POWER MARKETS - UPDATE & RELEVANCE TO CCUS

Mike Nasi

Partner, Jackson Walker LLP

Senior Advisor, *Life:Powered*

Midland CO2 Conference

December 10, 2020

DISCUSSION OUTLINE

1. Power Market Reliability Update
2. Why Power Markets Need CCUS
3. How to Position CCUS to Help
4. How to Talk About It!

PART ONE:

Power Market Reliability Update

What To Remember About 2020 CA Blackouts

1. CA demand was not higher than in prior years
2. Lower wind and solar generation during 2020 peak despite increased capacity
3. Greater reliance on imports in 2020 vs. prior years (while policies discriminate against imports throughout remainder of the year)
4. 3.3 million people left without power
5. Example: pump failures dumped 50K gallons of raw sewage into East Bay

Source: https://www.caiso.com/Documents/CaliforniaISOPeakLoadHistory.pdf

Quoted Reasons for Blackouts

"Governor Newsom pointed to California's shift to renewable resources as part of the reason for the supply shortage. Newsom said, "**We need to sober up" and "we cannot sacrifice reliability",** and promised to be more aggressive in making sure that is the case".

– City News Service: Deadline, August 17, 2020

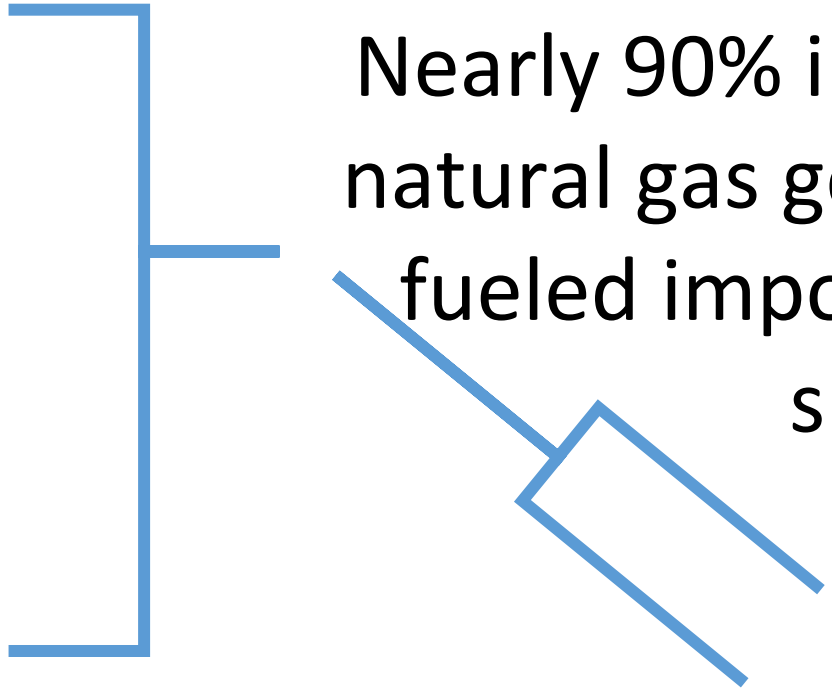
"There are several things at play," said Stephen Berberich, president of the California Independent System Operator [CAISO], which runs the state grid. "The first is we do have less capacity here in California. A number of units have been retired since the 2006 heat wave, and there's also **less resources across the West because many of the large units in the West have retired or are retiring, as people move off of coal."**

– ABC News, Aug. 17, 2020

"It's a challenge that will only intensify as California adds more solar panels and wind turbines to meet its targets of 60% renewable electricity by 2030 and 100% emissions-free power by 2045."

– Los Angeles Times: August 17,2020

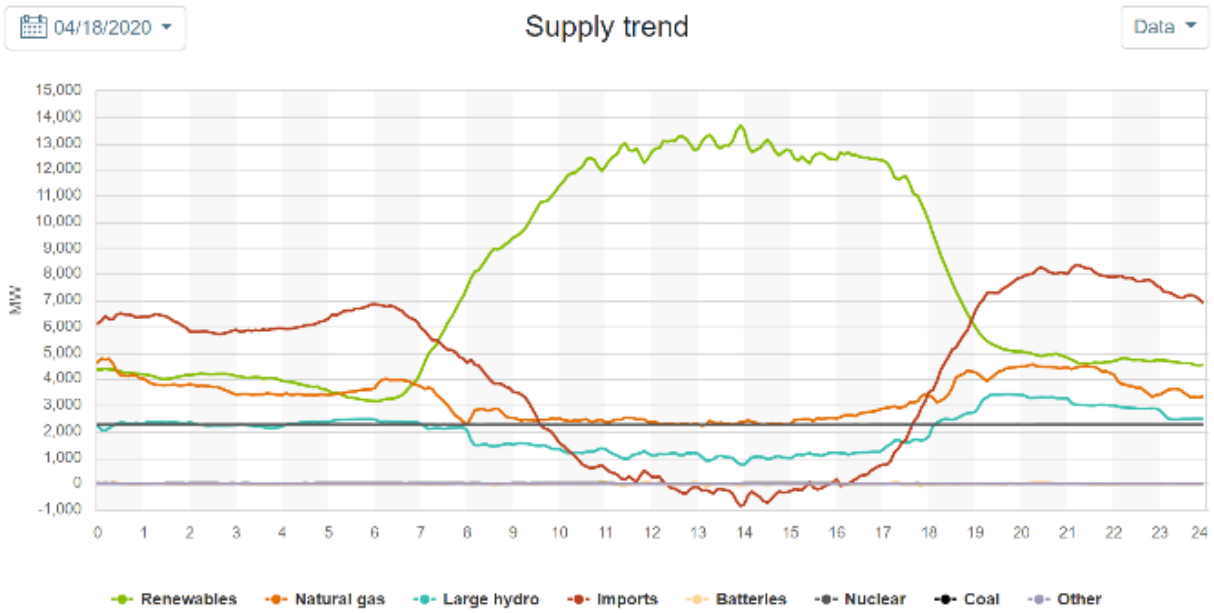
Wild Seasonal Swing of Generation Sources for CA *(Case study: 5 pm on April 14 vs. 5 pm on August 18)*



Nearly 90% increase for in-state natural gas generation and fossil fueled imports from spring to summer.

Non-Dispatchable Dependence = Unsustainable Market

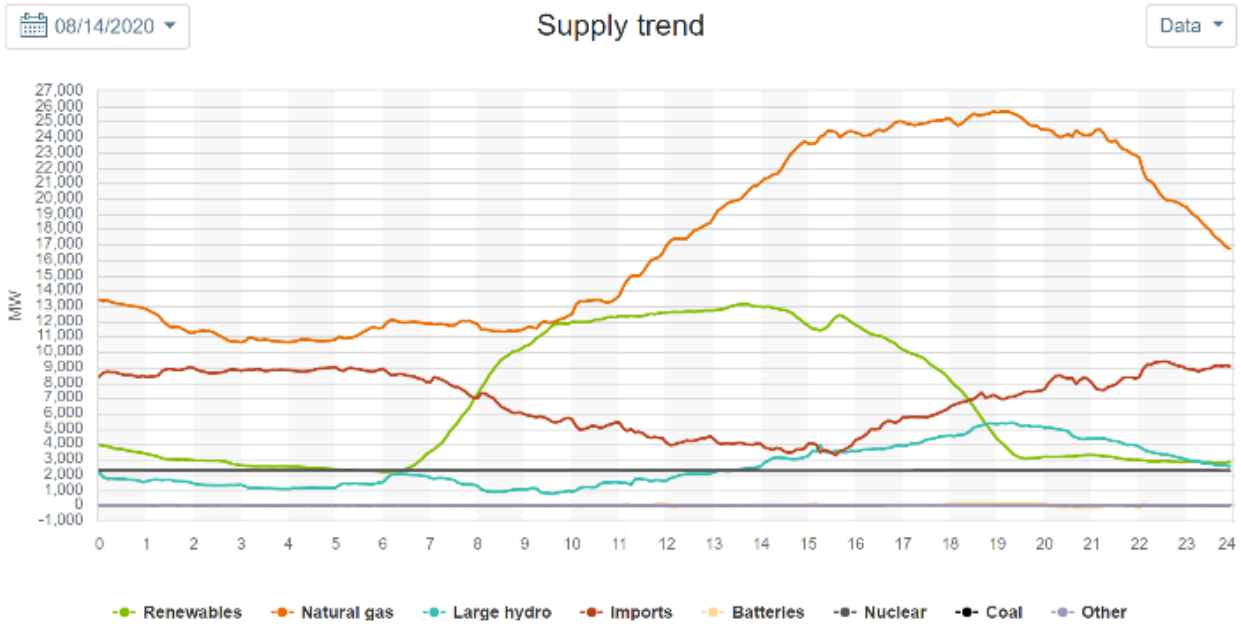
April 18, 2020



Expect other states to keep plants open despite cost, so they can save California when demand is high

Self-generate & dump electricity on other states when demand is low

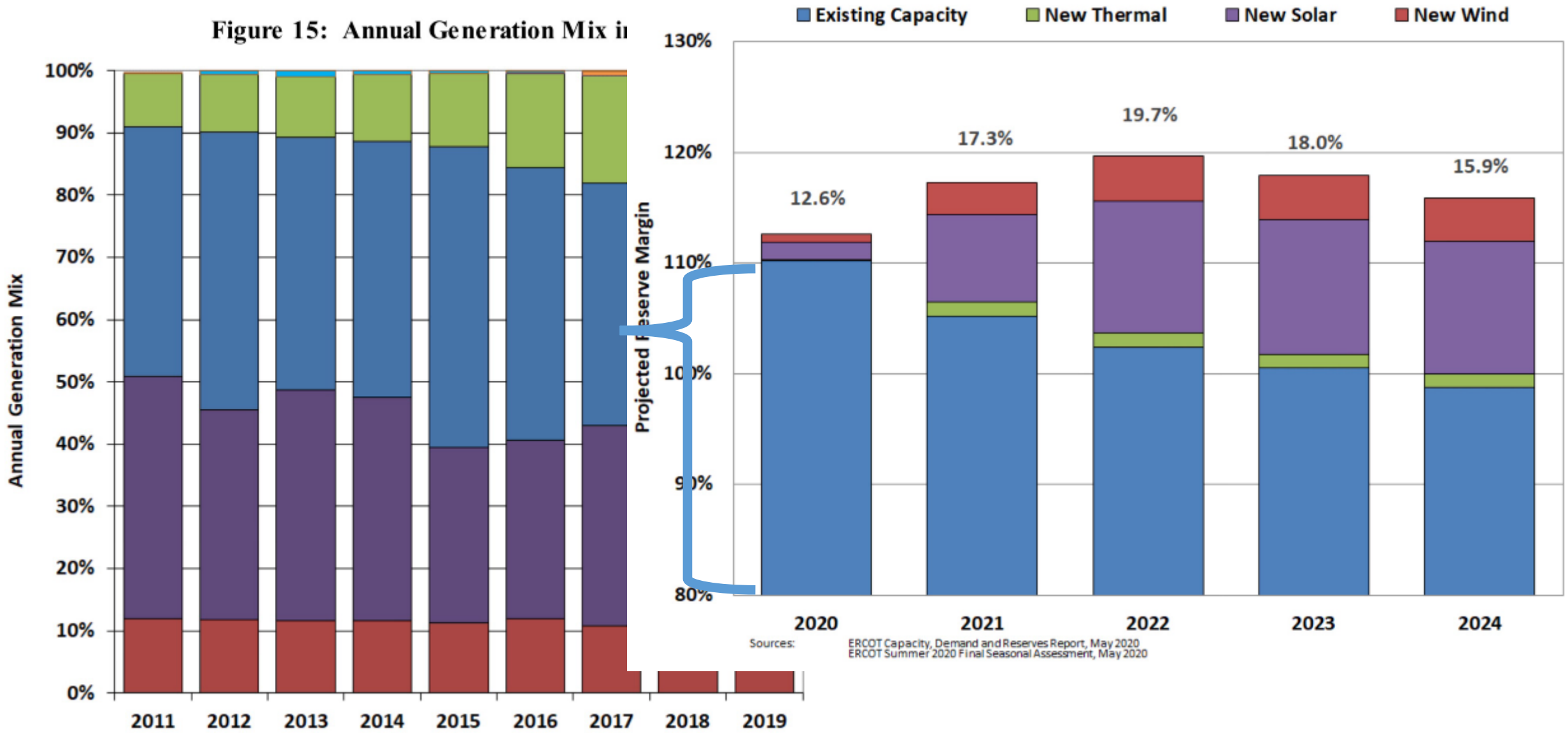
August 14, 2020



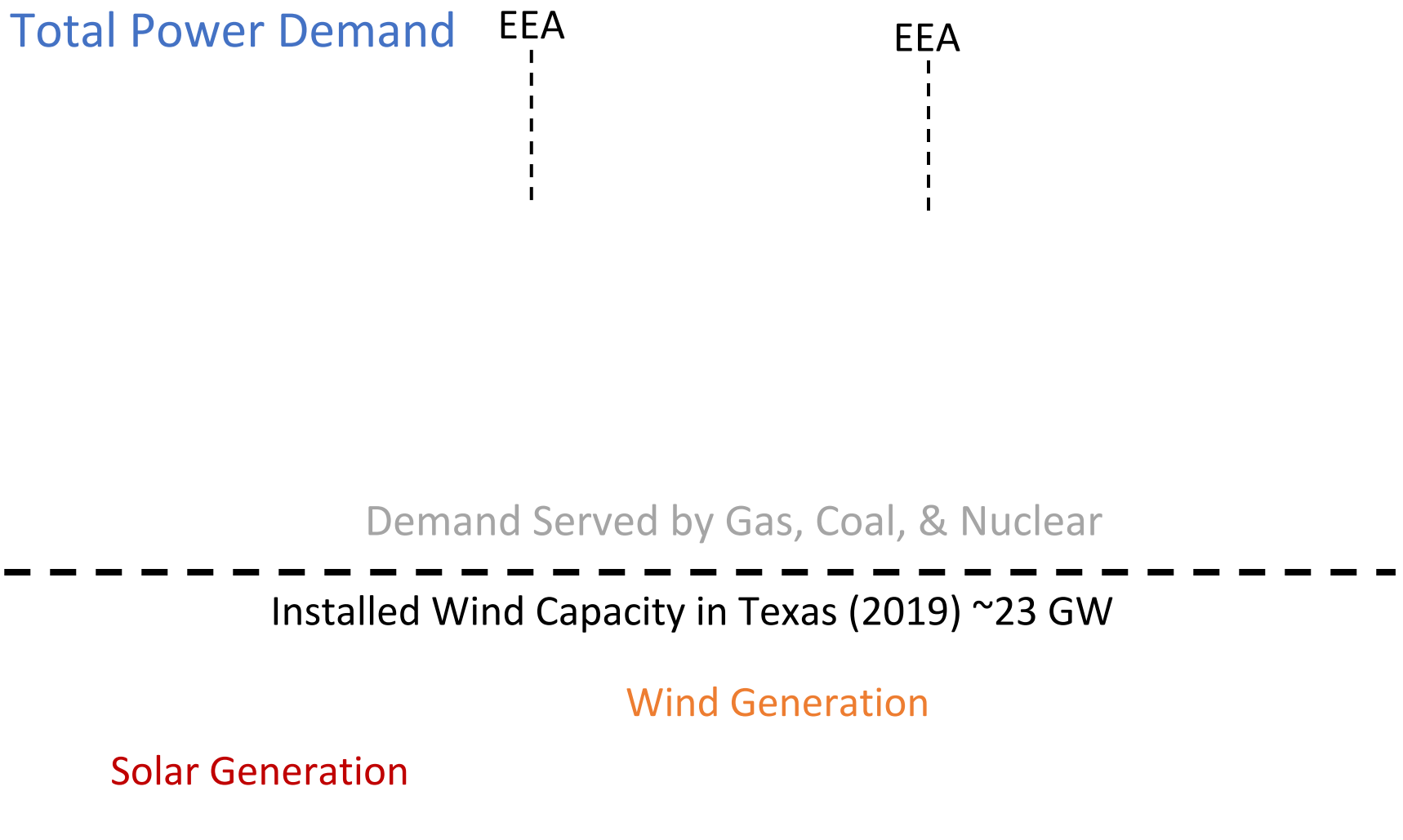
Source: CAISO
https://www.caiso.com/Documents/CaliforniaISOPeakLoadHistory.pdf

Life:Powered

TEXAS GRID RELIABILITY IN QUESTION AS THERMAL FLEET (& INVESTMENT) SHRINKS



TEXAS GRID RELIABILITY IN QUESTION AS THERMAL FLEET (& INVESTMENT) SHRINKS

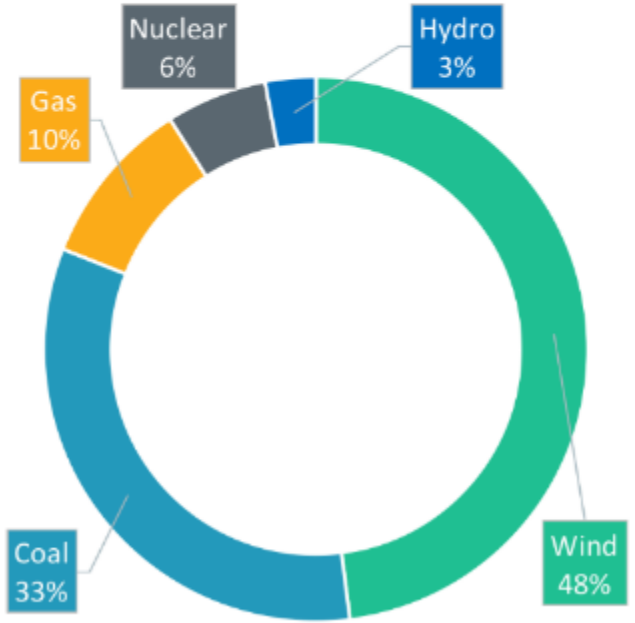


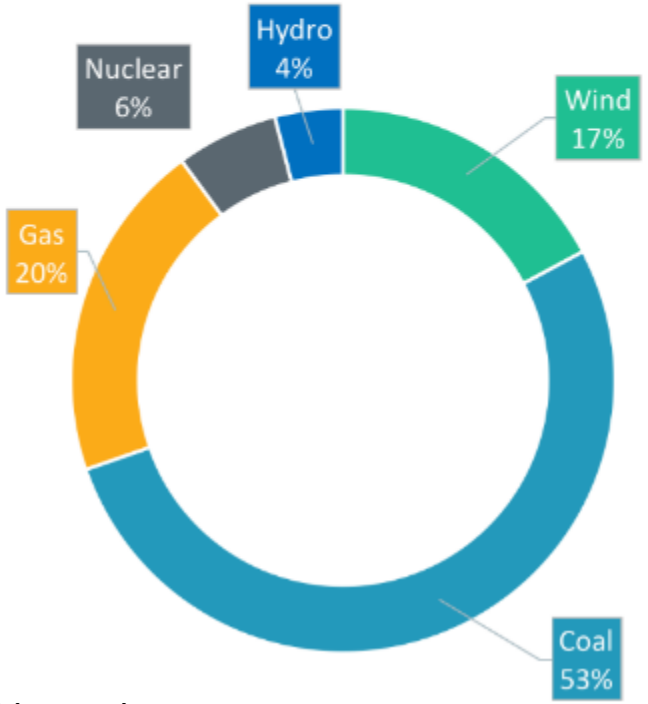
It is NOT Just About Summer in CA &TX – See SPP

THE DIFFERENCE A DAY MAKES

- On Dec. 20, 2018 at 07:40, a record output of 16,283 MW of wind power served 48 percent of our load. A day later, wind shrank to 17 percent of our generation mix, and other sources like coal and gas ramped up to serve load. This illustrates the value of a diverse fuel mix able to accommodate a wide variety of operational circumstances!

Dec. 20 @ 07:40



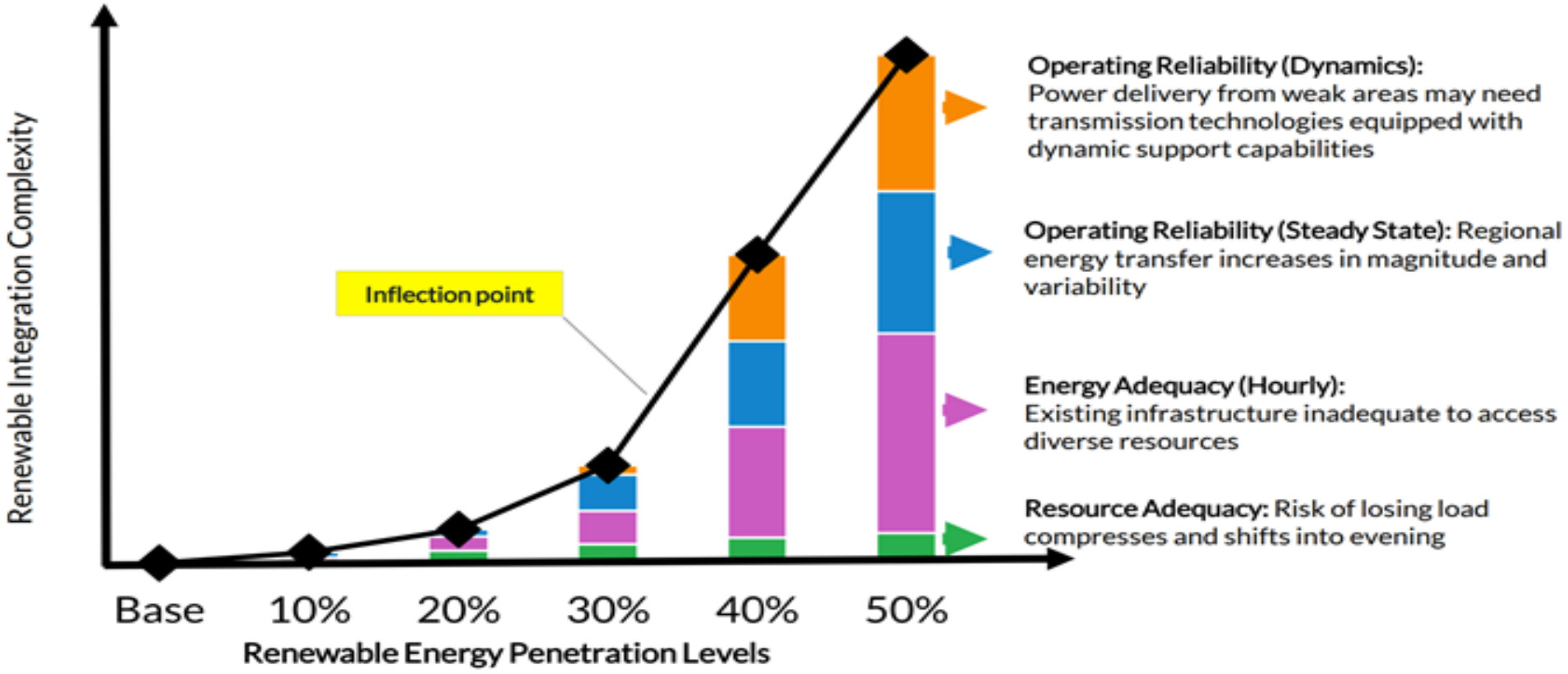


Approx. 24 hours later

Source: Southwest Power Pool (SPP)(2019)

It is NOT Just About Summer in CA &TX – See MISO

These resource changes will significantly impact grid performance with complexity increasing sharply after 30% penetration levels



MISO

PART TWO:

Why Power Markets Need CCUS

Why Can't Batteries Solve This Problem?

- There is No Moore's Law for Batteries

- Energy density increases roughly 5% per year.
- Time to market is 10 years, 10 more years to dominate.
- Steps in the battery evolution
  - 5 years: Gen 2 Li-ion, currently entering market
  - 15 years: Li-metal anode, 5x jump in energy density
  - 25 years: Oxygen or pure metal cathode, 10x energy density
- We can reach 10x energy density, and then we need new physics.

Technology & Cost are Not the Biggest Limitation on Battery Storage - Scale Is

2020 Production ≈ 200 GWh
2 hours of U.S. demand

Technology & Cost are Not the Biggest Limitation on Battery Storage - Scale Is

2020 Production ≈ 200 GWh
2 hours of U.S. demand

100% renewable will require
between 1 day and 1 month

AND THEN THERE ARE THE MINERAL/MINING NEEDS

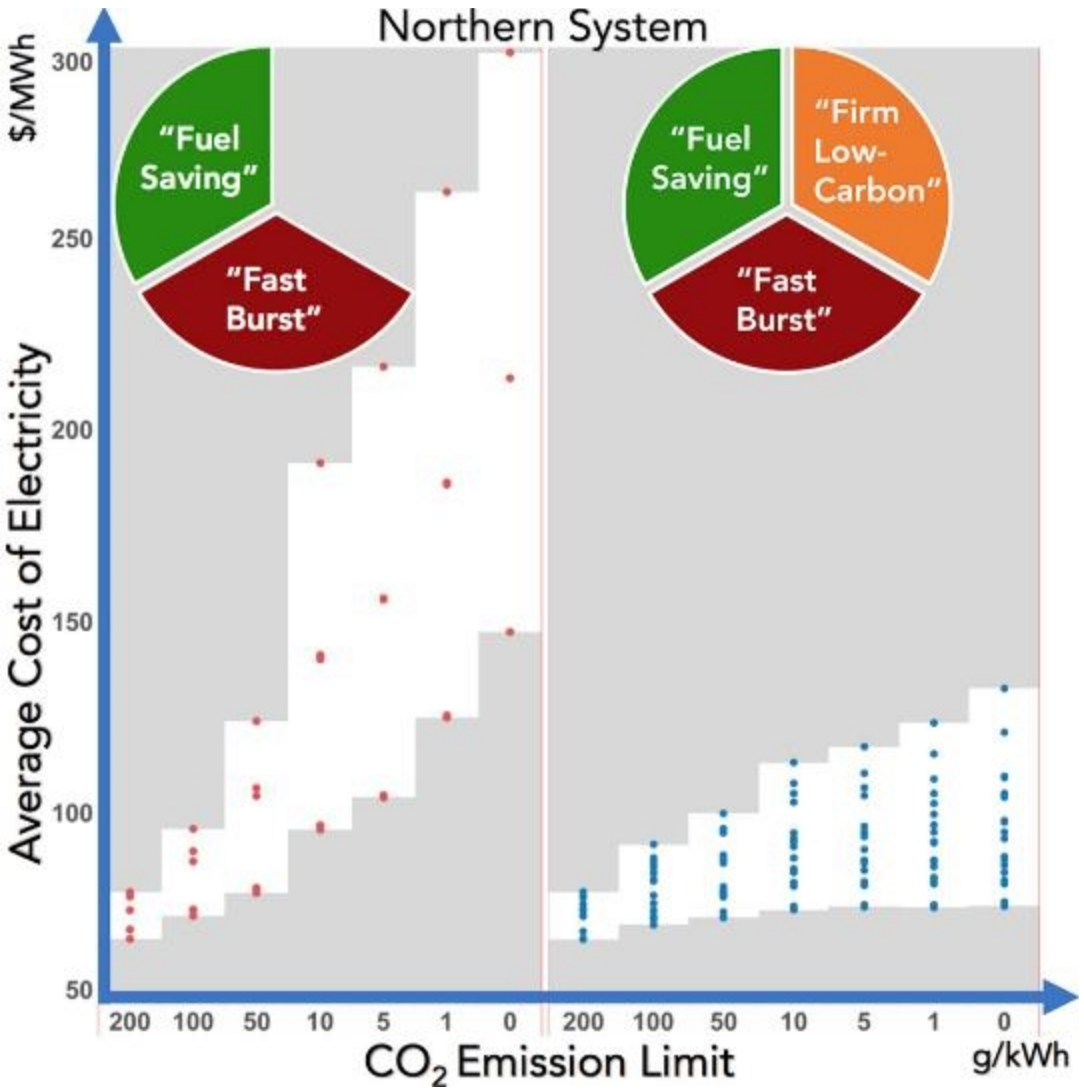
4x global increase just to satisfy U.S. demand

- 2020 production ≈ 200 GWh
- 20 million EVs per year = 1,500 GWh
- 100% decarbonization of US grid = 11.5 TWh total or 500 GWh per year for 20 years
- 10x increase in battery production just to satisfy U.S. demand

Cost Escalation of Decarbonization Without CCUS – *MIT Study*

"Without these [firm] resources, electricity costs rise rapidly as CO2 limits approach zero. Batteries and demand flexibility do not substitute for firm resources."

– Sepulveda et al. MIT Energy Institute



Source: Sepulveda et al, *Joule* 2(11), 2018, 2403-2420 https://doi.org/10.1016/j.joule.2018.08.006

Life:Powered

NECESSITY OF LOW CARBON 24/7 THERMAL RESOURCES:
In the U.S., Not All Carbon Reductions are Created Equal

Because CCUS at a dispatchable fossil fuel plant can deliver low carbon power 24/7, it is a much more valuable low-carbon asset to the grid than deep penetration of intermittent wind or solar & should be competitive with energy storage.

PART THREE:

How to Position CCUS to Help

1. Require Regulatory Decarbonization Comparison

WIND/SOLAR/STORAGE	KEY CONSIDERATIONS	CCUS RETROFIT
• Low Capacity Factors • Transmission Additions • Reliability & Resilience Penalty	**LCOE is an Academic Discussion - Focus Should be on "Levelized Cost of Dispatchable, Delivered Energy (LCODDE)"**	• High Capacity Factors • No New Transmission • High Reliability & Resilience
• Bird Strikes • Habitat Destruction • Lithium/Cobalt Mining for Batteries • Rare Earths for Turbines & Solar	**Non-GHG Externalities**	• Air Quality Not Impacted < Known "Safe" Levels (NAAQS) • Successful & Established Coal Reclamation Programs
• Backup Power Emissions • Life-Cycle GHGs From Construction & Land Use • Missed R&D opportunity	**GHG Externalities**	• No Backup Power Required – (24/7 carbon-free resource) • R&D Drives Down Future Costs (global game changer)
• Dependence on Minerals & Products Not Mined/Made in US	**Economic Impact & Geopolitical**	• Domestic fuels (coal & gas) + export commodity (oil & tech)

2. State/RTO Reliability Standards

<u>State-Established Reliability (and/or "Firming" Requirements)</u>

- Like renewable portfolio standards, but focused on grid reliability and resilience – must be uplifted to RTOs
  - *(MISO recently confirming that they are "policy takers, not makers")*
- Non-dispatchable resources could be made to procure dispatchable (low carbon?) power to mitigate against the reliability/resilience penalties they impose on the grid
- Even in states with aggressive low carbon goals, CCUS, nuclear, and batteries can compete on level playing field.

3. CCUS PORTFOLIO STANDARDS

<u>WYOMING - HF 159 (Stick)</u>

- "Good faith offer for sale" as prerequisite to retirement

<u>WYOMING - HB 200 (Carrots and Sticks)</u>

- Mandatory CCUS evaluation in IRPs
- CCUS Portfolio Standard - compliance as prerequisite to accelerated depreciation for coal plant retirement and/or cost recovery for replacement power
- Innovative Ratemaking to (1) enable IOUs to "earn" outside of rate-base and (2) allow large loads to aggregate behind the meter

2020-24 IS AMERICA'S DEFINING CCUS MOMENT

With Every Retirement of an Existing Coal (& ultimately, gas) Plant,

We Lose Resilient/Reliable Power, Employment and an Opportunity to Commercialize CCUS Technology

(along with its energy security benefits) . . .

<u>FOREVER.</u>

PART FOUR:

How to Talk About It!

THE PROBLEM:

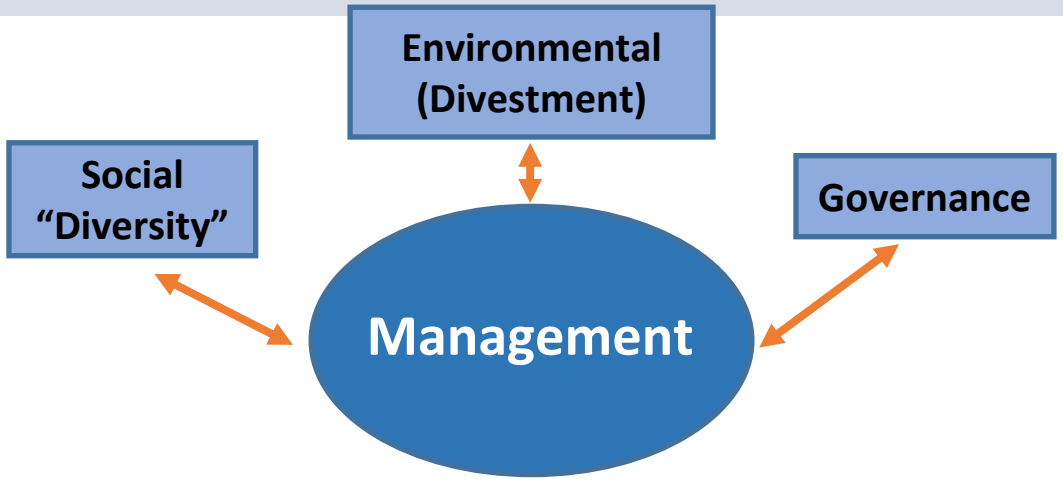
FOSSIL FUEL BASHING & LOW AMERICAN ENERGY IQ

=

ERODING POLITICAL & FINANCIAL SUPPORT FOR ANY FOSSIL FUEL PROJECT INVESTMENT, REGARLDESS OF CARBON

MULTIFACETED ANTI-FOSSIL PR CAMPAIGN

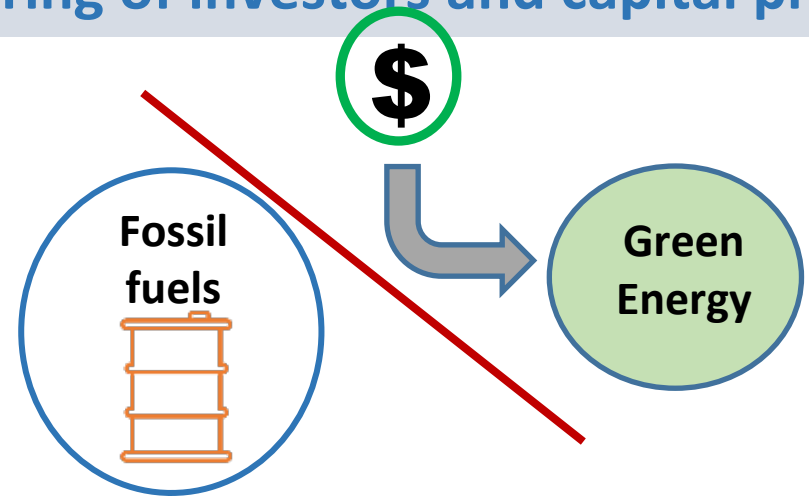
WHAT IS ESG? Corporate level - influencing board rooms and management



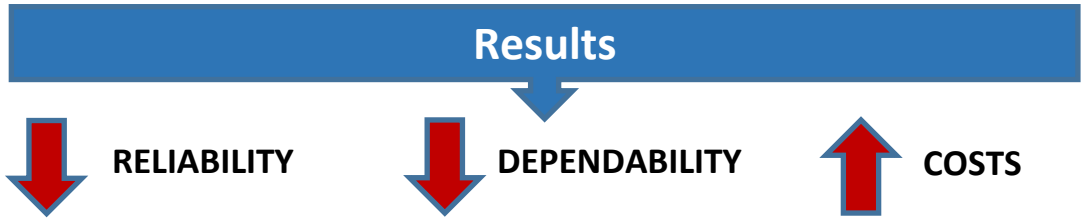
- Inserts political agendas into commercial enterprises
- Inherent tension fiduciary responsibility to the shareholders / public pensioners

HOW DOES ESG GET MANIPULATED?

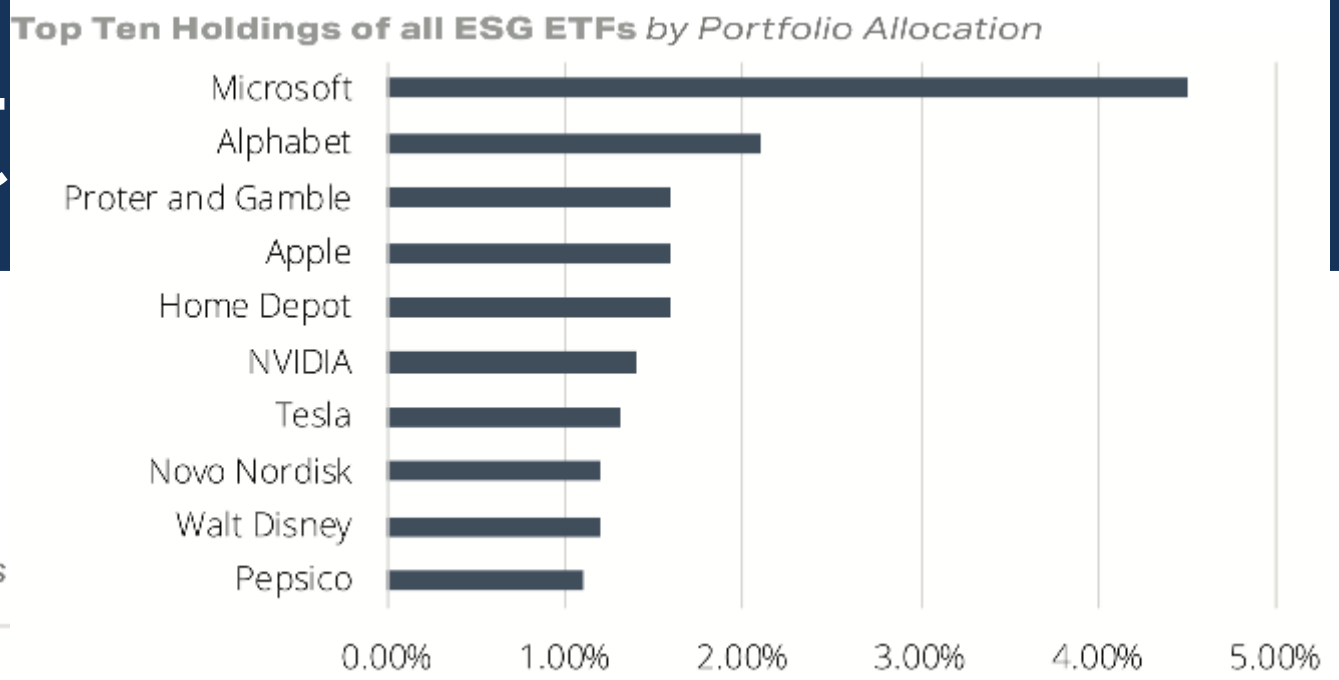
Pressuring of investors and capital providers

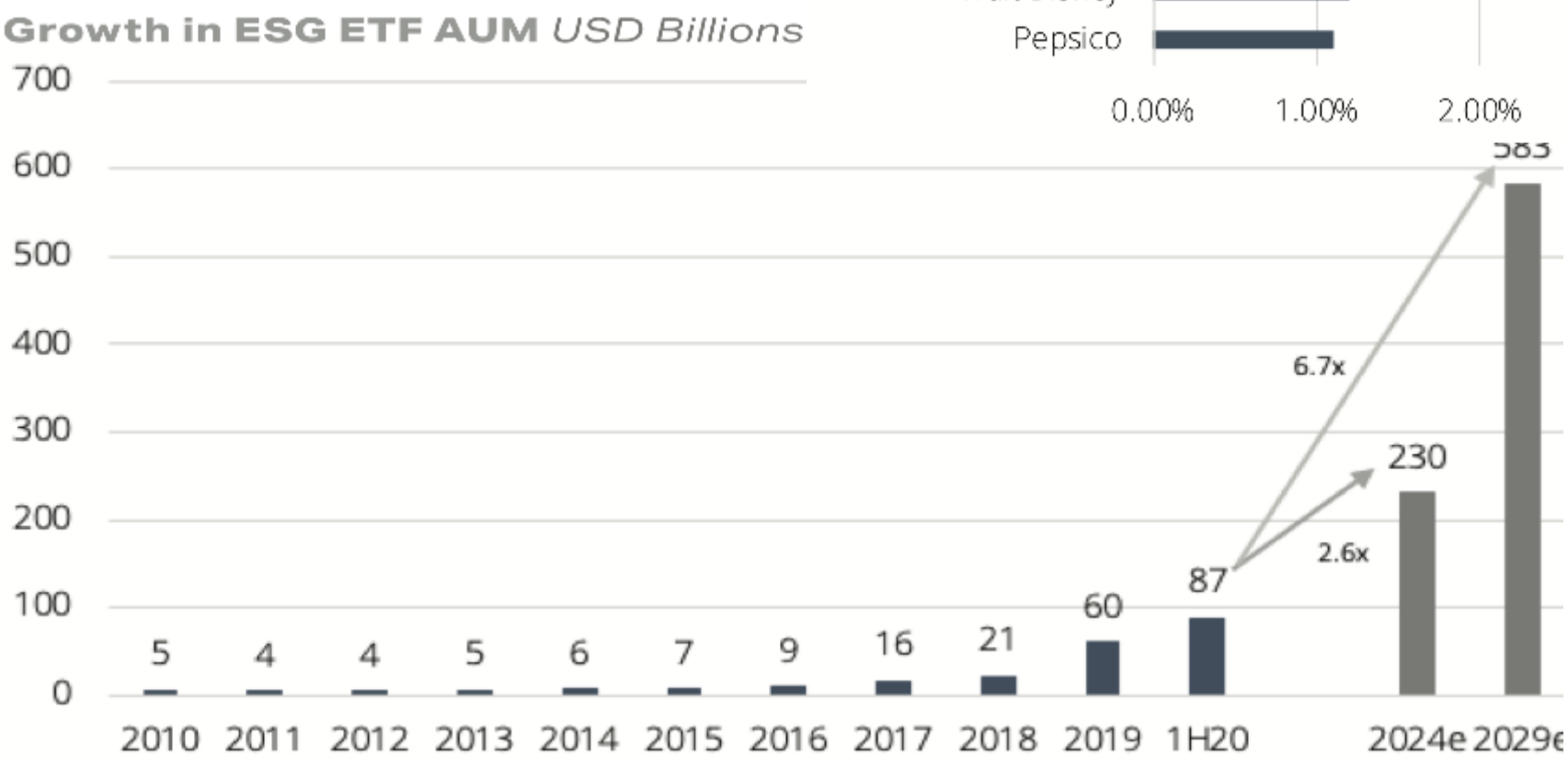


- Potential to create significant discrimination against domestic fossil fuels (Russia, China and OPEC win)
- Subsidies and distortions already compromising the marketplace and misused ESG could exacerbate distortions.



Growing Fast

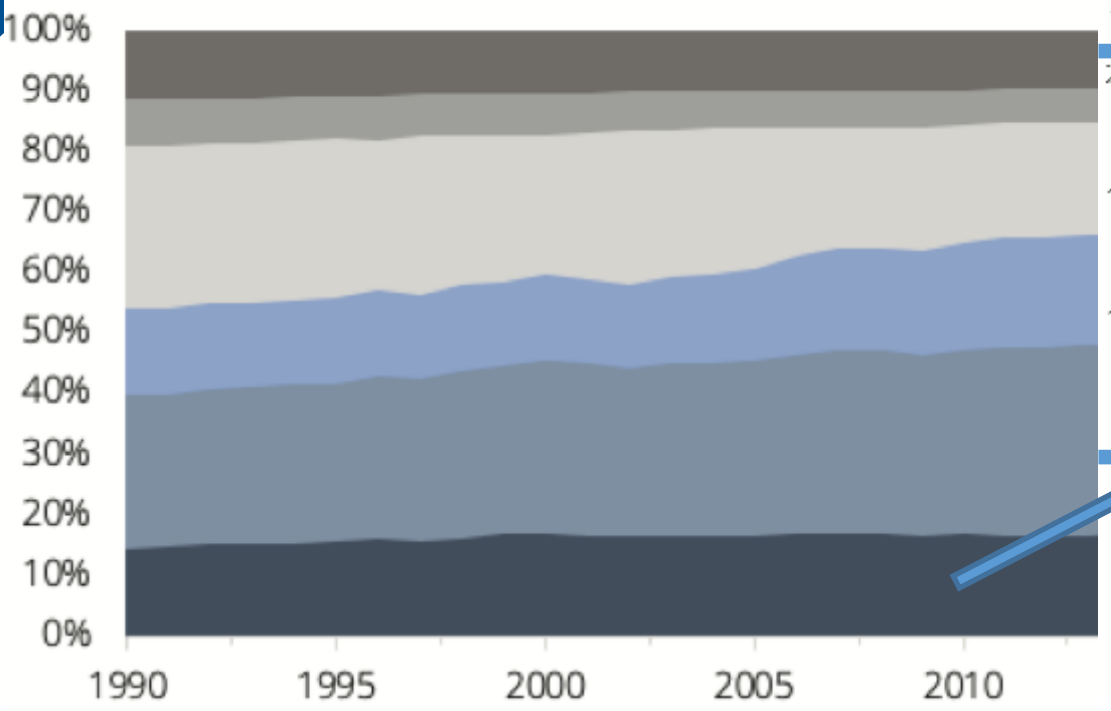


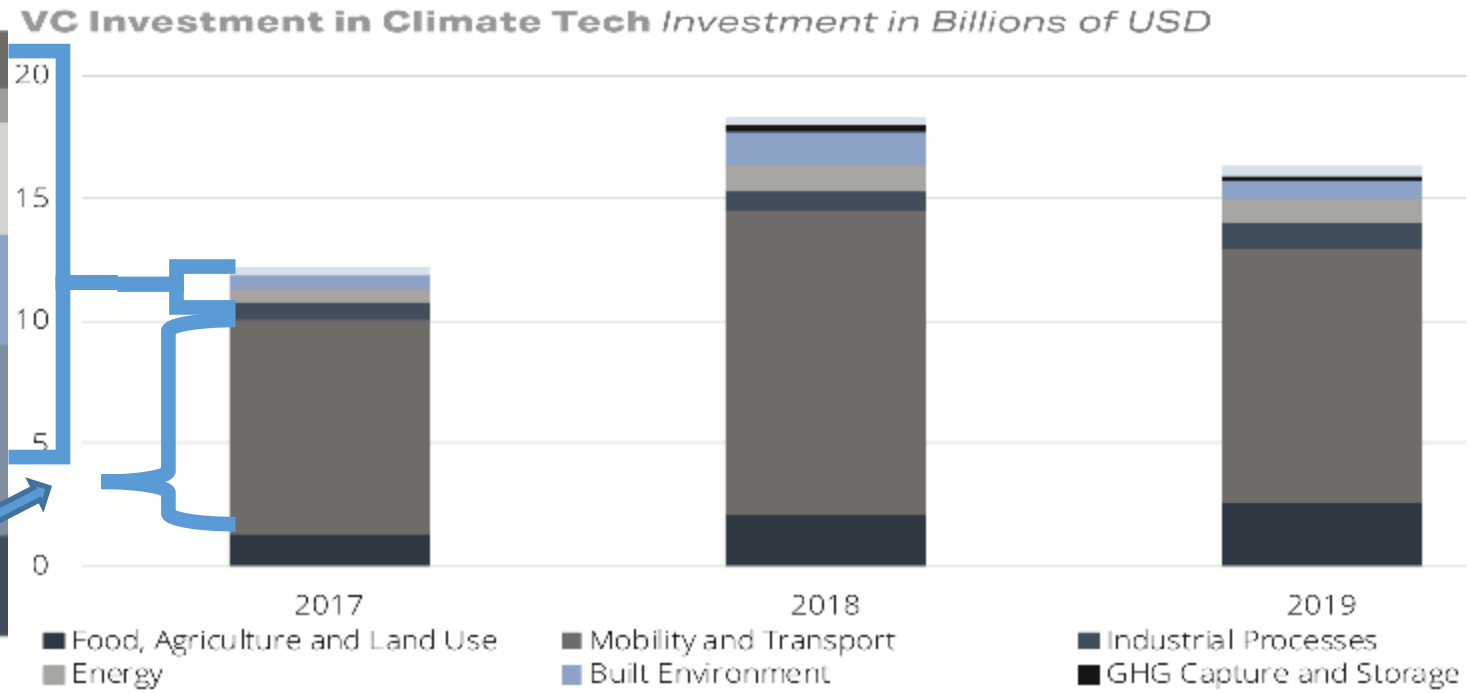


Source: Massif Capital, Morgan Stanley, Morningstar, Blackrock

YET - Most ESG Investment Won't Solve "Problem"

Sources of Global Green House Gas (GHG) Emissions Over Time





Source: Massif Capital, PWC, Dealroom

- All Transport
- Electricity
- Industry, Manufacturing & Construction
- Ag and Land Use
- Buildings
- Waste and Misc

Source: Massif Capital, CAIT Climate Data Explorer via Climate Watch

BILL GATES CHALLENGES ASSUMPTIONS

Bill Gates Quotes Vaclav Smil to explain why financial community cannot ignore physics & real drivers of global emissions.

- "Do you guys on Wall Street have something in your desk that makes steel?"
- "Are planes going to fly through the sky based on some number you put on your spreadsheet."

SO WHAT DO WE DO TO INCREASE THE AMERICAN IQ & CHANGE THE NARRATIVE?

Life:Powered

1.

Help Americans Realize that Their Everyday Lives Depend on Fossil Fuels (from minerals, to plastics, to electricity sources).

Life:Powered

HOW MUCH WE DEPEND UPON AMERICAN FOSSIL FUELS IN OUR DAILY LIVES!

"Fossil Fuels -Essential to Every Day Life" Video

https://youtu.be/mclv06jR_e0

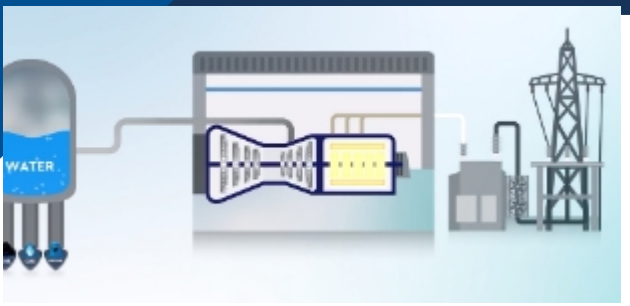
Life:Powered

2.

Make Power Markets Understandable to Americans so the Religious Belief in "100% Renewable" is Replaced with Bipartisan, Technology-Focused Goal of Decarbonization

Life:Powered

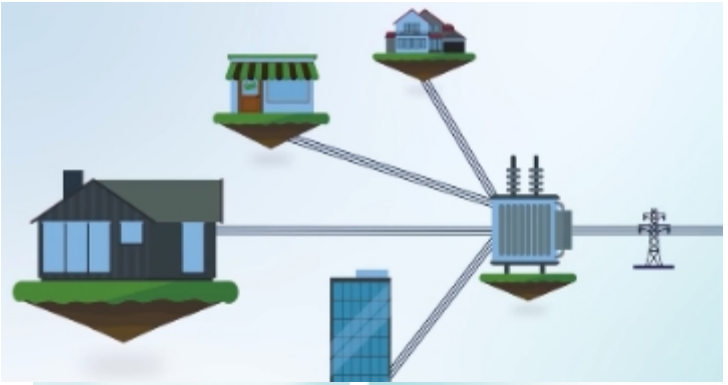
NEW ANIMATED EDUCATIONAL VIDEO SERIES ON ELECTRICITY & ENVIRONMENTAL TECHNOLOGY (*www.LifePowered.org*)



VIDEO 1 - Energy 101: Why We Need Electricity
https://youtu.be/ZfrBnddgFAU

VIDEO 2 - Energy 101: The Electric Grid
https://youtu.be/WiMtU6O1SxM

VIDEO 3 - Energy 101: Where Electricity Comes From
https://youtu.be/AKuoIeupGHc



VIDEO 4 - Energy 101: Energy Density
https://youtu.be/6d-HGzZHPG4

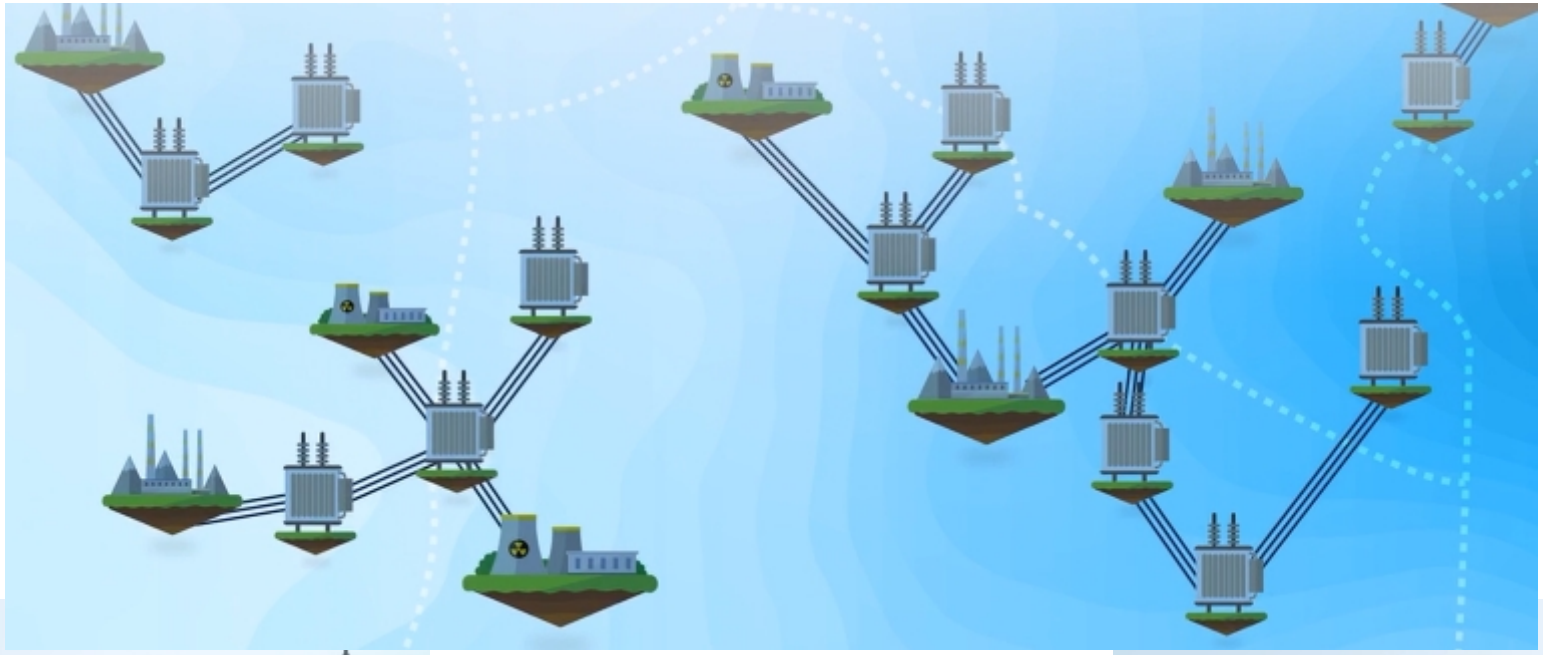
VIDEO 5 - Energy 101: Mining and Rare Earths
https://youtu.be/yu3mkFpiGmo

VIDEO 6 - Energy 101: Environmental Technology
https://youtu.be/aodsngzbZqA

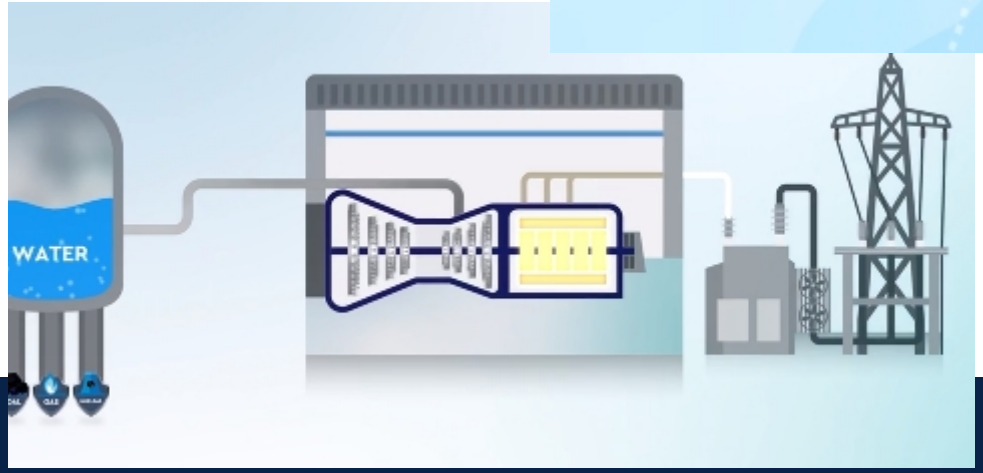
NEW ENERGY 101 EDUCATION VIDEOS –

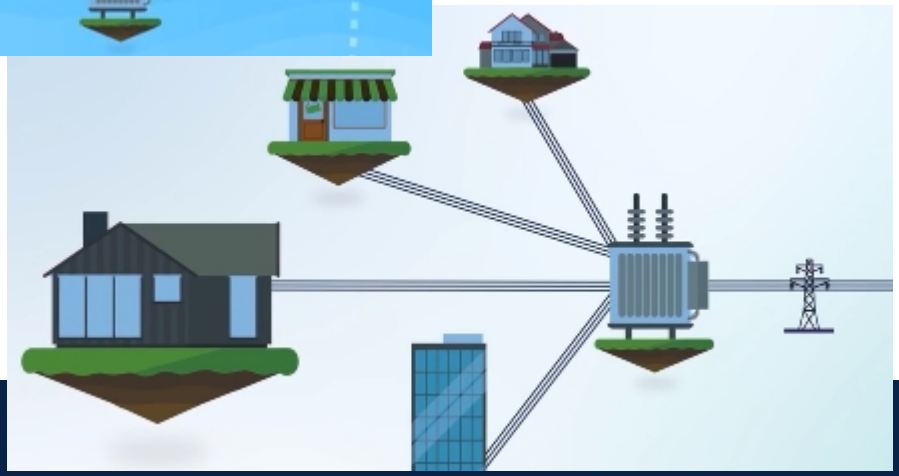
2. The Electric Grid

English Version Link



Spanish Version Link



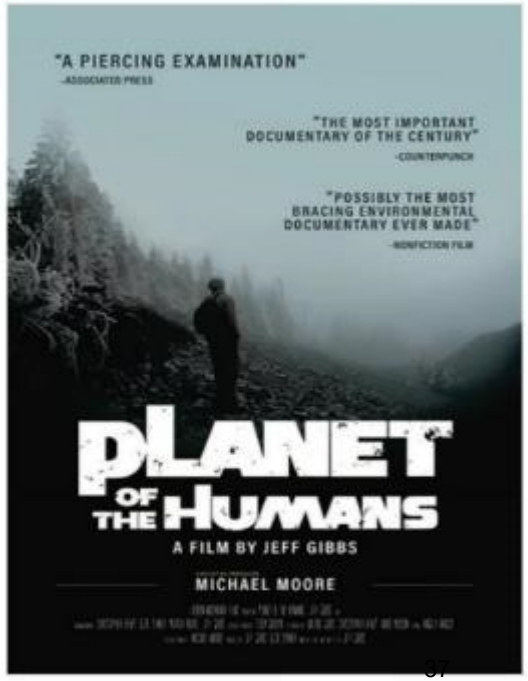


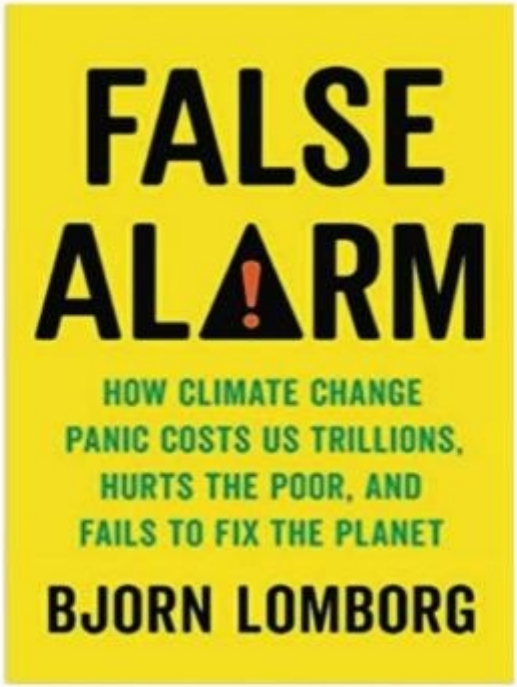
3.

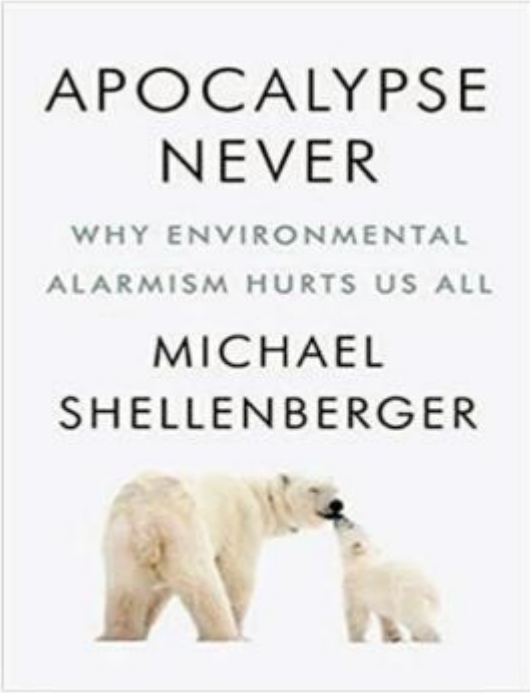
Help Americans Understand the Externalities of Renewables & the Inhumanity of Slowing Energy Access to the People of the Developing World

Life:Powered

2020 IS TURNING OUT TO BE THE YEAR MEMBERS OF THE LEFT STARTED ACKNOWLEDGING THE ENVIRONMENTAL CONSEQUENCES OF "100% RENEWABLE" PLANS



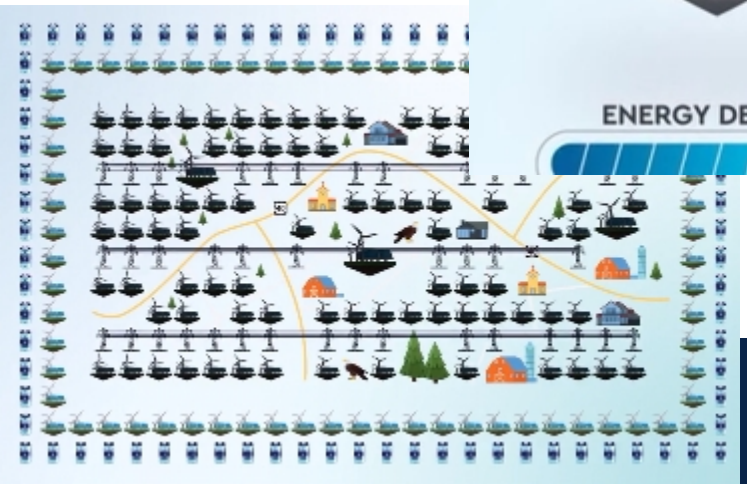


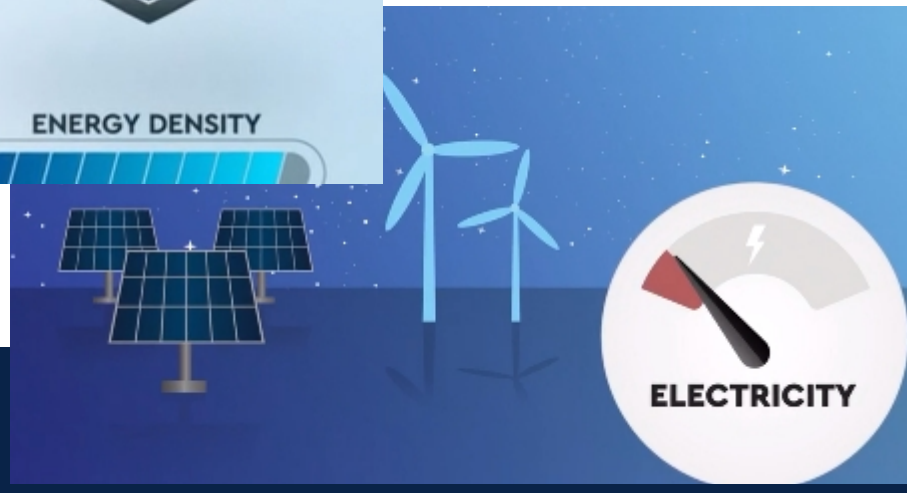


New Educational Series on Electricity Fundamentals – 4. Energy Density:

English Version Link

Spanish Version Link

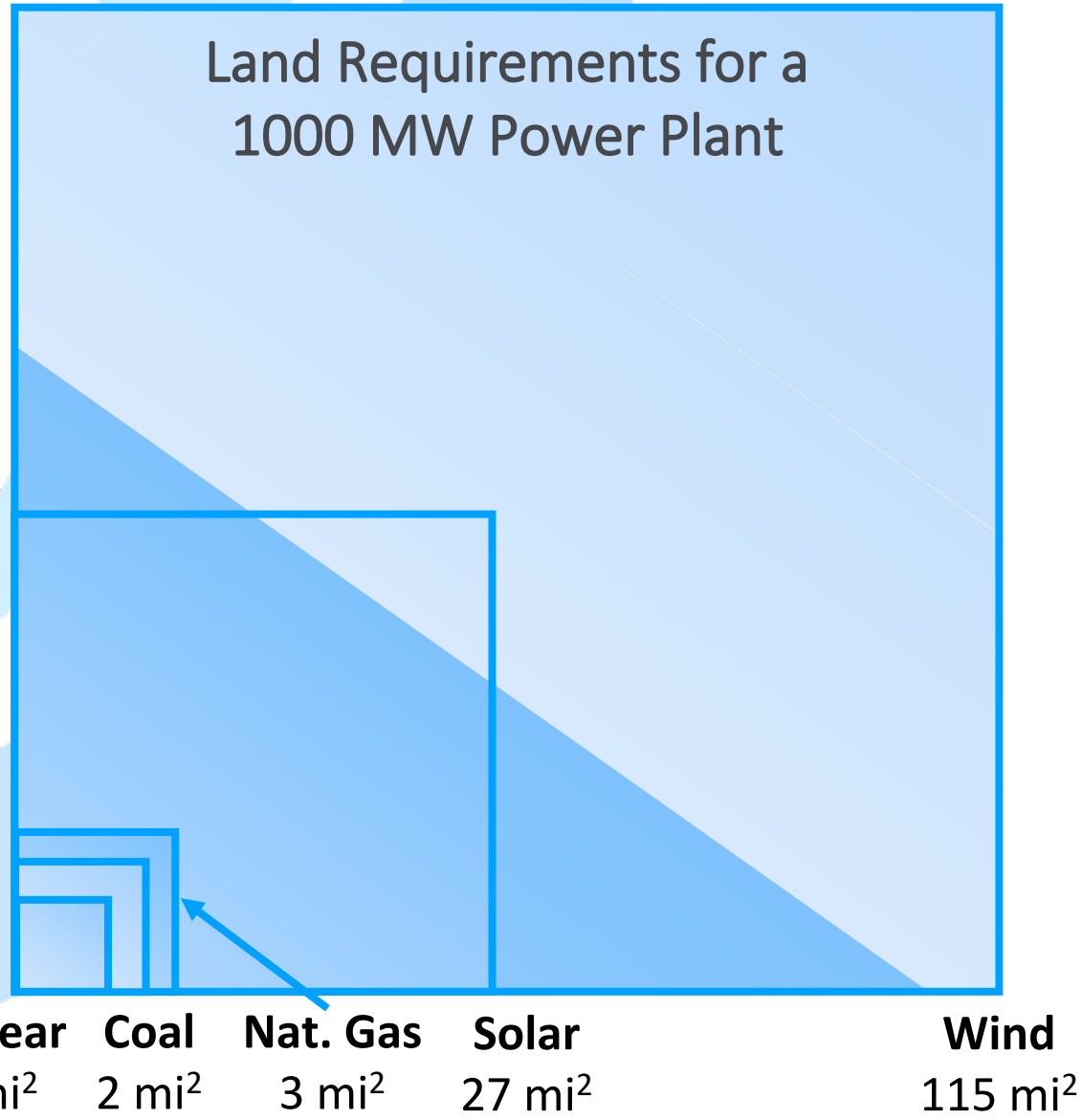




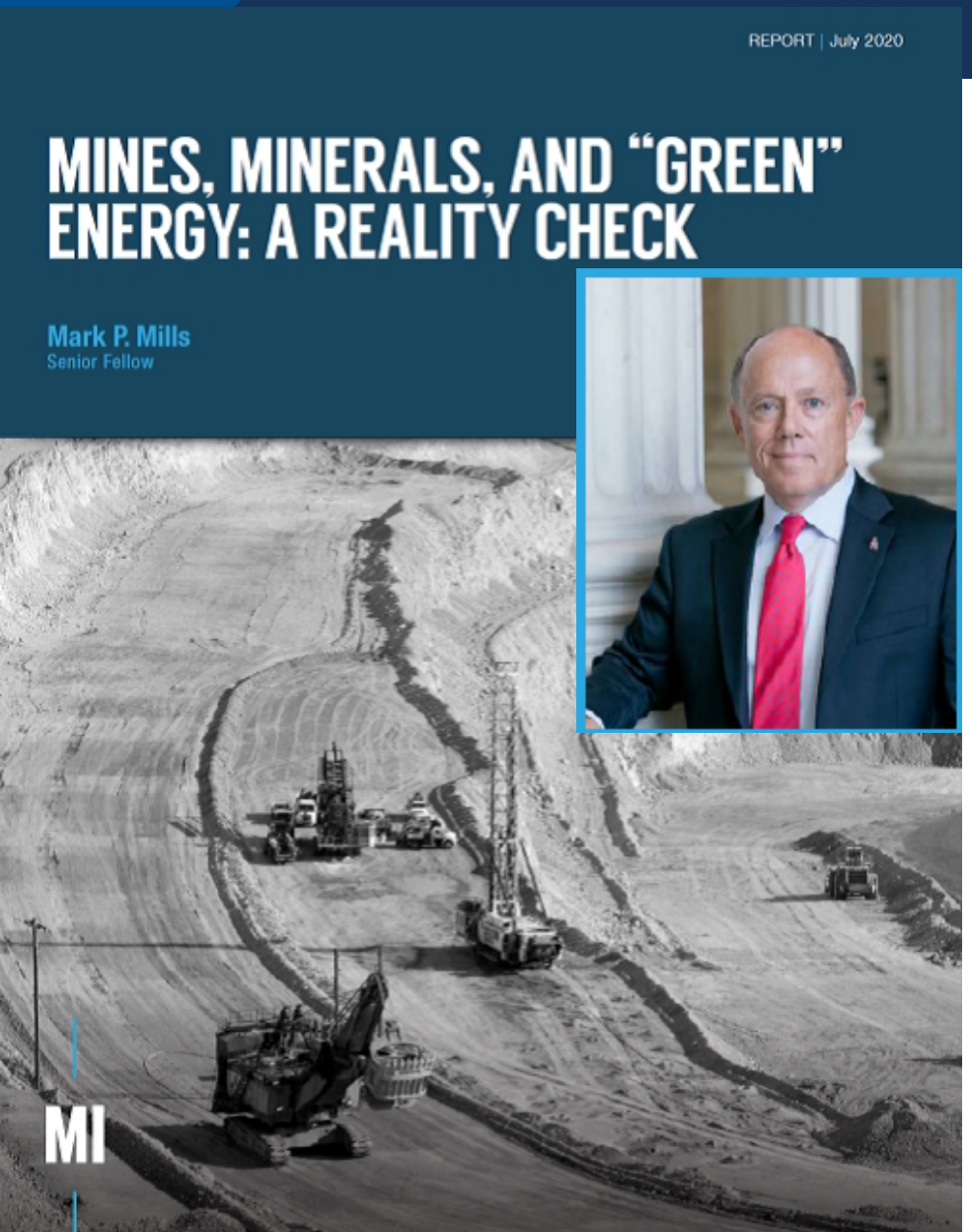
Energy Density = Environmental Stewardship

Density of U.S. Energy Resources

Power Source	W/m²
Nuclear	307
Coal	182
Natural Gas	101
Crude Oil	22
Solar	8
Hydroelectric	1.7
Wind	1.0
Ethanol	0.3



RECOMMENDED READING/VIEWING:



<u>ALSO A GREAT VIDEO</u>

Explaining the Physical Limitations & Other Reality-Checks on Non-Thermal Decarbonization

https://www.prageru.com/video/whats-wrong-with-wind-and-solar/

GLOBAL ENERGY REALITY CHECK:
In the U.S., Not All Carbon Reductions are Created Equal

If we are serious about mitigating anthropogenic CO2, it is critical that we advance commercialization of CCUS in the U.S. so we make it affordable for immediate retrofit deployment across the developing world.

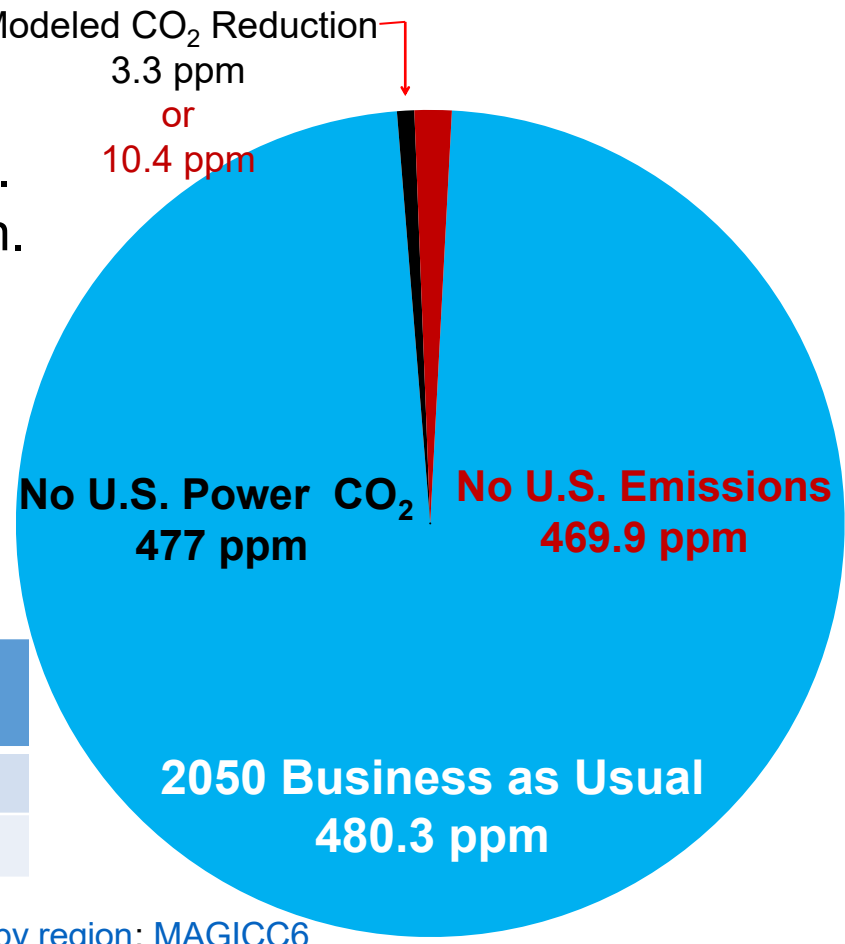
DON'T FORGET THE MATH:
The World Needs our Technology, Not Anti-Fossil Fuel Ideology

2050 IMPACT OF DECARBONIZING ELECTRICITY:

- NO COAL FLEET = 2.06 ppm (0.4%) reduction in CO_2 concentration.
- NO FOSSIL FLEET = 3.3 ppm (0.7%) reduction in CO_2 concentration.
- Modeled global temperature reduced by a mere 0.016°C.

2050 IMPACT OF DECARBONIZING ENTIRE U.S.:

- 10.4 ppm (2.2%) reduction in CO_2 concentration.
- Modeled global temperature reduced by 0.053°C.



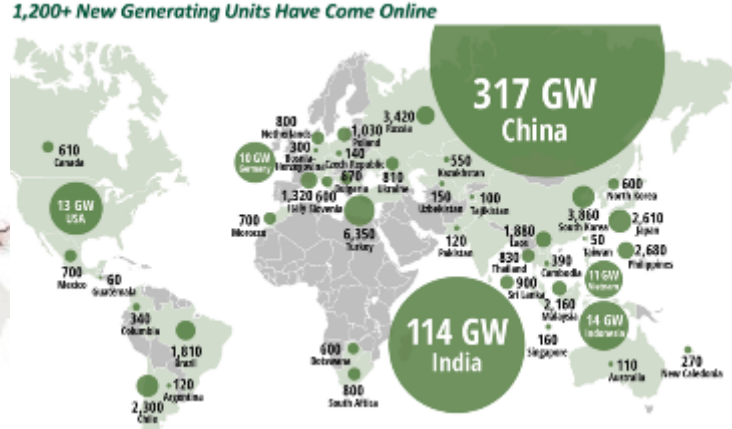
CO2 Emissions	2010	2020	2030	2040	2050	% Change
World	30,834	34,972	36,398	39,317	42,771	+38.7%
U.S.	5,571	5,260	4,839	4,867	5,071	-8.9%

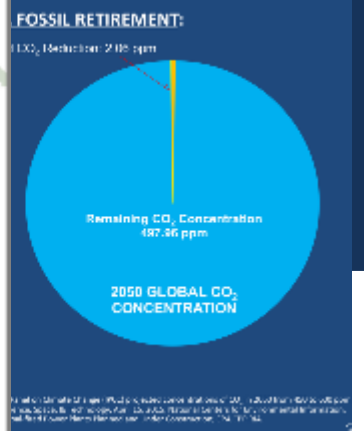
Sources: Energy Information Administration, International Energy Outlook 2017, World carbon dioxide emissions by region; MAGICC6 Model; Intergovernmental Panel on Climate Change Fifth Assessment Report Working Group I, Summary for Policymakers; National Oceanic and Atmospheric Administration Global Land and Temperature Anomalies.

"Energy Poverty" Video

https://www.youtube.com/watch?v=nEovKjVkUpc

Life:Powered





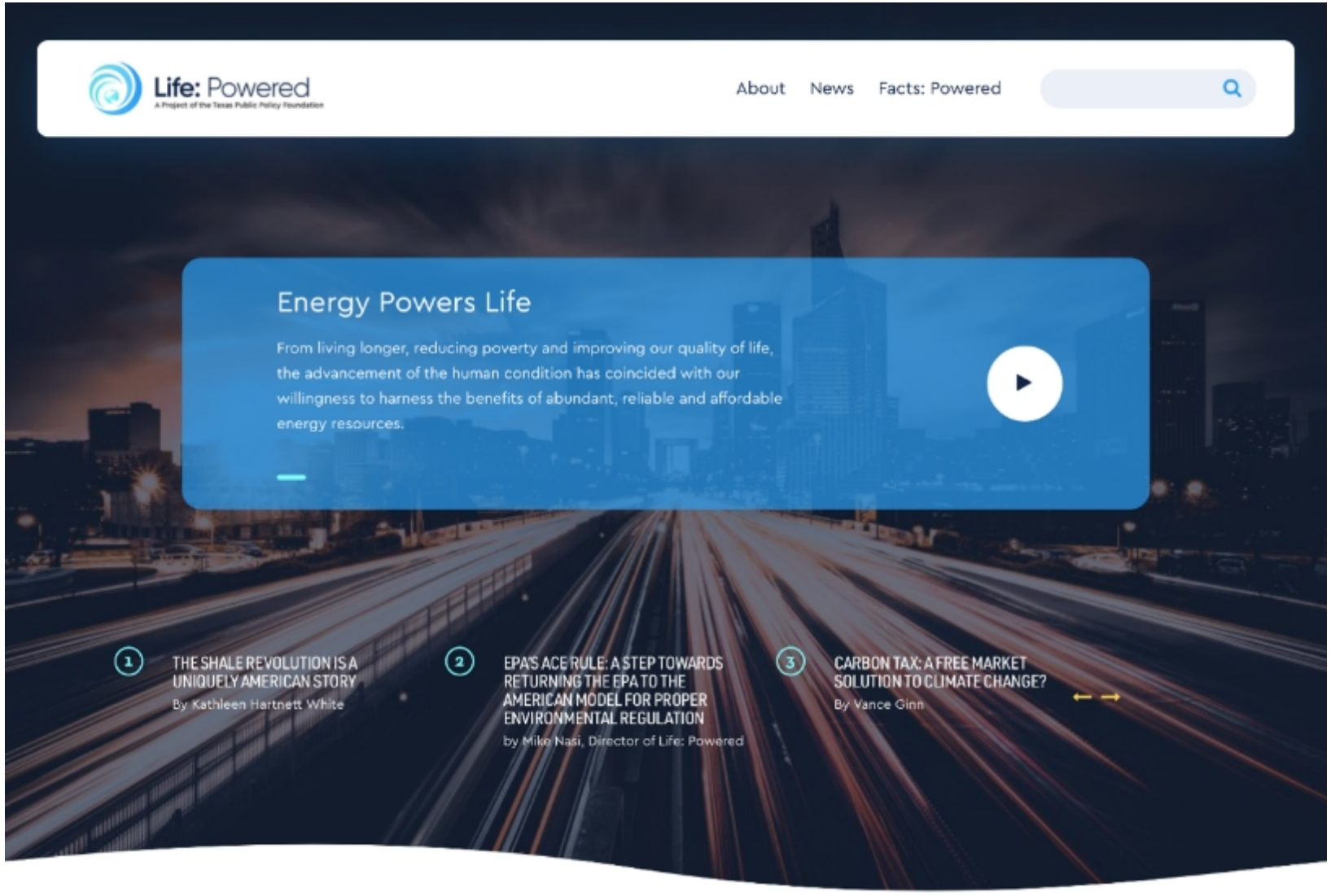
"Converting Carbon to a Commodity" Video

https://www.youtube.com/watch?v=TlXVvAoQBjc

Life:Powered

CENTERPIECE OF OUR EDUCATION CAMPAIGN!

www.LifePowered.org



SUBSCRIBE!

FOLLOW!

DISTRIBUTE!

&

REACH OUT TO SUPPORT THE EFFORT!

Mike Nasi
Director, ***Life:Powered***
Partner,
Jackson Walker L.L.P.
mnasi@jw.com
512-236-2000

QUESTIONS / FOLLOW-UP?

Mike Nasi

Partner, Jackson Walker LLP

Senior Advisor, *Life:Powered*

mnasi@jw.com

512-736-9200