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State Of the Markets: Key Opportunities On The Path To Net-Zero GHG Part 1

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Alan Brazil

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State Of the Markets: Key Opportunities On The Path To Net-Zero GHG

- Part 1: Framing the magnitude of a net-zero GHG emissions policy for the world and the US
  - Example of transitioning to a 100% electric vehicles
  - Example of projected costs for the US of a 100% renewable energy grid
- Part 2: The problem with renewable energy is that it is variable across hours, days, months and years
- Part 3: Key opportunities along the path to Net-Zero

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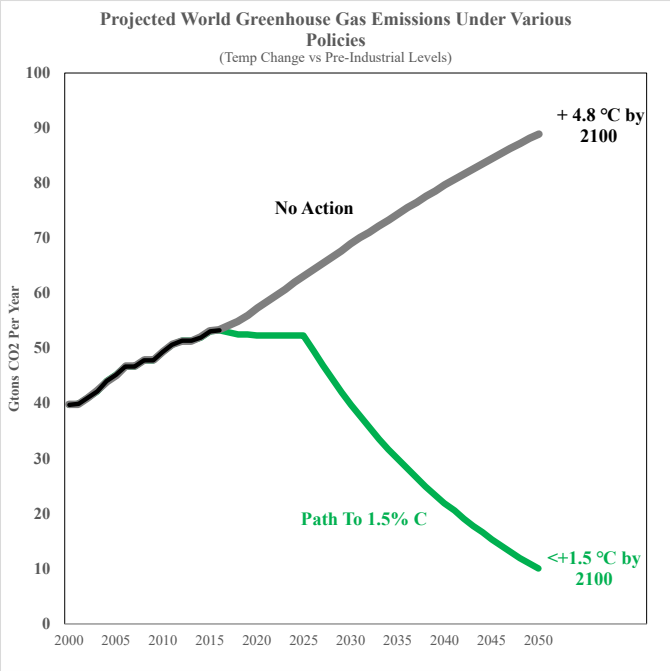
Step 1: Macro Theme

Governments Are Ramping Up Polices For "Zero-Net" Emissions of GHG To Combat Global Warming

No Policy Means The World Continues to Heat Up



Major Prospective Net-Zero Policy Moves By Major Economies

	US	EU	China
Net Zero	Net-Zero 2050	Net-Zero by 2050, reduction of 50-55% by 2030	Net Zero by 2060 and peak emissions before 2030
	Decarbonize all sectors of economy: Transportation, power and consumer, industrial and commercial	Decarbonize all sectors of economy: Transportation, power and consumer, industrial and commercial	Decarbonize all sectors of economy: Transportation, power and consumer, industrial and commercial
Transportation	***Move to 100% EV transportation by 2050***	***Move to 100% EV transportation by 2050***	***Move to 100% EV transportation by 2060***
	Build 500,000 EV charging stations	Build 1MM EV charging stations, and 13 MM EV on the road by 2025	
	Consumer rebates/incentive to buy and produce EVs	Consumer rebates/incentive to buy and produce EVs	Consumer rebates/incentive to buy and produce EVs
	Substantially higher fuel economy standards to pushout ICE vehicles		Focus on EV batteries with 2/3 of mega factory capacity will by in china by 2023
			100% of natural graphite, 50 of lithium, 805 of cobalt battery supply chain
Power Sector	100% pollution-free emissions by 2035	90% driven by renewable energy by 2050 from 15% today	By 2050, electricity will drive 65% of all end-use energy consumption vs 25% today
	$2 trillion infrastructure for clean energy over next two years		
	80% electrical power generated by renewable energy by 2035	Growing Off-shore wind from 12 Gw to 60 GW by 2030 and 300 GW by 2050	
	Build the next generation electric transmission and distribution network	***Build the next generation electric transmission and distribution network***	***Build the next generation electric transmission and distribution network***
	Green hydrogen that is cost competitive to carbon based fuel sources	***Expansion of Green Hydrogen from 500 GW of electrolysers by 2050 from 1 GW today***	***Expansion of Green Hydrogen***
	Development and deployment of large scale carbon capture systems	Development and deployment of large scale carbon capture systems	Development and deployment of large scale carbon capture systems
	$400 billion in additional energy research next 4 years		
	Grid scale battery storage at 1/10th the cost of Lithium-ion battery		

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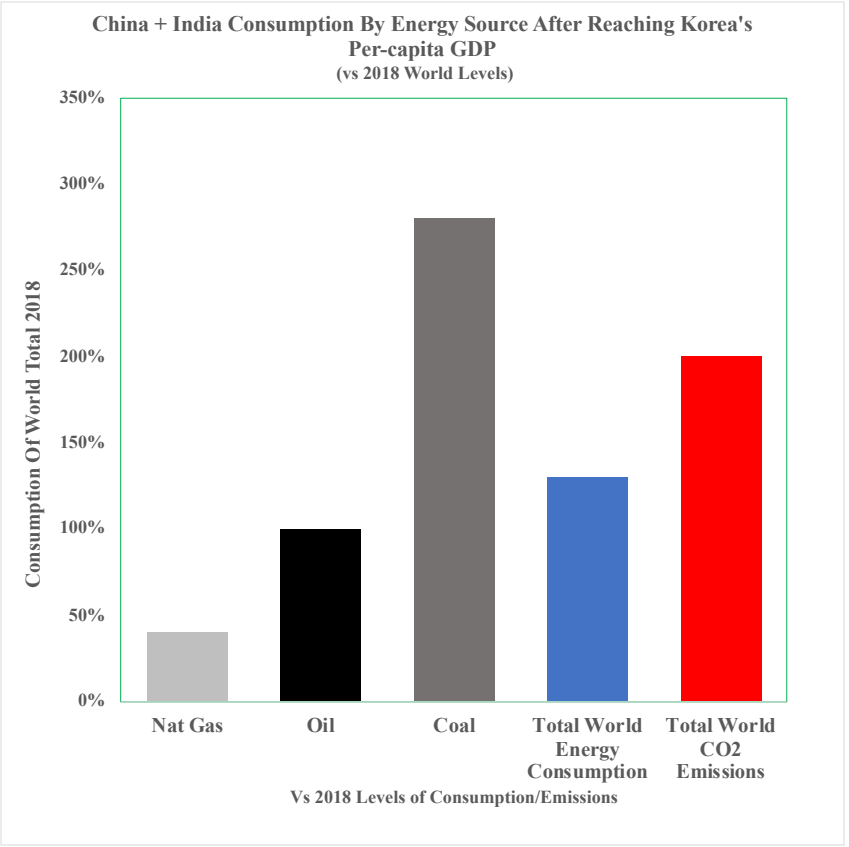
Step 2: Fundamental Economic Framework

EMs Also They Need to Reduce Their Dependency On Carbon Energy To Continue to Grow

Carbon Demand If China/India Grow To Per-Capita GDP Of Korea

	Base Line 2018			Growth To Per-Capita GDP Of Korea	
	Per-Capita GDP (2010 USD)	GDP ($bil 2010 USD)	Consumption of Electricity (TWh)	GDP ($bil 2010 USD)	Consumption of Electricity (TWh)
India	**2,152**	2,822	1,309	37,610	17,444
China	**8,255**	10,873	6,990	37,851	24,333
S Korea	**28,675**	1,453	563		
USA	55,753	17,913	4,194		

Demand Would Soak Up All The Available Carbon Supply



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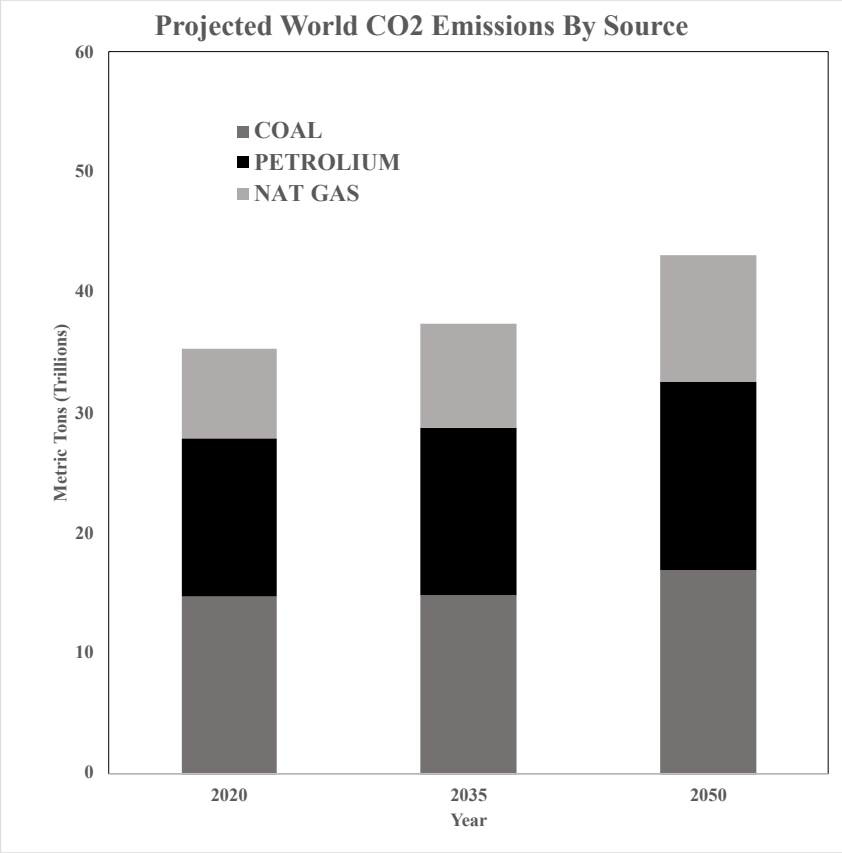
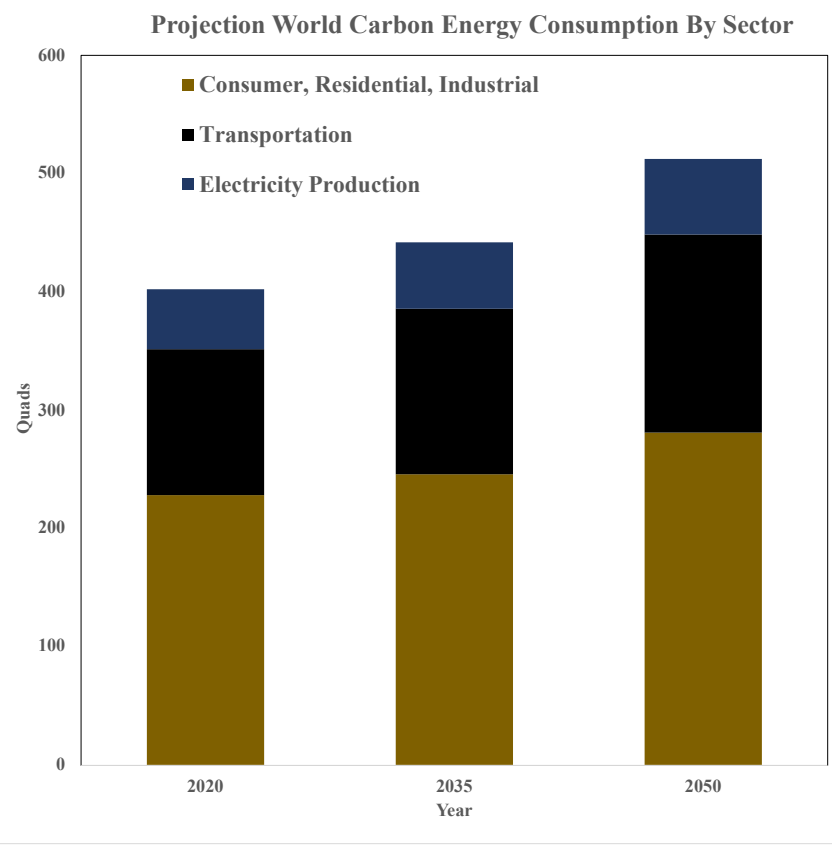
Without Policy Shifts, Emissions Will Continue To Grow

Fossil Fuel Demand Growth Means More GHGs



Transportation And The Non-Power Sector Are The Biggest Source



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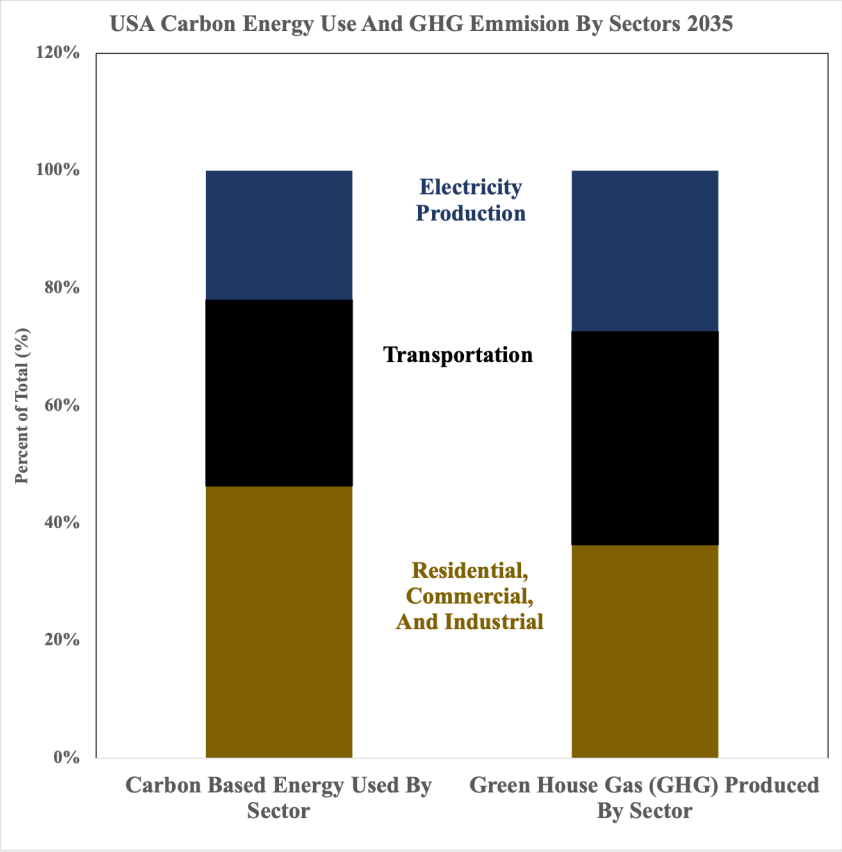
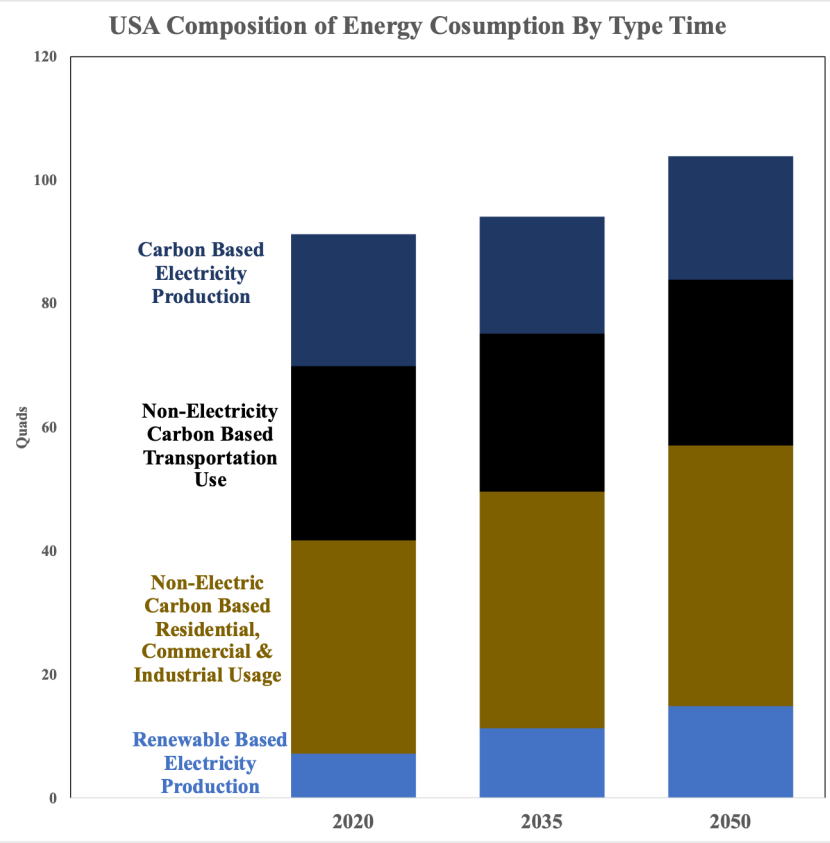
The US Looks Similar And With Little Prospect For Improvement in Renewable Energy Absent Policy Shifts

Transportation And Electricity Represent 60% of Emissions



Renewable Electricity Production Is Projected To Grow Slightly



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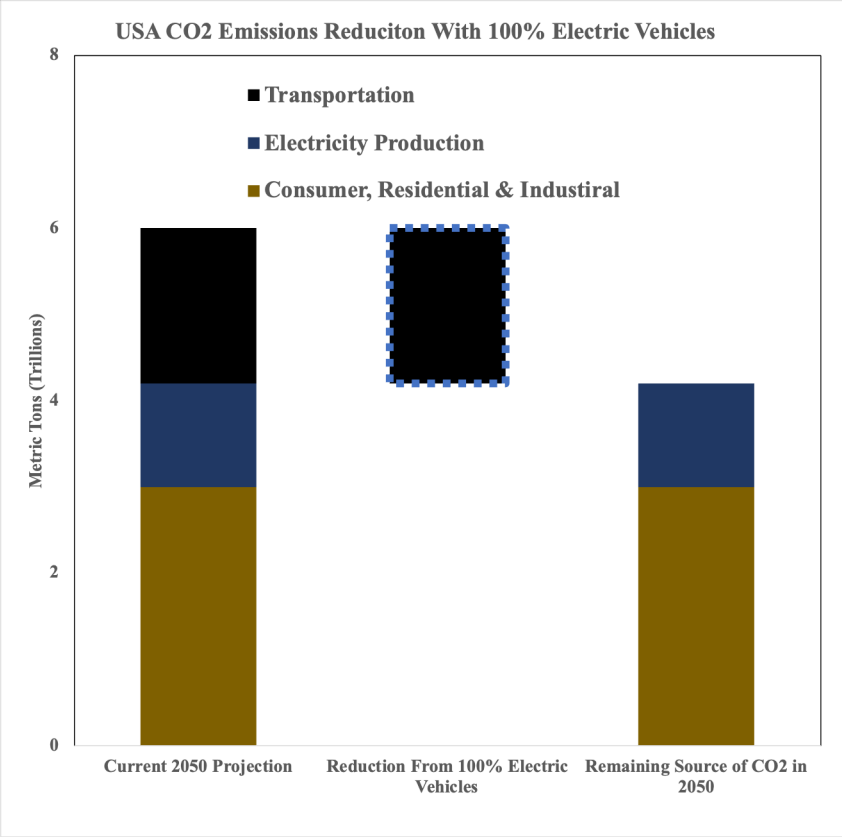
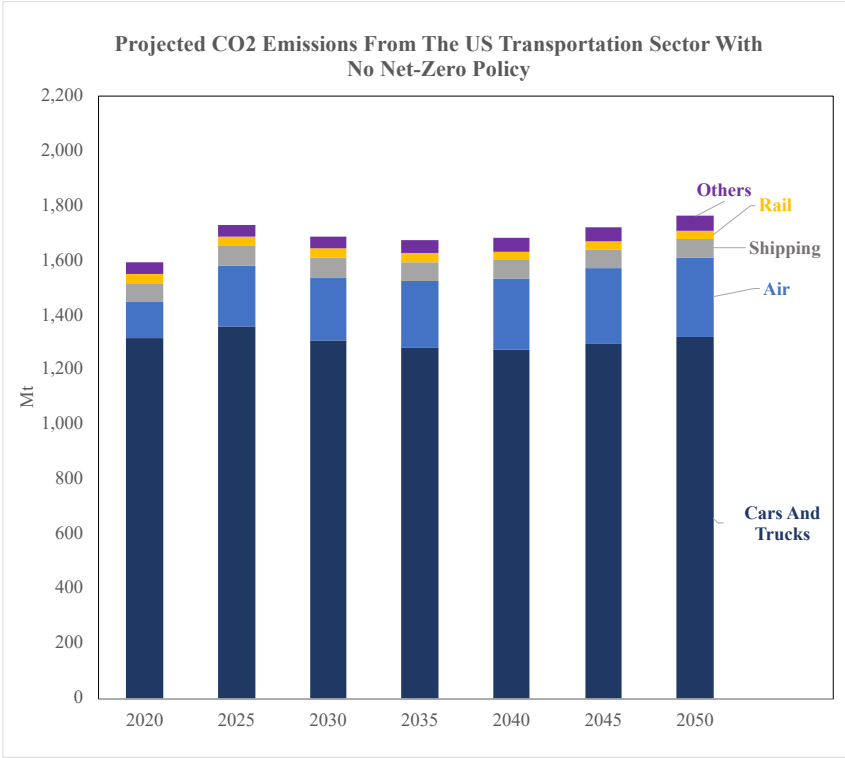
The Goal Of Transforming Transportation (EVs) Highlights The Challenge of Net-Zero

Start With Reducing The Carbon Footprint of Transportation …



And That Means Turning ICE Vehicles To EVs



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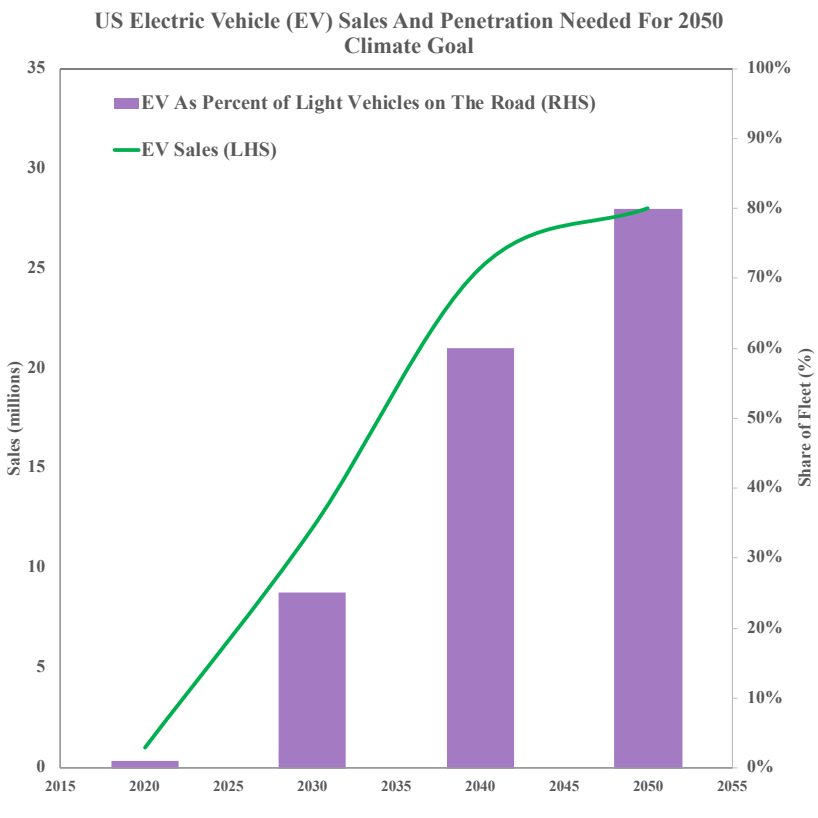
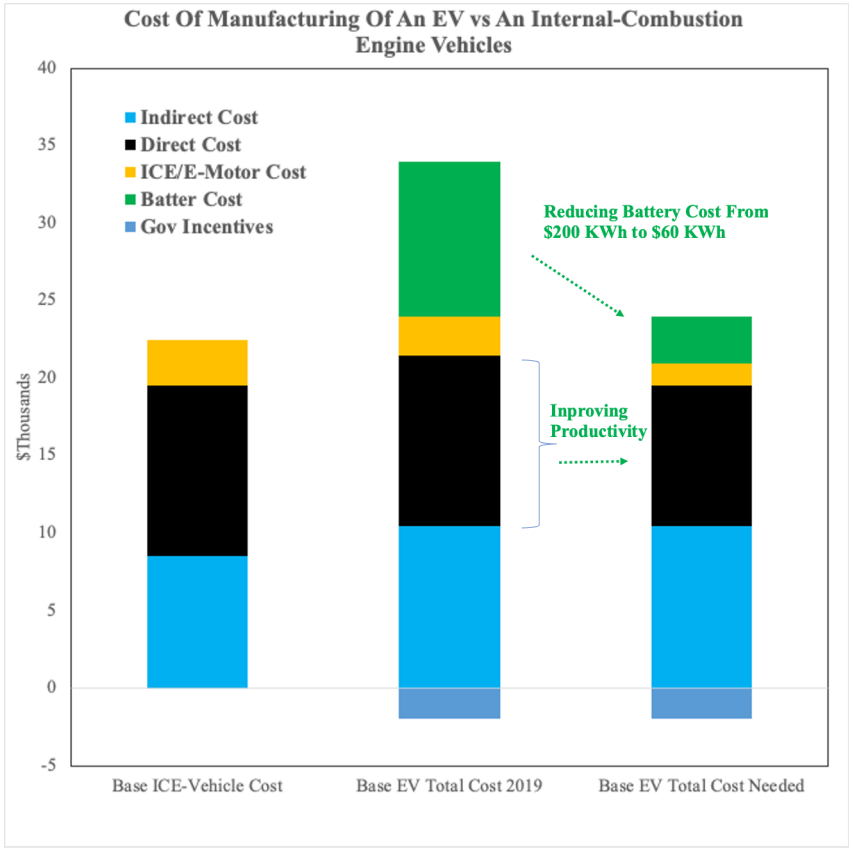
EV Sales Needs To Grow Quickly To Get To Net-Zero By 2050, Problem Is EVs Are Too Expensive To Produce…

The Benchmark For Net-Zero Is EVs Represent 30% of Sales By 2030



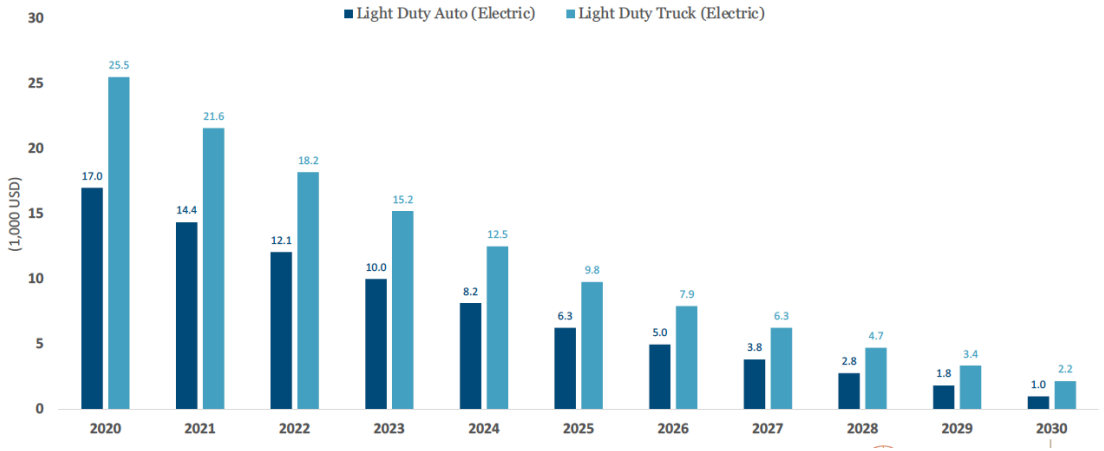
Producers Cannot Make A Profit On EVs Because Of Battery Costs



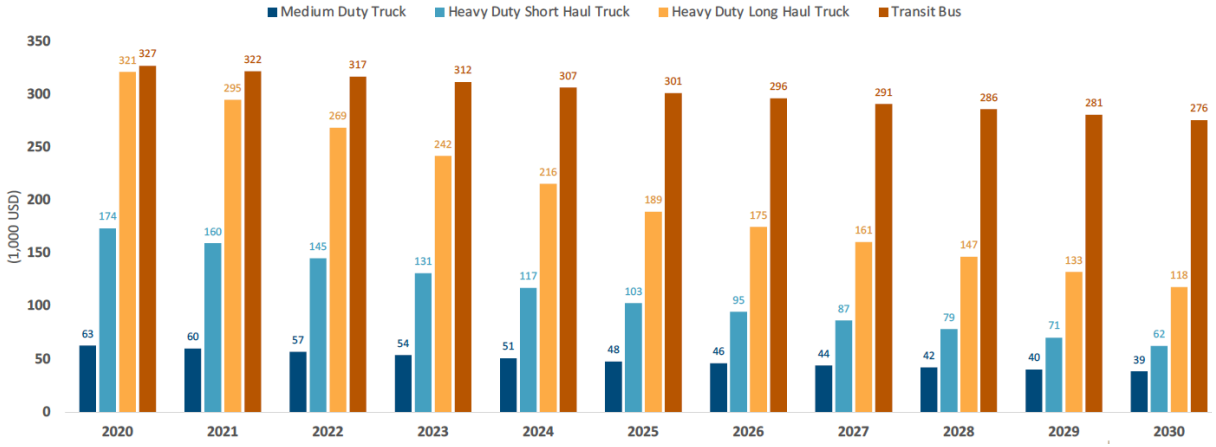
1.
2 McKinsey Center for Future Mobility, "Making electric vehicles profitable" , March 2019

Step 2: Fundamental Economic Framework

Electric Vehicles Are Still Not Cost Competitive With ICE Vehicles, But When Then Are……



Per vehicle upfront cost difference (2016$)
Electric vs. Reference Gasoline Vehicle



Per vehicle upfront cost difference (2016$)
Electric vs. Reference Diesel Vehicle

1. E. Larson, C. Greig, J. Jenkins, E. Mayfield, A. Pascale, C. Zhang, J. Drossman, R. Williams, S. Pacala, R. Socolow, EJ Baik, R. Birdsey, R. Duke, R. Jones, B. Haley, E. Leslie, K. Paustian, and A. Swan, Net-Zero America: Potential Pathways, Infrastructure, and Impacts, interim report, Princeton University, Princeton, NJ, December 15, 2020.

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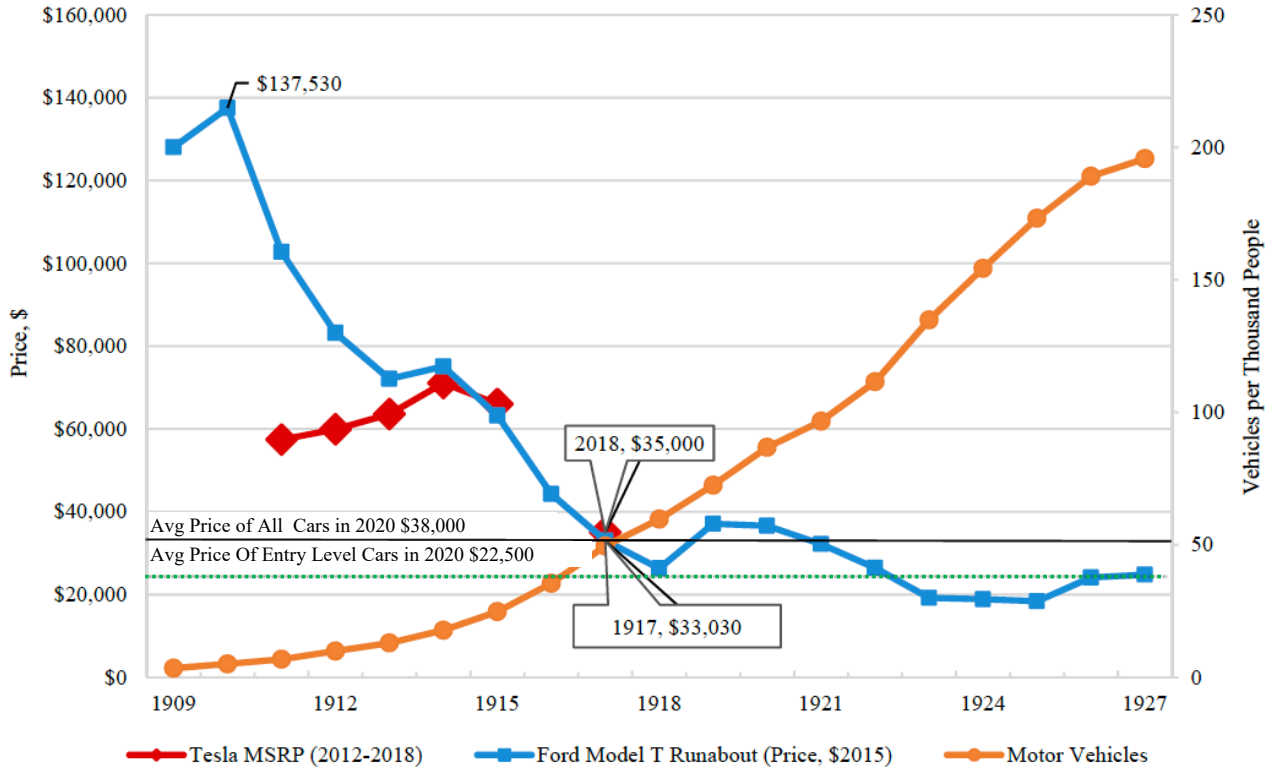
Electric Vehicles Demand Could Follow The Path of The Model-T

Price Adjusted Value of the Model-T with Todays Vehicles Suggest The Ramp To Wide Scale Adoption Is Not That Far Away

Figure 8: Electric and Motor Vehicles Adoption and Prices



1. Cherif, et al, " Riding the Energy transition: Oil Beyond 2040", IMF working paper, 12/120, May 2017

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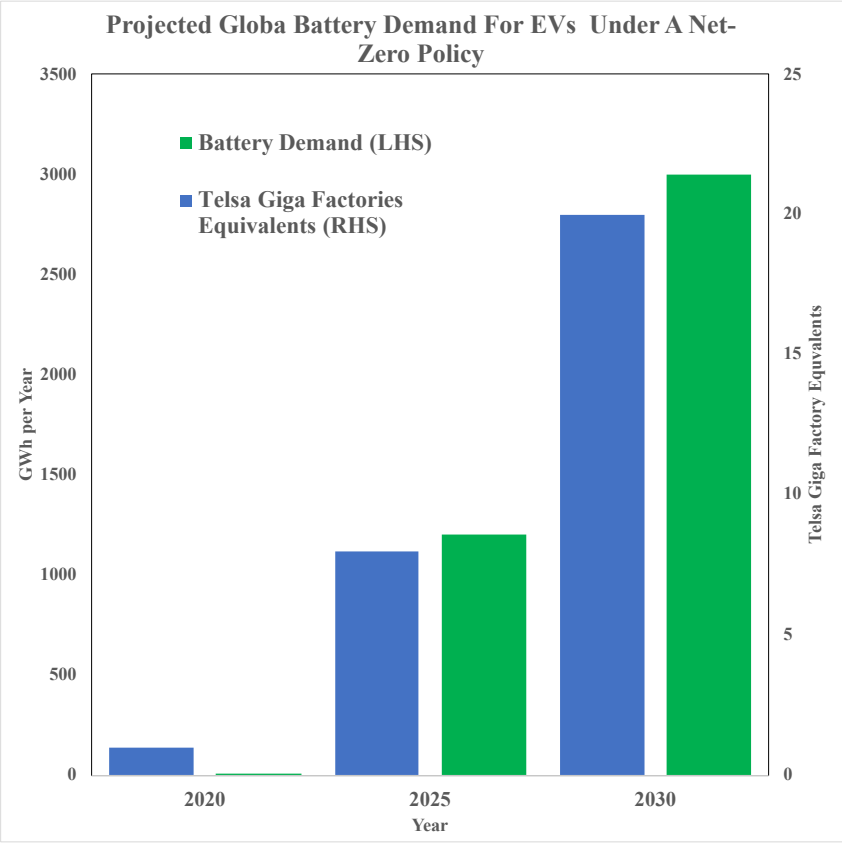
Battery Supply Will Need To Grow Substantially While Getting Cheaper

World Demand For Lithium EV Batteries Will Growth 20x Net 10 years



A Giga Factory Is Huge, Think of Building Two A Year For Ten years

1. Xu, C., Dai, Q., Gaines, L. *et al.* Future material demand for automotive lithium-based batteries. *Commun Mater* **1**, 99, 2020.
2. Tesla

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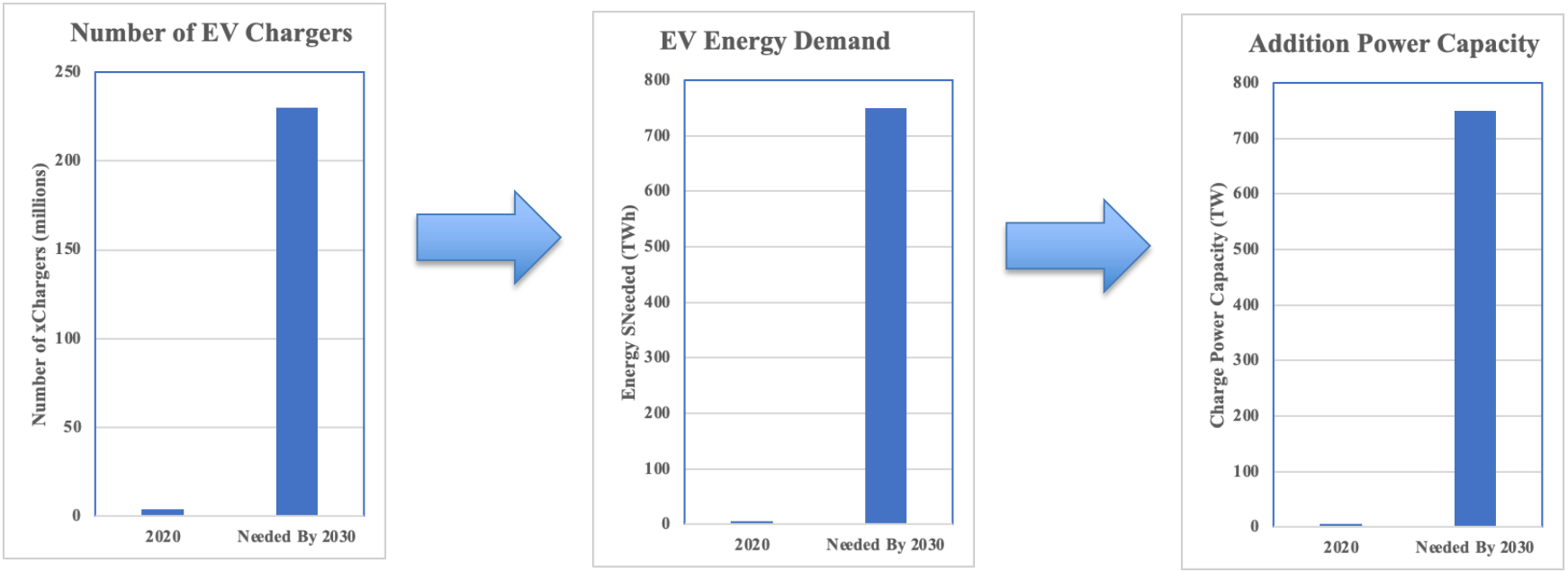
Scaling Up EV Stock Means Scaling Up Infrastructure And Electrical Generation Capacity Based On RE



1. IEA

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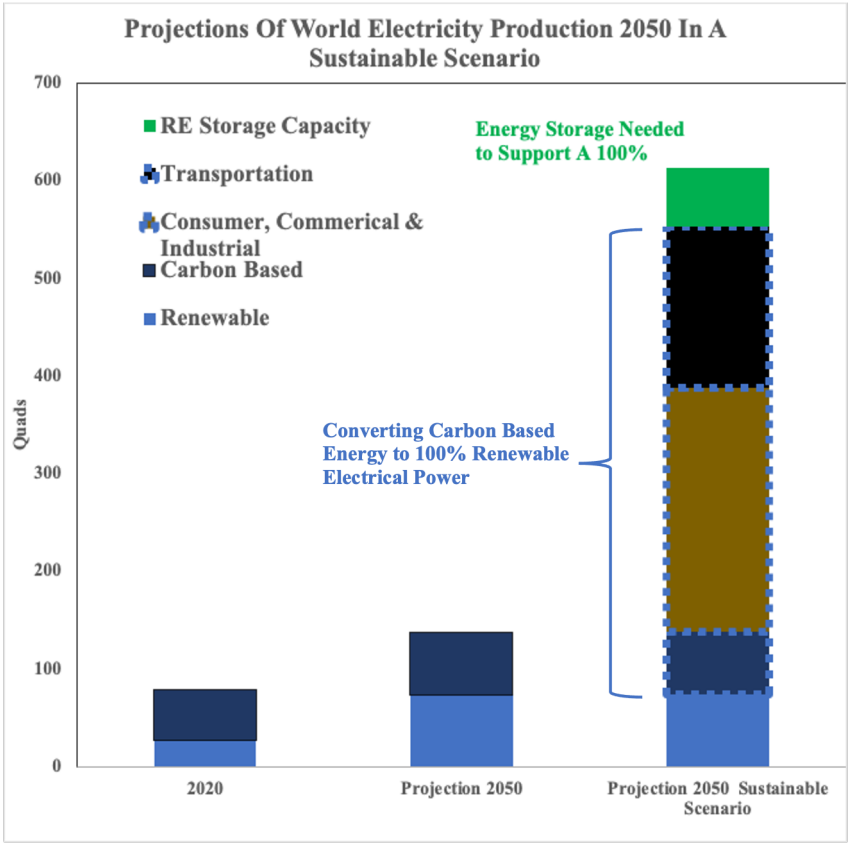
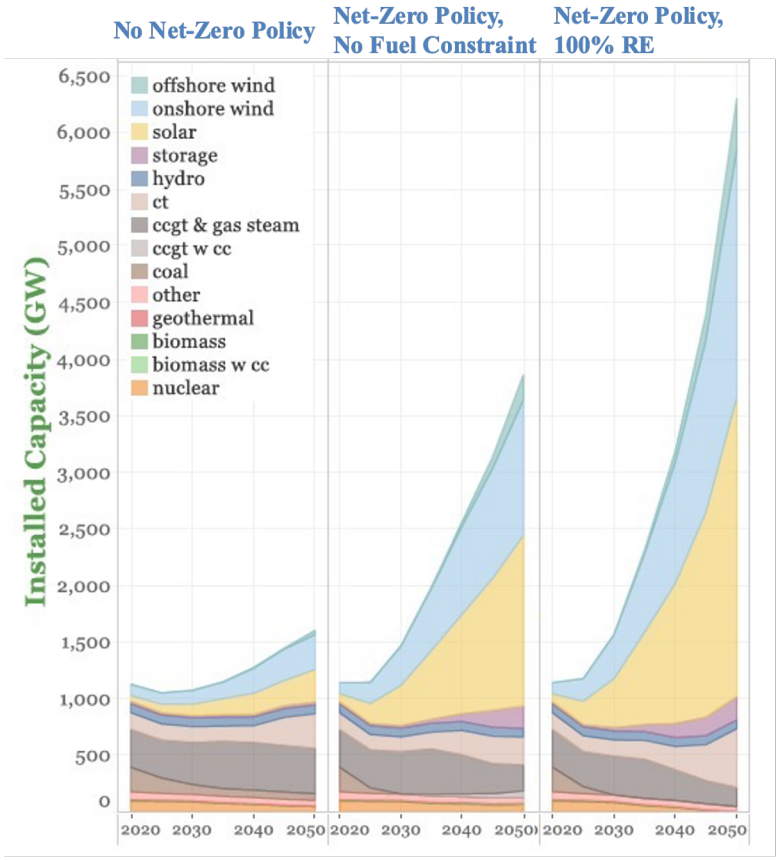
Net-Zero Means Almost All Energy Will Come From Expanding RE Electricity Exponentially

Net-Zero Mean Electricity Generation Capacity Needs To Grow



Growing It With 100% RE Electricity Means Even More Capacity



1

2. E. Larson, C. Greig, J. Jenkins, E. Mayfield, A. Pascale, C. Zhang, J. Drossman, R. Williams, S. Pacala, R. Socolow, EJ Baik, R. Birdsey, R. Duke, R. Jones, B. Haley, E. Leslie, K. Paustian, and A. Swan, Net-Zero America: Potential Pathways, Infrastructure, and Impacts, interim report, Princeton University, Princeton, NJ, December 15, 2020.

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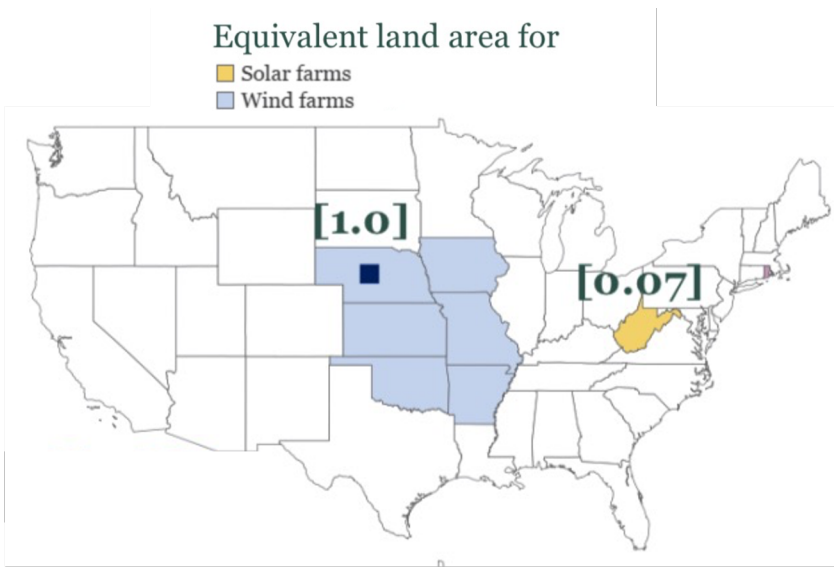
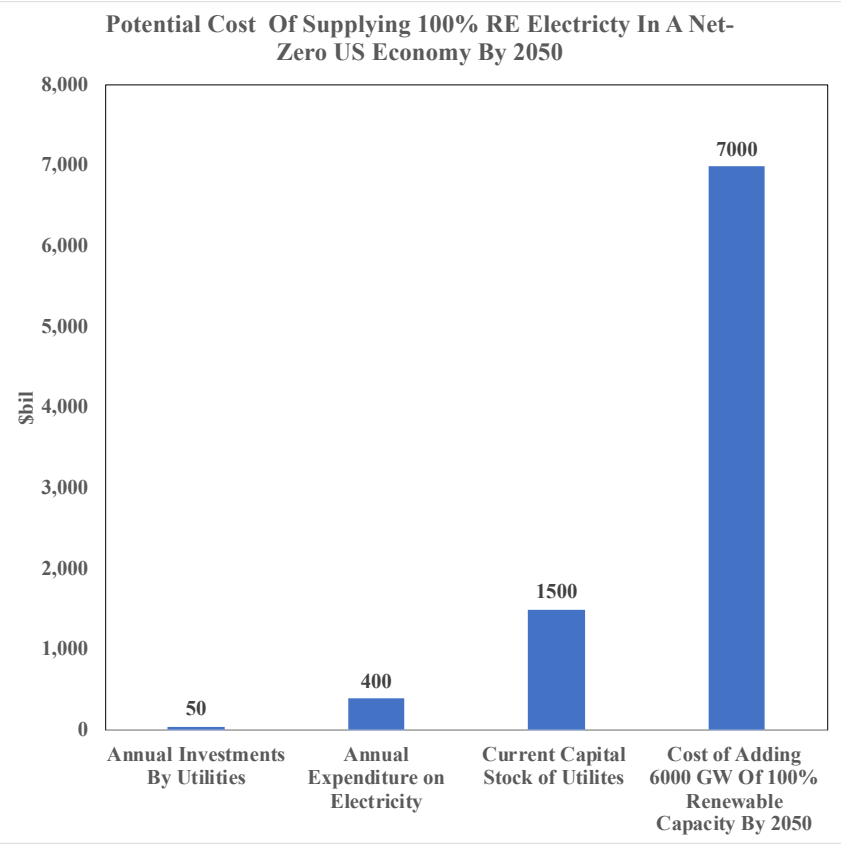
The Scale of Investment Needed To Implement A Net-Zero Policy For The US is Daunting

Land Area For New Wind Farms Is About the Area Of The Midwest



And Investment Of Than 7x The Capital Stock Of The Utility Sector



1. E. Larson, C. Greig, J. Jenkins, E. Mayfield, A. Pascale, C. Zhang, J. Drossman, R. Williams, S. Pacala, R. Socolow, EJ Baik, R. Birdsey, R. Duke, R. Jones, B. Haley, E. Leslie, K. Paustian, and A. Swan, Net-Zero America: Potential Pathways, Infrastructure, and Impacts, interim report, Princeton University, Princeton, NJ, December 15, 2020.
2. BEA
3. Aurthor's calculation using $1 billion per GW of capacity and $500 billion of transmission infrastructure

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Next

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