

ENERGY DISRUPTIONS: ASPIRATIONS vs REALITIES



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Demand Disruptions 'Hidden' In Four Big Questions

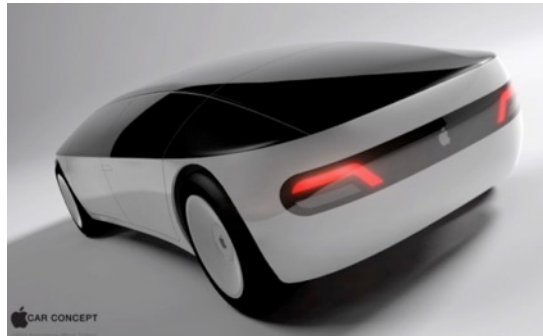
What happens when ...

- **World adds 1 billion cars & batteries don't beat barrels ?**
- **Digital infrastructures consume more energy than Japan ?**
- **Millennials buy homes & U.S. factories return ?**
- **World economy grows & hydrocarbon demand doubles?**

1. Cars – Big Kahuna For Oil Demand

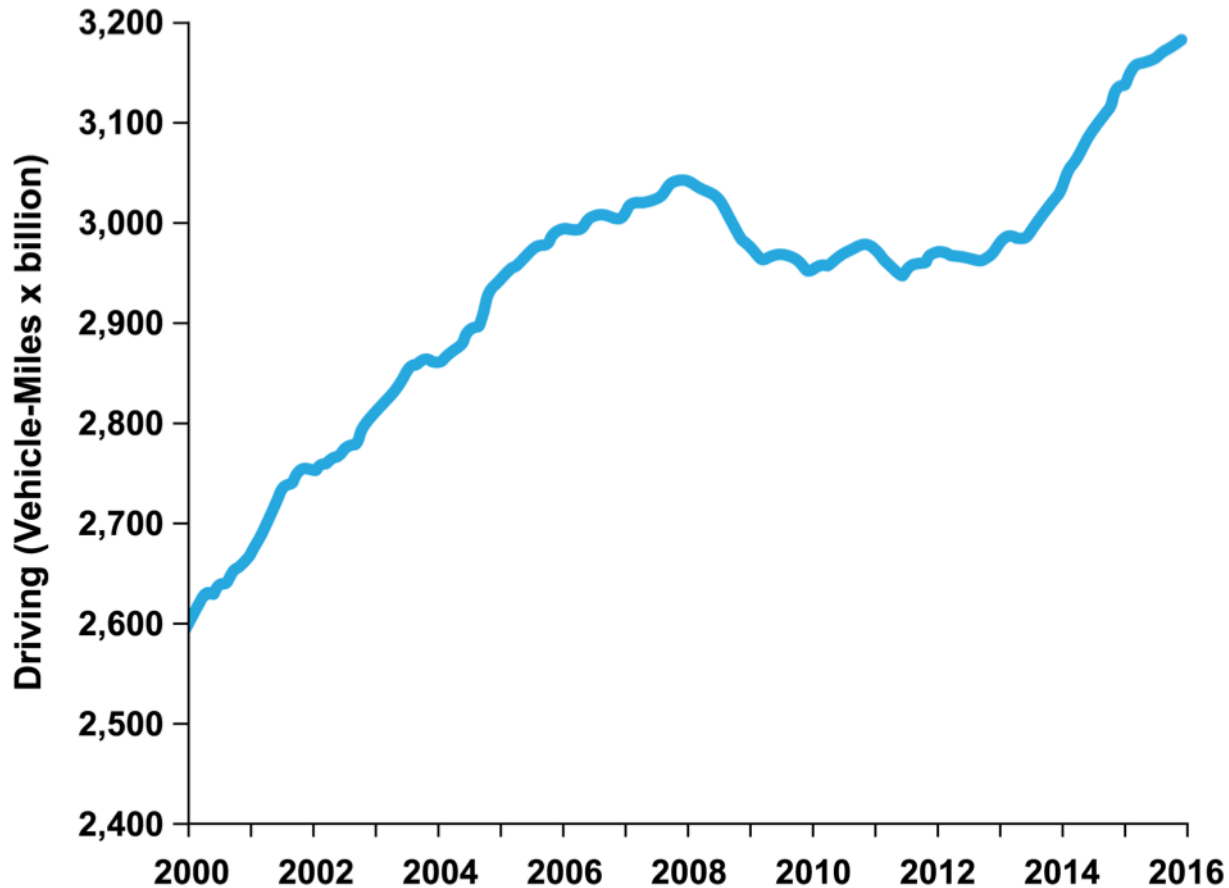
The future of personal transport

- **Fuel** because of Tesla
- **Ownership** because of Uber
- **Driving** because of Google



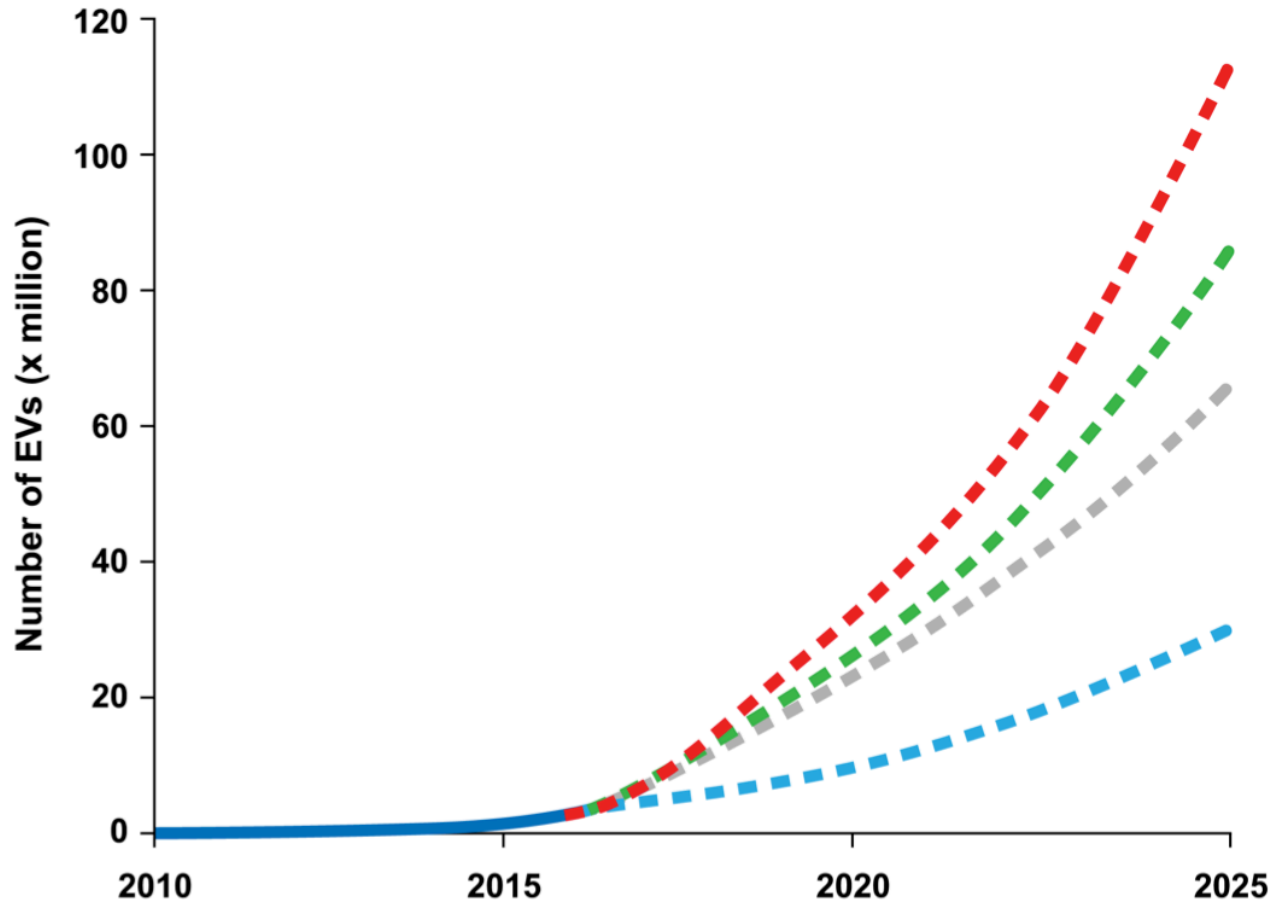
But First... Has U.S. Reached Peak Driving?

Annual U.S. Vehicle-Miles

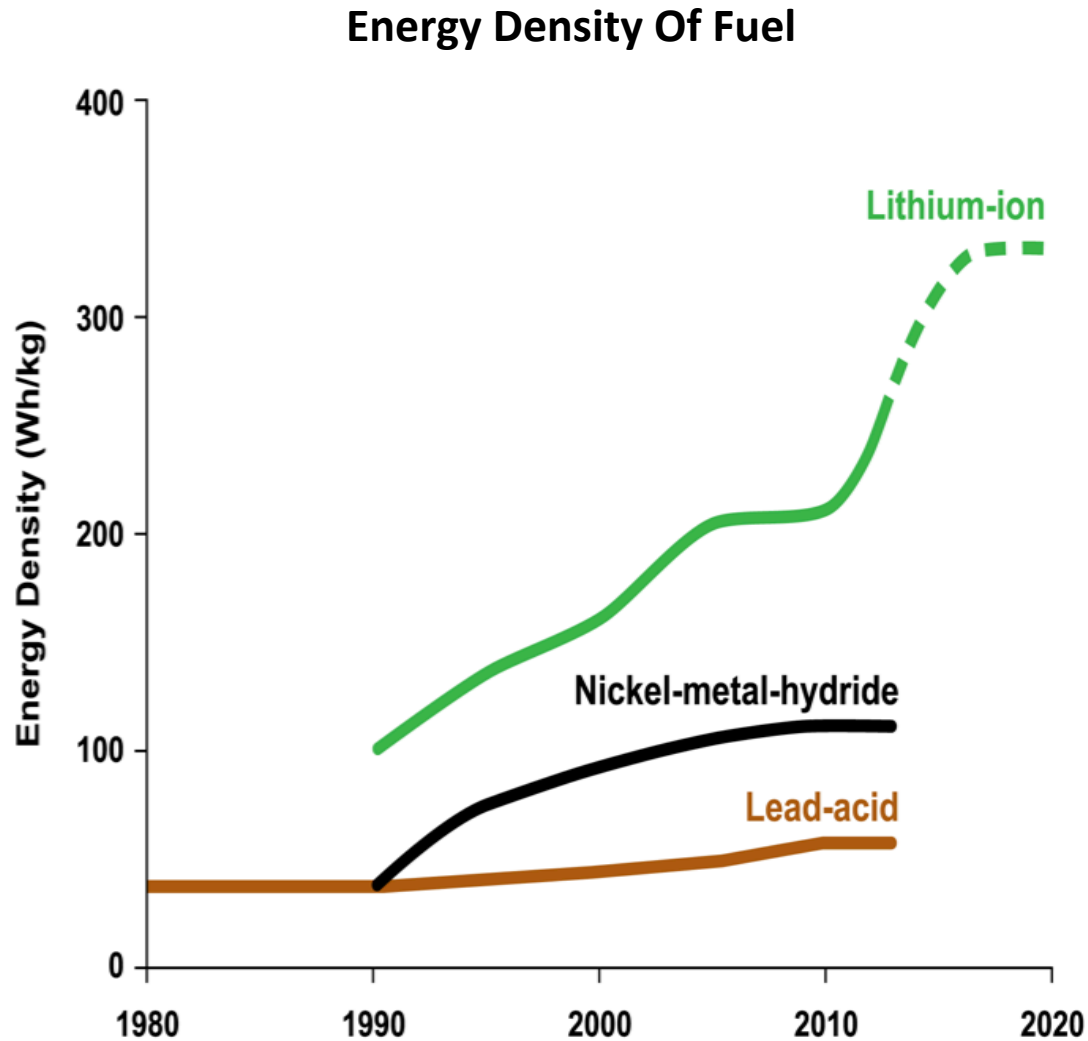


Tesla Effect: What If EV Optimists Are Right?

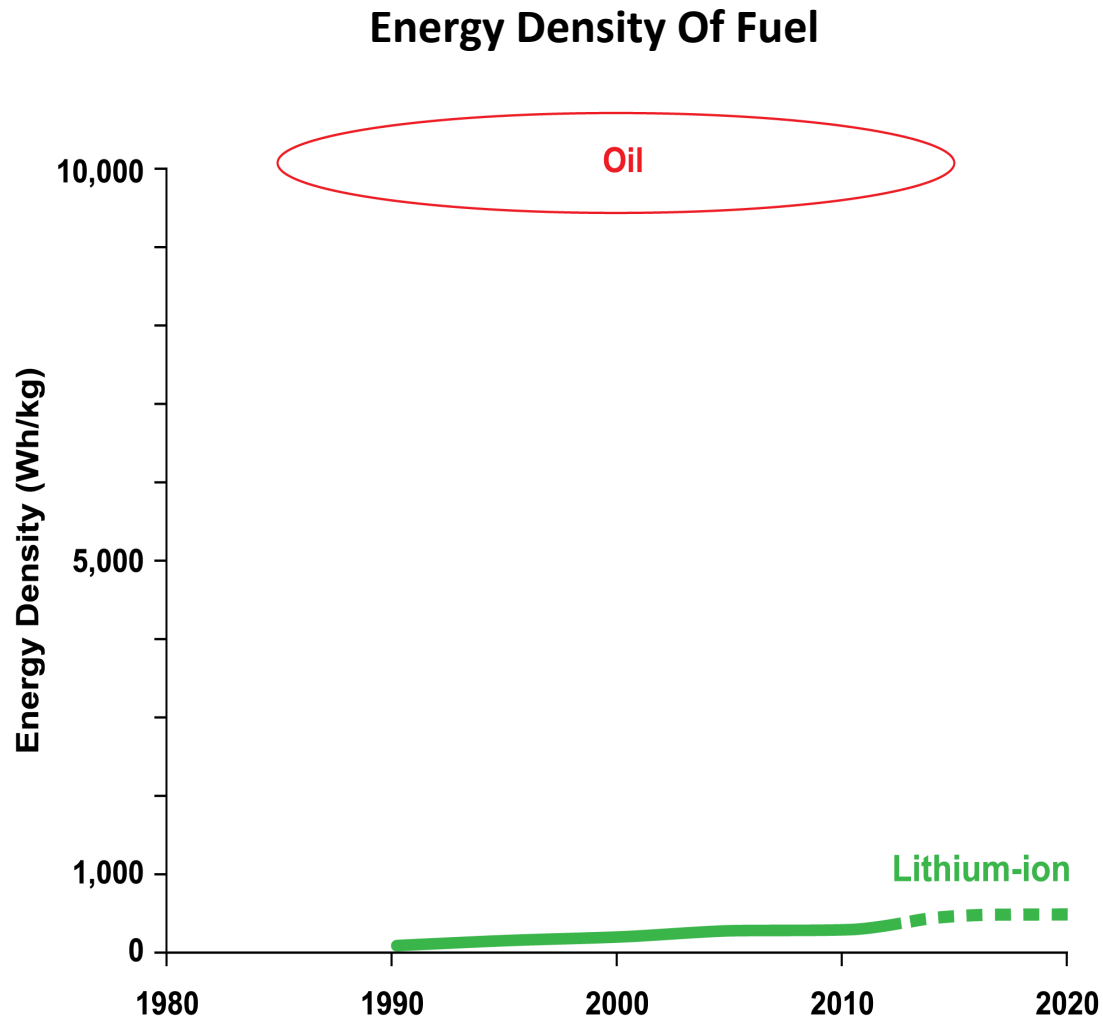
IEA Global EV Outlook



The Big Bet On Better Batteries

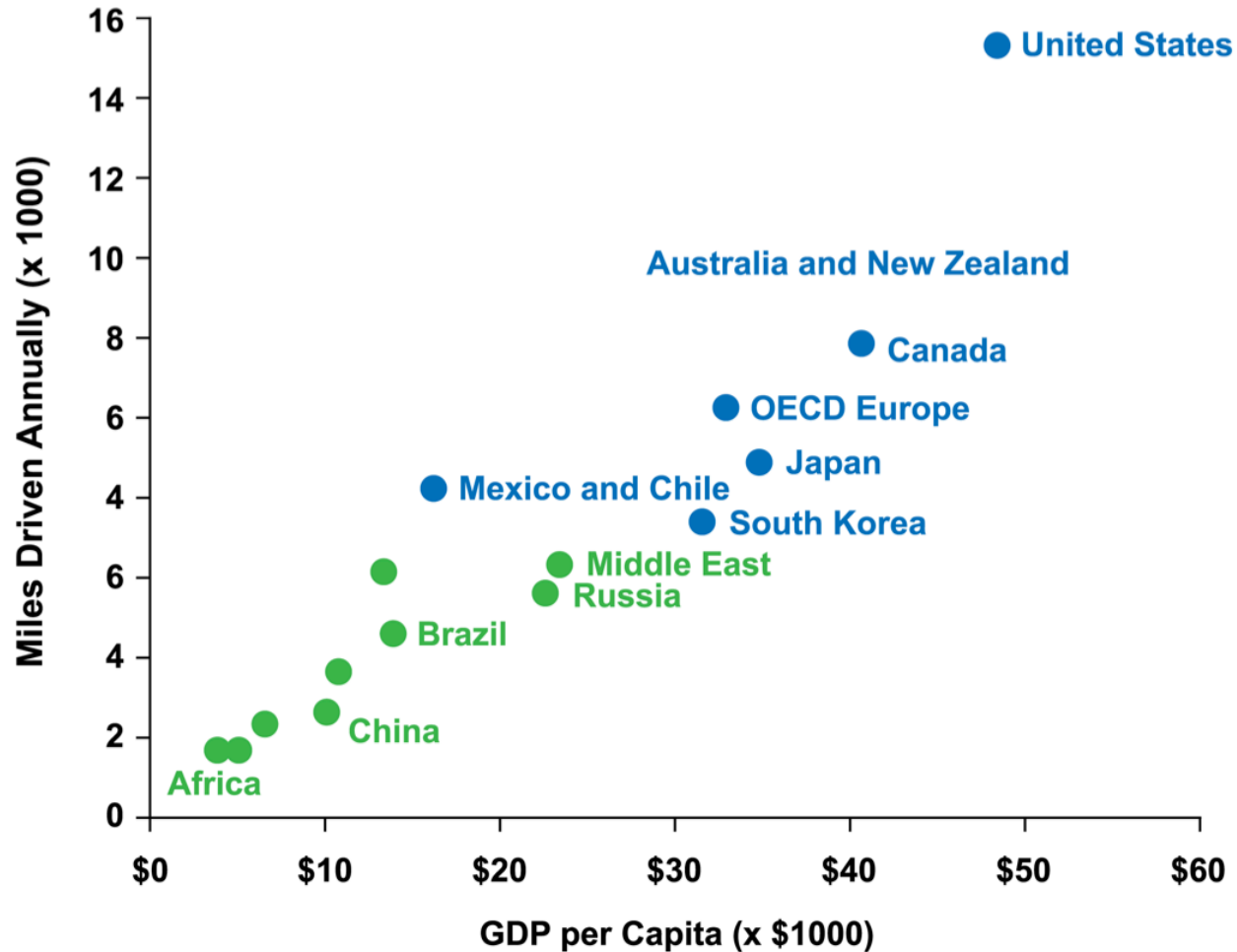


But... Batteries Will Never Get Good Enough



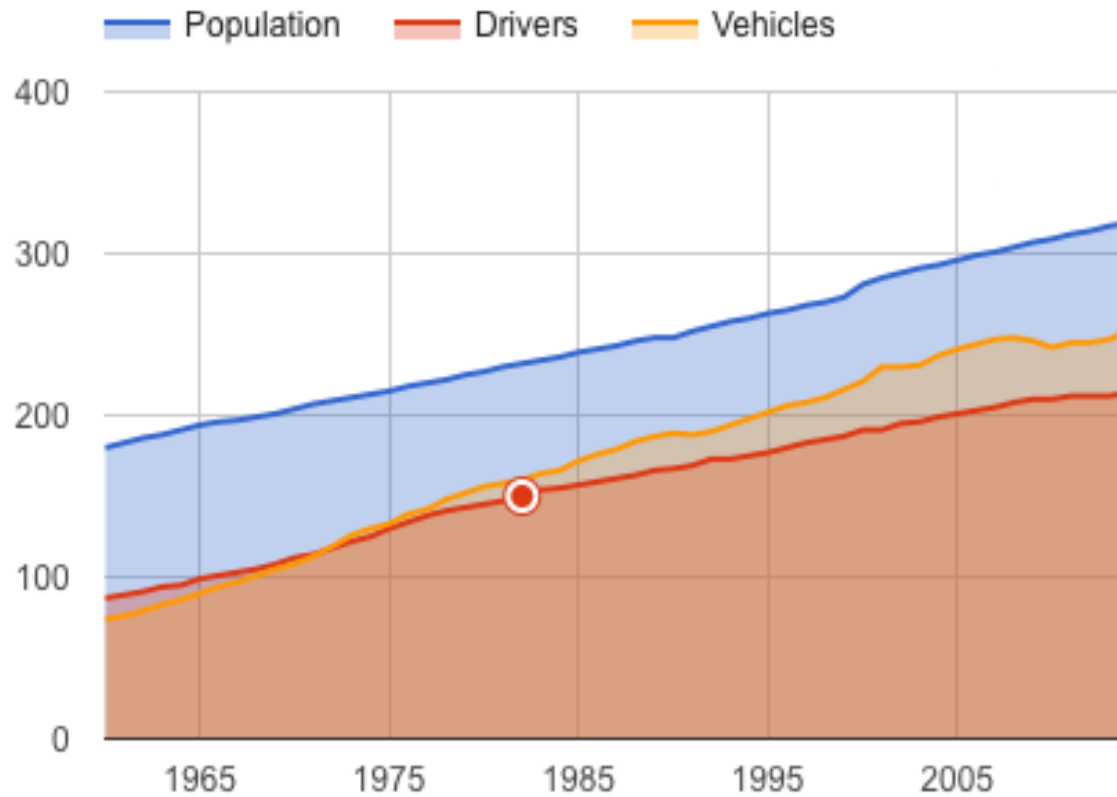
Uber Effect → Driving More Affordable

Wealth Increases Driving



Another Uber Effect → More Fun Cars

U.S. Population, Vehicles & Drivers (x 1 million)



Google Effect: Eternal Dream Of Self-Driving

The car of the future will have no such thing as a “driver’s seat.” Driving will be done from a small control board.”

January 5, 1918, Scientific American



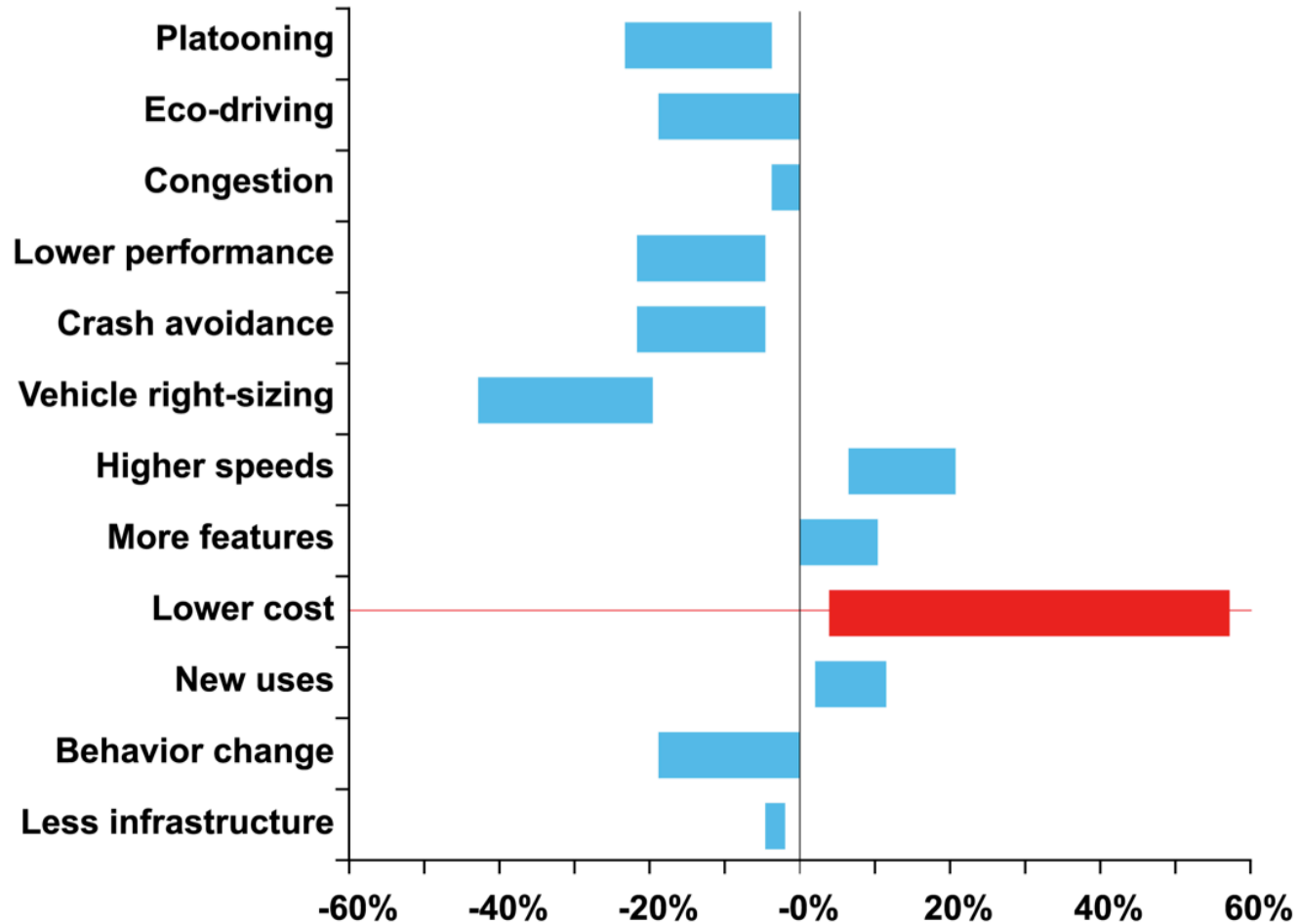
Eternal Dream ... Again

“You reach over to your dashboard and push the button marked ‘Electronic Drive.’...Fantastic? Not at all. The first long step toward ... was successfully illustrated by RCA ... on a public highway.”

October 10, 1957



Energy Impacts of Sharing & Robocars



Demand Wild Card: Amazon Drones & Uber Air

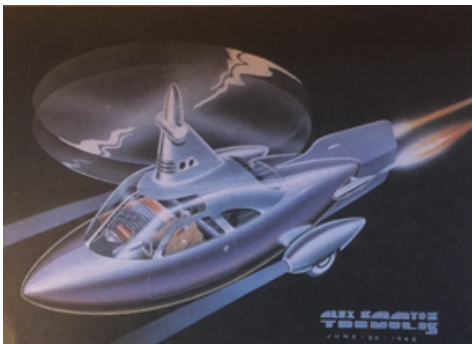
2017 Airbus Self-Flying Taxi



2016 China's Ehang

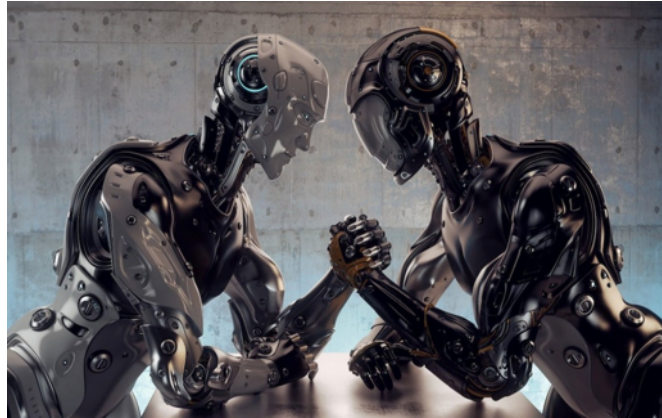


1944 Artist's Conception



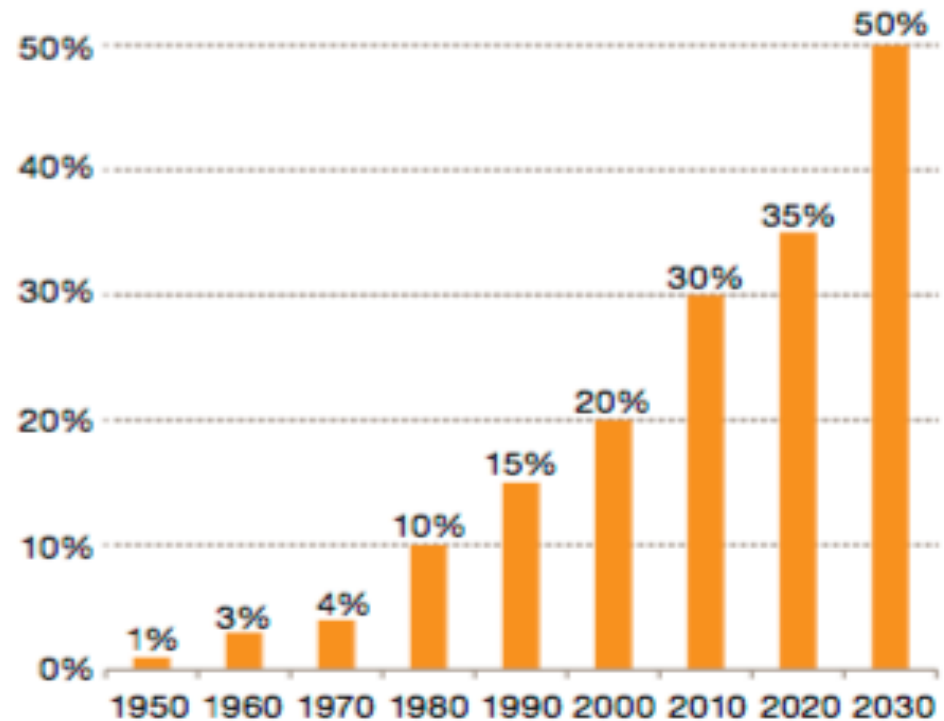
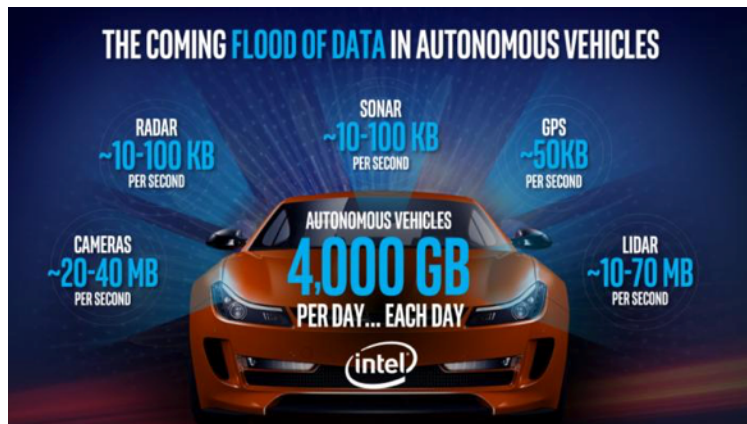
Eventual Google + Uber Effect → End Of Mass Transit

Robots vs. Subways & Buses



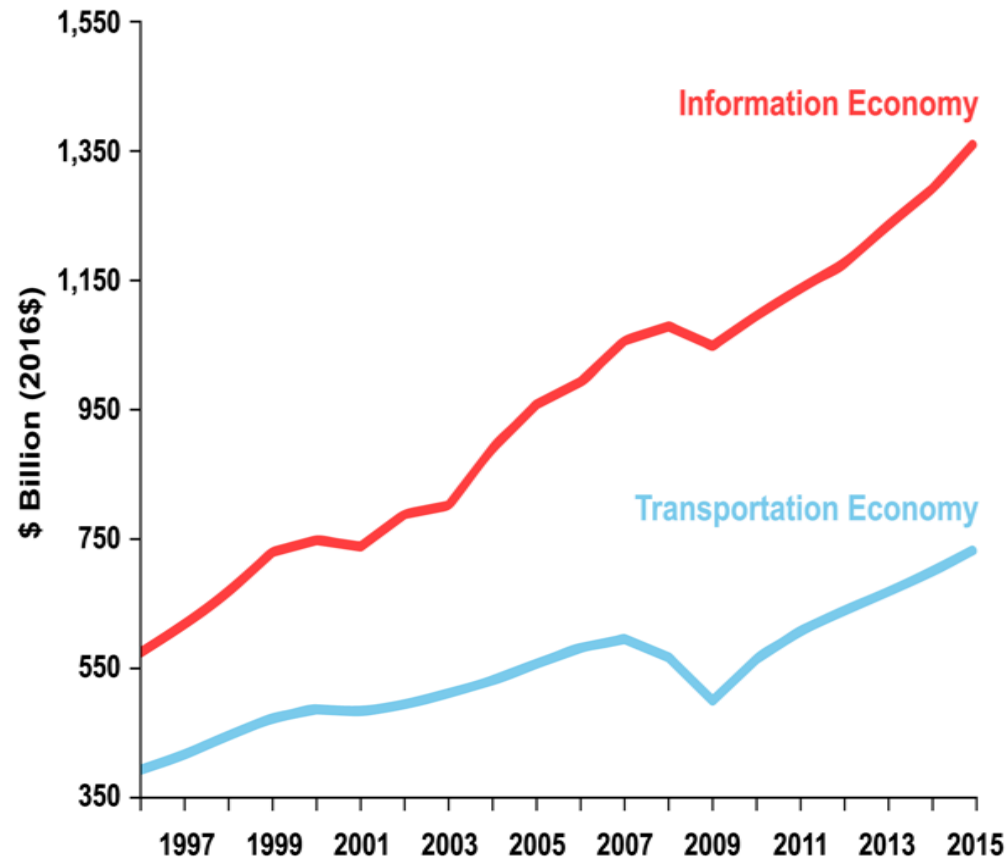
Real Google Effect ... Demand For Silicon & Data

Electronics Share Of Cost To Build A Car



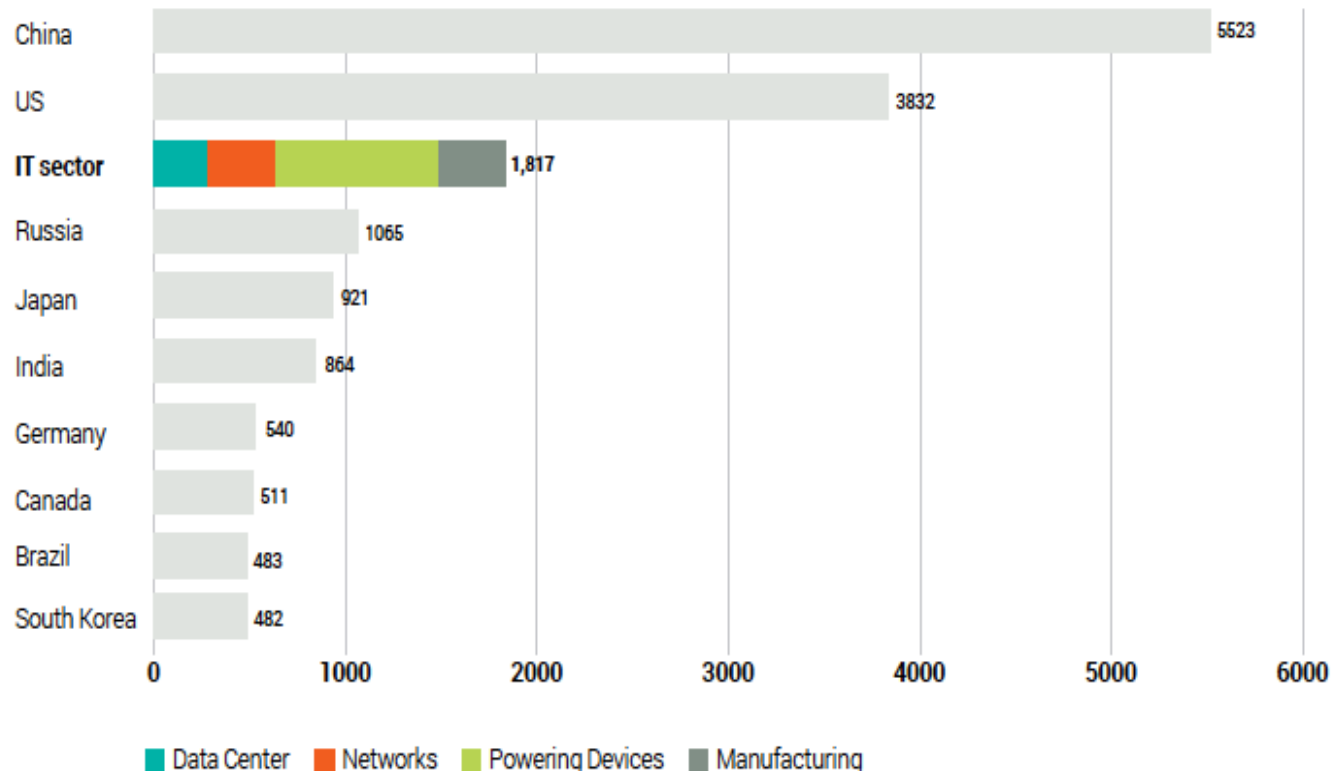
2. Energy Demand From The Digital Infrastructure

Share Of U.S. GDP



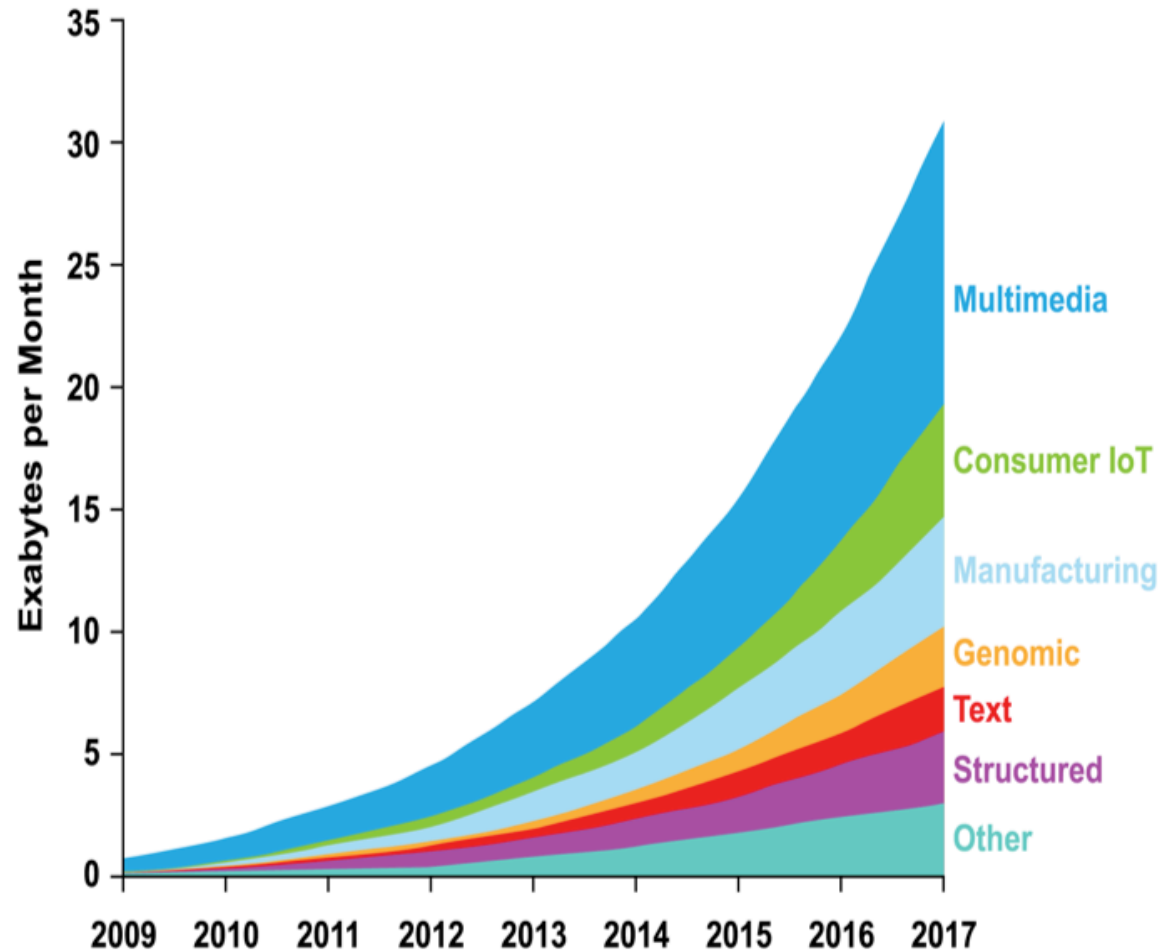
Electricity Demand: Countries vs The Cloud

Greenpeace “Clicking Green”
billion kWh/yr



Insatiable Demand For Bytes

Demand For Bytes Growing Exponentially In All Sectors

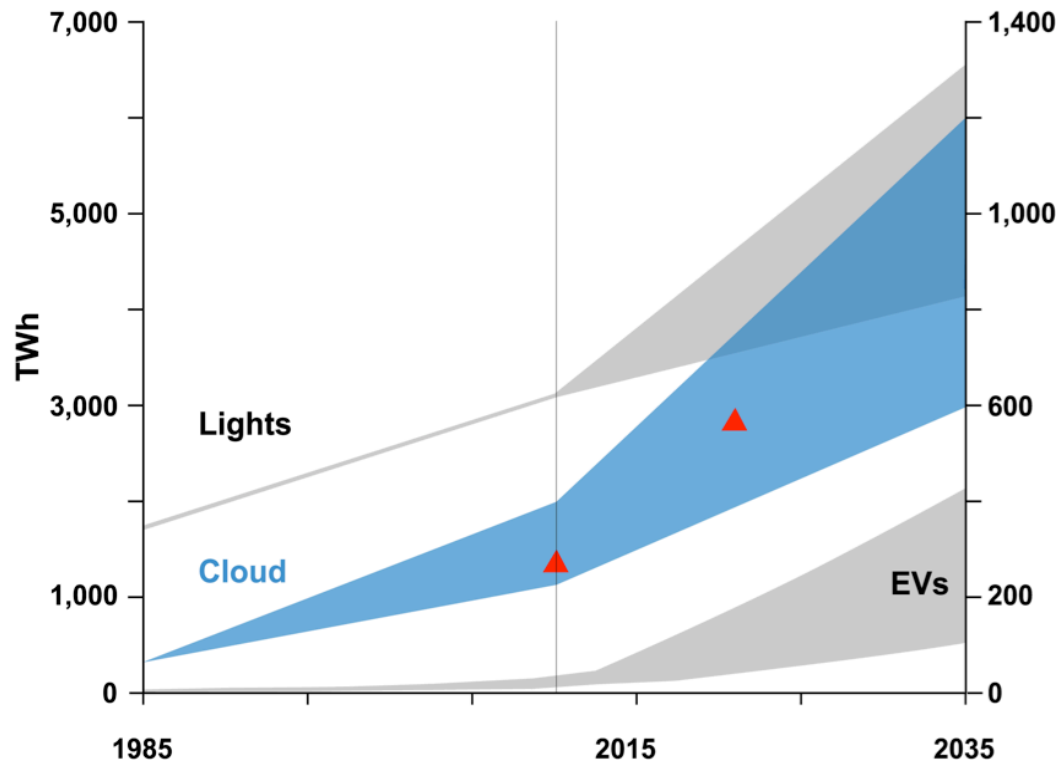


Ascendancy Of The 4th Energy Service

*“[A]s dependent as we are on communication technology,
we’re even more dependent on electricity.”*

Vinton Cerf, Google VP and Chief Internet Evangelist, 2016

Electricity Use: Cloud, Cars, Lights



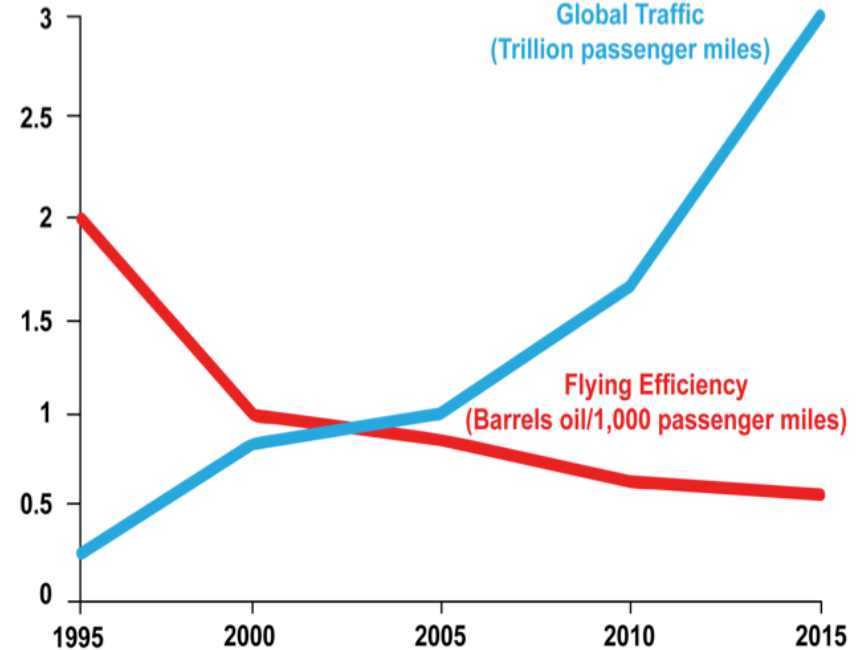
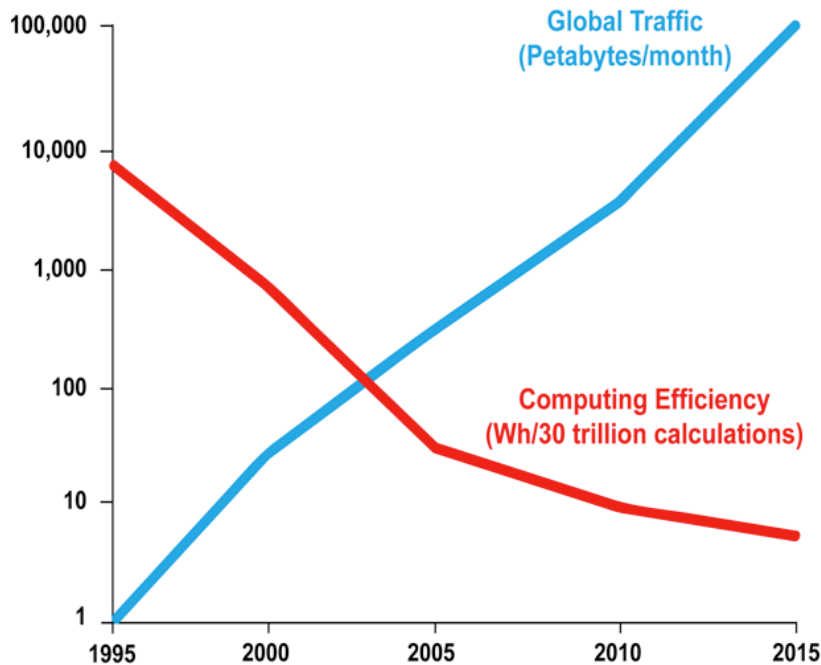
The Fallacy Of Efficiency As A Demand Killer

Efficiency Increases Demand

Computing Energy Efficiency Gains

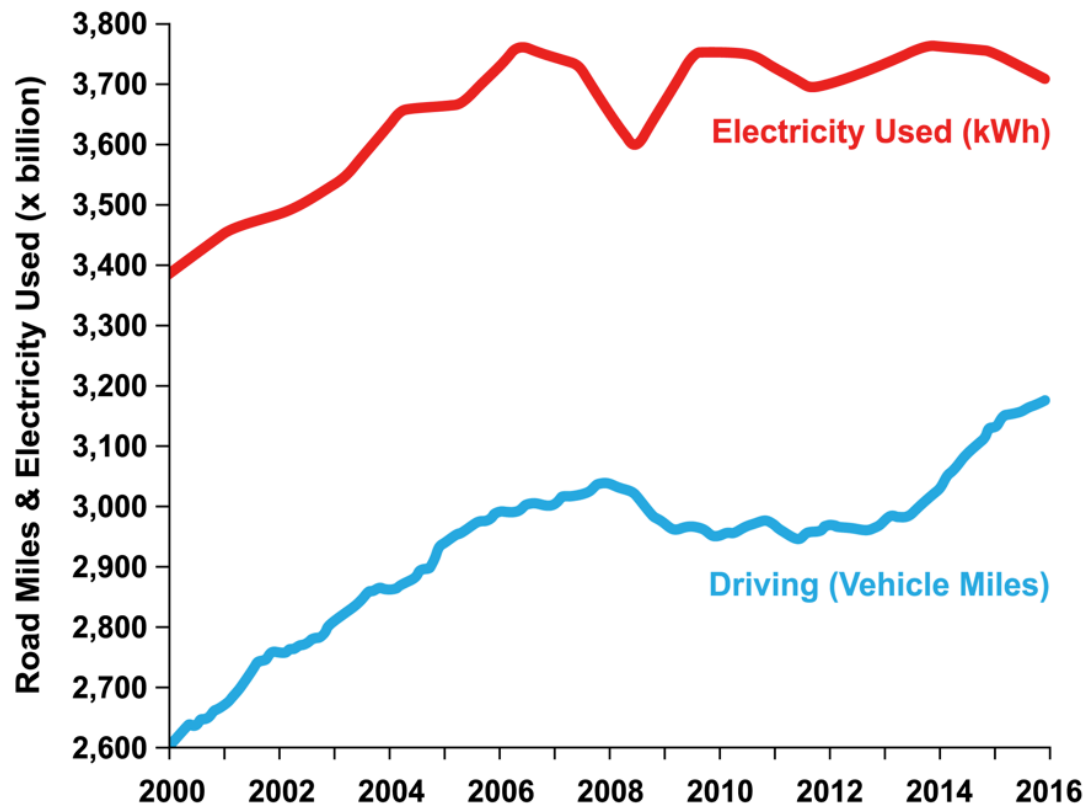


Echoes Aviation Trends



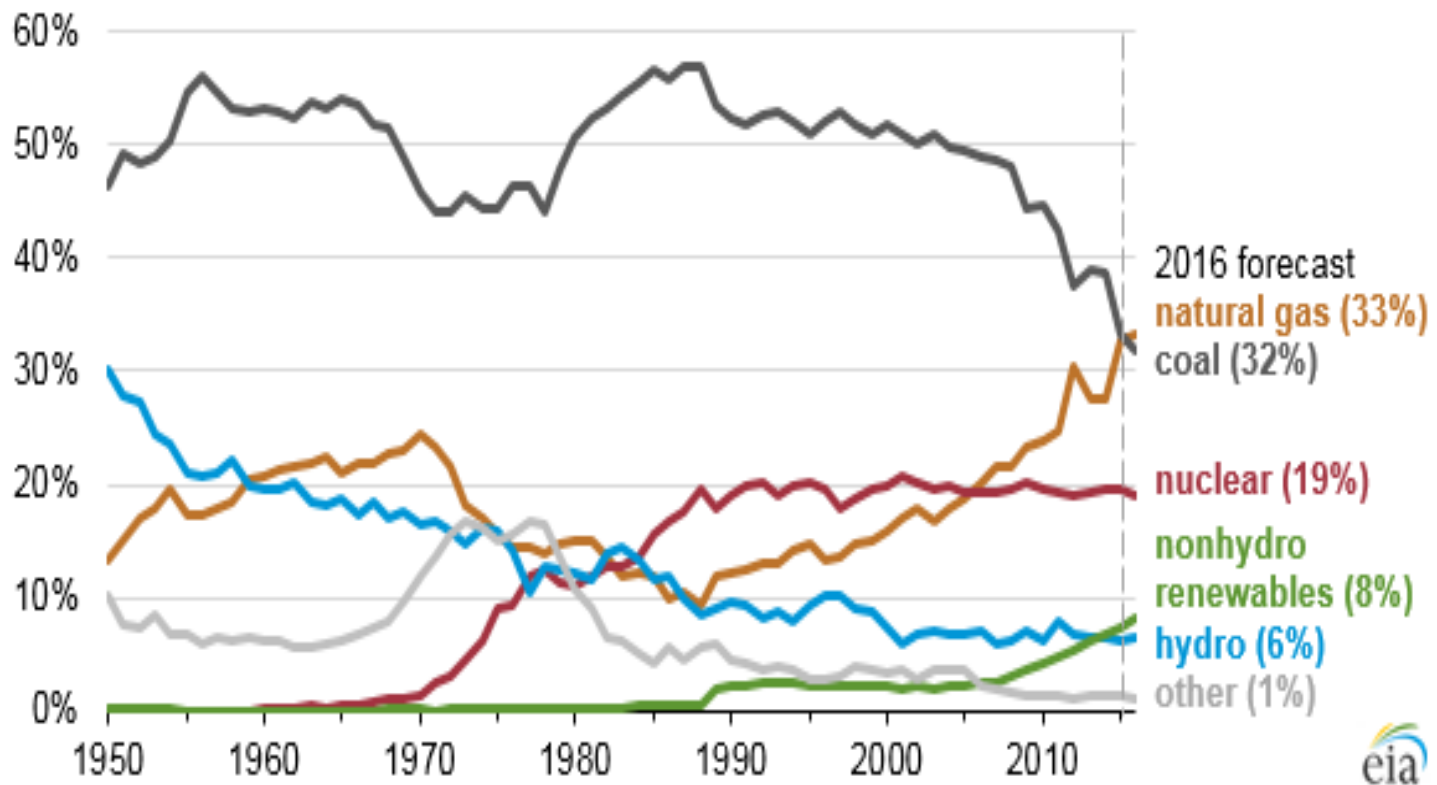
3. Are We At Peak Electricity Demand?

Confusing A Recession 'Effect' With A "New Normal"



Does Electric Demand Matter For Shale?

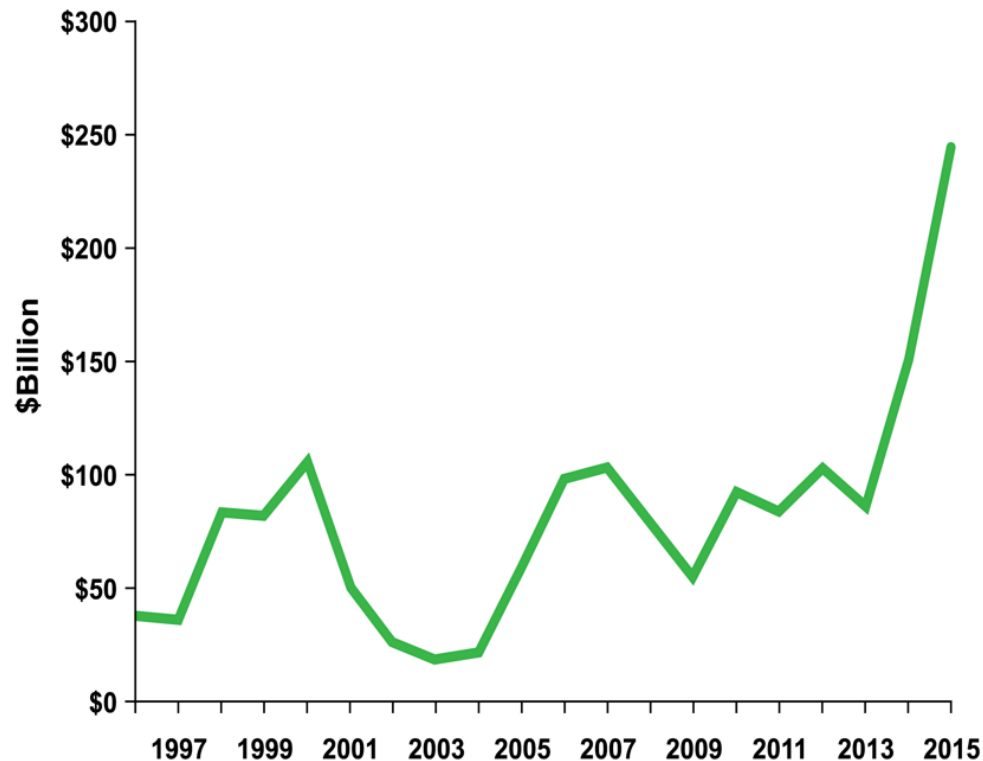
Share of U.S. Electric Supply



What Happens If Factories Get Built Again?

- **\$160B in 264 new chemical projects coming on line < 5 yrs**
American Chemistry Council

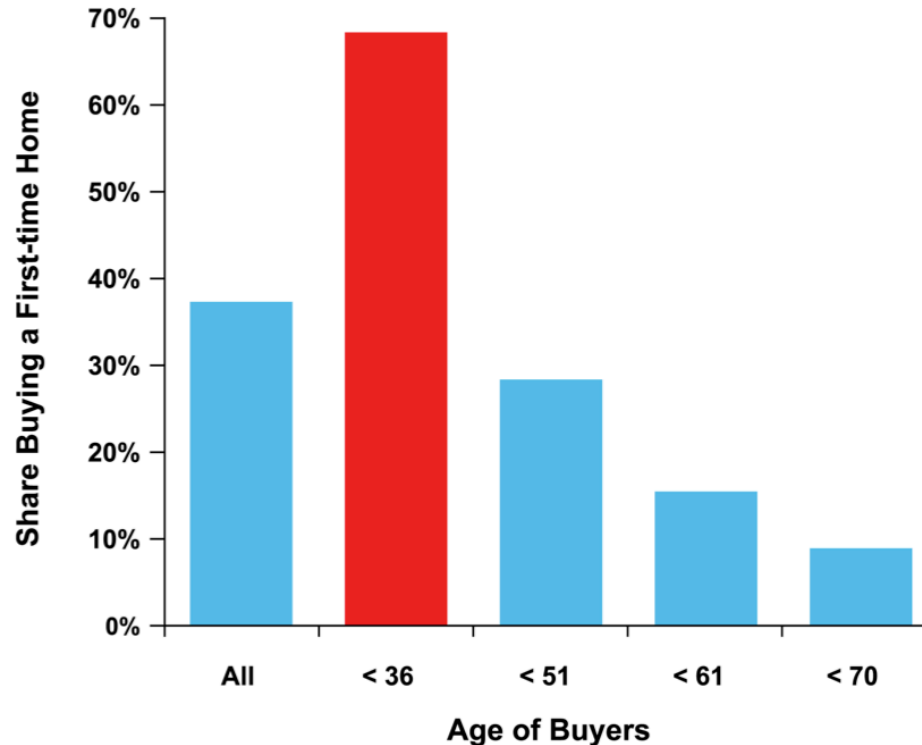
Foreign Direct Investment



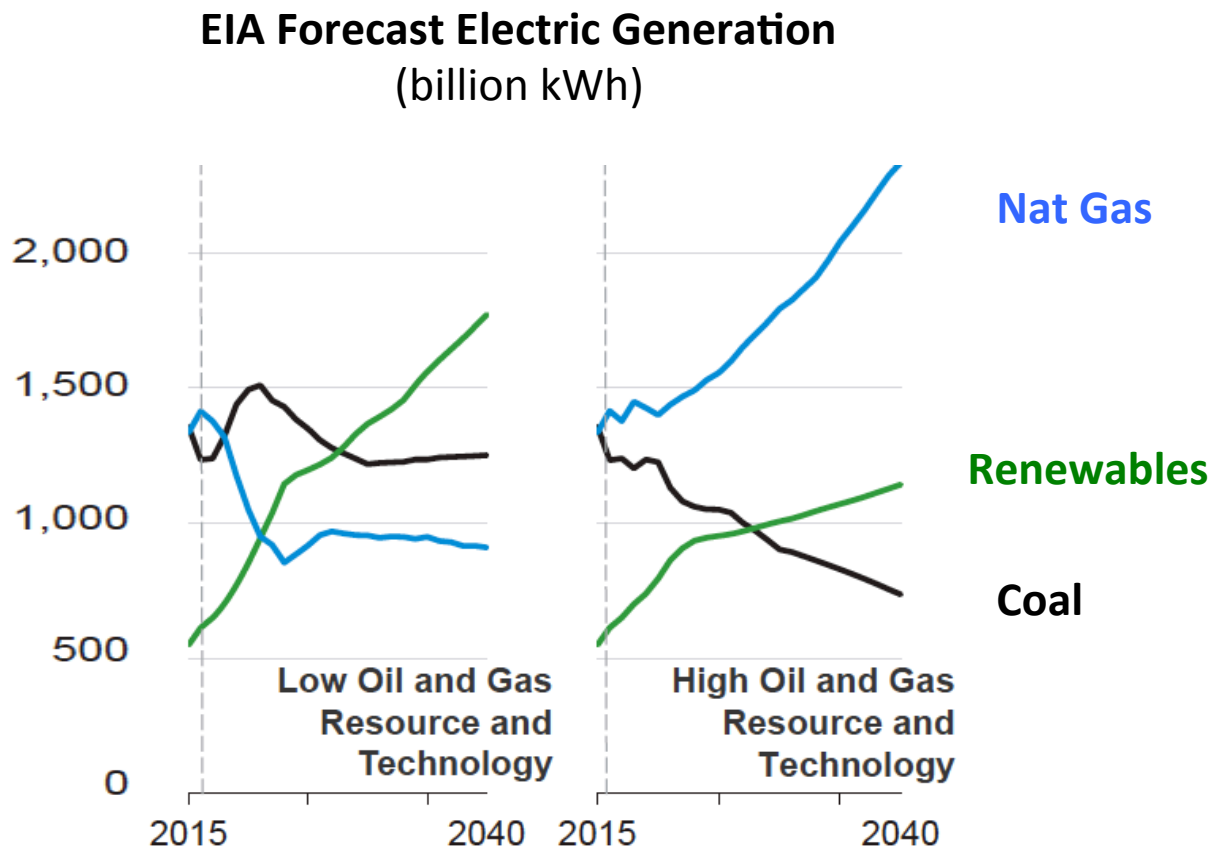
What If Millennials Buy (Big) Houses

- **4th** consecutive year Millennials largest group buying
- **1st** home 25% bigger than Boomers

First-Time Home Buyers

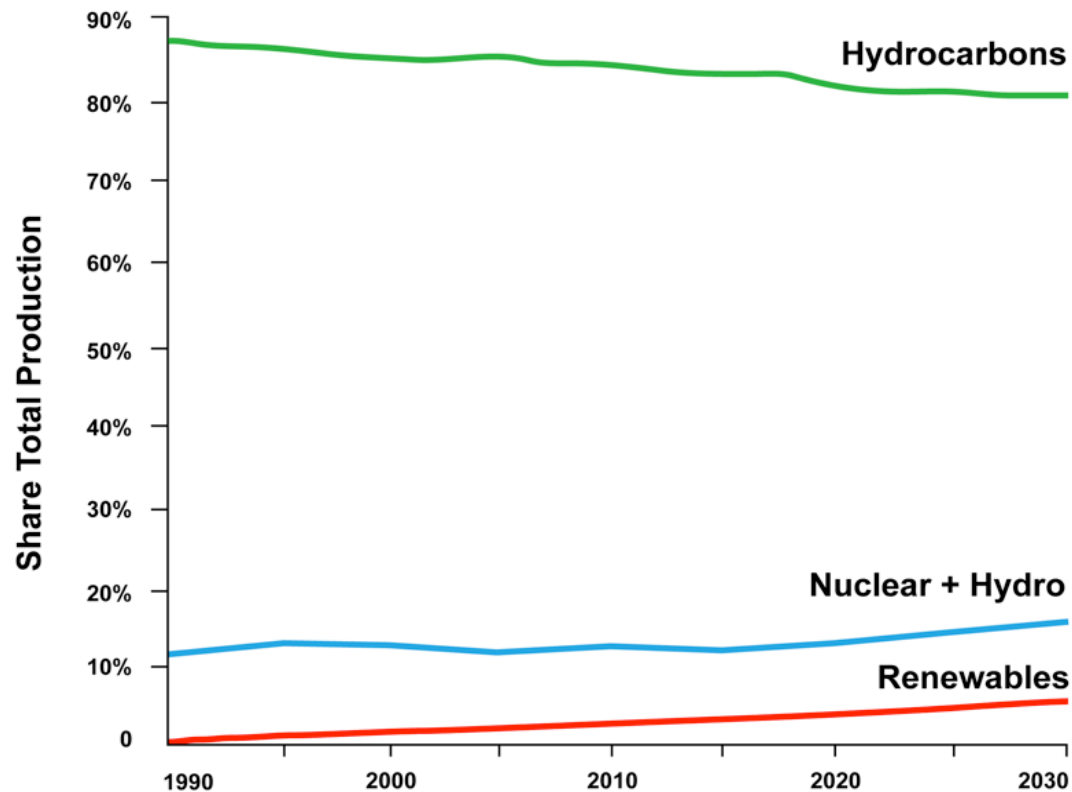


Future Gas Demand Depends On Technology



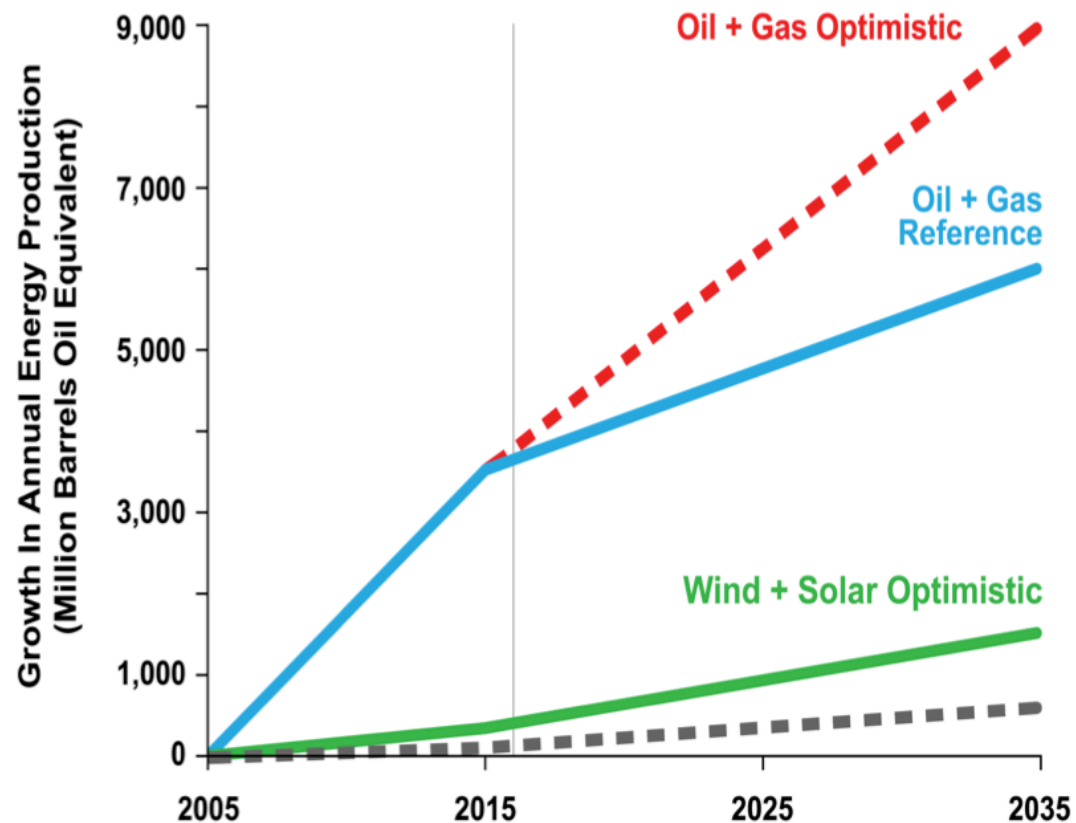
4. Global Energy Demand Disruption?

History & Future Of World Energy Demand



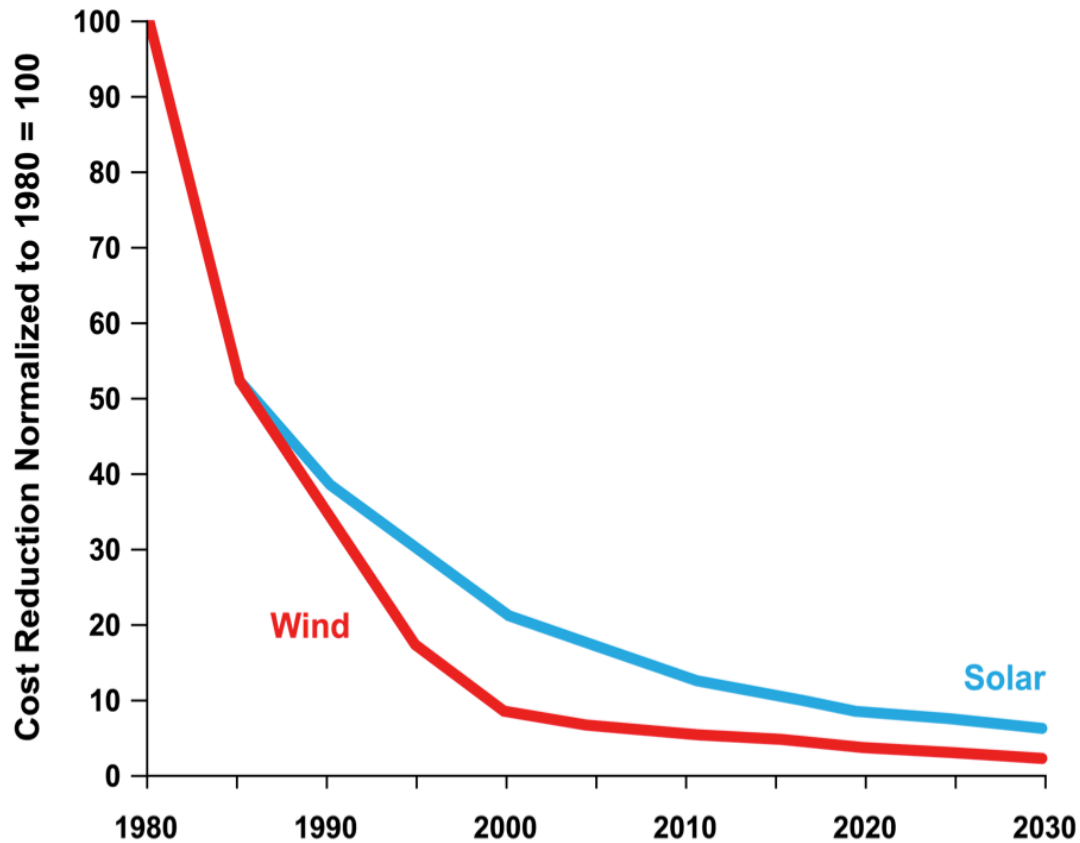
U.S. Energy Supply Disruption?

History & Forecast Growth In U.S. Energy Production



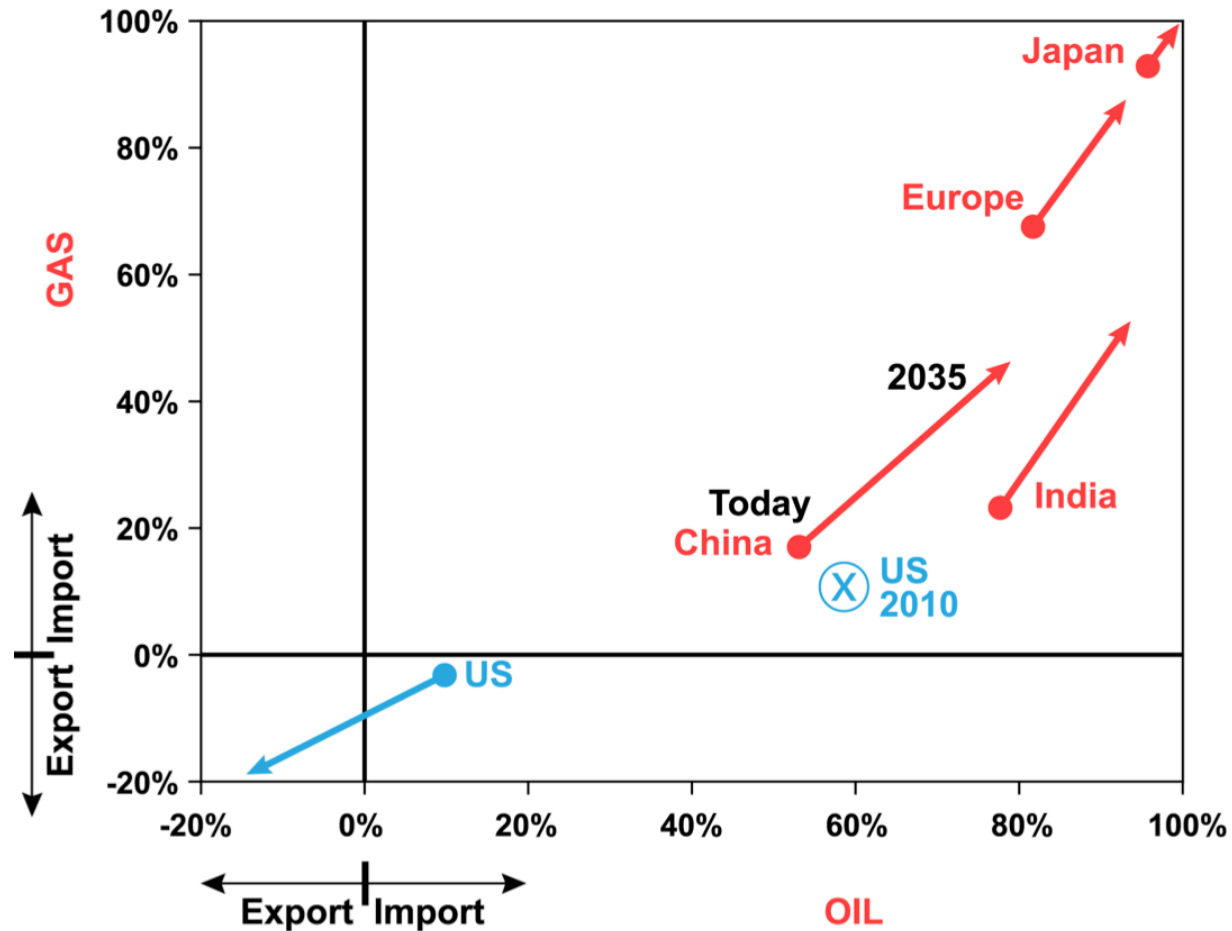
Technology: Green 2.0 vs Shale 2.0

On The Asymptote: Solar & Wind Technology Efficacy



Why Shale Matters

Global Energy Dependencies



But... The Public & Political Realities

PEW: Share Adults Saying Give Priority To Alternative vs Fossil Energy

