# 50% GHG Reduction by 2030 is Doable

Chandu Visweswariah



### Purpose: review a recent Think Tank report "100% Solar, Wind & Batteries is Just the Beginning"

#### **References**

- "100% Solar, Wind and Batteries is Just the Beginning," by Adam Dorr and Tony Seba, RethinkX, October 2020, downloadable from <u>https://www.rethinkx.com/energy#energy-download</u>.
- "The Great Stranding: How Inaccurate Mainstream LCOE Estimates are Creating a Trillion-Dollar Bubble in Conventional Energy Assets," Adam Dorr and Tony Seba, RethinkX, February 2021, downloadable from <a href="https://www.rethinkx.com/energy-lcoe-download">https://www.rethinkx.com/energy-lcoe-download</a>.
- 3. "A Wartime Plan for Electrifying America," podcast with Saul Griffith of Rewiring America, May 2021, available at <a href="https://www.greentechmedia.com/articles/read/a-wartime-plan-for-electrifying-america">https://www.greentechmedia.com/articles/read/a-wartime-plan-for-electrifying-america</a>.

#### The importance of 50% GHG reduction by 2030

SPECIAL REPORT

# Global Warming of 1.5 °C

In model pathways with no or limited overshoot of  $1.5^{\circ}$ C, global net anthropogenic CO<sub>2</sub> emissions decline by 40–60% levels by 2030.



#### **Mission Statement**

Croton100 is an all-volunteer community-based organization that seeks to reduce Greenhouse Gas (GHG) emissions in Croton-on-Hudson, NY (zip code 10520) to net zero by 2040, or 5% reduction per year, through a combination of advocacy, education and campaigns.



# Biden Promises to Slash Greenhouse Gas Emissions by 50 Percent by 2030

#### **Of Moon Shots and "Earth Shots"**





	Moon Shot	"Earth Shot"
Announcement by	President Kennedy	President Biden
Date of announcement	May 25, 1961	April 22, 2021 (Earth Day)
Deadline	"End of decade"	"End of decade"
Urgency	Win the cold war	Future of the planet
Age of President	43	78
Degree of difficulty	Hard	Super-hard
Invention required	Yes	Less so
Average citizens' role	Minimal	Central

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#### Where will the 50% come from in this decade?



#### A word about Tony Seba



 Rethinking

 Food and

 Agriculture

 D200-2030

Clean Disruption of Energy and Transportation : How Silicon Valley Will Make Oil, Nuclear, Natural Gas, Coal, Electric Utilities and Conventional Cars Obsolete By 2030 by Tony Seba







Rethinking Transportation 2020-2030: The Disruption of Transportation and the Collapse of the Internal-Combustion Vehicle and Oil Industries (RethinkX Sector Disruption) (Volume 1) by James Arbib and Tony Seba

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Disruption, Implications, and Choices

RethinkX

# Part 1: Executive summary

- 1. We are on the cusp of the **fastest**, **deepest**, **most profound disruption** of the energy sector
- 2. In the '20s, solar PV will get cheaper by 72%, lithium-ion batteries by 80%, wind power by 43%
- 3. 100% SWB (Solar, Wind, Battery) is physically possible, economically affordable and inevitable by 2030
- 4. Coal, gas and nuclear will become stranded assets in this decade and no new investment is rational at this point... committed emissions get us to 1.8°C of warming
- 5. The new system will include a **super-abundance of clean energy** ("super energy") at near-zero marginal cost that will create new economic opportunities and allow us to decarbonize 50% economy-wide by 2030
- 6. What happened in the world of bits will happen in the world of electrons



Disruption

#### Part 2: Cost curves

U.S. Solar PV Capital Cost (logarithmic plot)

#### U.S. Stationary Lithium-Ion Battery Energy Storage Capacity Cost (pack level) (logarithmic plot)



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### Cost of a 100% SWB system\* in ERCOT\*\*



Sources: Berkeley Labs, 2019; NREL, 2019; BNEF, 2019; RethinkX, 2020.13.8

\*Battery-firmed capacity that makes electricity from solar and wind dispatchable all day and all night year-round

\*\*Electricity Reliability Council of Texas manages power flow to 26M+ customers in Texas

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#### Part 3: Clean energy U-curve introduction



Electricity generation, transmission, and distribution

Replace by an equivalent amount of solar and wind (and batteries), right? Wrong! Super size the amount of solar and wind!

## **Clean energy U-curve**



#### Disproportionate super power returns on additional system capex investment



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## Part 4: Findings

- The study looked at CAL-ISO, ERCOT and ISO-NE
- A lowest cost SWB analysis was conducted for each region
- Storage requirements were based on historical weather patterns and an optimal mix of wind and solar
- Conservative assumptions to create a limit scenario:
  - No technology breakthroughs other than what is implied in cost curves
  - No carbon tax or subsidies
  - No withdrawal of massive fossil fuel subsidies in place today
  - No credit for "health dividend"
  - No imports of energy, no Distributed Energy Resources (DERs), no Demand-Side Management (DSM), no Energy Efficiency (EE) gains, no Vehicle to Grid (V2G), no peak shaving

## Findings in CAL-ISO, ERCOT, ISO-NE

CALIFORNIA	Lowest Cost 100% SWB System	Lowest Cost 100% SWB System + 10% Investment	Lowest Cost 100% SWB System + 20% Investment	Today
Capital cost	\$115 billion	\$127 billion	\$139 billion	
Solar PV capacity	213 gigawatts	278 gigawatts	328 gigawatts	28 gigawatts
Wind capacity	25 gigawatts	25 gigawatts	25 gigawatts	6 gigawatts 🗼
Generation capacity	3.8x	4.8x	5.6x	
Battery capacity	1194 gigawatt-hours	945 gigawatt-hours	833 gigawatt-hours	
Battery average demand hours	37 hours	29 hours	26 hours	
Annual super power	309 terawatt-hours	466 terawatt-hours	592 terawatt-hours	
Fraction of days with super power	93%	98%	98%	
Electricity cost (0% of super power utilized)	3.1 cents/kilowatt-hour	3.4 cents/kilowatt-hour	3.8 cents/kilowatt-hour	
Electricity cost (50% of super power utilized)	2.0 cents/kilowatt-hour	1.9 cents/kilowatt-hour	1.8 cents/kilowatt-hour	
Electricity cost (100% of super power utilized)	1.5 cents/kilowatt-hour	1.3 cents/kilowatt-hour	1.2 cents/kilowatt-hour	

Source: RethinkX

TEXAS	Lowest Cost 100% SWB System	Lowest Cost 100% SWB System + 10% Investment	Lowest Cost 100% SWB System + 20% Investment	
Capital cost	\$197 billion	\$218 billion	\$239 billion	
Solar PV capacity	362 gigawatts	505 gigawatts	583 gigawatts	4.6 gigawatts
Wind capacity	40 gigawatts	40 gigawatts	40 gigawatts	29.4 gigawatts
Generation capacity	4.9x	6.7x	7.6x	
Battery capacity	2325 gigawatt-hours	1610 gigawatt-hours	1498 gigawatt-hours	
Battery average demand hours	49 hours	34 hours	32 hours	
Annual super power	504 terawatt-hours	814 terawatt-hours	983 terawatt-hours	
Fraction of days with super power	93%	96%	97%	
Electricity cost (0% of super power utilized)	3.5 cents/kilowatt-hour	3.9 cents/kilowatt-hour	4.0 cents/kilowatt-hour	
Electricity cost (50% of super power utilized)	2.2 cents/kilowatt-hour	2.0 cents/kilowatt-hour	1.9 cents/kilowatt-hour	
Electricity cost (100% of super power utilized)	1.6 cents/kilowatt-hour	1.3 cents/kilowatt-hour	1.3 cents/kilowatt-hour	

Source: RethinkX

NEW ENGLAND	Lowest Cost 100% SWB System	Lowest Cost 100% SWB System + 10% Investment	Lowest Cost 100% SWB System + 20% Investment	
Capital cost	\$91 billion	\$100 billion	\$109 billion	
Solar PV capacity	87 gigawatts	158 gigawatts	197 gigawatts	1.5 gigawatts
Wind capacity	27 gigawatts	27 gigawatts	27 gigawatts	1.5 gigawatt
Generation capacity	3.8x	7.3x	10.8x	
Battery capacity	1232 gigawatt-hours	835 gigawatt-hours	729 gigawatt-hours	
Battery average demand hours	89 hours	58 hours	43 hours	
Annual super power	61 terawatt-hours	143 terawatt-hours	189 terawatt-hours	
Fraction of days with super power	64%	84%	91%	
Electricity cost (0% of super power utilized)	6.1 cents/kilowatt-hour	6.6 cents/kilowatt-hour	7.2 cents/kilowatt-hour	
Electricity cost (50% of super power utilized)	4.9 cents/kilowatt-hour	4.2 cents/kilowatt-hour	4.1 cents/kilowatt-hour	
Electricity cost (100% of super power utilized)	4.0 cents/kilowatt-hour	3.1 cents/kilowatt-hour	2.8 cents/kilowatt-hour	

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![](_page_15_Figure_0.jpeg)

![](_page_15_Figure_1.jpeg)

Source: RethinkX

Source: RethinkX

![](_page_15_Figure_4.jpeg)

System CapEx

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#### Electricity cost and super power use

![](_page_16_Figure_1.jpeg)

Electric Power Transportation Residential Industrial Commercial Electric Power Transportation Residential Commercial Industrial Electric Power Transportation Residential Commercial Industrial Source: RethinkX

#### Part 5: Implications: cost of generating energy

# **Conventional energy**

# **Renewable energy**

#### **Stranded** assets

![](_page_18_Picture_1.jpeg)

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#### **Cost considerations**

- Cost of a 100% SWB system nationwide by 2030 is \$2T
  - Perspective: about 1% of the US GDP a tiny investment in the scheme of things
  - Perspective: ZCAP (Zero Carbon Action Plan) puts the cost between 0.2% and 1.2% of the GDP
- Value of economic activity and technology leadership: priceless!
- Annual savings in energy cost is \$0.5T
- For a median family with income of \$61,000, energy cost will reduce from \$4,500 to \$2,500 per year

#### Implications: cost of moving energy

# **Moving energy**

# **Generating energy**

### Take-aways

- 1. 100% SWB system is possible, affordable, inevitable
  - a. Not dependent on subsidies or carbon taxes or unpredictable innovations
- 2. Amount of battery storage is much less than widely believed (43 to 89 averagedemand hours of storage)
- 3. A 100% SWB system will be the cheapest option for electricity
- 4. Economic benefits
  - a. Build-out will create millions of jobs
  - b. Super power will lead to new businesses and opportunities
- 5. Can eliminate 50% of greenhouse gases by 2030
- 6. Super power is a solution, not a problem and drives down costs for all
  - a. Can accelerate the decarbonization of heating, transportation, industry, agriculture
  - b. Can generate economic benefits... a race to the top... a virtuous cycle
  - c. Energy efficiency is less important... like trying to conserve film with a film camera

#### So... what should I do?

![](_page_22_Picture_1.jpeg)

![](_page_22_Picture_2.jpeg)

![](_page_22_Picture_3.jpeg)

- 1. Disruption: expect <u>very high penetration of renewable electricity</u> to the tune of 100% by 2030
- 2. Disruption: expect <u>very low-cost electricity</u> towards a penny a kilowatt hour by 2030
- 3. <u>Prioritize electrification</u> over energy efficiency
  - a. Electrify your vehicle
    - ... and your School's and your municipalities' and your neighbors and your relatives'
  - b. Electrify your heating
  - c. Electrify your appliances
    - ... hot water heater, cook-top, oven, clothes dryer, lawnmower, leaf blower, trimmer
  - d. Get your electricity from your own solar, community solar, CCA, clean ESCO
  - e. Eat less meat!
  - f.//The rest is pennies on the dollar (or kilograms on the ton)

#### **Of Moon Shots and "Earth Shots"**

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