



Renewable & Appropriate Energy Laboratory

**RAEL**



# Accelerating Climate Protection and the Just Transition

**Daniel Kammen**

Senior Advisor for Energy Innovation, US Agency for International Development  
Former Science Envoy, United States Department of State

Building a Blue New Deal: Ocean Health for a Livable and Just Planet

Energy and Resources Group (Chair)  
Goldman School of Public Policy  
Department of Nuclear Engineering  
Director, Renewable and Appropriate Energy Laboratory  
University of California, Berkeley

# To access the materials presented today:

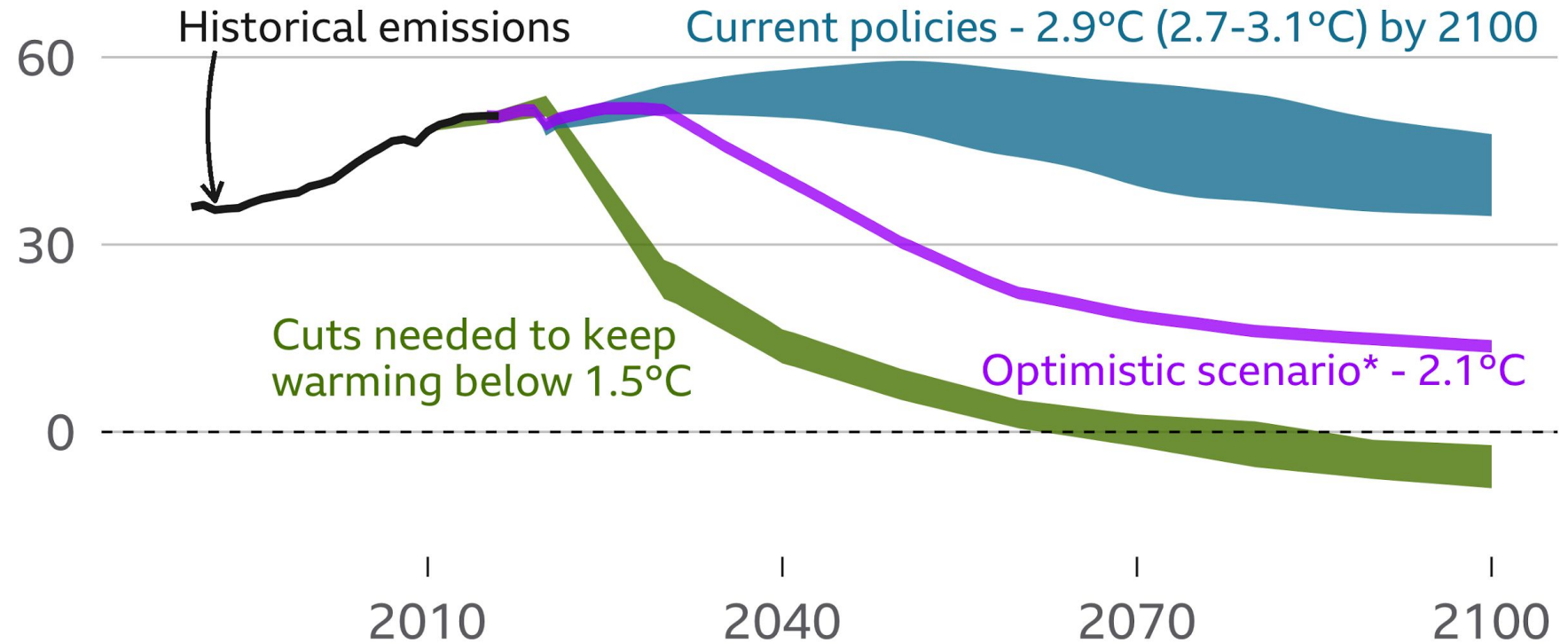
<http://rael.berkeley.edu>



@dan\_kammen

# Greenhouse gas emissions projections

Gigatonnes of global CO<sub>2</sub> equivalent emissions per year

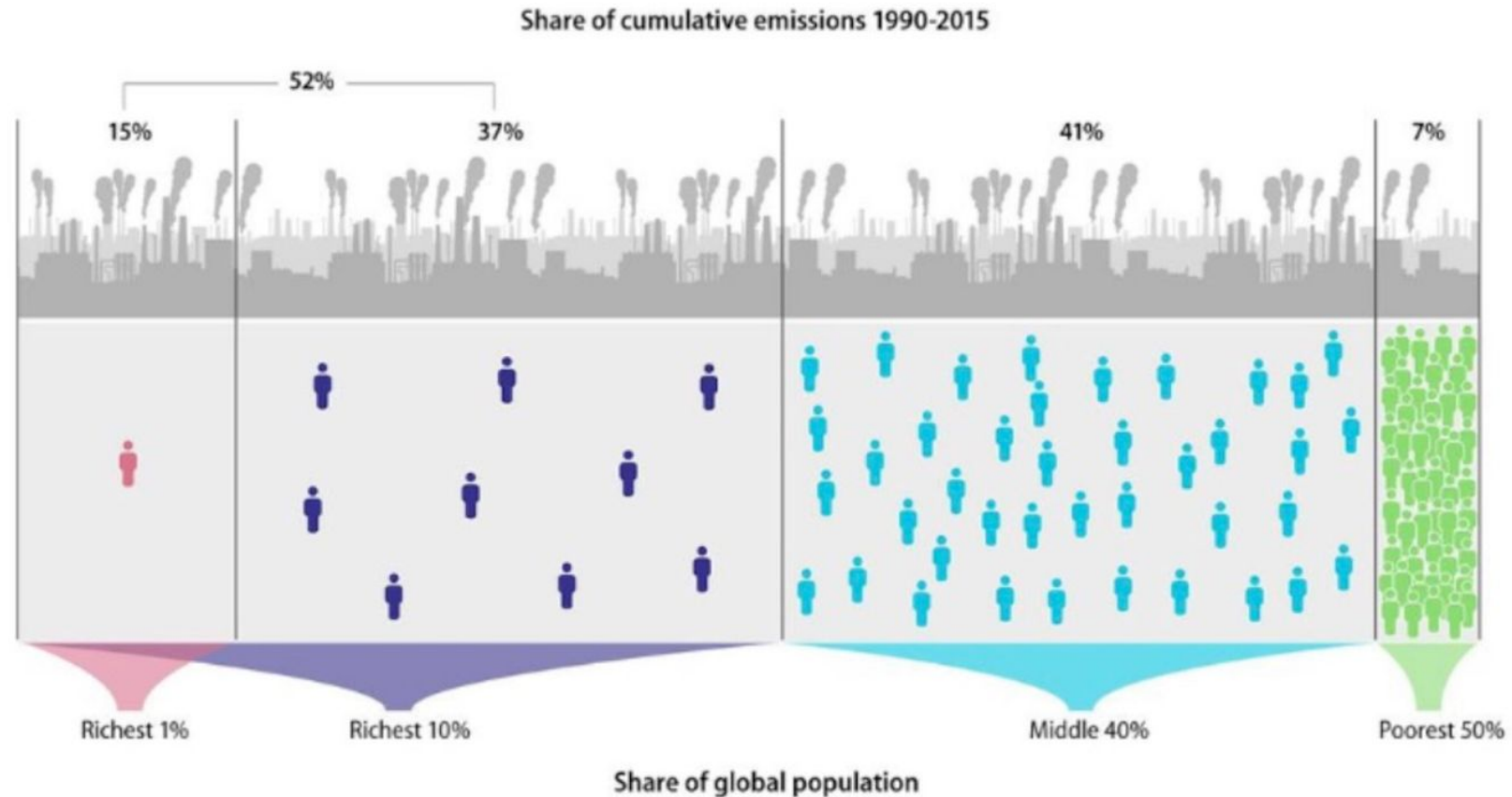


\*Based on new long term promises by China, US, EU and others

Source: Climate Action Tracker

BBC

# The future of climate protection is Justice (data: 1990 – 2015)

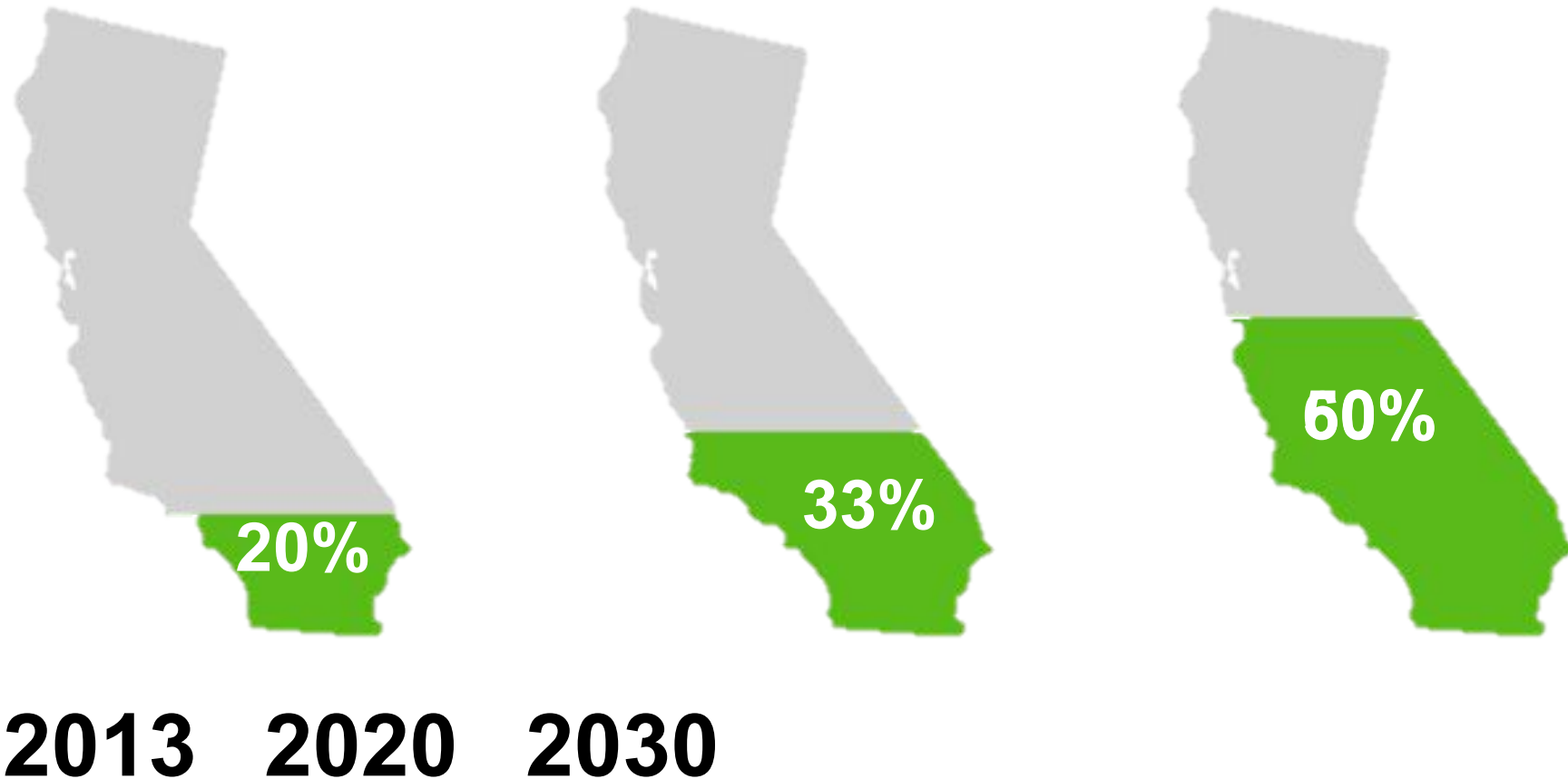


Analytics: The richest 1% reduce their emissions by a factor of *thirty* while the poorest increase their emissions by a factor of *three* for the world to stay within the global carbon budget in a fair way.

**Profound implications for how we design energy systems for the Just Transition**

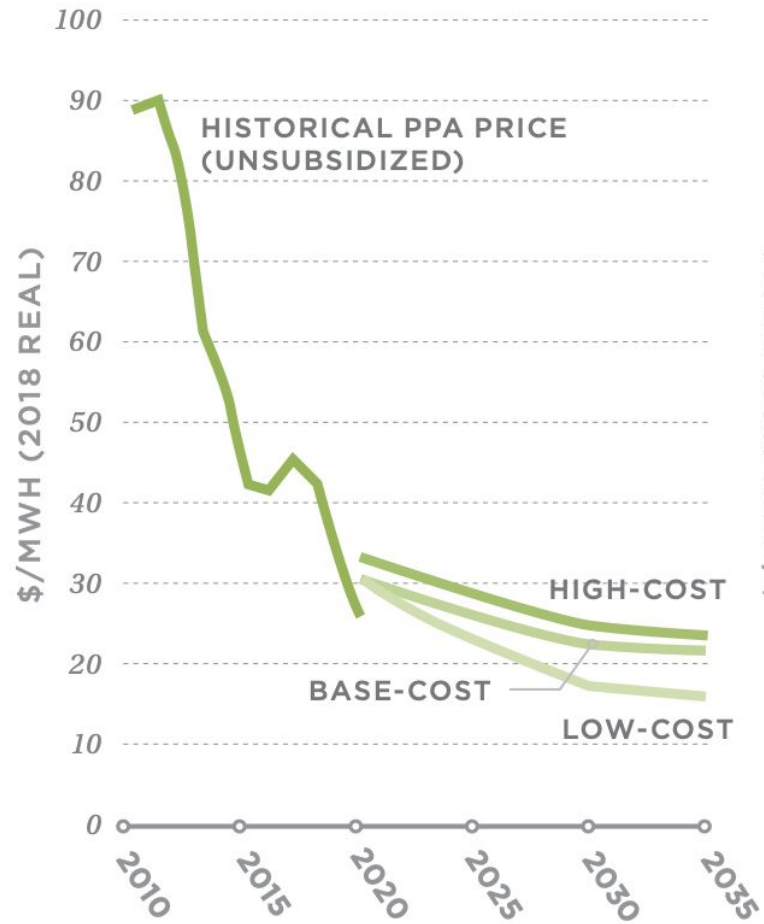
# California Energy & Environmental Justice Path

## 35% of Carbon Cap & Trade Funds for Under-Served Communities

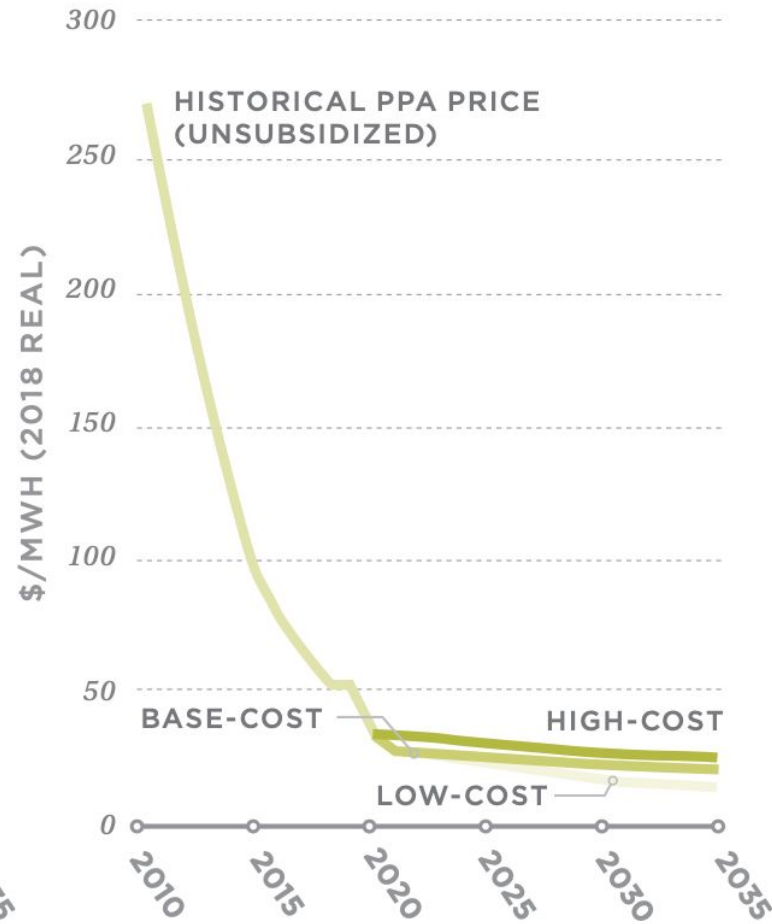


California Senate Bill 100: 100% clean energy by 2045 and  
2030 standard now 60% (without nuclear or large hydro)

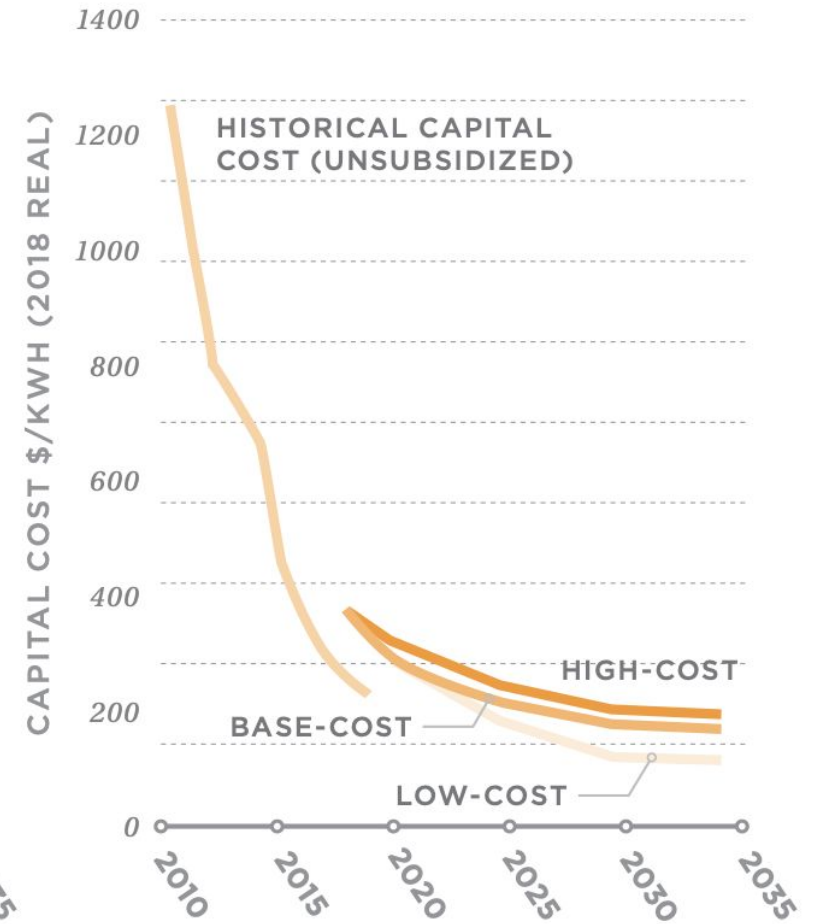
## WIND LCOE



## SOLAR LCOE



## BATTERY STORAGE CAPITAL COST



**Now cheaper to *build renewables* than to *operate fossil fuel power plants***

# California sets new clean energy records:

## Update: 104% of demand met by clean energy, May 2022

Los Angeles Times

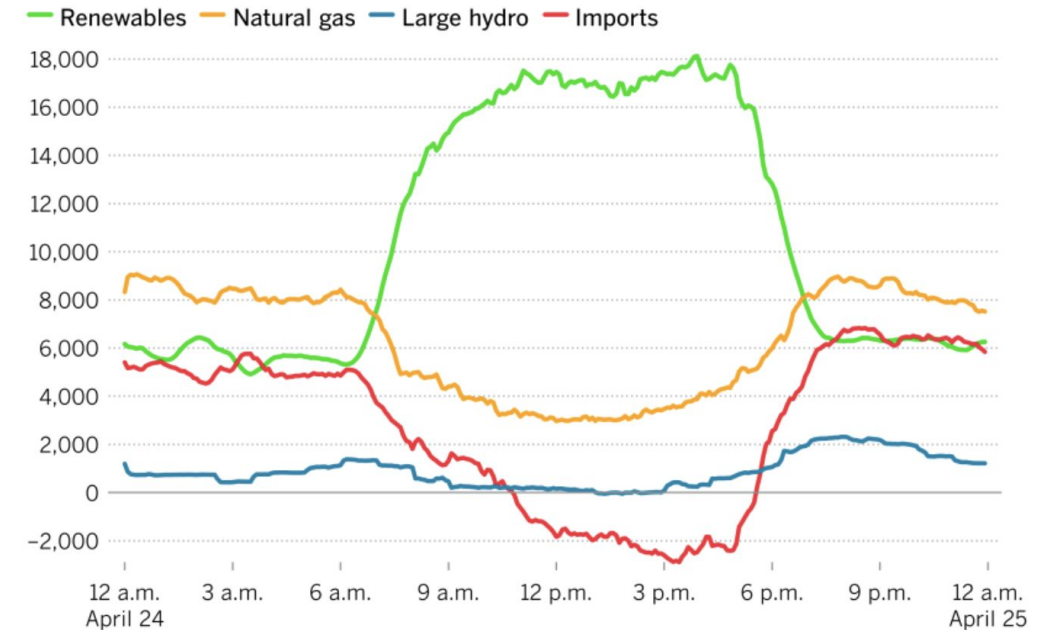


California just hit 95% renewable energy.  
Will other states come along for the ride?



### California power supply, April 24 2021

Megawatts



California Independent System Operator

Today's Outlook AS OF 11:00 04/29/2021



**22,507 MW**  
Current demand



**29,026 MW**  
Forecasted peak



**15,257 MW**  
Current renewables



**68%**  
Renewables serving load



# California, the 4<sup>th</sup> or 5<sup>th</sup> largest economy on the planet set new clean energy records in 2021 &

## Renewable energy supply and overall energy demand on April 30 in California

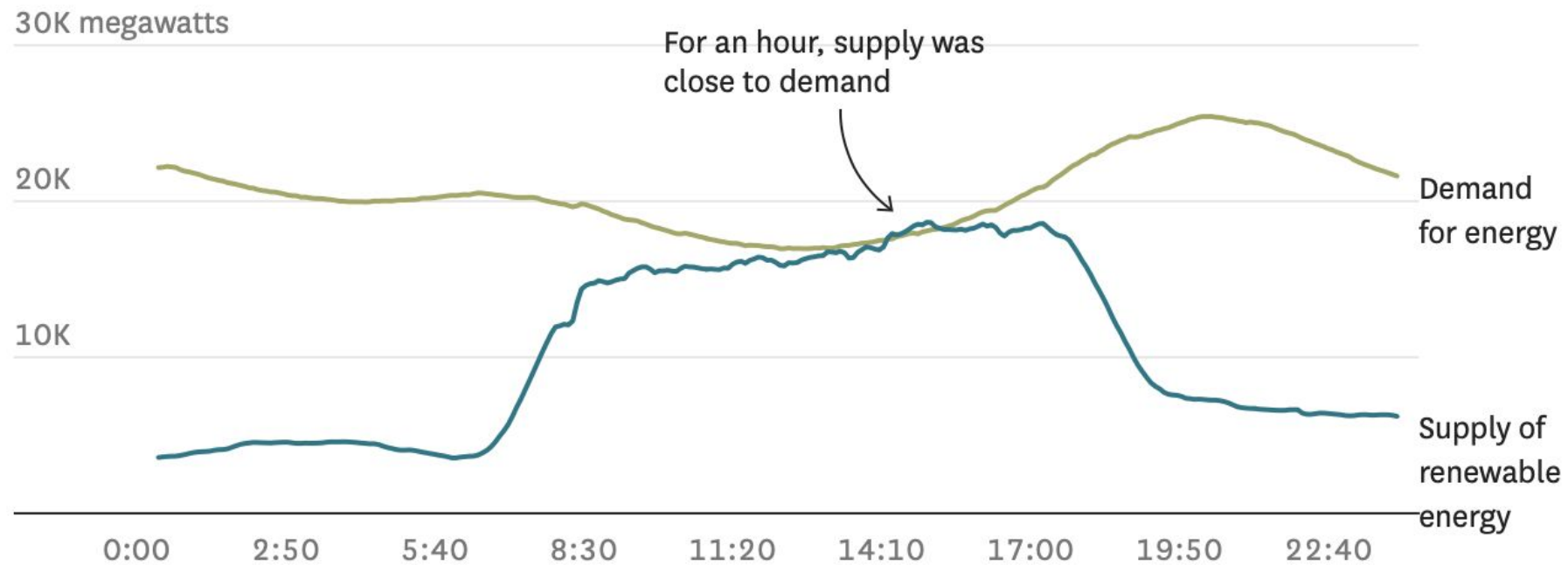


Chart: Hilary Fung • Source: [California ISO](#)



OPINION



## Op-Ed: California can do better than carbon neutrality by 2045



<https://www.latimes.com/opinion/story/2022-05-17/california-air-resources-board-carbon-neutrality-2045-2030>

# Job creation and community empowerment is fundamental achieving a decarbonized energy sector by 2035

Energy Source	Direct Jobs	Indirect Jobs	Induced Jobs	Total Jobs
Oil & natural gas	0.8	2.9	2.3	5.2
Coal	1.9	3.0	3.9	6.9
Building retrofits	7.0	4.9	11.8	16.7
Mass transit/ rail	11.0	4.9	17.4	22.3
Smart grid	4.3	4.6	7.9	12.5
Biomass	7.4	5.0	12.4	17.4
Solar	5.4	4.9	8.4	13.3
Wind	4.6	4.4	9.3	13.7

Table 1: Job creation per million \$ spending across fossil fuel (grey), infrastructure (blue) and renewable energy (green). Data is compiled from a range of sources including annual updates of the Wei, Patadia and Kammen (2010) paper, and the U. S. Department of Energy (2017) *Energy and Employment Report*.

"All the News  
That's Fit to Print"

# The New York Times

Late Edition

Today, clouds and sun, thunderstorms, high 92. Tonight, partly cloudy, humid, low 80. Tomorrow, partly sunny skies, thunderstorms, high 94. Weather map, Page B7.

VOL. CLXXI . . . No. 59,509

© 2022 The New York Times Company

NEW YORK, MONDAY, AUGUST 8, 2022

\$3.00

## SENATE VOTE PUTS CLIMATE ACTION IN REACH



KENNY HOLSTON FOR THE NEW YORK TIMES

**DEALMAKER** Senator Chuck Schumer, the majority leader, helped resurrect a long-sought, but scaled-back, domestic bill. Page A15.

**Urgent Response  
Is 5 Decades  
in Making**

By CORAL DAVENPORT  
and LISA FRIEDMAN

WASHINGTON — In 1969, President Richard Nixon's adviser Daniel Patrick Moynihan wrote a memo describing a startling future. The increase of carbon dioxide in the atmosphere caused by burning oil, gas and coal, Mr. Moynihan wrote, would dangerously heat the planet, melt the glaciers and cause the seas to rise. "Goodbye New York," Mr. Moynihan wrote. "Goodbye Washington, for that matter."

Fifty-three years later, Congress is on the cusp of finally responding to what Mr. Moynihan termed "the carbon dioxide problem."

On Sunday, Senate Democrats muscled through a \$370 billion bill designed to move the country away from fossil fuels and toward solar, wind and other renewable energy. If the House passes the legislation later this week as expected, it will be the nation's first major climate law, coming as scientists warn that nations have only a few remaining years to make deep enough cuts in carbon dioxide to avoid planetary catastrophe.

Once enacted, the new law is

**Bill Also Tackles  
Taxes and Cost  
of Drugs**

By EMILY COCHRANE

WASHINGTON — The Senate passed legislation on Sunday that would make the most significant federal investment in history to counter climate change and lower the cost of prescription drugs, as Democrats banded together to push through major pieces of President Biden's domestic agenda over unified Republican opposition.

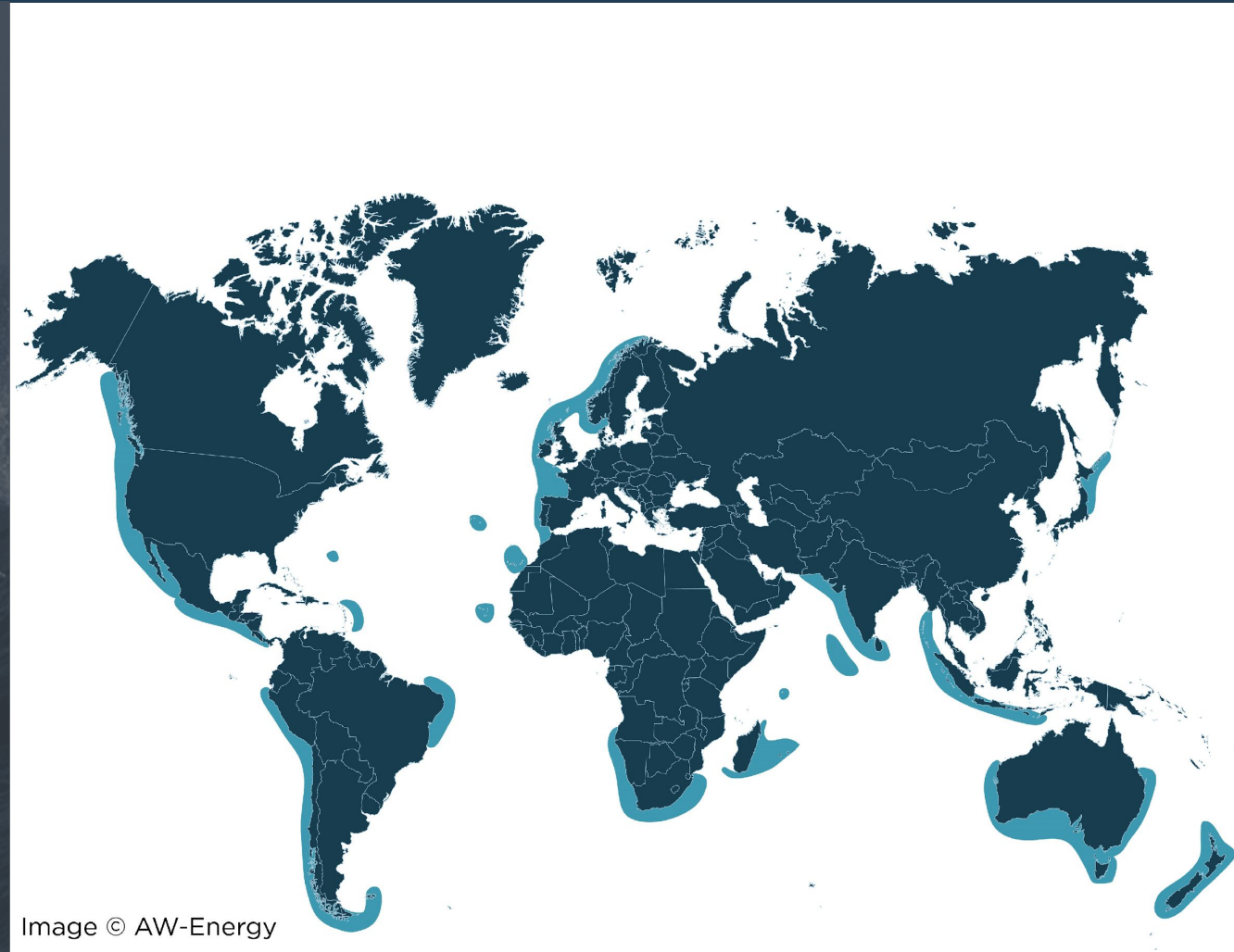
The measure, large elements of which appeared dead just weeks ago amid Democratic divisions, would inject more than \$370 billion into climate and energy programs. Altogether, the bill could allow the United States to cut greenhouse gas emissions about 40 percent below 2005 levels by the end of the decade.

It would achieve Democrats' longstanding goal of slashing prescription drug costs by allowing Medicare for the first time to negotiate the prices of medicines directly and capping the amount that recipients pay out of pocket for drugs each year at \$2,000. The measure also would extend larger premium subsidies for health coverage for low- and middle-income people under the Affordable Care Act for three years.

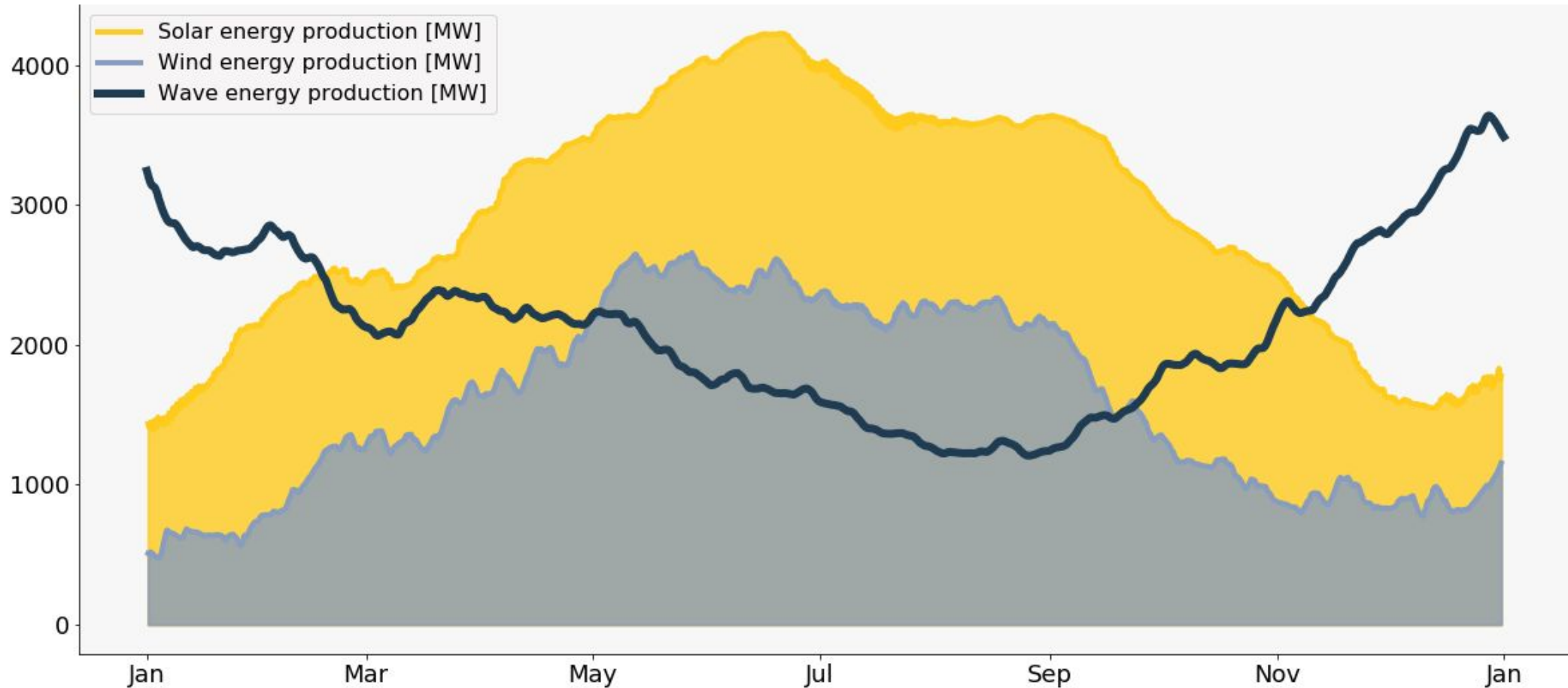
**A Pipeline Project Seemed Doomed Until Manchin Stepped In**

# THE OPPORTUNITY: 500 GW OF OCEAN POWER | 10% OF GLOBAL ELECTRICITY

- 500 GW | 2300 TWh
- CO<sub>2</sub> Reduction | 1 – 2.2 Gigaton / year (vs Gas - Coal)
- Production profile is very consistent, predictable: an ideal partner with solar & wind
- Provides **grid balancing** enabling 100% renewable electricity systems.



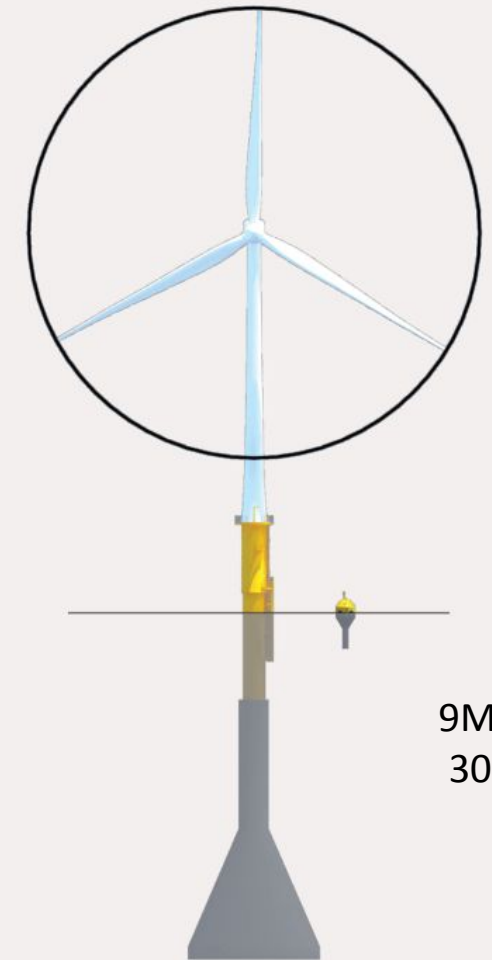
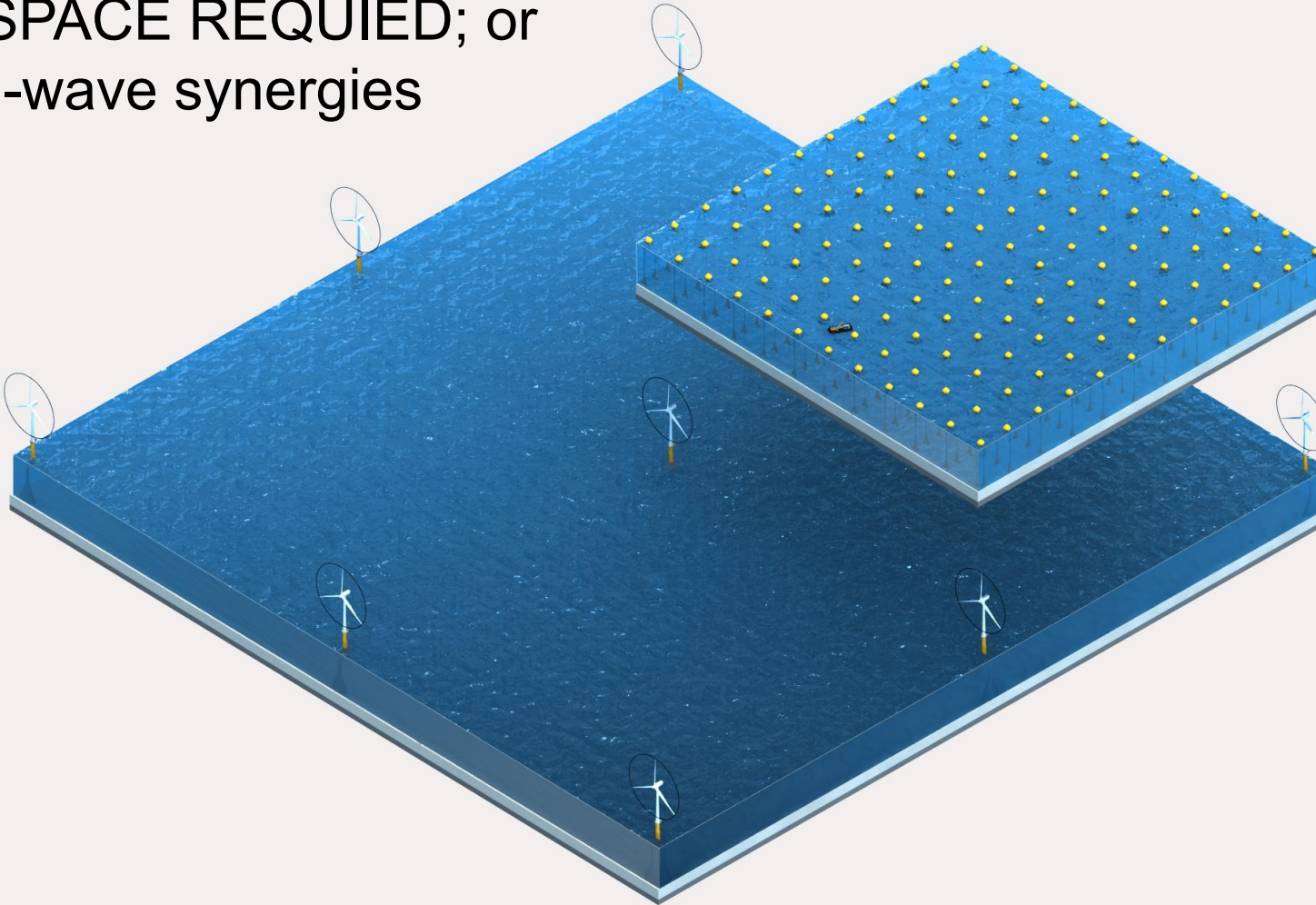
# MARINE ENERGY: ANNUAL PROFILE FOR THE WEST COAST OF NORTH AMERICA



Wind (6.5 GW) and solar (13.5GW) production: Actual time series of the period  
Wave production (6.0 GW): Estimate based on measured wave data and CorPower power matrix  
6 GW wave energy devices evenly distributed over four sites along the coast of California

# OCEAN FOOTPRINT & DEVICE SIZE

1/3  
OF SPACE REQUIRED; or  
wind-wave synergies



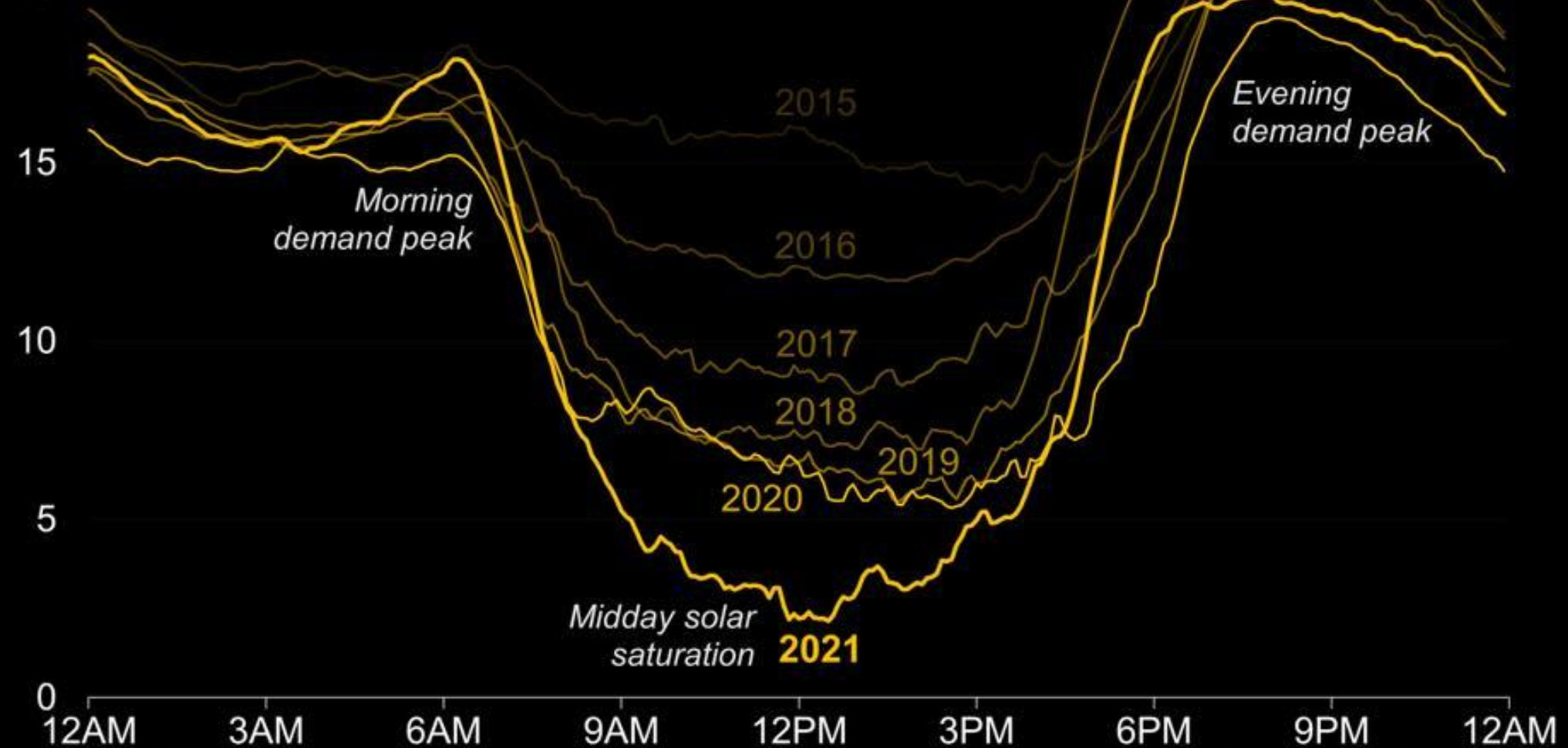
9MW turbine  
300kW WEC

# From Risk to Reward: *Decapitating the Duck*

## California's duck curve is dipping deeper than ever

Lowest net load day each year in CAISO, 2015-2021

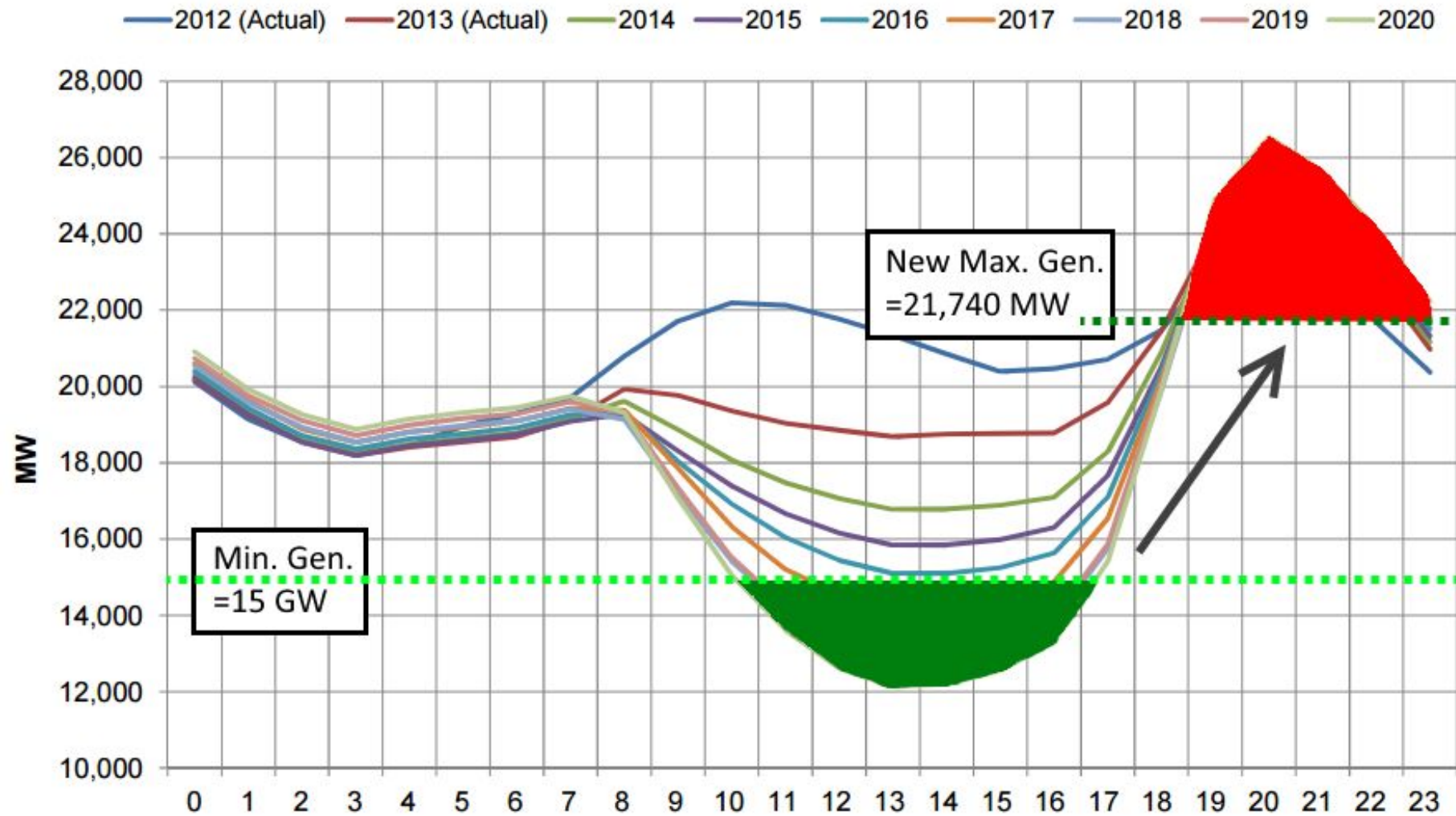
20GW



Source: CAISO

Note: Net load shown is demand minus utility-scale wind and solar

# California Advancing Energy Efficiency



# Opportunities to integrate energy innovation & social justice

The New York Times

Opinion

## Why Housing Policy Is Climate Policy

In California, where home prices are pushing people farther from their jobs, rising traffic is creating more pollution.

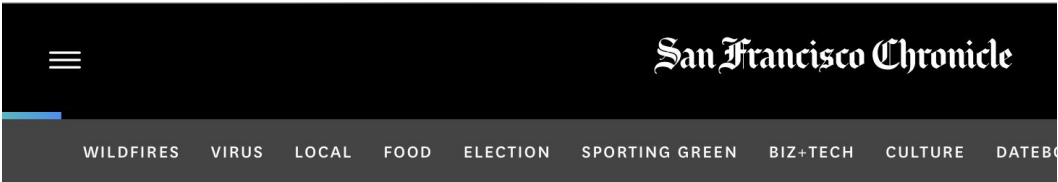
By Scott Wiener and Daniel Kammen

Senator Wiener is the chairman of the California Senate's Housing Committee. Dr. Kammen is a professor of energy at the University of California, Berkeley.

March 25, 2019



<https://www.nytimes.com/2019/03/25/opinion/california-home-prices-climate.html>



OPINION

## How electric vehicles can help advance social justice

By Daniel Kammen | June 21, 2020 | Updated: June 22, 2020 6:21 p.m.



<https://www.sfchronicle.com/opinion/article/How-electric-vehicles-can-help-advance-social-15351293.php>

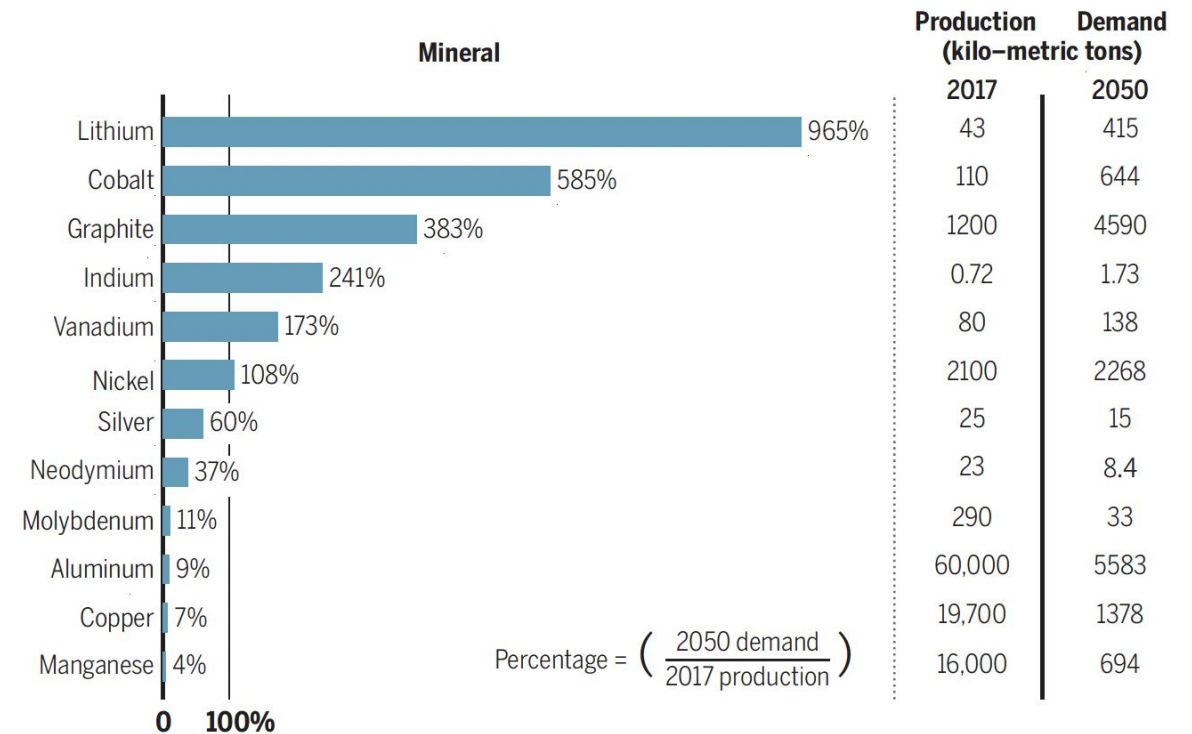
# Critical Materials and the Just Energy Transition

## The search for best practices & metrics



A creuseur, or digger, descends into a Congolese copper and cobalt mine in Kawama. Wages are low, and working conditions are dangerous, often with no safety equipment or structural support for the tunnels.

### Growth in mineral needs for low-carbon energy technology



All production and demand data reflect annual values. 2017 data reflect annual production for all uses. 2050 data reflect estimated demand for only low-carbon energy technology uses. Data from (7).

New research program in RAEL with BMW & Circular System for Assessing Rare Earth Sustainability or CSyARES via Rare Earth Industry Association (REIA)