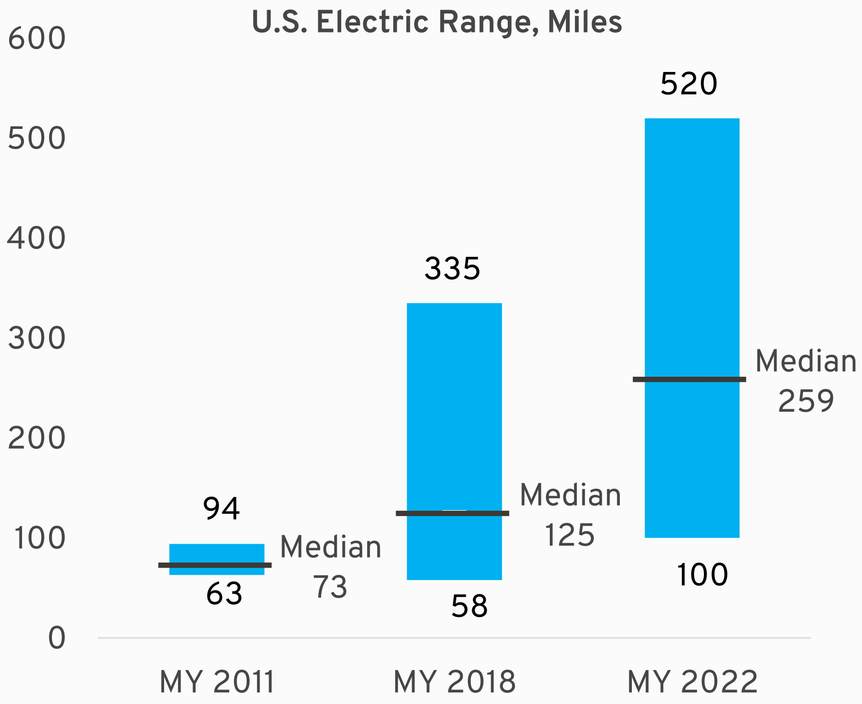


Sources: IHS Polk Registrations

Battery costs have declined ~20% per year, while EV range is increasing

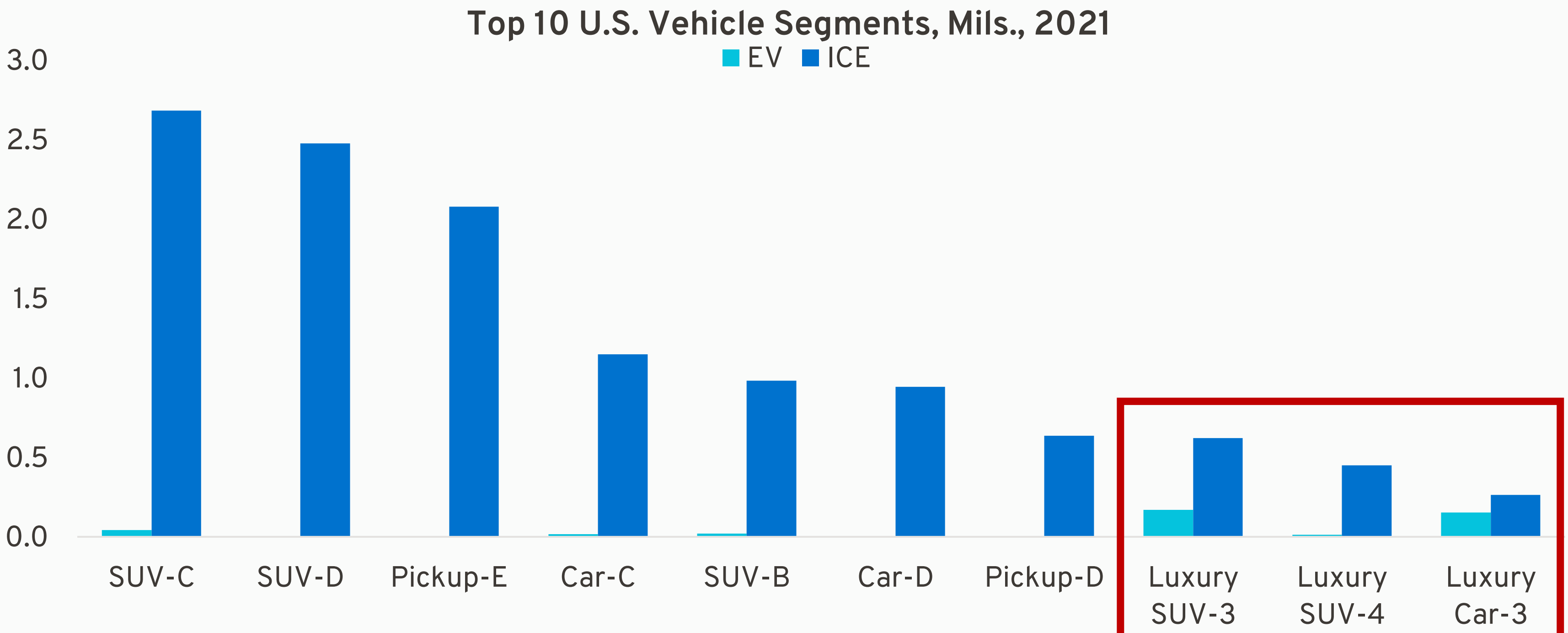


Source: Bloomberg New Energy Finance



Source: Fuel economy.gov

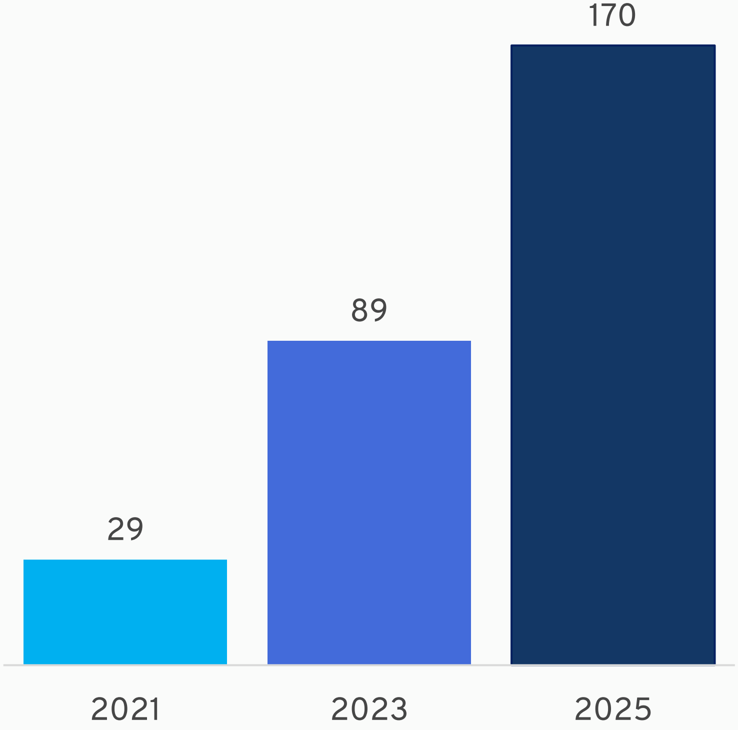
Most of the EV growth so far has been in luxury cars and SUVs, but a tremendous opportunity exists in the mainstream market



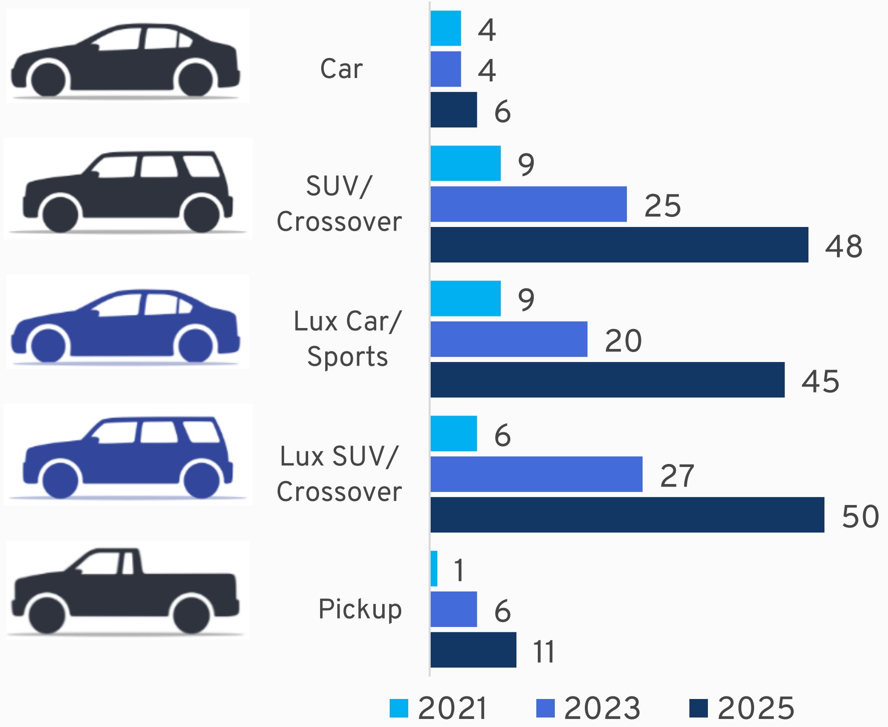
% EV	2%	0%	0%	1%	2%	0%	0%	21%	3%	37%

Number of U.S. EV entries increasing exponentially

Total U.S. EV Entries



Top EV Segments in U.S.



Sources: General Motors, IHS VPaC May 2022 (minimum 100 sales)

At current gas prices, a BEV saves ~$1.4K in fuel costs per year
based on national average electricity rates and gas prices

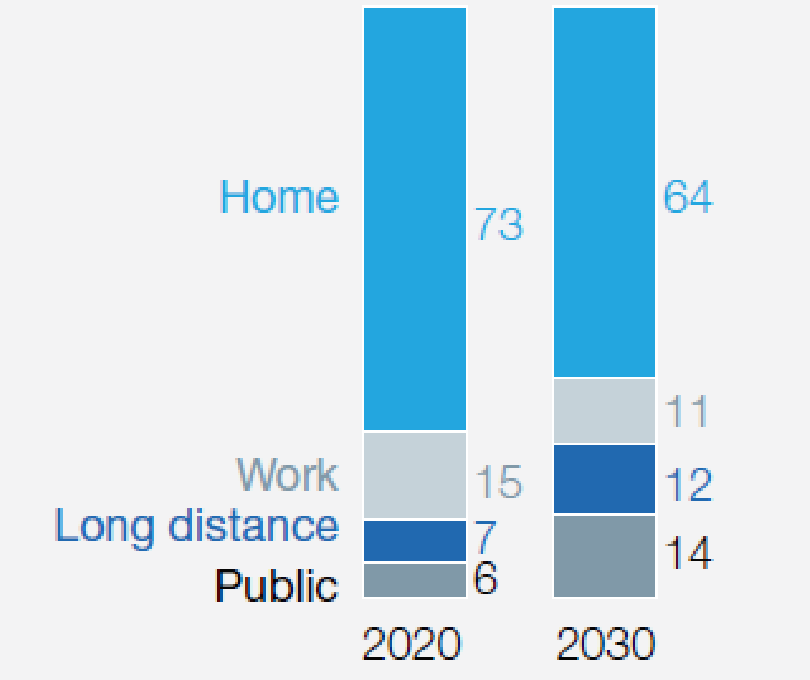
	Battery Electric Vehicle (BEV)	Internal Combustion Engine (ICE)			
		Current	$5.00/gal	$4.00/gal	$3.00/gal
Miles/yr[1]	12,416				
Electricity ($/kWh)[2] or Gasoline ($/gal)	$0.15	$3.75[3]	$5.00	$4.00	$3.00
Miles/kWh[4] or Miles/gal[5]	3.1	23.6			
Fuel cost/yr	$601	$1,973	$2,631	$2,104	$1,578
BEV savings		$1,372	$2,030	$1,503	$977

1 Annual miles per vehicle according to *Highway Statistics 2000*; fhwa.dot.gov
2 US average residential cost of electricity per kWh, Apr 2022; eia.gov
3 US average retail gasoline price (regular grade), September 8, 2022; gasprices.aaa.com
4 Median efficiency of 2021 MY electric vehicles is 104 mpge (or 3.1 mi/kWh); fueleconomy.gov
5 Median fuel economy of 2021 MY gasoline vehicles; fueleconomy.gov

Early adopters will do majority of charging at home or work

U.S. Energy Demand, Home-Centered Scenario

% of kilowatt-hours



Source: McKinsey, Charging ahead: electric vehicle infrastructure demand

Policy matters: Recent federal policies that will drive EV investment and adoption

1. **$7.5B of public investment in charging stations**
2. **Consumer EV purchase incentives for new, used, and commercial EVs**
3. **Production tax credits to support domestic critical mineral processing and EV battery production**
4. **Grants to support transition of auto manufacturing facilities to EV production**
5. **More stringent GHG and fuel economy standards**

Policy matters: ICE phase-out dates

Phase-Out Year	Market	Market (Cities and States)
2025	Norway	London
2030	Iceland Sweden Ireland Israel Netherlands Singapore	**Los Angeles** **Seattle** Paris Barcelona
2035	Denmark United Kingdom	**California** **Massachusetts** **New York**
2040	Canada China France Portugal Spain Taiwan	

Source: International Council on Clean Transportation; June 2021

The EV Supply Chain

Establishing a sustainable EV raw material value chain

GM is actively pursuing opportunities to localize as much of the supply chain as possible

Partnerships created for lithium, cobalt, rare earths, alloy flakes, permanent magnets, and CAM

Recycling should be primary source of battery raw materials in the long term

Recycling today: cobalt, nickel

Future recycling: cobalt, nickel, lithium, graphite, copper, manganese, and aluminum

GM sustainable EV supply chain partnerships

Lithium:

- **Controlled Thermal Resources** to secure lithium produced by the 1st stage of its California Hell's Kitchen Project.
- **Livent** will supply battery-grade lithium hydroxide under a multi-year agreement, with the goal of transitioning 100% of Livent's downstream lithium hydroxide processing for GM to North America.

Cobalt with Glencore, which will supply Australian cobalt under a multi-year agreement.

Rare earth materials with GE, to develop a rare earth value chain.

Alloy flakes with MP Materials, which will establish the first North American processing site for alloy flakes. The company will expand into magnet manufacturing ~2025 at its new production facility in Fort Worth, TX.

Permanent magnets with VAC, which will establish a North America footprint to support GM's magnet requirements starting in 2024, including locally sourced raw materials and finished magnet production.

CAM:

- **POSCO:** The Quebec site will process CAM, a key battery material consisting of components like processed nickel, lithium and other materials representing about 40% of the cost of a battery cell.
- **LG Chem** will supply CAM under a multi-year agreement, with enough CAM for ~5 million units of EV production. GM and LG Chem will also explore the localization of a CAM production facility in North America.

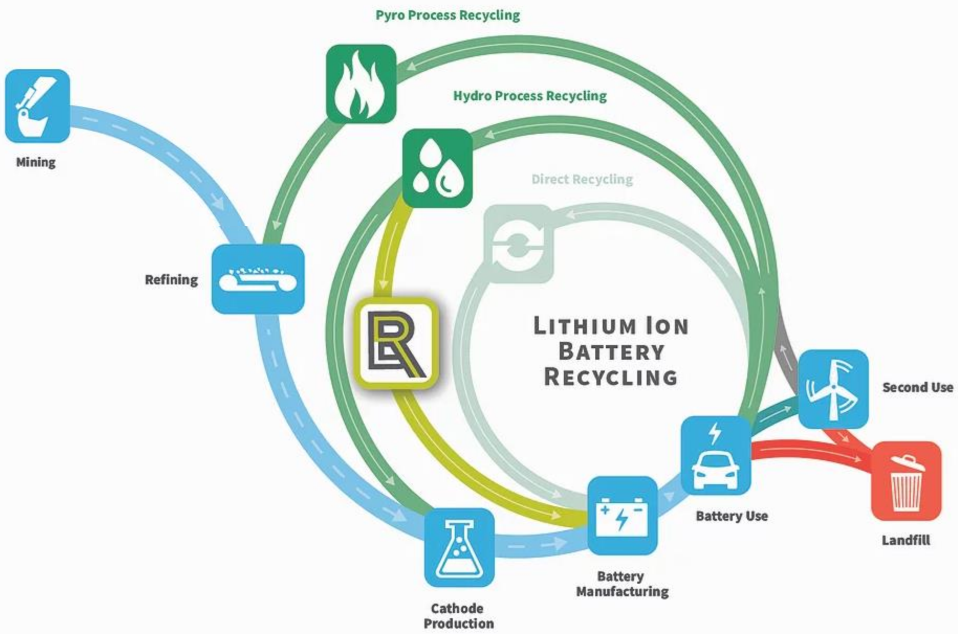
Recycling should be primary source of battery raw materials in the long term

Our Ultium Cells LLC joint venture with LG Energy has an agreement with Li-Cycle to recycle up to 100% of material scrap from our battery cell manufacturing process.

Modular design of Ultium batteries also makes them easy to reuse or recycle.

Recycling today: cobalt, nickel

Future recycling: cobalt, nickel, lithium, graphite, copper, manganese, and aluminum using a new process that emits 30% fewer emissions than traditional recycling processes.



Macroeconomic Stability Benefits of the EV Transition

What does the EV transition imply for the U.S. economy?

The EV transition can improve macroeconomic stability by reducing vulnerability to oil price shocks.

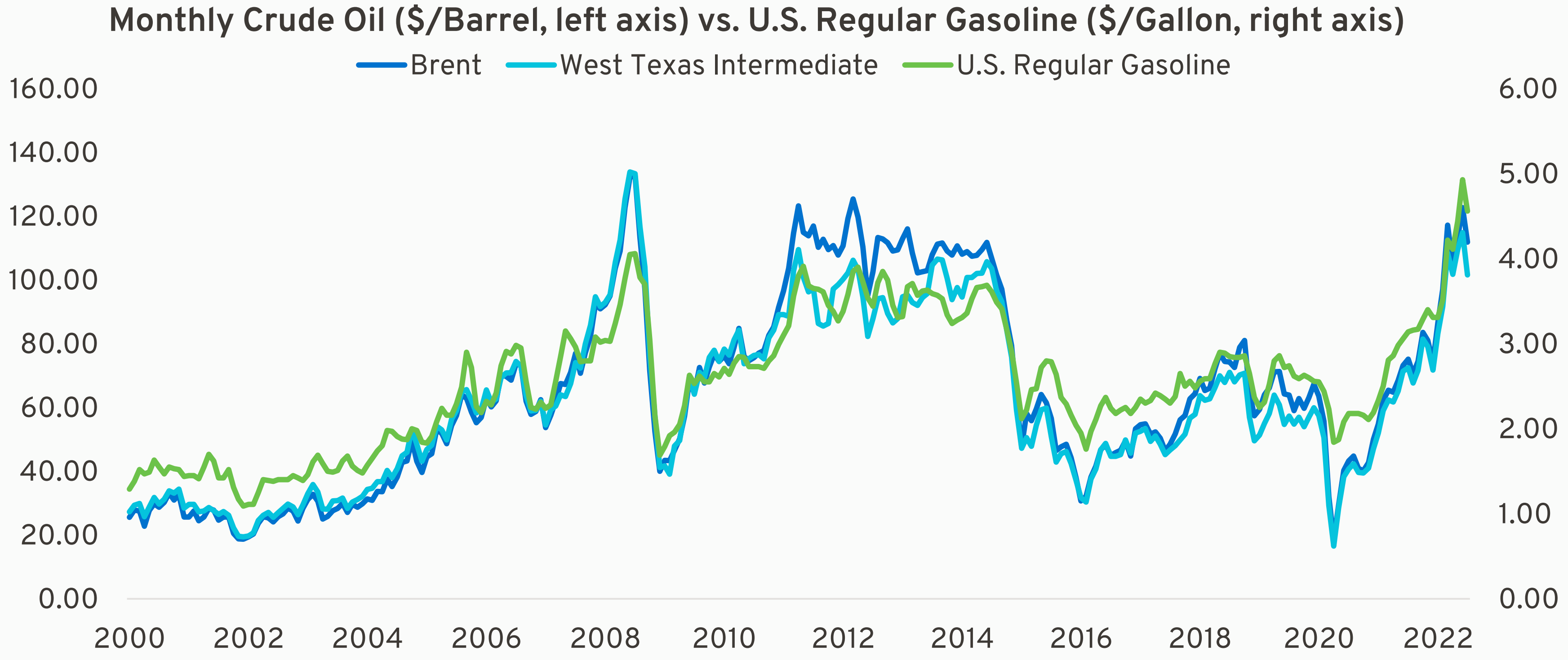
Shifting transportation energy demand from oil products to electricity will reduce U.S. energy price volatility. The energy sources that power the electricity grid are more diversified, have more stable prices, and are less affected by geopolitical risk.

Reduced vulnerability to oil supply shocks and less dependence on gasoline will **insulate consumers from high and volatile gasoline prices**, which have been found to negatively impact consumer sentiment, consumption, and GDP.

EVs can be powered by cleaner energy sources over time. Combined with optimizing charging times, emissions can fall substantially further.

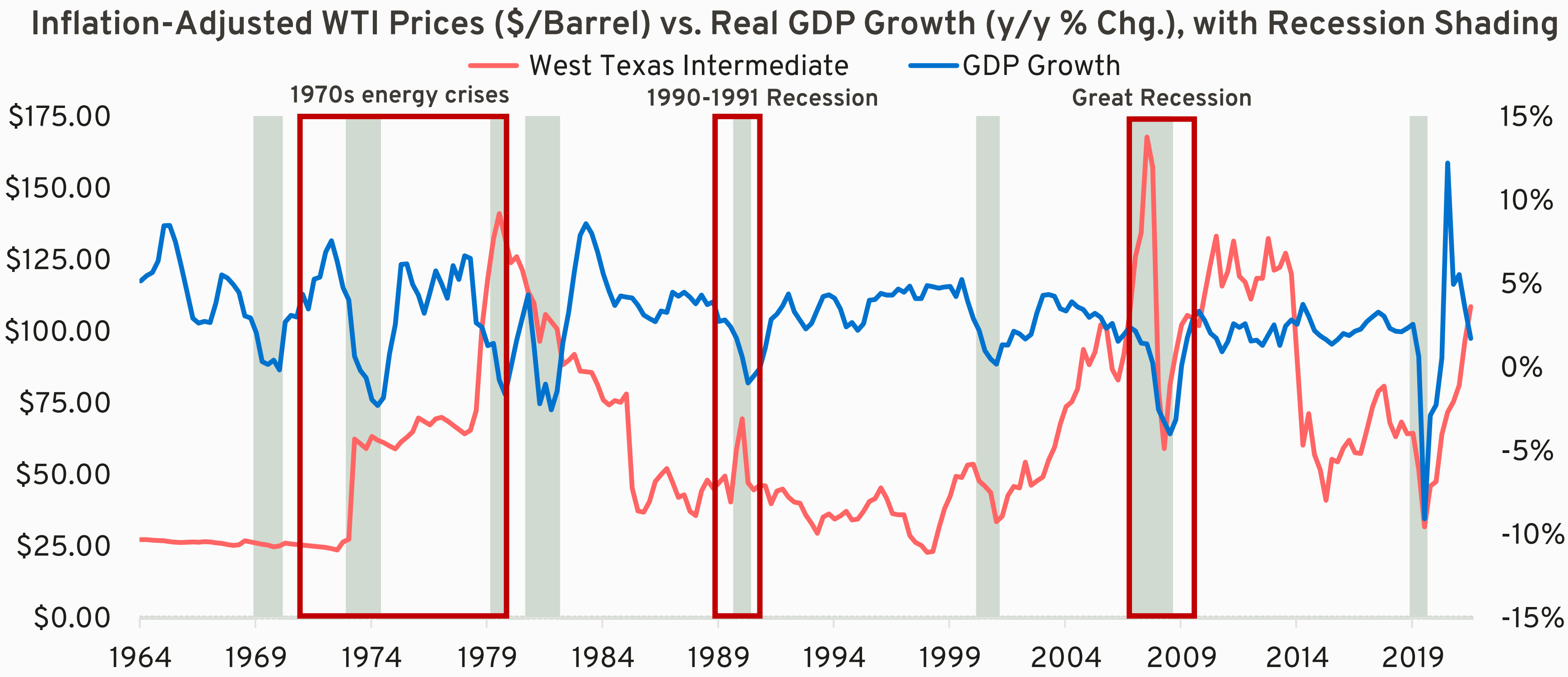
Global oil market volatility drives volatile gas prices

U.S. gasoline prices are closely tied to international oil prices



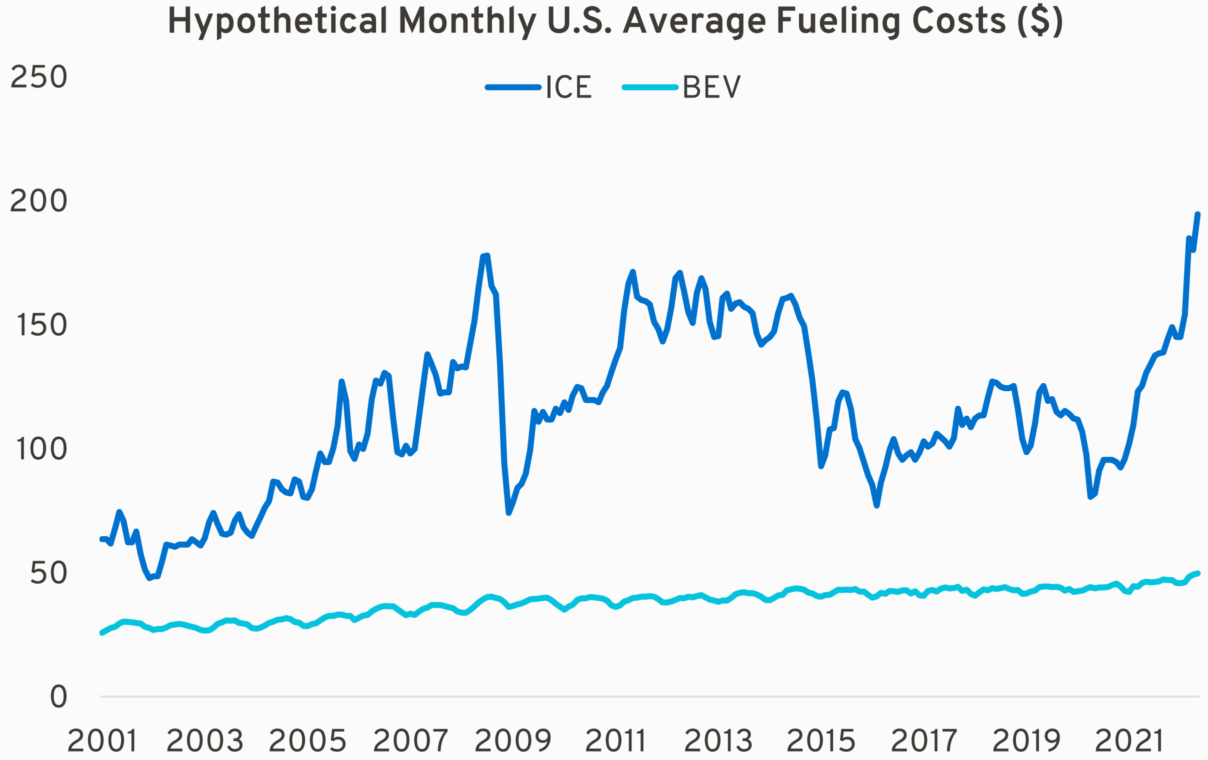
Sources: EIA, Haver Analytics

Large run ups in oil price preceded several U.S. recessions



Sources: EIA/Chicago Mercantile Exchange, Bureau of Economic Analysis, Bureau of Labor Statistics, National Bureau of Economic Research, Haver Analytics

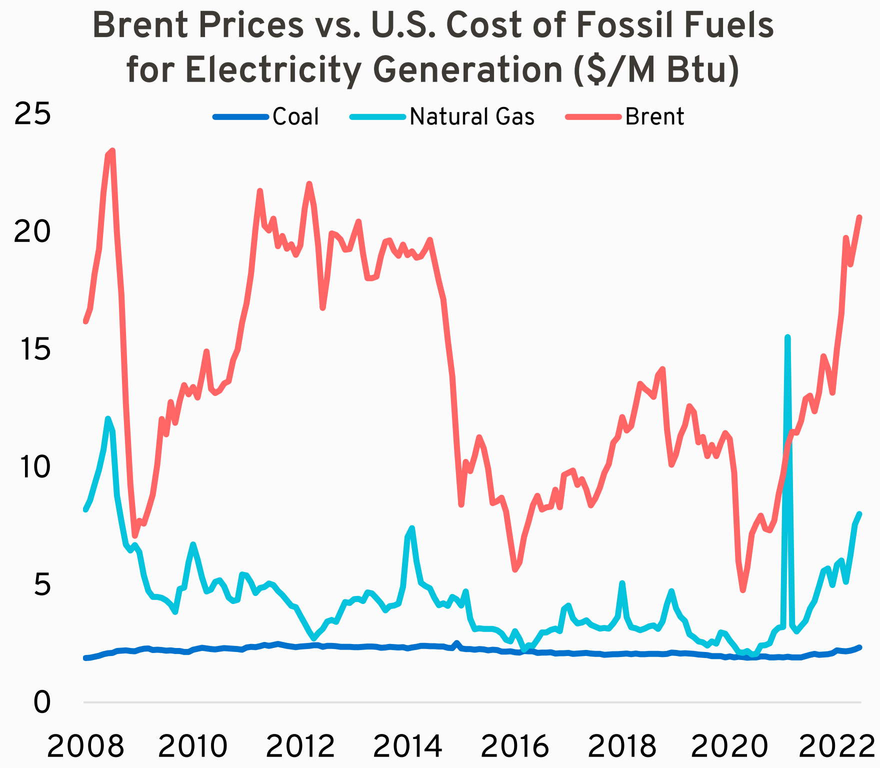
U.S. EV owners are insulated from oil price volatility
Based on historical data, BEV fueling costs are lower and less volatile



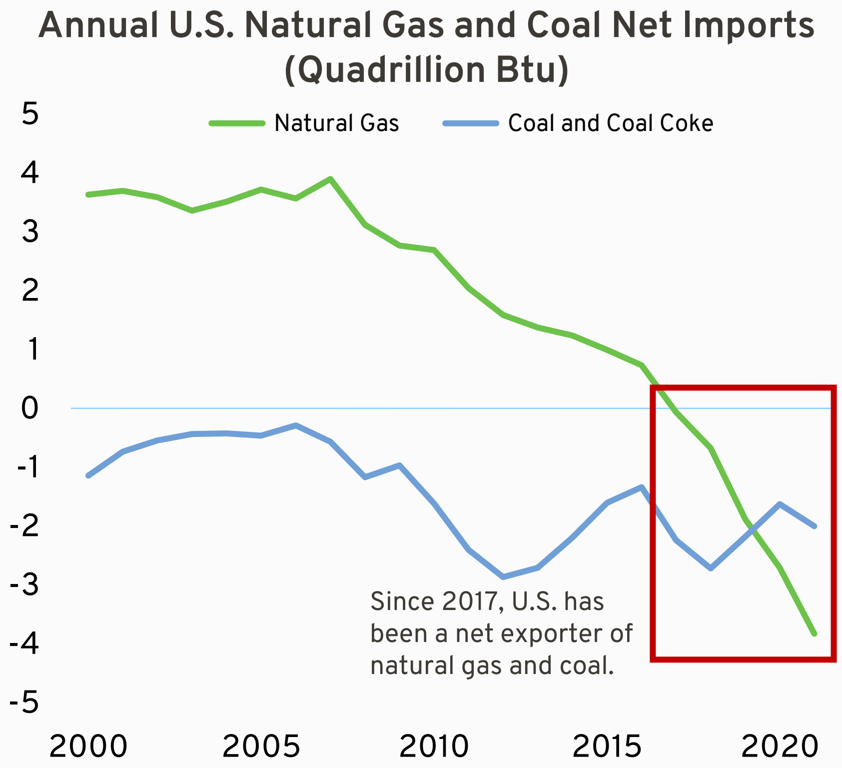
Fueling costs calculated assuming:

- 1,035 miles/month based on annual miles per vehicle of 12,416 according to Highway Statistics 2000; fhwa.dot.gov
- U.S. monthly average residential price of electricity per kWh. Residential electricity prices vary by state. *Source: EIA, Haver Analytics*
- U.S. monthly average regular gasoline price. *Source: EIA, Haver Analytics*
- Median efficiency of 2021 MY electric models is 104 mpge (or 3.1 mi/kWh). *Source: fueleconomy.gov.*
- Median fuel economy for 2021 MY is 23.6 miles per gallon. *Source: epa.gov.*

U.S. electricity grid is ~60% powered by coal and natural gas
whose prices are less volatile than oil and in which the U.S. is self-sufficient

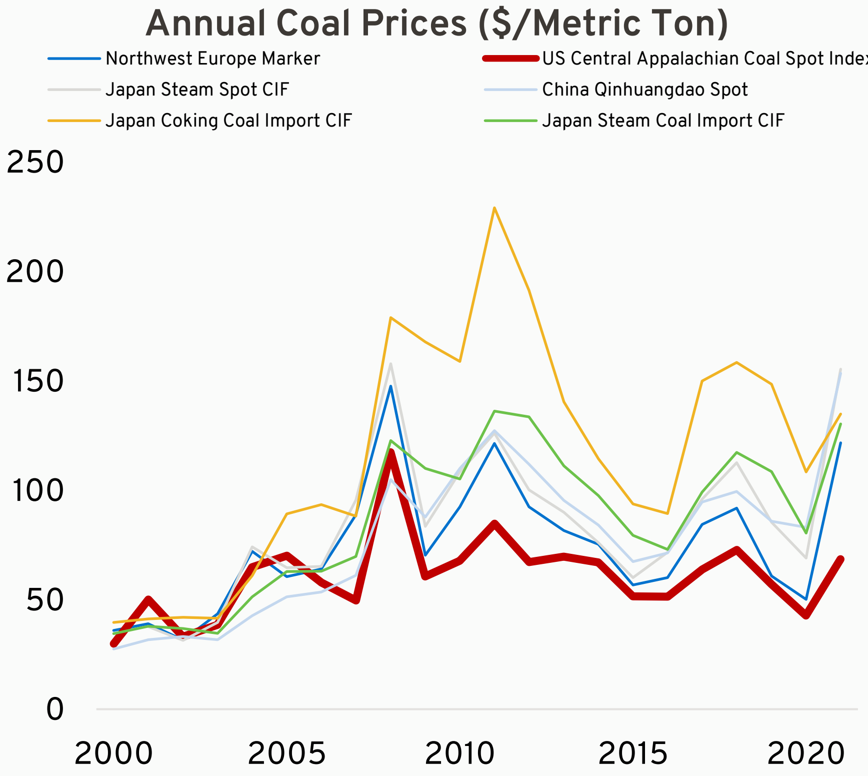


Sources: EIA, Haver Analytics. Assume 1 barrel of crude oil = 5,691,000 Btu; EIA.

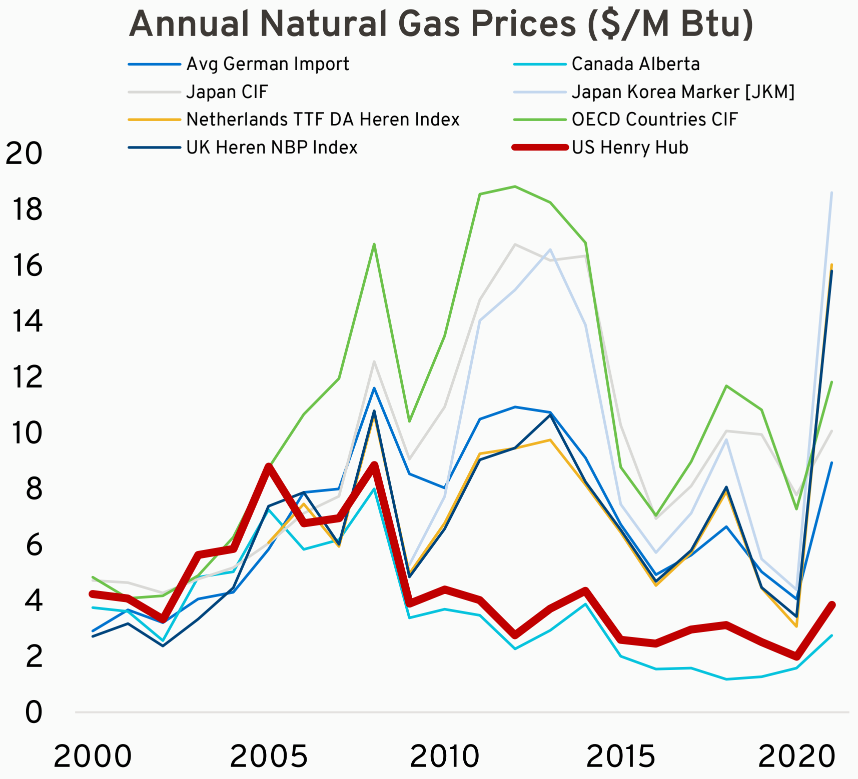


Sources: EIA, Haver Analytics

U.S. coal and natural gas prices are lower than and less closely tied to international prices than oil

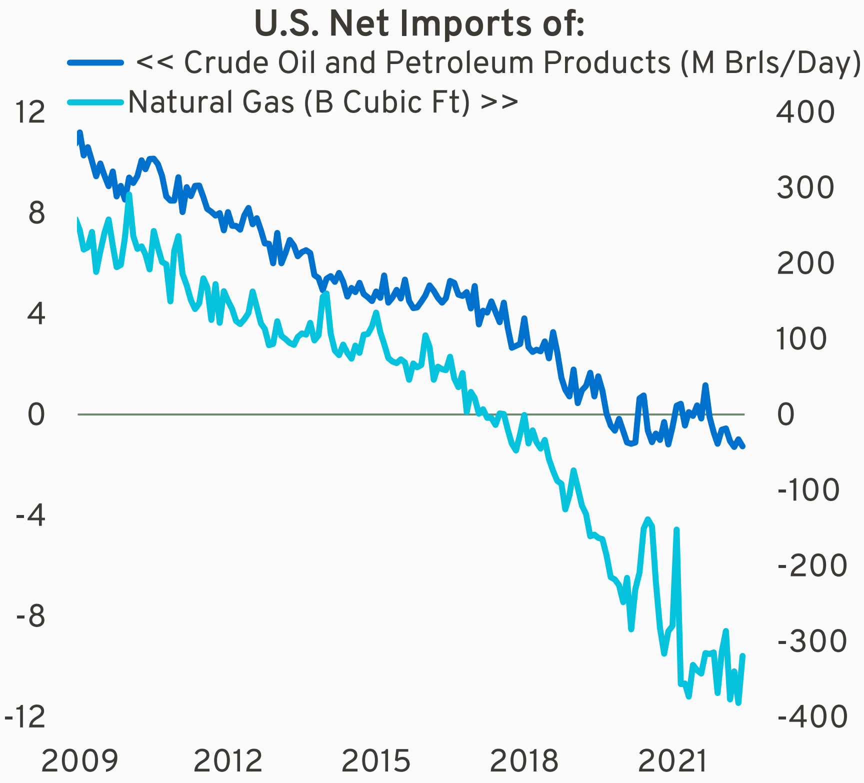


Sources: British Petroleum, Haver Analytics

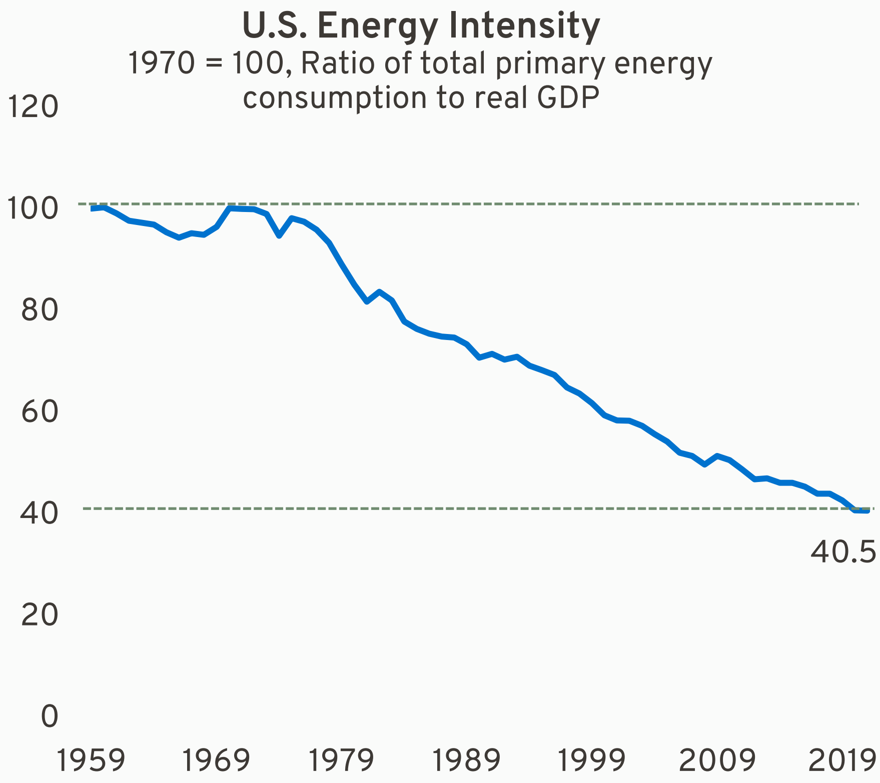


Sources: British Petroleum, Haver Analytics

U.S. vulnerability to oil price shocks has fallen greatly due to increased U.S. production and greater energy efficiency



Sources: EIA, Haver Analytics



Sources: Bureau of Economic Analysis, Haver Analytics

Gasoline and diesel are 22-23% of current U.S. energy consumption and two-thirds of petroleum use

U.S. Share of Energy Consumption by Source

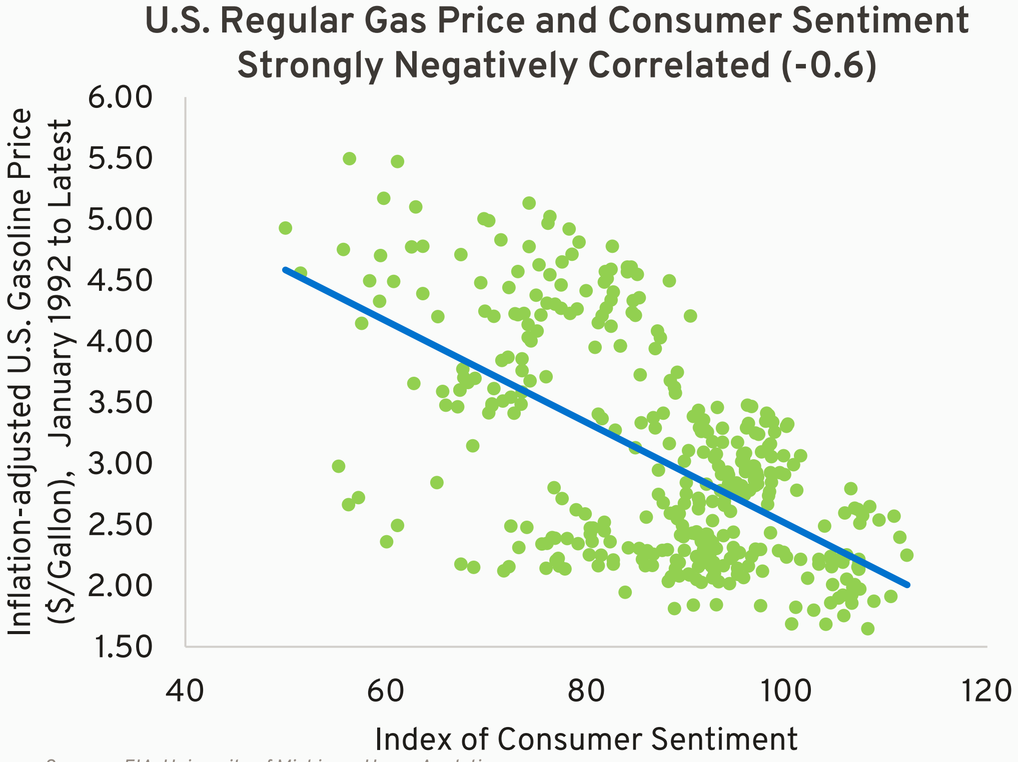
	2019	2020	2021
Petroleum	37	35	36
Motor Gasoline and Diesel[1]	23	22	23
Other Petroleum Products[2]	14	13	13
Natural Gas	32	34	32
Coal	11	10	11
Nuclear	8	9	8
Renewables	11	12	13

[1]Motor gasoline and diesel consumption for the transportation sector.
[2]Other petroleum products include liquefied petroleum gases and other; jet fuel; kerosene; distillate fuel oil use outside the transportation sector; residual fuel oil; petrochemical feedstocks; and other petroleum (e.g., aviation gasoline, road oil, misc. petroleum products).

Sources: EIA, Haver Analytics

But sentiment remains closely tied to gas prices

Lower, stable EV fueling costs could positively impact sentiment



"Consumer sentiment becomes more pessimistic with rising gas prices. This effect is strongest for consumers who lived through the recessionary oil crises in the 1970s…"

– Binder and Makridis (2022)

"[W]e also find that aggregate demand and other oil demand shocks have significant influence on household satisfaction with economic policy measures 'to fight inflation and unemployment.'"

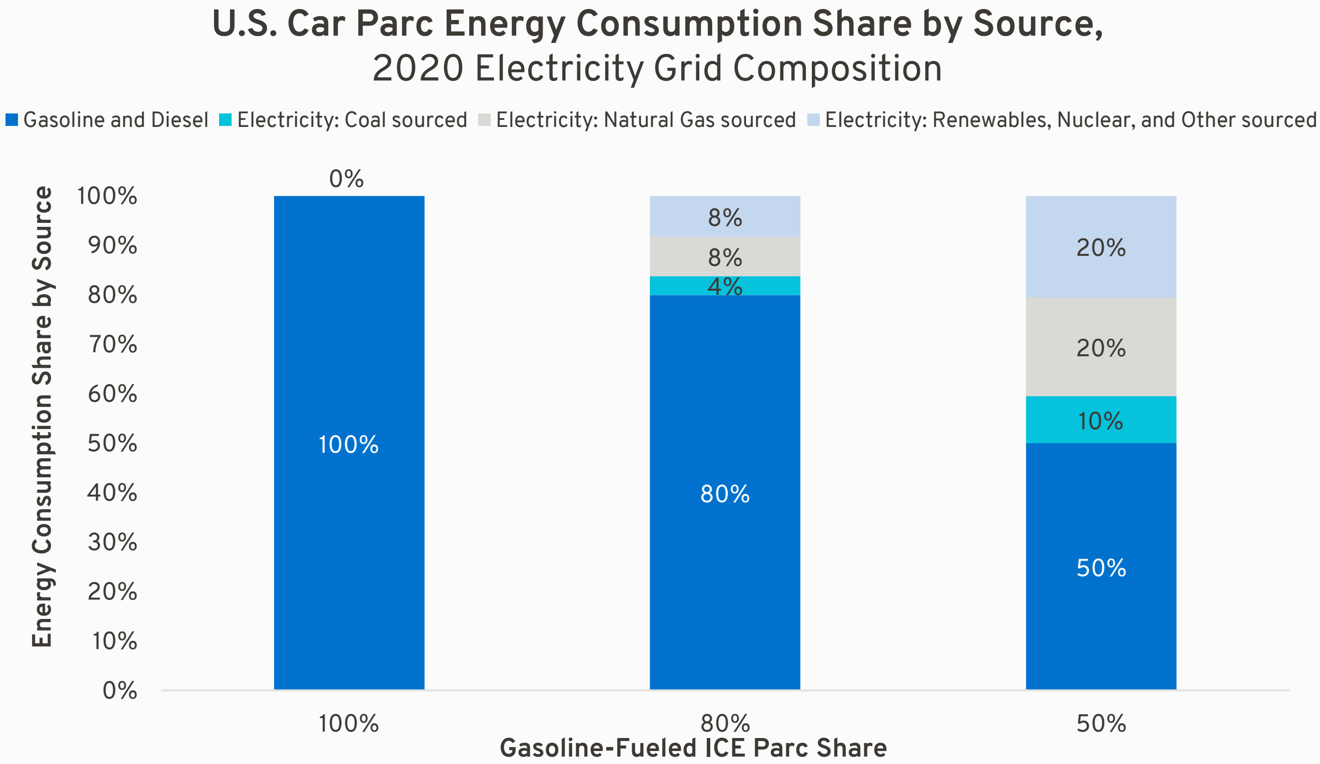
– Güntner and Linsbauer (2018)

"[H]istorically energy price shocks have been an important factor in explaining U.S. real consumption growth, but by no means the dominant factor."

–Edelstein and Kilian (2009)

Sources: EIA, University of Michigan, Haver Analytics

Mass EV adoption would transform U.S. energy consumption even with the 2020 mix of electricity sources

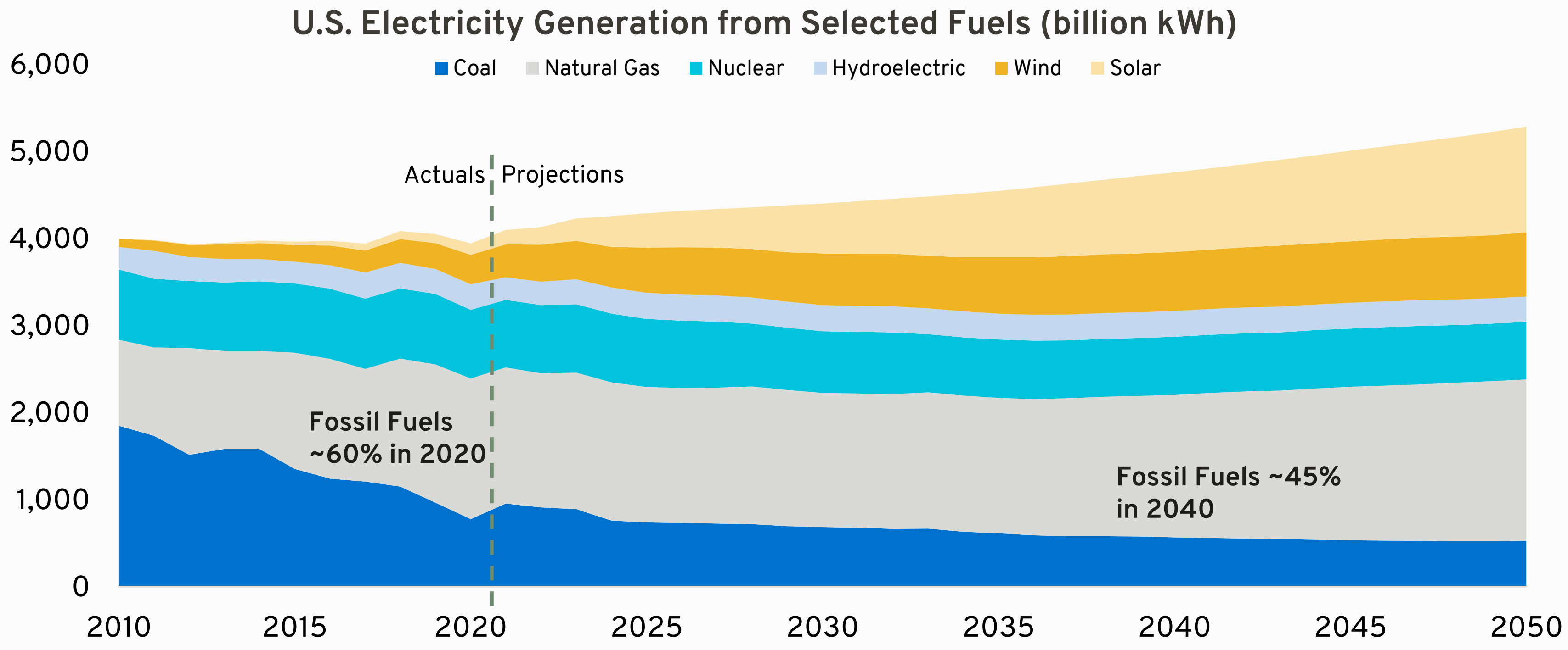


- Calculations reflect different ICE parc share scenarios under an immediate EV transition, with the electricity grid mix as in 2020.
- 2020 U.S. electricity generation sourced from coal ~19% and from natural gas is ~40%. *Source: EIA*
- Assumes that EVs will use as much energy (in Btus) as ICE. Calculations based on 2021 MY EV efficiency and ICE fuel economy suggest EVs may potentially use less energy than ICE.

Sources: EIA, Haver Analytics

Increasingly renewable U.S. electricity generation will further increase climate benefits as the U.S. vehicle fleet transitions to EVs

~60% electricity generation from fossil fuels in 2020 down to ~45% in 2040.



Sources: EIA, Annual Energy Outlook 2022, Reference case; Haver Analytics

Optimized charging can further increase the climate benefits

“**Electrifying 100% of car miles traveled** (thereby eliminating gasoline vehicle carbon emissions) increases electricity-sector carbon emissions by 23-27% if vehicles are charged at night but **could *decrease* electricity-sector carbon emissions if vehicles are charged during the day.**”

If you further net out avoided gas/diesel emissions from ICE vehicles, annual welfare gains of 100% EV adoption relative to zero EV adoption **can increase by** as much as **9%-28% with optimized charging** (i.e., charging primarily in the afternoon).

Holland, Mansur, and Yates, “Decarbonization and Electrification in the Long Run,” NBER Working Paper 30082, September 2022.

Conclusion

The EV transition reduces U.S. vulnerability to macroeconomic shocks from oil price volatility and geopolitical risk. In doing so, it should reduce economic volatility.

The EV transition shifts U.S. energy consumption **away from crude oil to self-sufficient sources** that power the U.S. electricity grid.

EV owners can expect lower and more stable fueling costs on average recognizing that there may be local variation in electricity pricing. **Avoiding gas price shocks should reduce downside to consumer sentiment.**

The climate benefits of the EV transition will increase over time as the electricity grid becomes cleaner.