

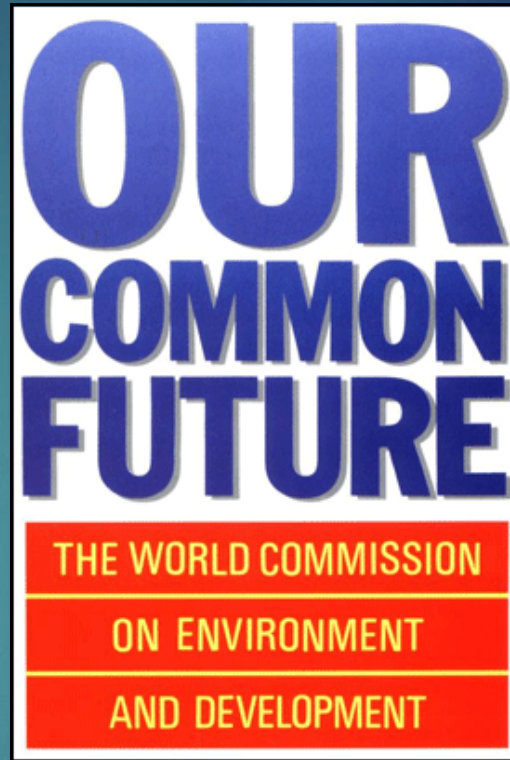
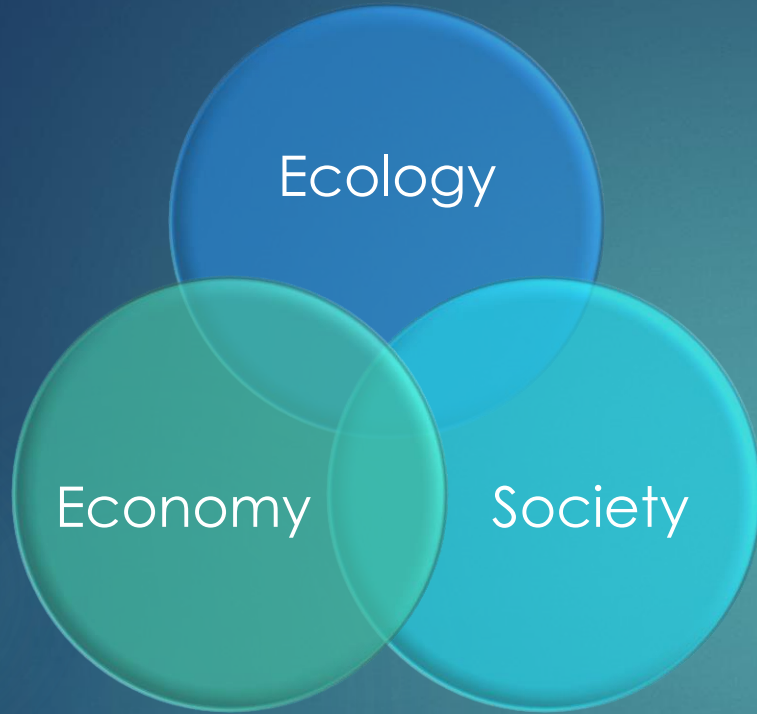


The Challenge of Sustainable Electricity

BRUCE LOURIE,

PLUG

OCTOBER 19, 2017



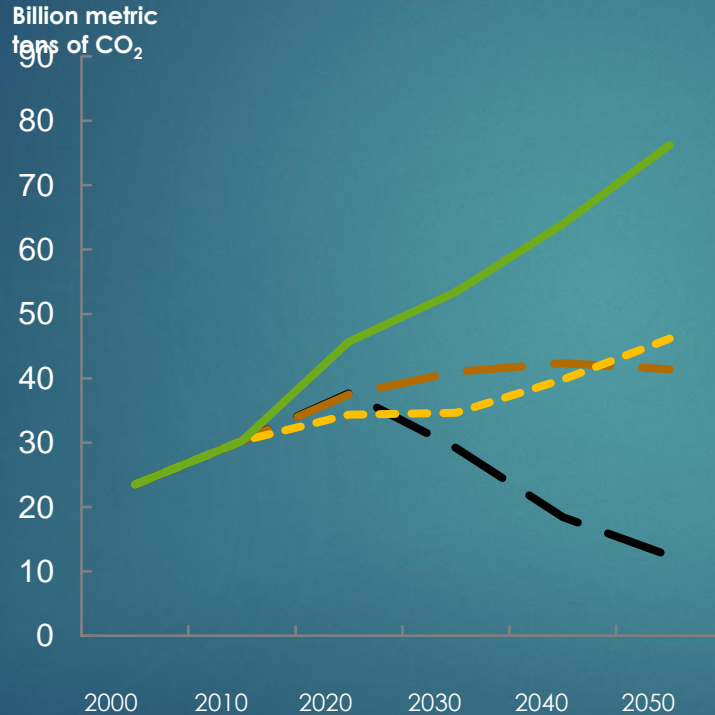
“Development that meets the needs of the present without compromising the ability of future generations to meet their own needs”

≈ 30 years later



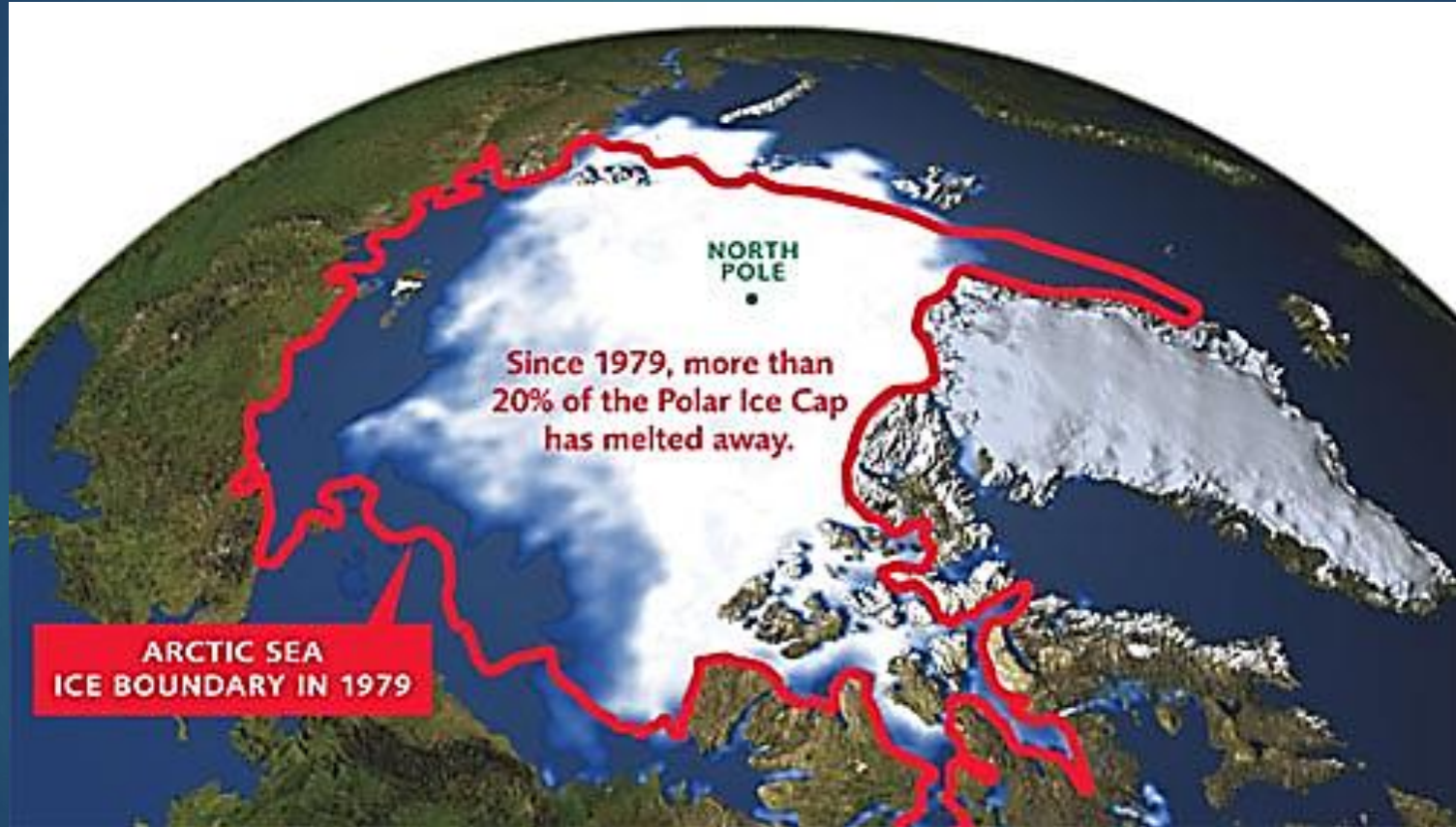
The world is currently on track for warming of around 3 - 4°C

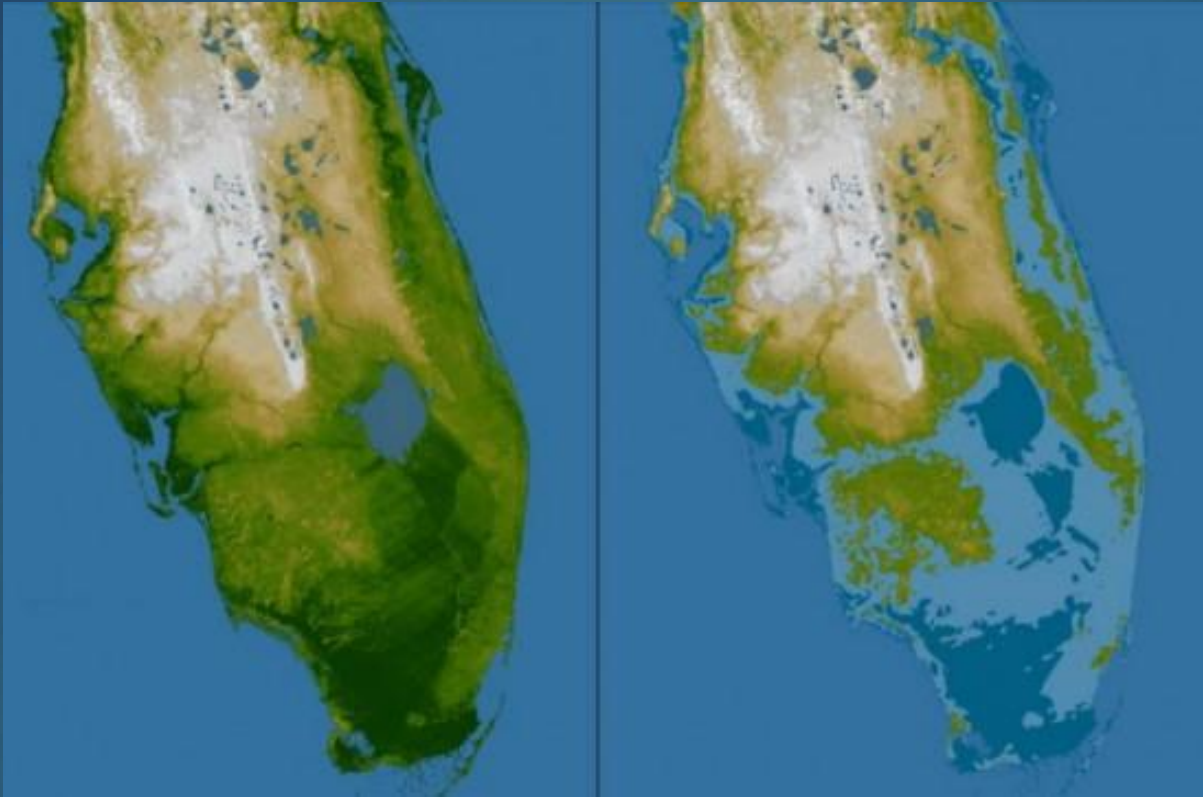
Annual CO₂ Emissions for Different Scenarios



- 1.6° C (RCP2.6)
- 2.4° C (RCP4.5)
- 2.8° C (RCP6.0)
- 4.3° C (RCP8.5)

Average temperature rise by 2100	Characteristics/assumptions of scenario
4.3°C (RCP8.5)	No policy change to reduce emissions
2.8°C (RCP6.0)	CO ₂ emissions peak in 2075, methane emissions are stable from now.
2.4°C (RCP4.5)	Stringent climate policies, lower energy intensity, strong reforestation programmes . Emissions peak in 2040
1.6°C (RCP2.6)	Low energy intensity, Methane emissions reduced by 40%, a world population of 9 billion by 2100 – much slower population growth than in most models





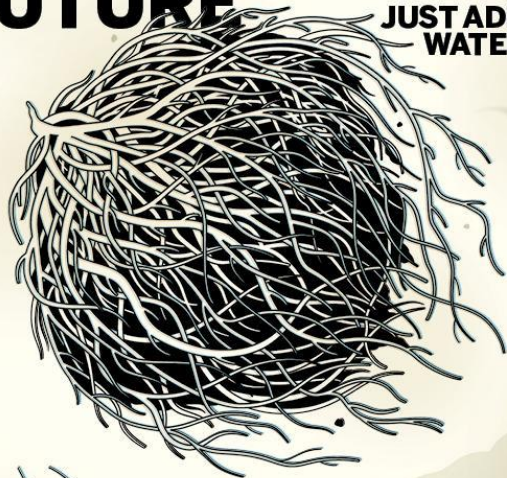
Potential Sea Level Rise in Florida

VOTE FOR ME: I'M UNQUALIFIED / APPS V. ISIS

Newsweek.

**CALIFORNIA'S
FUTURE** 05.01.2015

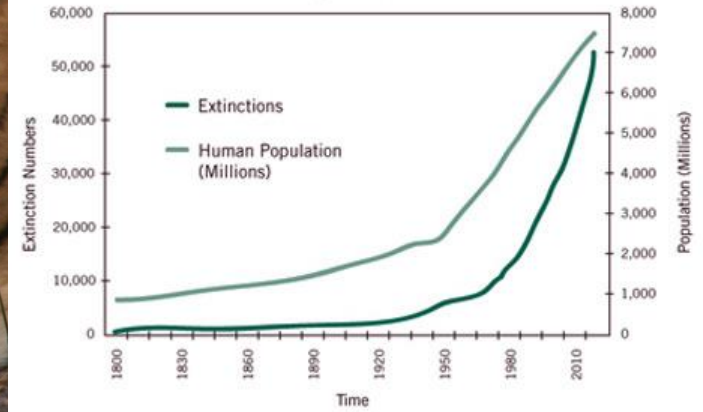
**JUST ADD
WATER**





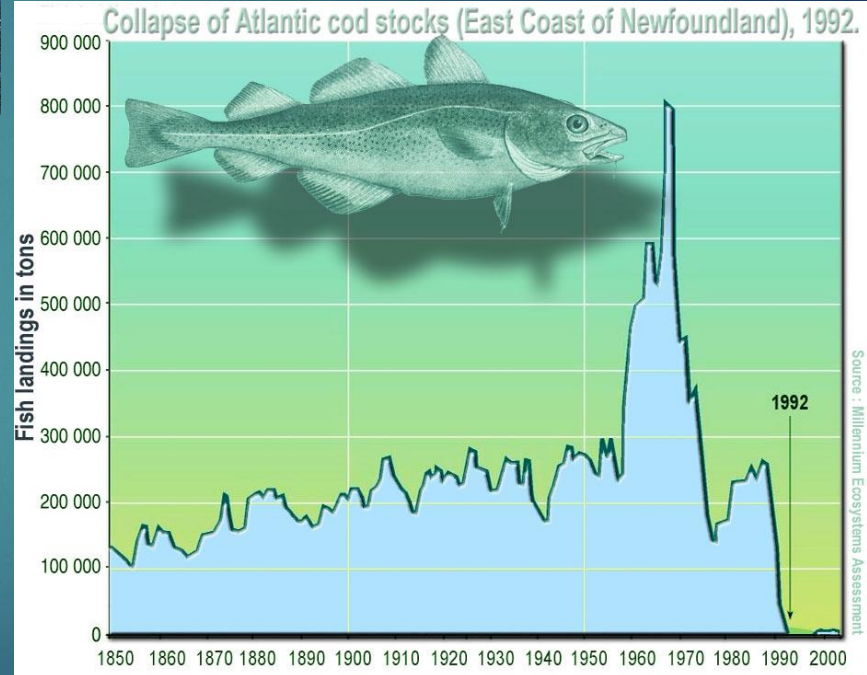
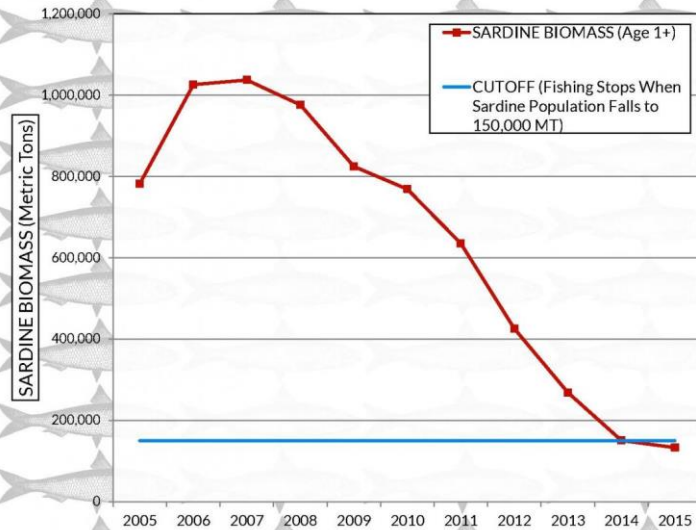
Species Extinction and Human Population

Graph source: USGS

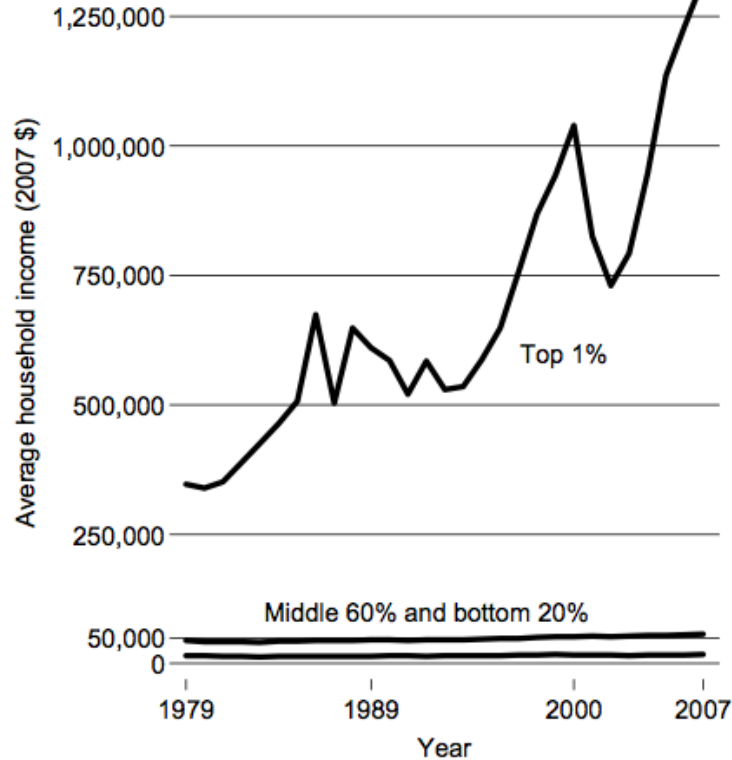




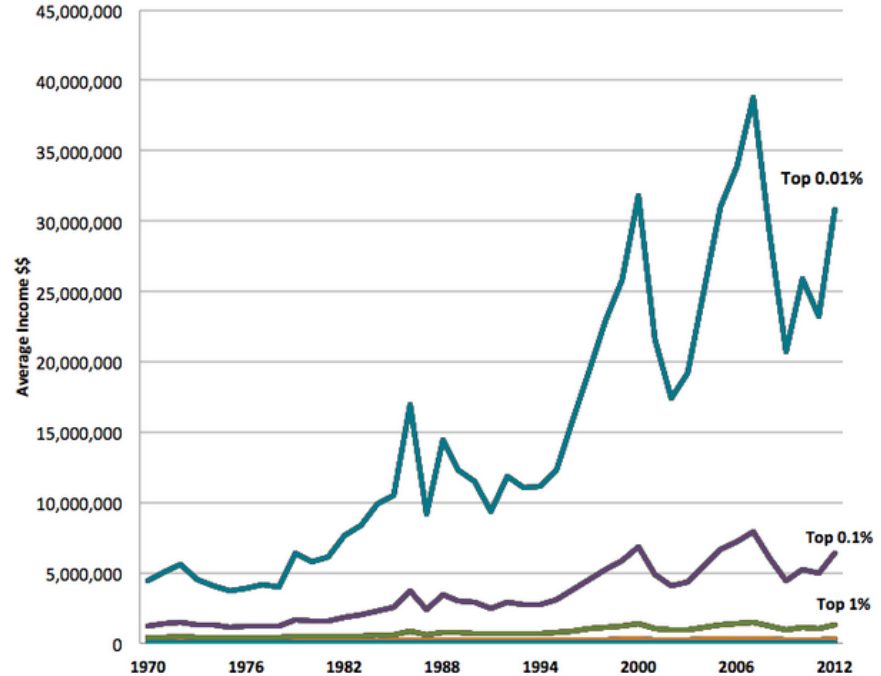
THE COLLAPSE OF PACIFIC SARDINE



Inequality rising: inflation-adjusted household incomes, 1979-2007

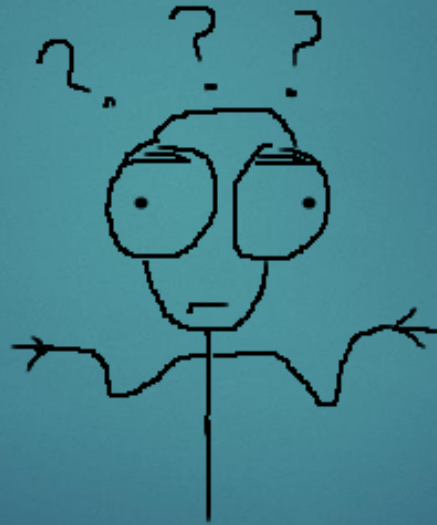


Income Inequality Achieves Escape Velocity
After the 1%



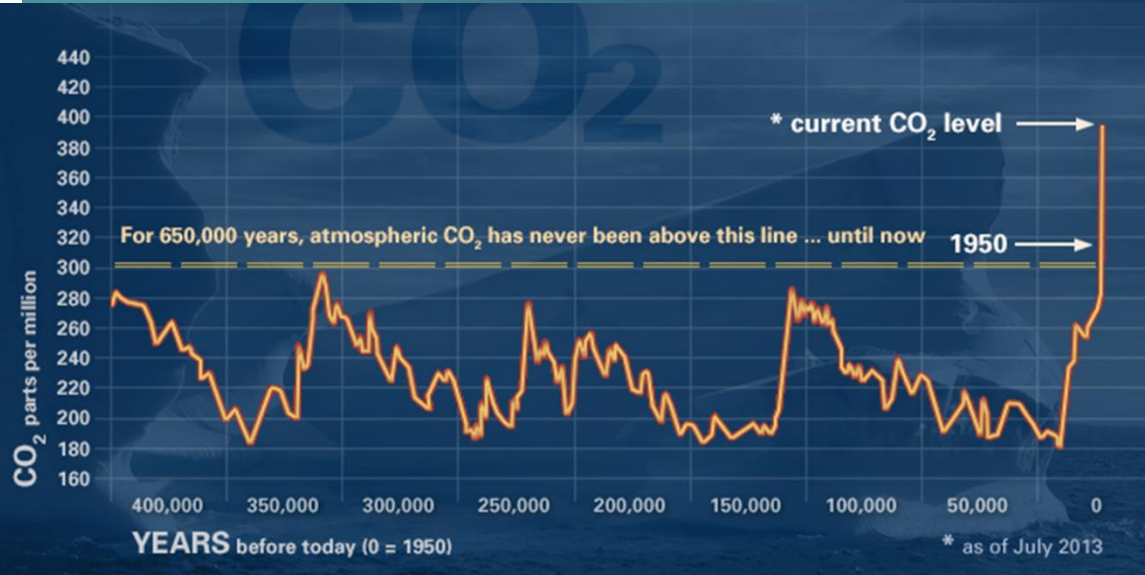
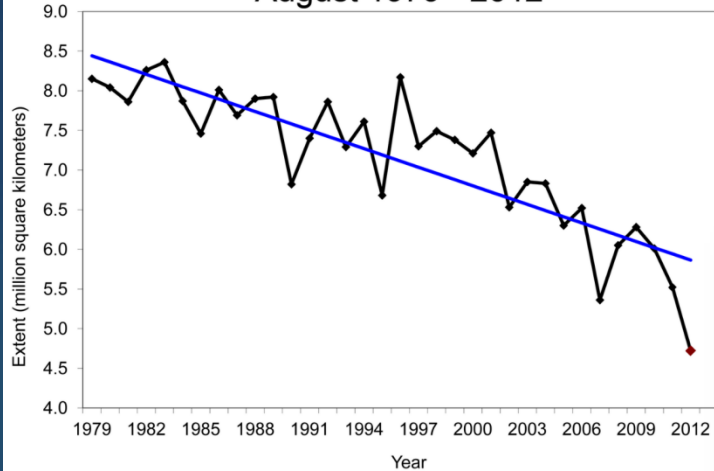
“A reasonably equitable distribution of income is thought by individuals of liberal disposition to be politically virtuous; in fact, it is economically highly functional.” JKG

Given what we know, why don't we act?



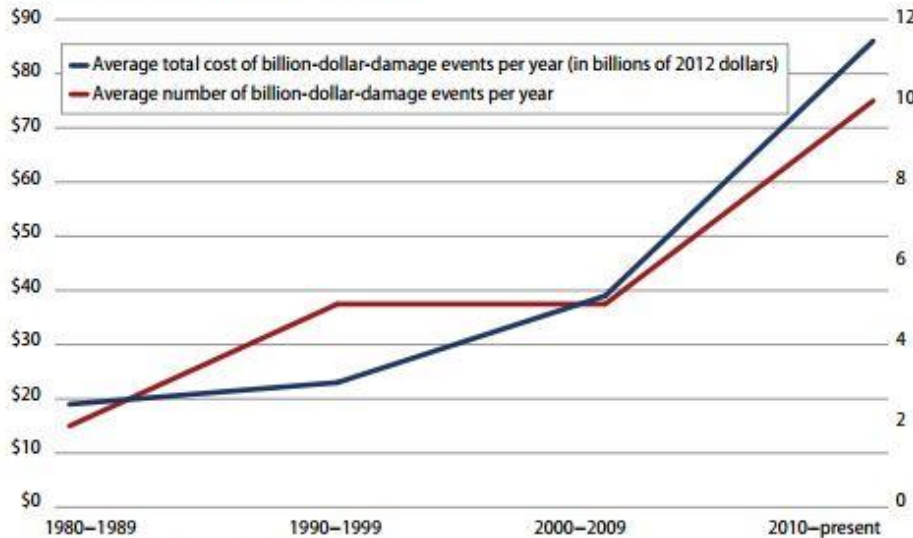
Solid scientific evidence

Average Monthly Arctic Sea Ice Extent
August 1979 - 2012

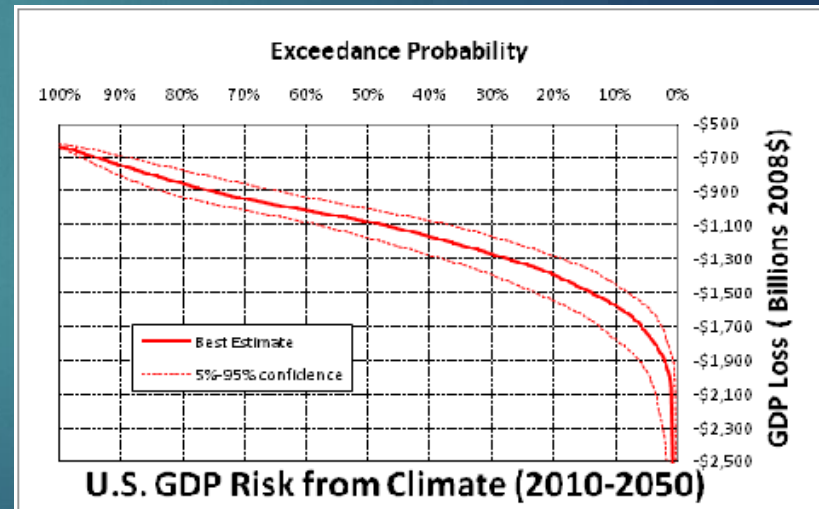


Solid economic evidence

FIGURE 1
Billions of dollars in damages from extreme weather events increasing in frequency, cost from 1980–2012



Source: National Oceanic and Atmospheric Administration.¹⁷



Corporate social responsibility

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“Traditional corporate social responsibility is failing to deliver, for both companies and society”

McKinsey & Company, 2013

A Brief History in Electricity

- ▶ Darlington 10 years late \$12 billion over budget - Davies/Peterson
- ▶ 30 years of debt payments
- ▶ 1993 recession electricity rates rising, capped by NDP – Bob Rae
- ▶ Conservatives promise free market electricity system to lower rates - Harris
- ▶ After 100s of millions spent market opens and prices spike, Conservatives cap electricity prices and abandon retail market - Eves
- ▶ Investment flees, brownouts predicted, system in poor repair
- ▶ Liberals promise to fix broken electricity system, McGuinty elected, creates OPA and starts rapid infrastructure renewal

And then there is forecasting...

1970s

1980s

1990s

2000s

2010s

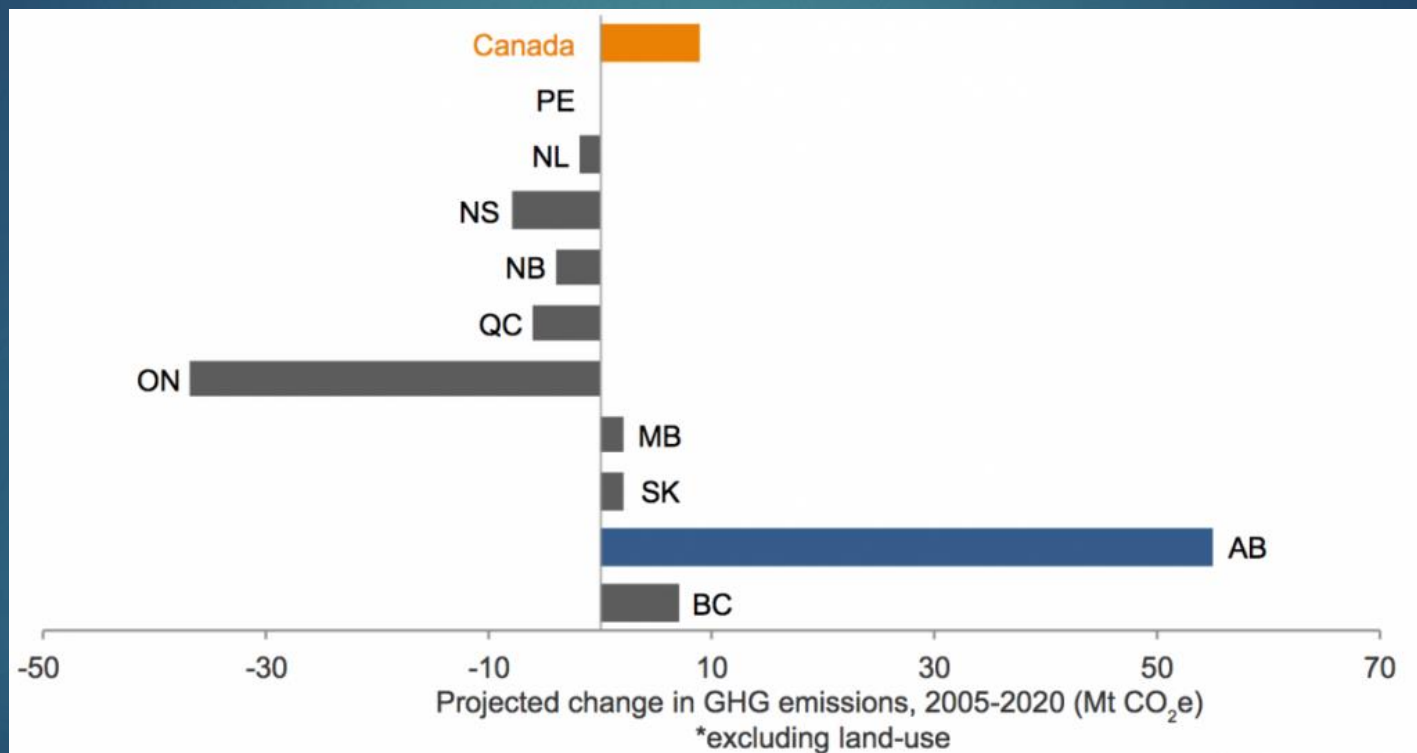
Shutting down coal

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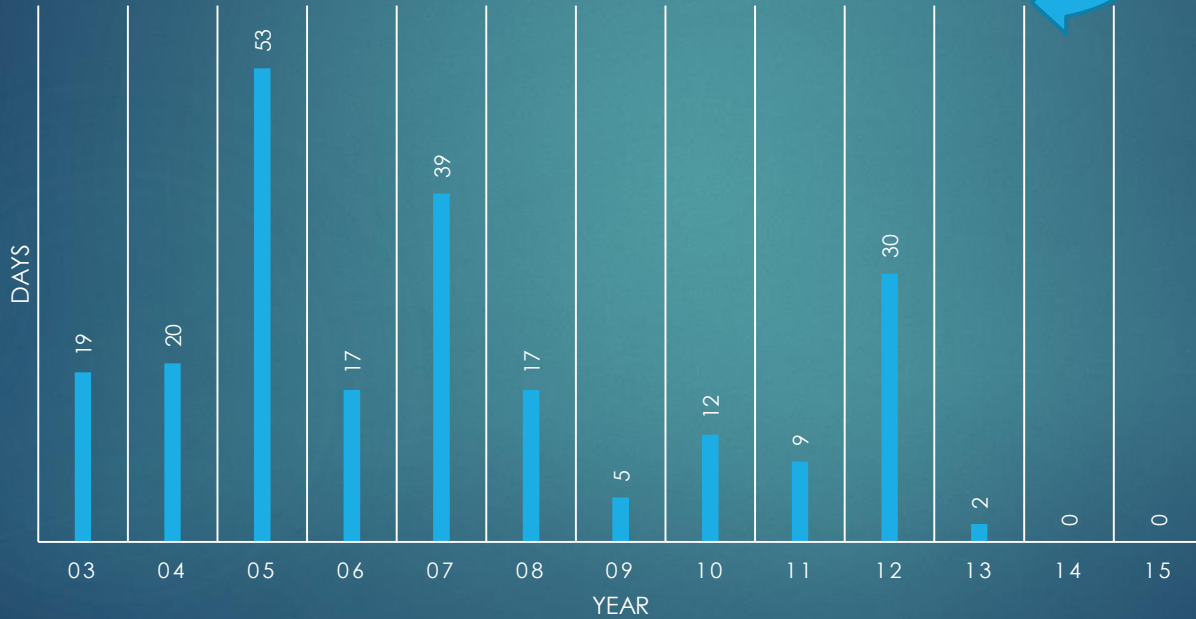
Canada

17



Last coal power plant in Ontario closes

ONTARIO SMOG ADVISORIES





Lakeview



Pickering



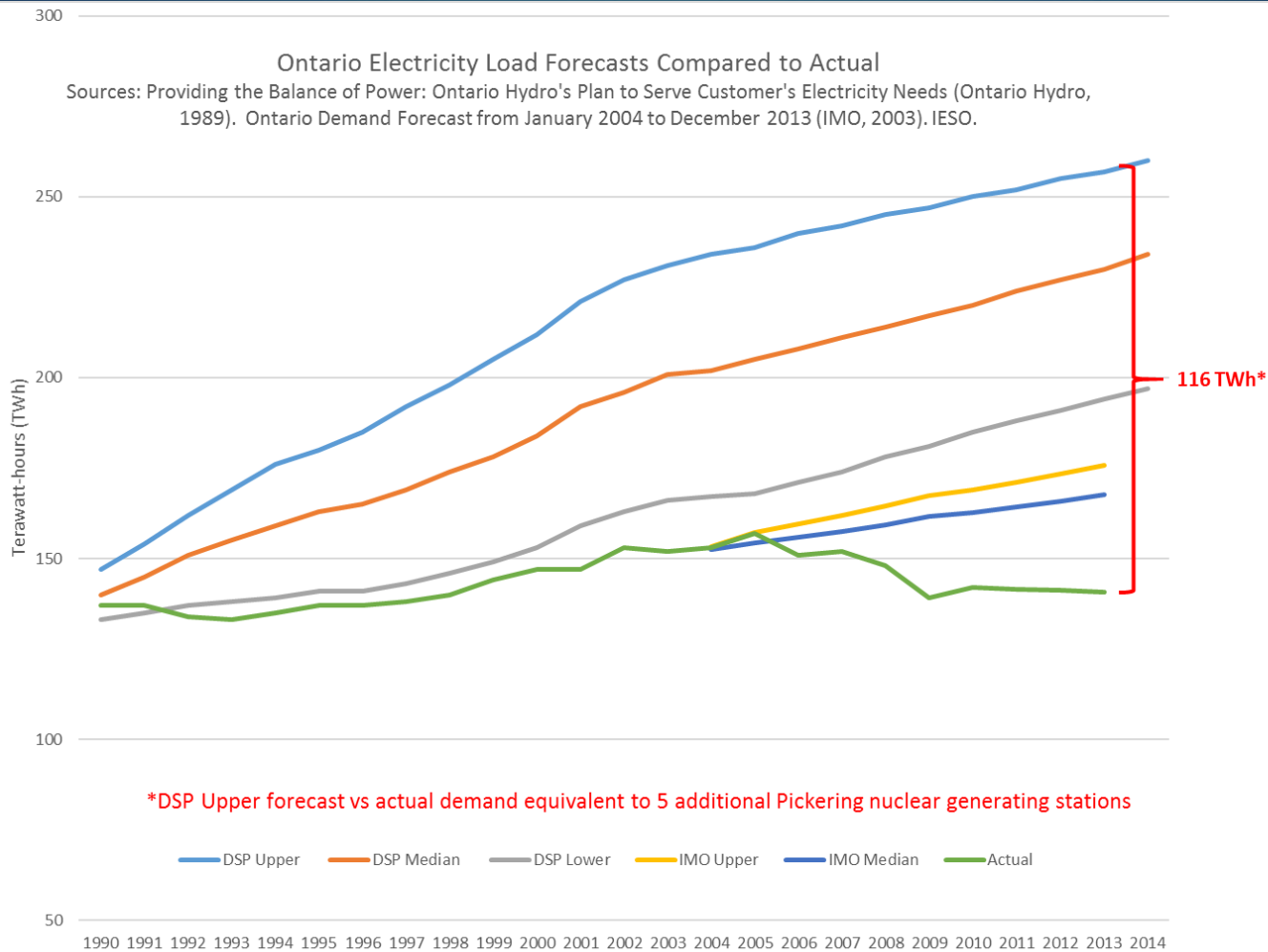
Bruce



Lambton

Ontario Electricity Load Forecasts Compared to Actual

Sources: Providing the Balance of Power: Ontario Hydro's Plan to Serve Customer's Electricity Needs (Ontario Hydro, 1989). Ontario Demand Forecast from January 2004 to December 2013 (IMO, 2003). IESO.



Green Energy

What went wrong... And right!

A “government approach”

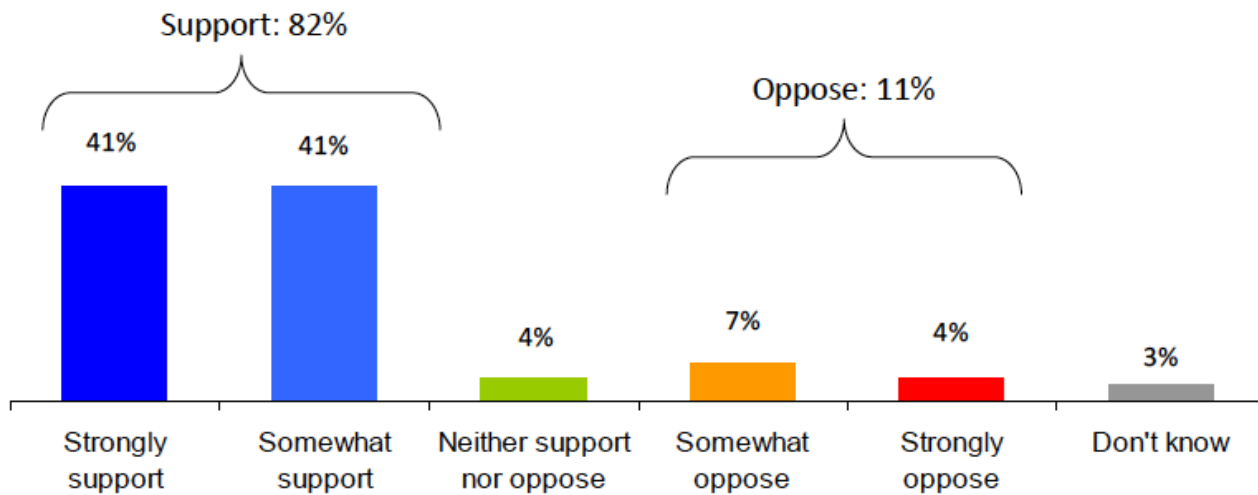
Minister dictates a plan

Bureaucrats told to implement it

Over 80% liked the idea of the Government's Green Energy Plan ...



The government is developing a plan that will encourage conservation, meets new demand, replaces aging infrastructure and shifts Ontario electricity generation to more environmentally friendly types of electricity generation. Do you support or oppose the government adopting a plan that will focus on encouraging conservation, meeting new demand, replacing aging infrastructure and making Ontario electricity generation to more environmentally friendly? (Nov 2010)

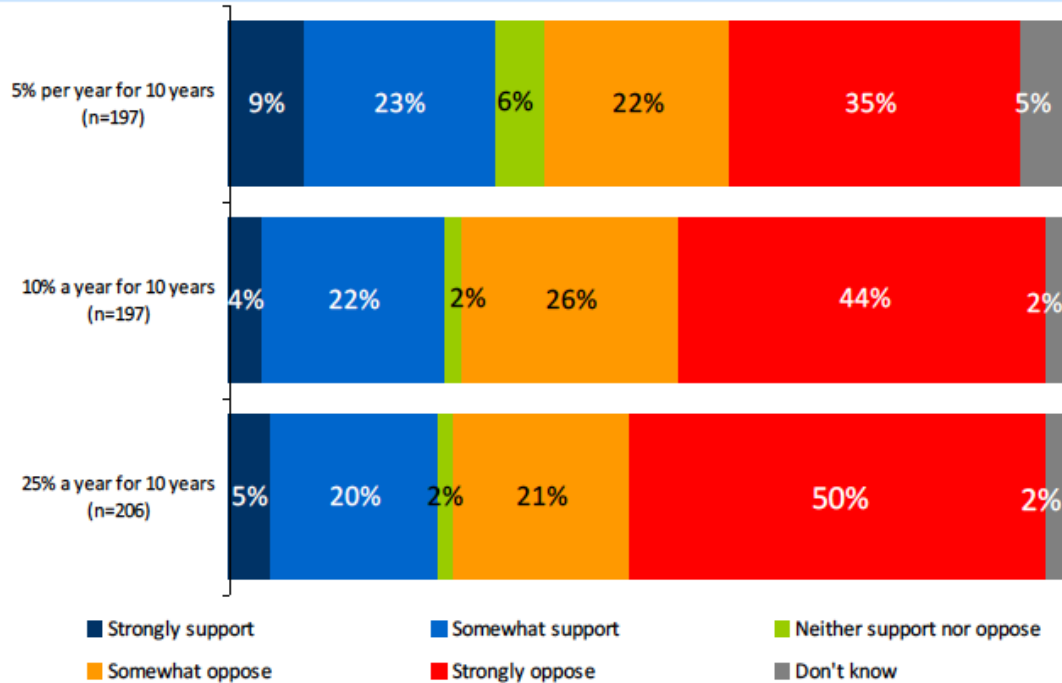


n=600

... but even at 5% annual increase, a majority opposed paying for it



Electricity prices will have to rise to pay for that plan. The more we pay, the more quickly we can implement the plan. Would you support or oppose implementing that plan if your electricity bill will grow by ... (Sample split into 3) (Nov 2010)



It's the resource base stupid

- ▶ Comparing electricity rates between jurisdictions with different supply options, economic structures and resource opportunities is pointless
- ▶ Why are Quebec and Manitoba the cheapest jurisdictions in North America – Clever politicians? Brilliant utility managers?
- ▶ Comparing Ontario electricity rates to North American jurisdictions with similar economic structure and resource availability and guess what....
- ▶ Ontario electricity rates are lower than most jurisdictions with similar populations, economies and resource base. People in New York and LA pay well over double what Ontarians pay

“Any politician who promises low electricity rates is selling a lie”

Bruce Lourie, Toronto Star, Feb. 23, 2017

“NDP Leader Horwath says she can chop electricity rates by 30 percent”

Toronto Star, Feb. 27, 2017

“Premier Kathleen Wynne will slash electricity rates by 25 percent”

Toronto Star, Mar. 1, 2017

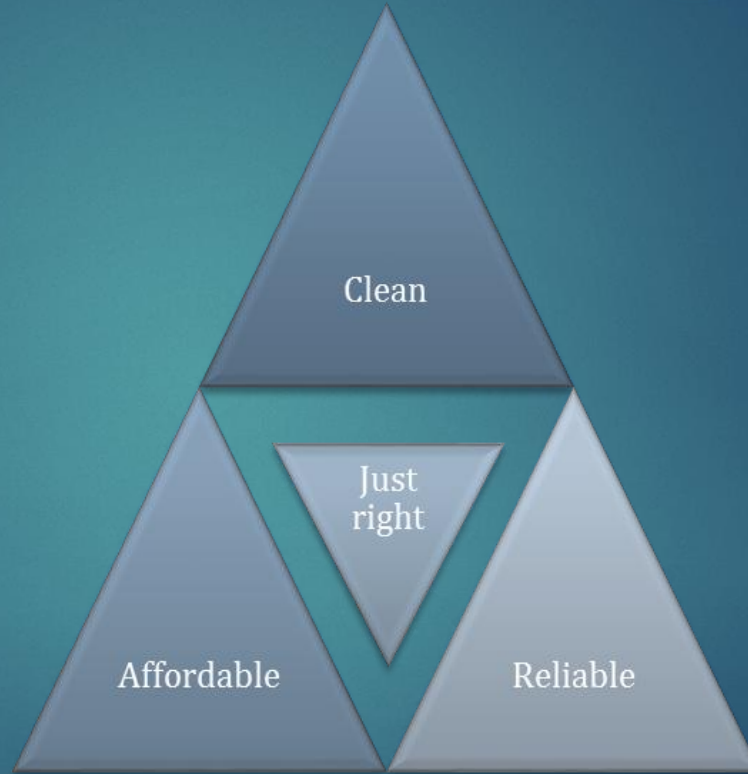
The Global Electricity Context

- ▶ 2001 to 2014 an 86 percent increase in US electricity rates
- ▶ New York \$0.21 per kilowatt hour
- ▶ Australia \$0.36 per kilowatt hour
- ▶ Germany \$0.40 per kilowatt hour
- ▶ Denmark \$0.50 per kilowatt hour

- ▶ My Toronto blended rate \$0.084
- ▶ 40 percent use 60 percent delivery etc

Electricity Trilemma

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The Electricity Imperative

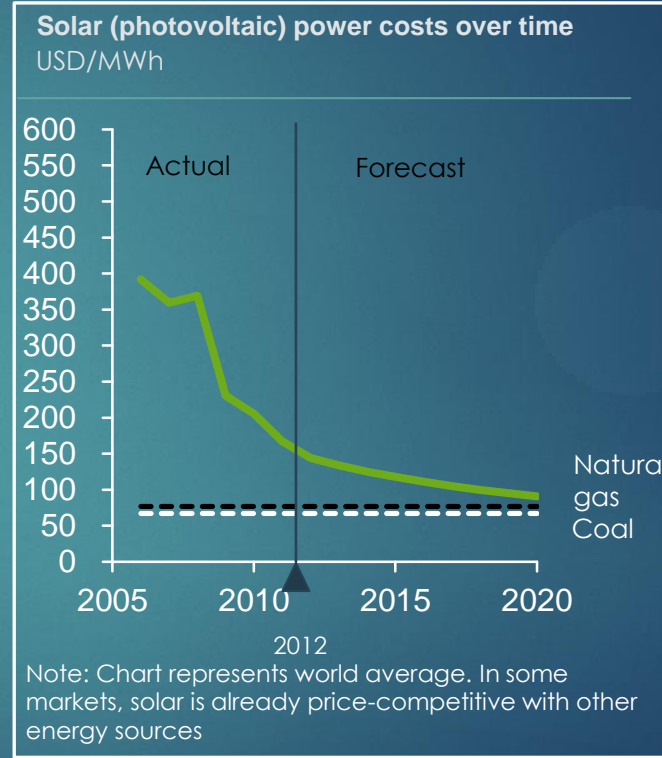
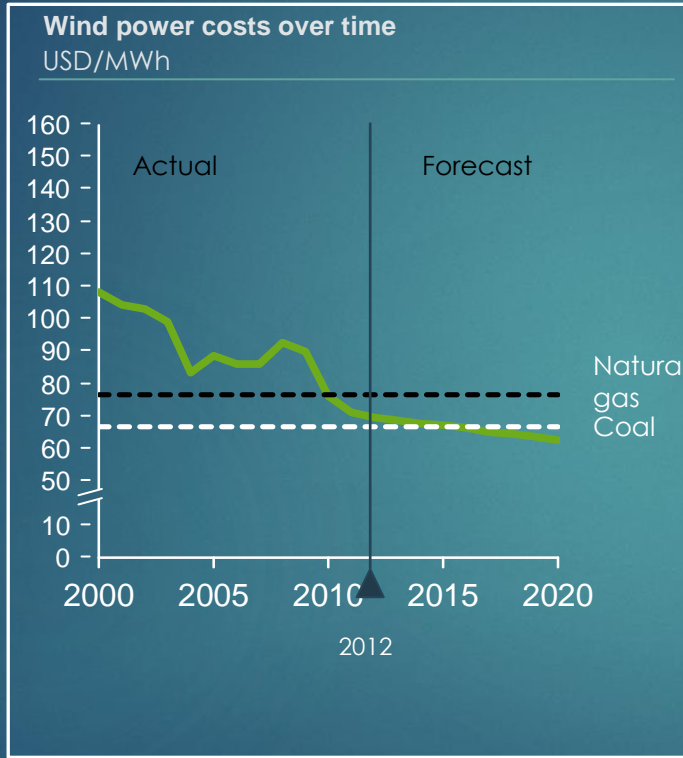
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Fossil fuels are decreasing, and electricity use is increasing.

This is the largest economic transition since the industrial revolution.

It's up to us to shape it.

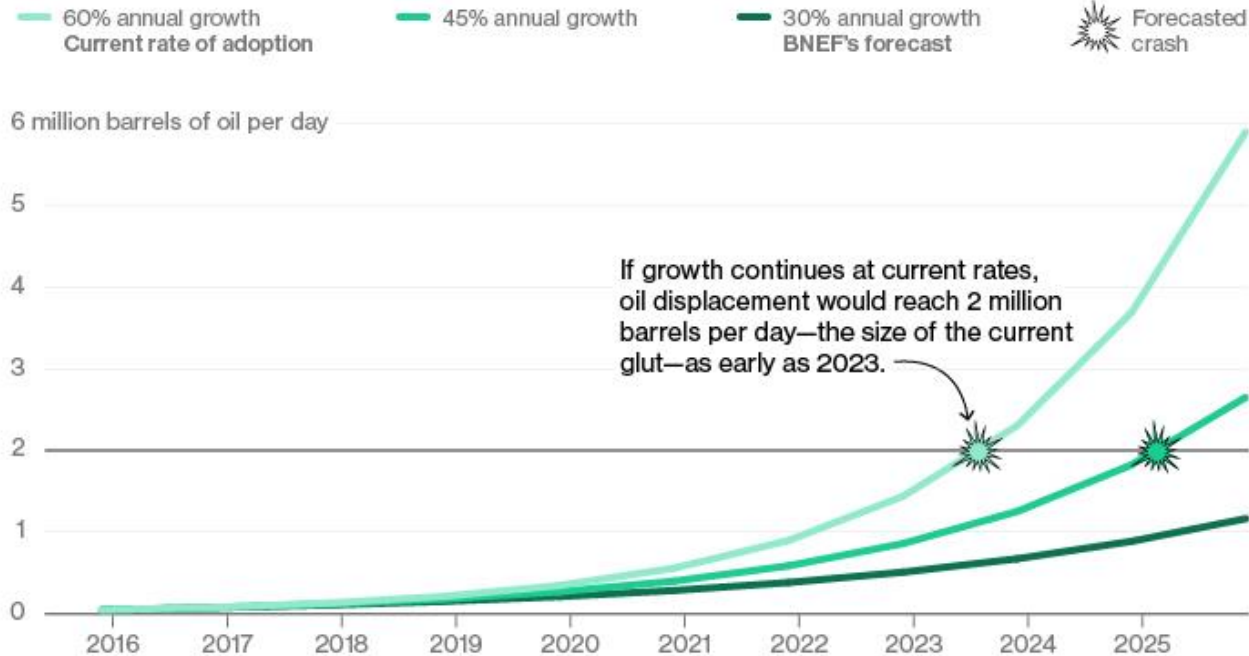
Wind and solar costs fall rapidly over time



Note: Assuming coal price of 70 USD/tonne and gas price of 10 USD/Mmbtu. Assuming a 35% capacity factor for wind power i.e. 35% utilisation, and a 15% capacity factor for solar power

Predicting the Big Crash

The amount of oil displaced by electric cars depends on when vehicle sales take off. Here are three scenarios for rising EV sales.



Source: Data compiled by Bloomberg

Disruption

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Tesla market cap: \$50bn

84,000 cars sold in 2016

GM market cap: \$50bn

10 million cars sold in 2016

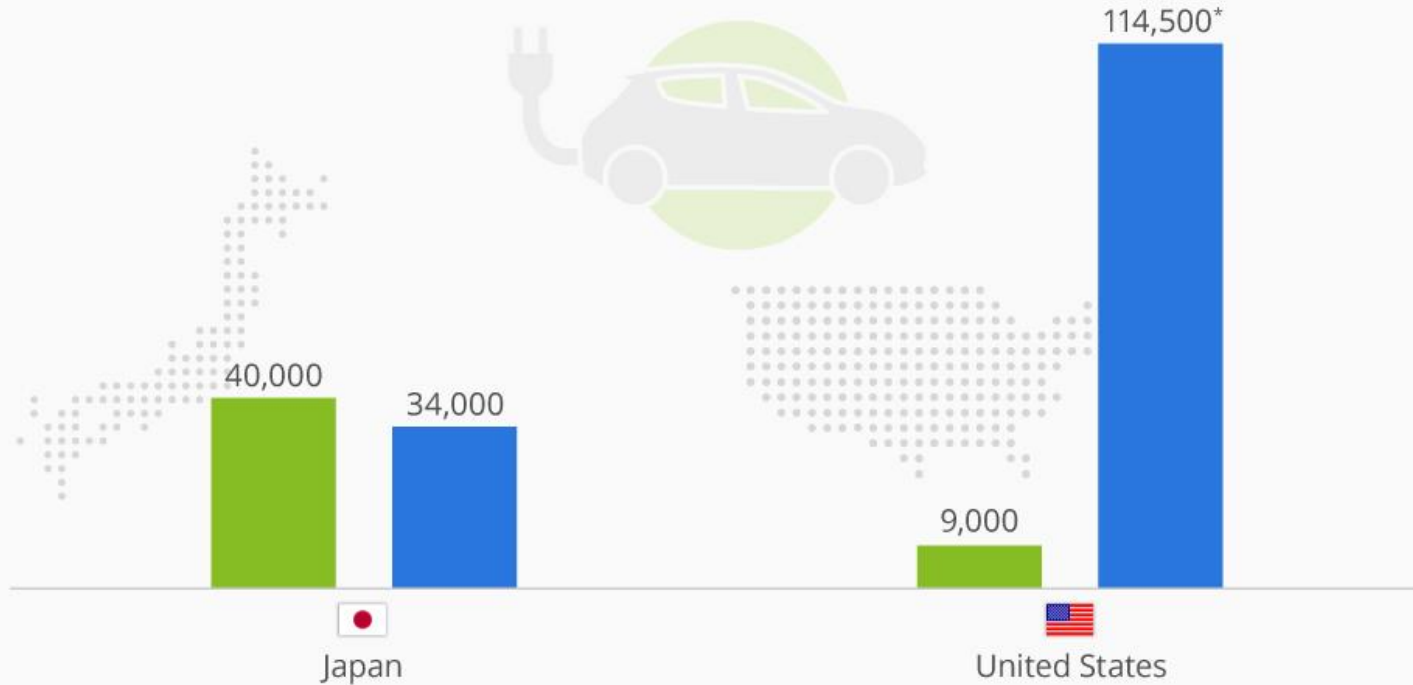


"All the geniuses here at General Motors kept saying lithium-ion technology is 10 years away, and Toyota agreed with us – and boom, along comes Tesla. So I said, 'How come some tiny little California startup, run by guys who know nothing about the car business, can do this, and we can't?' That was the crowbar that helped break up the log jam."
- GM's then-Vice Chairman Robert Lutz

Japan Has More Car Charging Points Than Gas Stations

Estimated number of vehicle charging points & gas stations in Japan and the U.S. (2016)

■ Electric vehicle charging stations ■ Gas stations



* 2012, latest estimate available

Sources: Nissan, Japan Times



A Snapshot of Peer-to-Peer, Rideshare, and Carshare Growth

2000-2014



Efficiency, Not Waste

“Energy efficiency is the most abundant, cheapest way to reduce GHG emissions.”



U.S. DEPARTMENT OF
ENERGY



The Conference Board
of Canada®

“Increasing energy efficiency should be a policy goal for Canada [...] as a way to mitigate climate change”

“The adoption of significant energy efficiency measures offers low-cost options for reducing GHG emissions.”

PROJET TROTTIER POUR
L'AVENIR ÉNERGÉTIQUE

TROTTIER ENERGY
FUTURES PROJECT



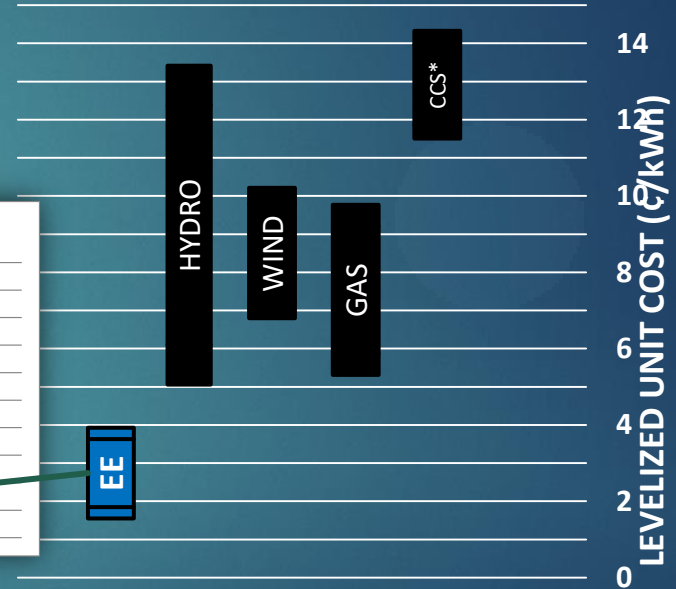
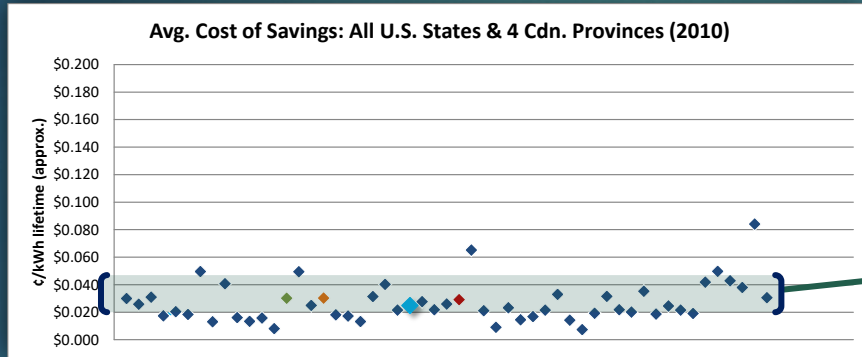
International
Energy Agency

“Energy efficiency [is] a mainstream tool for economic and social development.”

Energy Efficiency Most Cost-effective

▶ **LOWEST COST**

3-6x cheaper than new supply



More Power To You

Communities, businesses and even residents will shift from being *passive electricity users*, to *engaged electricity producers* – with much greater control over the cost, quality, and quantity of our electricity.

We have to stop subsidizing everyone, and target help where it's most needed.



Engaged and responsible

- ▶ Take responsibility and demonstrate leadership – e.g. resource stewardship, resource efficiency
- ▶ Accept that real, genuine change is not only necessary but inevitable, so get ahead of the market transformation curve
- ▶ Find constructive allies (avoid destructive allies)
- ▶ Understanding disruptive business models, circular economy, shifts in capital market governance
- ▶ Shift perspective: project → company → sector → society
- ▶ From interest-based to solutions-based
- ▶ Help shape renewed role for public policy

Today's electricity system is the result of 50 years of choices. Now, we have new choices and the chance to build a new system for the 21st century



Thank you

