DOCKETED	
Docket Number:	23-SB-100
Project Title:	SB 100 Joint Agency Report
TN #:	251719
Document Title:	Considerations for California's Decarbonization Investments
Description:	EDF - 08/22/23 - SB 100 Kickoff Workshop Presentation Slides
Filer:	Xieng Saephan
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	8/21/2023 8:47:38 PM
Docketed Date:	8/22/2023

Considerations for California's Decarbonization Investments

Senate Bill 100 Kickoff Workshop

August 22, 2023

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EDF
ENVIRONMENTAL DEFENSE FUND®
Finding the ways that work

Clean Firm Power

- EDF, in partnership with Clean Air Task Force, engaged modeling groups from Stanford, Princeton and E3 to see if SB 100 is realistic
  - These are reliability models that build out things at least cost when possible
  - We electrified large portions of the economy – so convert the existing electric grid AND increased demand by 2-3x

Study available online at https://issues.org/california-decarbonizing-power-wind-solar-nuclear-gas/

Growing the Grid available online at https://www.catf.us/resource/growing-grid-plan-accelerate-californias-clean-energy-transition/

Why do we need Clean Firm Power?

- Renewables are cheap – cost is no longer a limiting factor.
- However, solar and wind decline in output seasonally
- We need something else other than solar and wind to help dispatch the grid

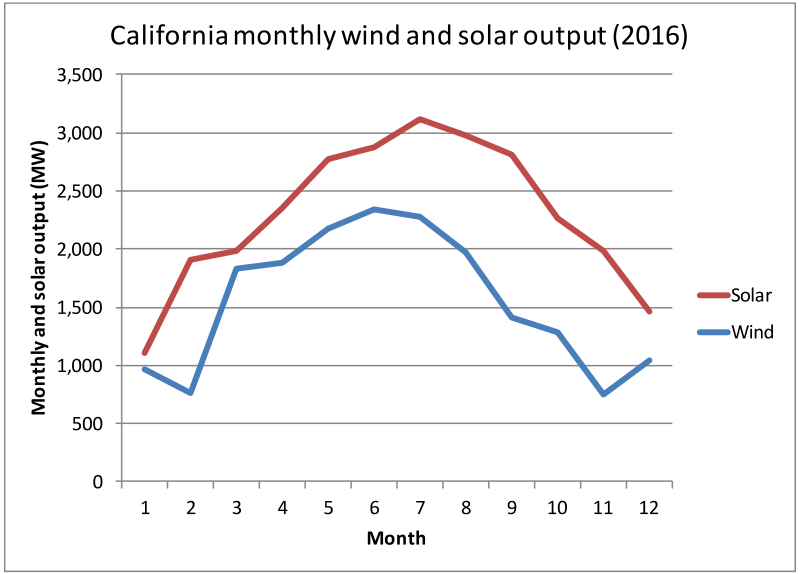
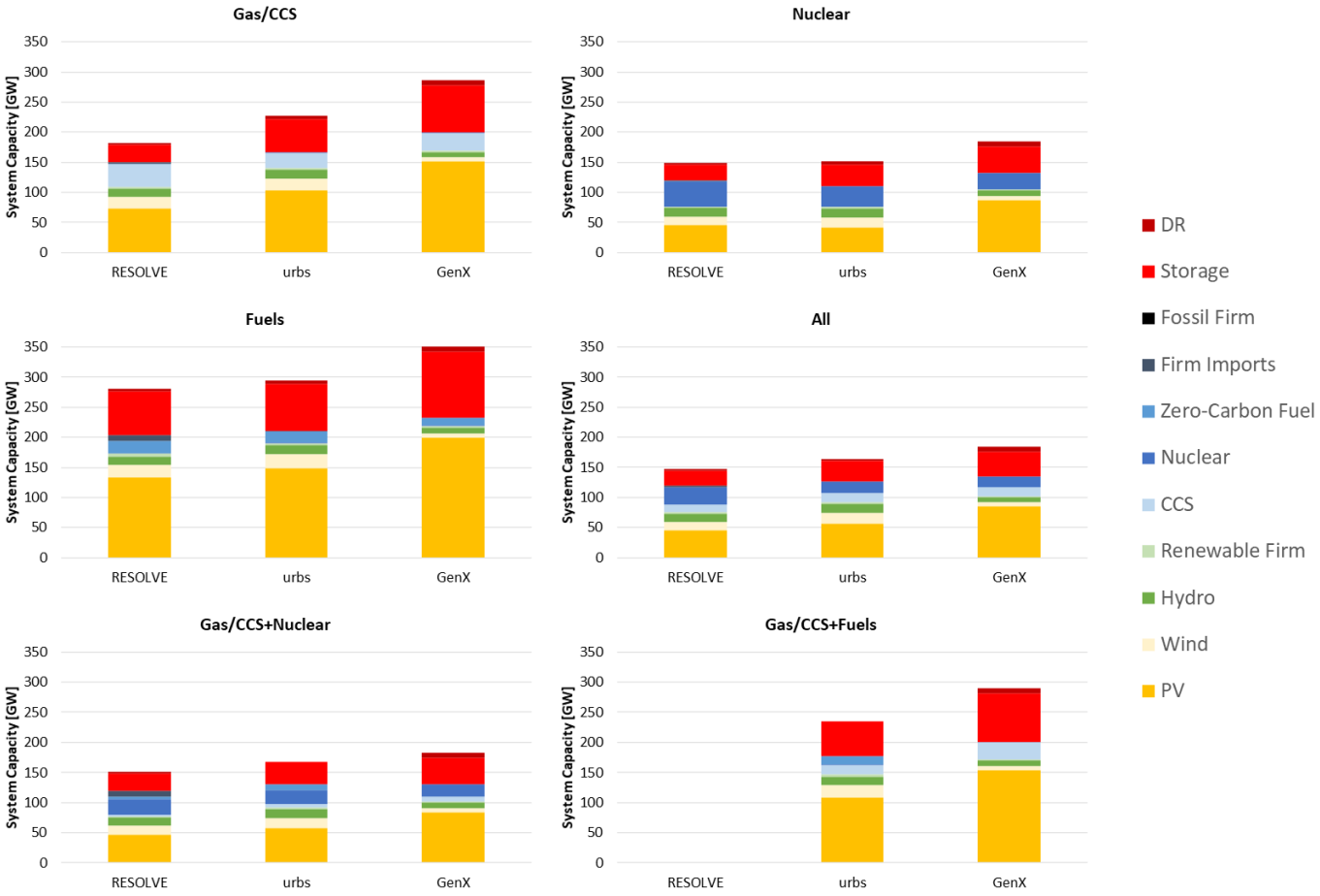
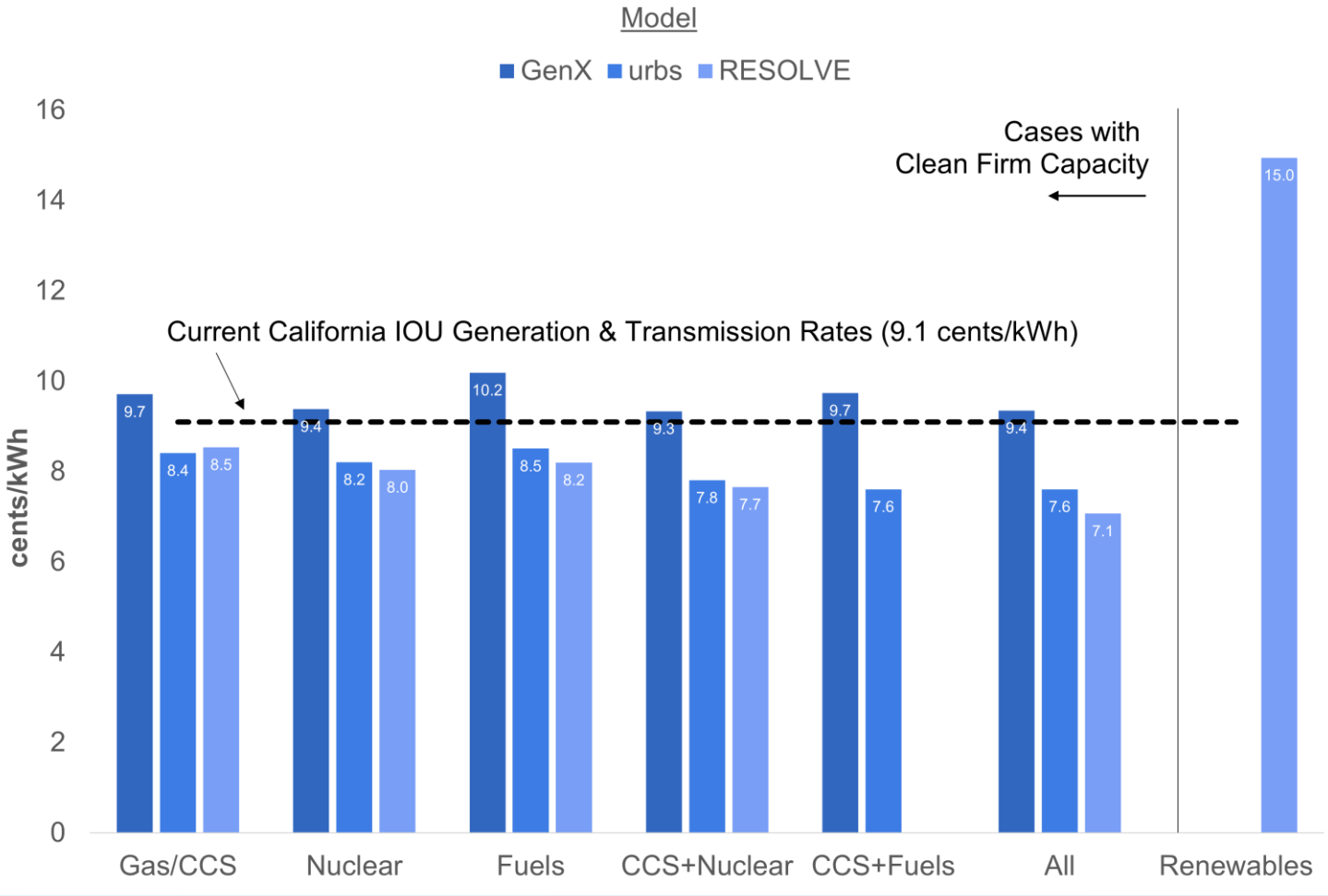


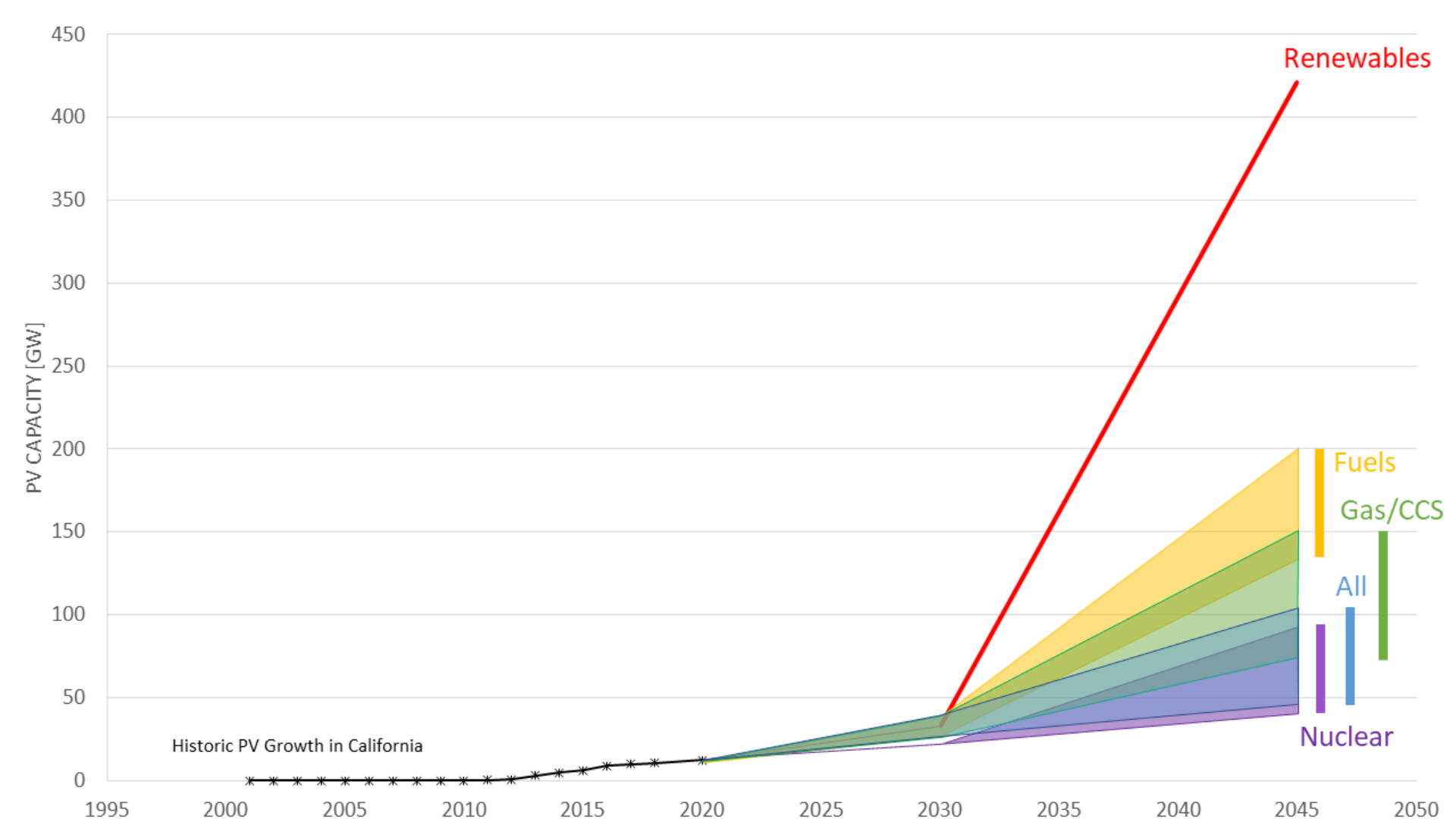
Figure 2. California monthly average wind and solar output in 2016. Reproduced from data in CAISO (2017a, Figure 1.8).

We need to build – a lot

- Examined a variety of different clean firm power technologies
  - Imported nuclear from out of state, clean fuels in existing turbines, abated fuels through carbon capture
- Will build 25-250 GW of new renewable capacity
- How much we build depends on what we supplement the grid with
  - Generation resources considered include a generic clean fuel, modular nuclear, gas + CCS, a renewables only build out and combinations
- Costs are less when you mix and match – the more diverse the resource, the better

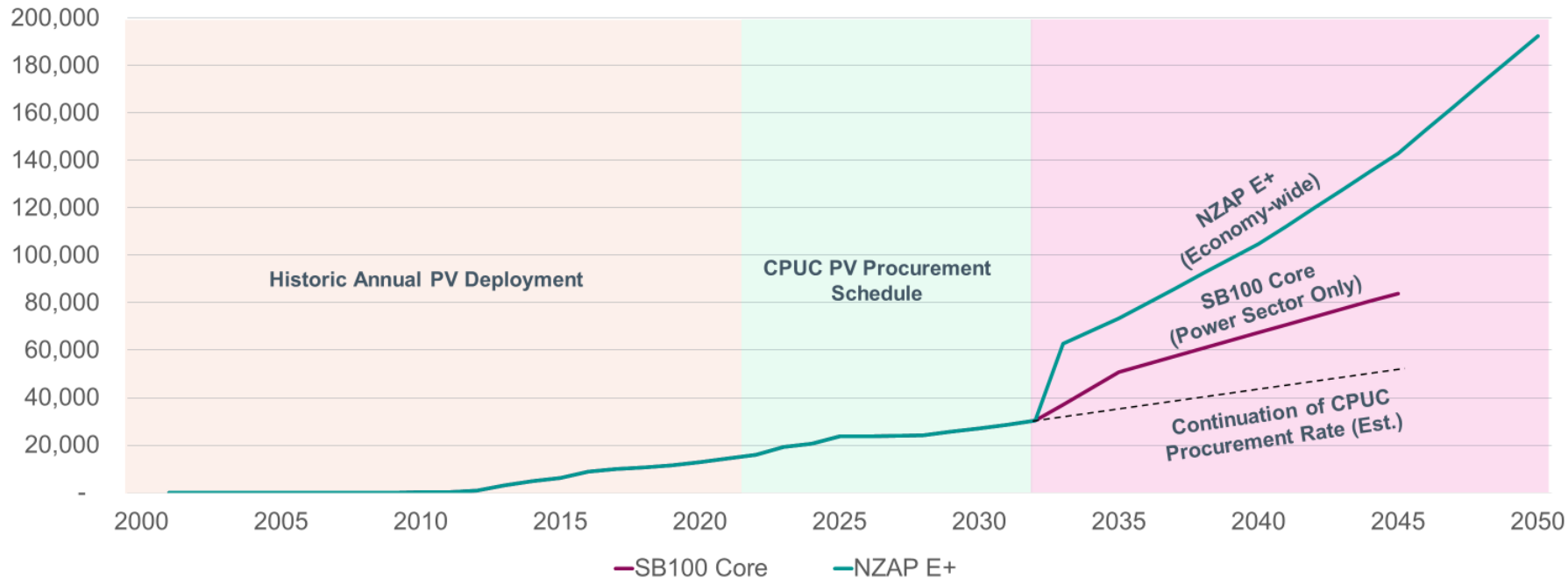

Gas/CCS
Nuclear
Fuels
All
Gas/CCS+Nuclear
Gas/CCS+Fuels
System Capacity [GW]
0
50
100
150
200
250
300
350
RESOLVE
urbs
GenX
DR
Storage
Fossil Firm
Firm Imports
Zero-Carbon Fuel
Nuclear
CCS
Renewable Firm
Hydro
Wind
PV


Model
GenX
urbs
RESOLVE
cents/kWh
16
14
12
10
8
6
4
2
0
Cases with
Clean Firm Capacity
Current California IOU Generation & Transmission Rates (9.1 cents/kWh)
9.7
8.4
8.5
9.4
8.2
8.0
10.2
8.5
8.2
9.3
7.8
7.7
9.7
7.6
9.4
7.6
7.1
15.0
Gas/CCS
Nuclear
Fuels
CCS+Nuclear
CCS+Fuels
All
Renewables

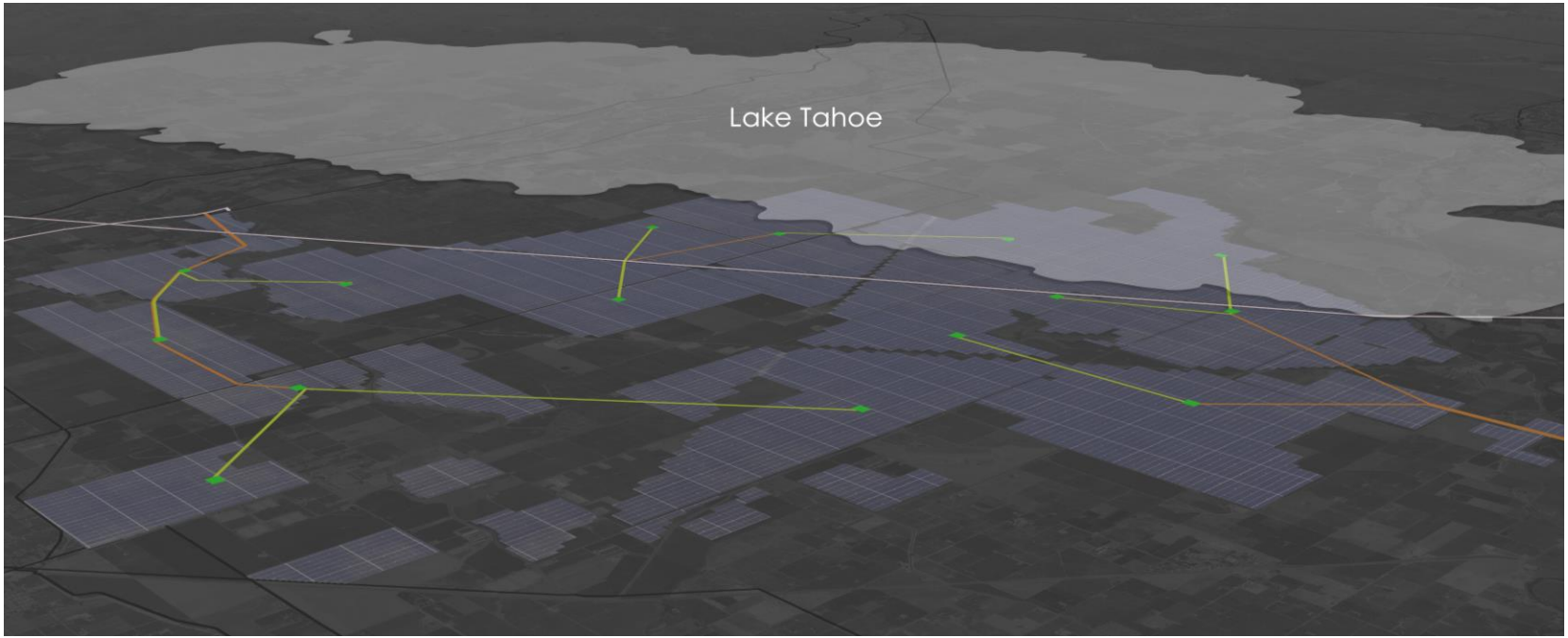

PV CAPACITY [GW]
450
400
350
300
250
200
150
100
50
0
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Renewables
Fuels
Gas/CCS
All
Nuclear
Historic PV Growth in California

Solar PV procurement in CA

(Assumes no additional utility-scale PV beyond that listed in the CPUC procurement schedule until 2032)



The clean energy transition will require an astonishing amount of land



CATF-commissioned visual simulation of a 6-Gigawatt solar farm

So what did we learn?

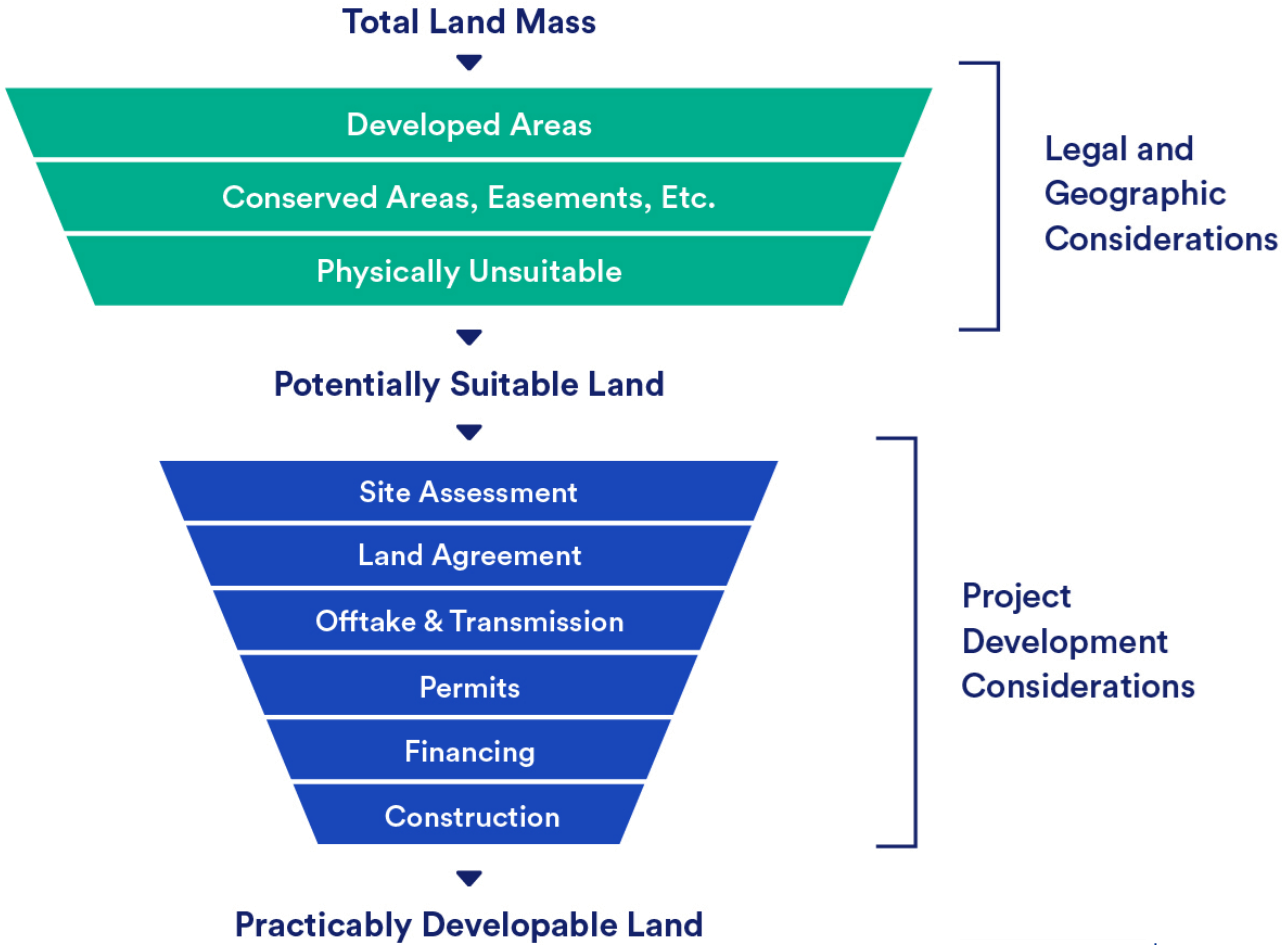
The grid can be decarbonized in an affordable, reliable manner!

California needs to make different procurement choices than the pathway we are on

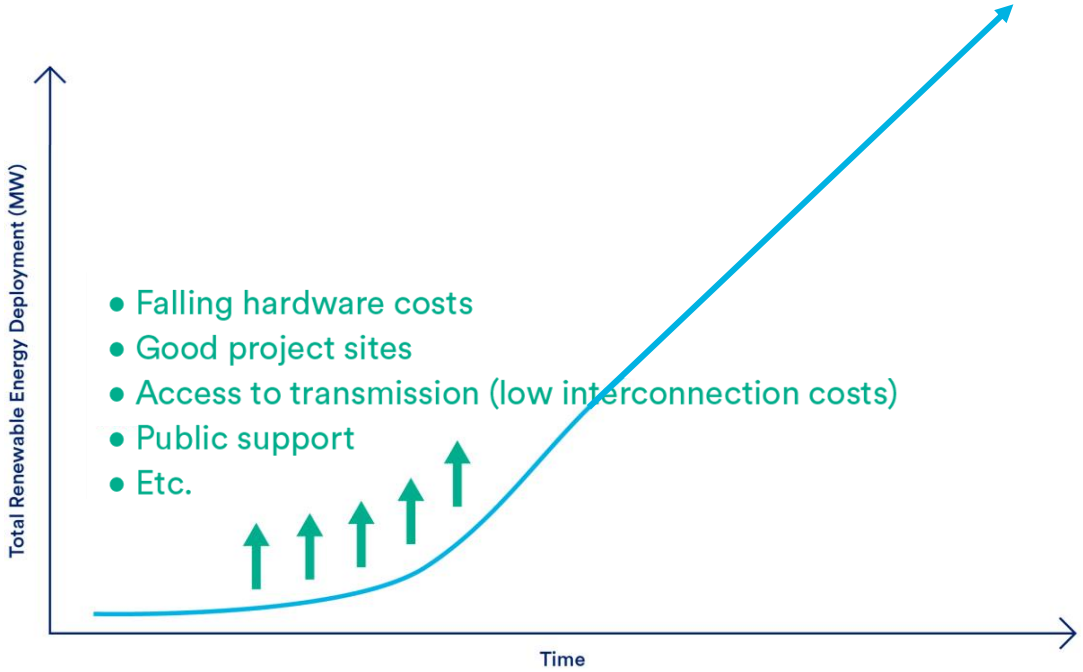
How much flexibility does the state have?

- Procurement needs to be just and reasonable – not just least cost. Need to consider **total system cost** and not just least cost resource
- The “40%” other category gives us a lot of flexibility, and that helps contain cost
- Cost is no longer the limiting constraint – we have three other concerns
  - Land Use, Permitting, Community engagement

Not all *potentially suitable* land for clean energy is *practicably developable* land



The real-world obstacles to clean energy deployment will likely grow if left unaddressed



Derived from: Cherp et. al, "National growth dynamics of wind and solar power compared to the growth required for global climate targets," Nature Energy, Vol 6, July 2021.

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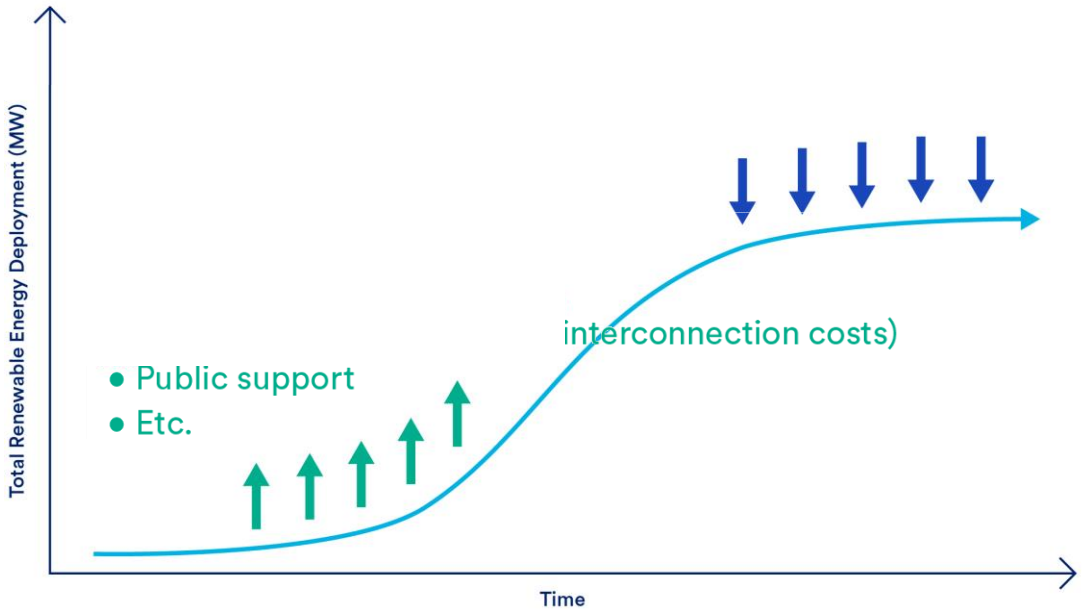
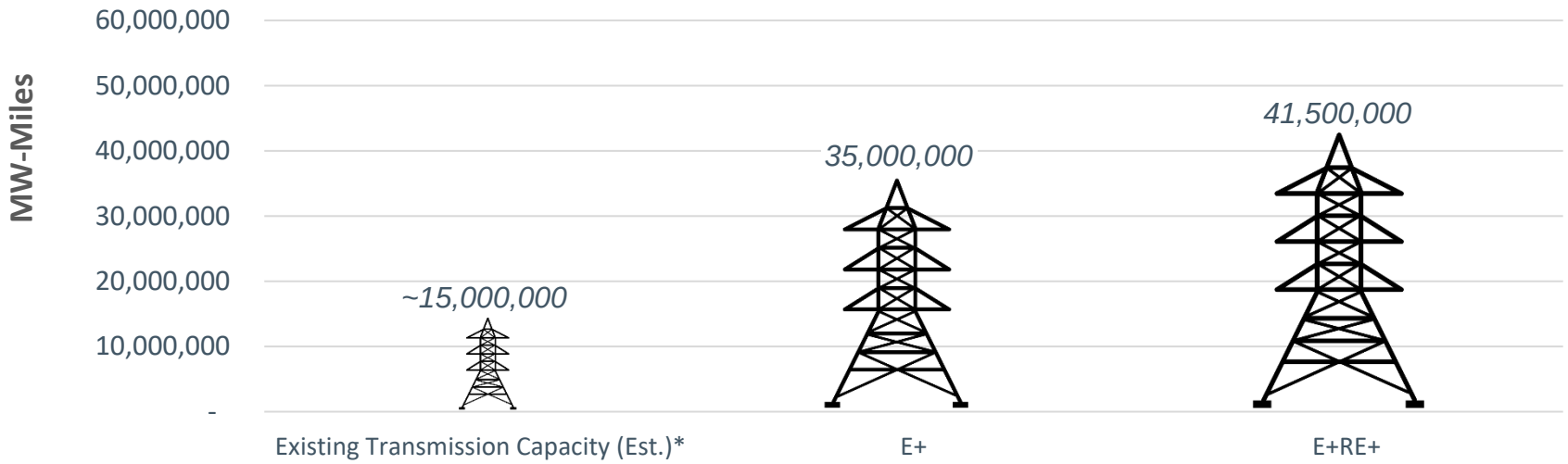


- Increasing land costs & competing needs
- Fewer amendable landowners
- Further from transmission
- Lower capacity factors/poorer resource
- Public opposition
- Diminishing available transmission capacity
- Etc.

Derived from: Cherp et. al, "National growth dynamics of wind and solar power compared to the growth required for global climate targets," Nature Energy, Vol 6, July 2021.

~2-3x increase in transmission capacity



(High Electrification; Few constraints on generation options)

(High Electrification; 100% Renewable)

**Based on GIS analysis; only includes transmission >=220 kV*

Existing Transmission, Rail, and Highway Infrastructure in CA

1:6,725,610

N
W E
S

E+ Scenario:
34,725,097 MW-miles Required

Tranmission Voltage (kV)
- 220 & 230 (~8,400 miles)
- 287; 345 (~426 miles)
- 500 (~4,800 miles)

~18,250,000 MW miles ← ~53% of total need

CA Rail Network
- Miles of Track: 6,124

~18,370,000 MW miles ← ~53% of total need

CA Highway System
- Limited Access (~4520 miles)
- Highway (~6110 miles)

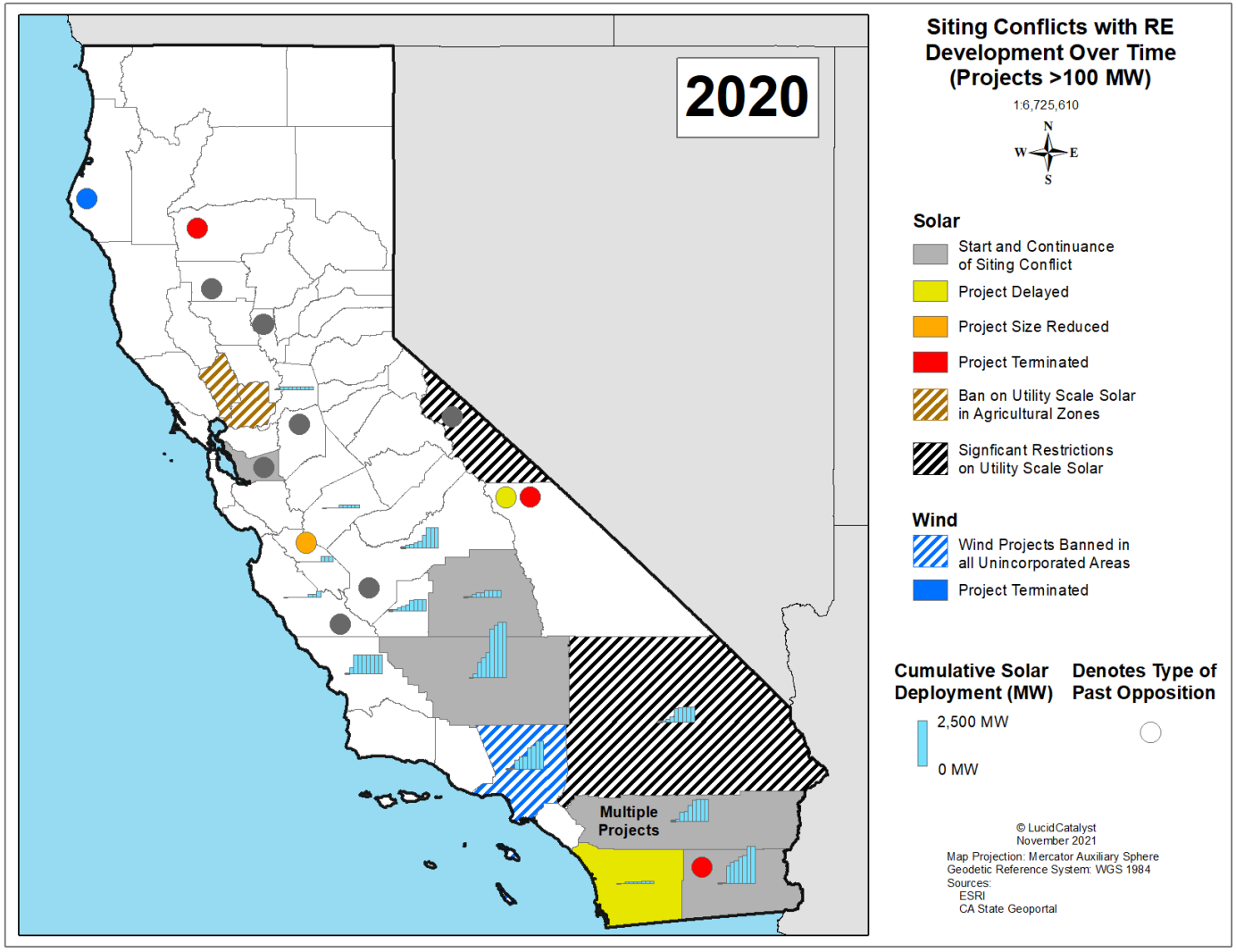
~31,899,900 MW miles ← ~92% of total need

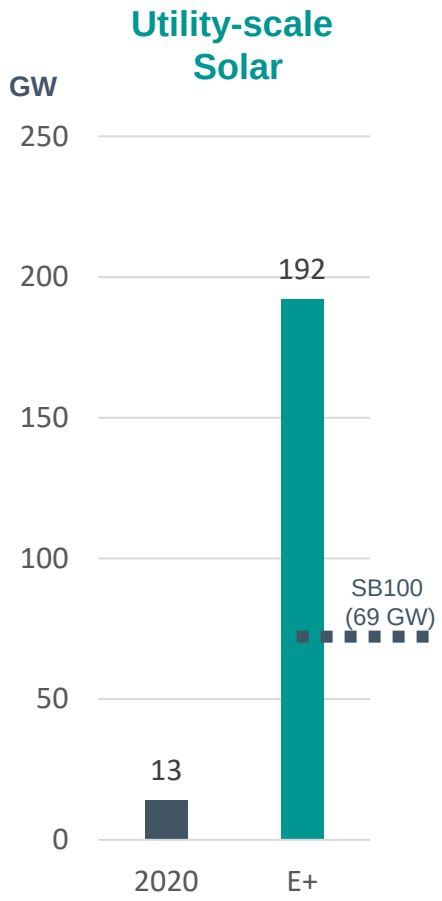
Map Projection: Mercator Auxiliary Sphere
Geodetic Reference System: WGS 1984
Sources:
ESRI
CA State Geoportal

How much capacity can we add by building in existing Right-of-Ways?

Inclusive Transmission Planning and Use of Existing Corridors Will Be Key

Cacophony of Voices	Developing transmission requires approval from dozens of disparate stakeholders, and multiple agency reviews, and can be very risky and time-consuming.
Timing of Projects	The past five 500 kV transmission projects in California over 100 miles have taken, on average, a decade to build.
Building New Lines	This will require a never-before-seen build rate for transmission upgrades and importantly, new lines.
Using Existing Corridors	Use of existing corridors is possible, but this is not a complete solution: there are many corridors that do not overlap; required incremental transmission paths and co-location along highway and rail corridors can create use conflicts.


2020
Siting Conflicts with RE Development Over Time (Projects >100 MW)
1:6,725,610
N
W
E
S
Solar
Start and Continuance of Siting Conflict
Project Delayed
Project Size Reduced
Project Terminated
Ban on Utility Scale Solar in Agricultural Zones
Signficant Restrictions on Utility Scale Solar
Wind
Wind Projects Banned in all Unincorporated Areas
Project Terminated
Cumulative Solar Deployment (MW)
2,500 MW
0 MW
Denotes Type of Past Opposition
Multiple Projects
© LucidCatalyst
November 2021
Map Projection: Mercator Auxiliary Sphere
Geodetic Reference System: WGS 1984
Sources:
ESRI
CA State Geoportal


Utility-scale Solar
GW
250
200
150
100
50
0
192
SB100 (69 GW)
13
2020
E+

Equity considerations are critical

- Regardless of the resource mix, the communities most impacted by the required infrastructure build-out in California are the communities that are already disproportionately burdened by multiple sources of pollution and other vulnerabilities.
- EJ considerations will be present in nearly every infrastructure project and/or decision.

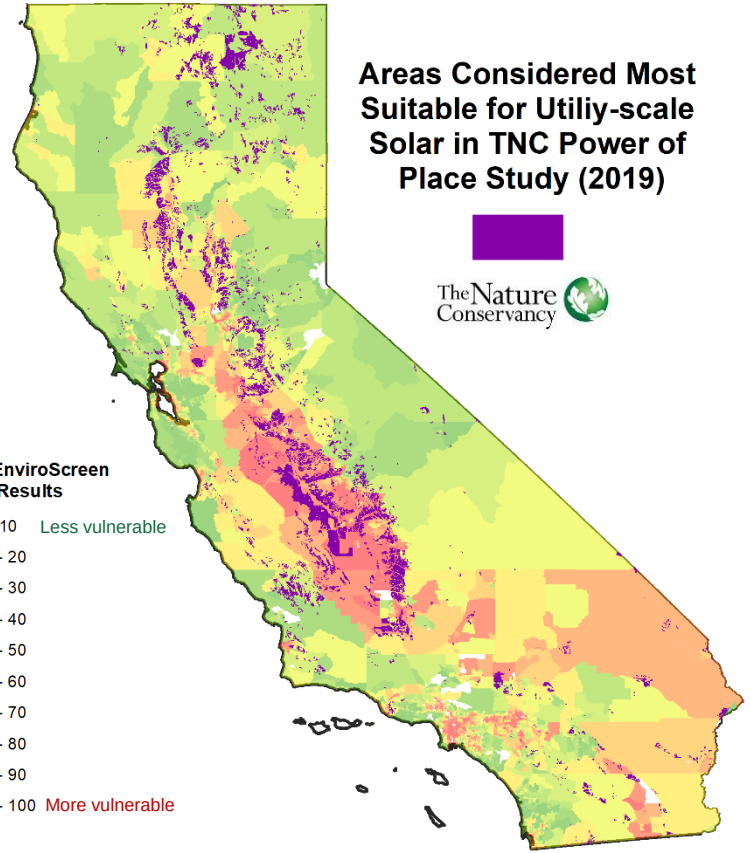
Pollution Burden ✖ **Population Characteristics** = **CalEnviroScreen Score**

Exposures
- Ozone Concentrations
- PM2.5 Concentrations
- Diesel PM Emissions
- Drinking Water Contaminants
- Children's Lead Risk from Housing
- Pesticide Use
- Toxic Releases
- Traffic Impacts

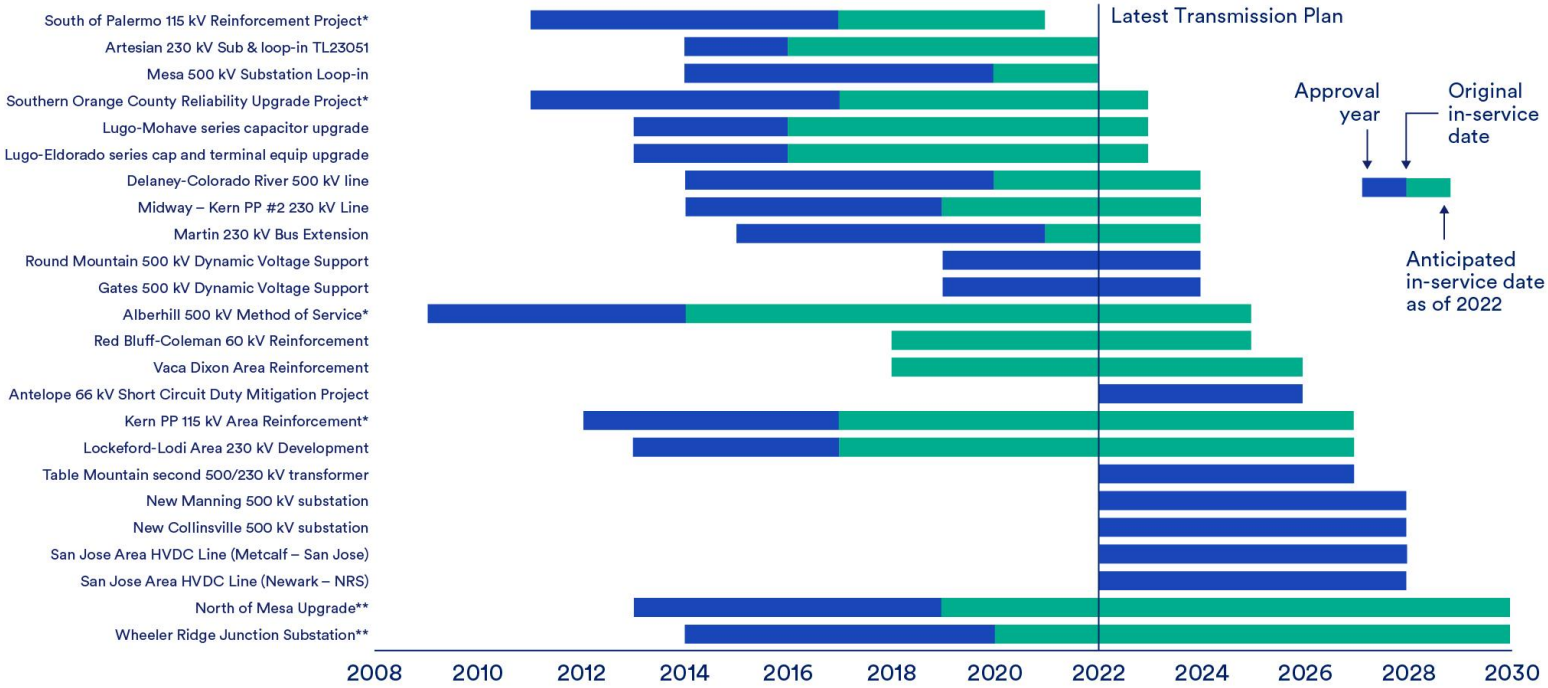
Environmental Effects
- Cleanup Sites
- Groundwater Threats
- Hazardous Waste
- Impaired Water Bodies
- Solid Waste Sites and Facilities

Sensitive Populations
- Asthma Emergency Department Visits
- Cardiovascular Disease (Emergency Department Visit for Heart Attacks
- Low Birth-Weight Infants

Socioeconomic Factors
- Educational Attainment
- Housing-Burdened Low-Income Households
- Linguistic Isolation
- Poverty
- Unemployment



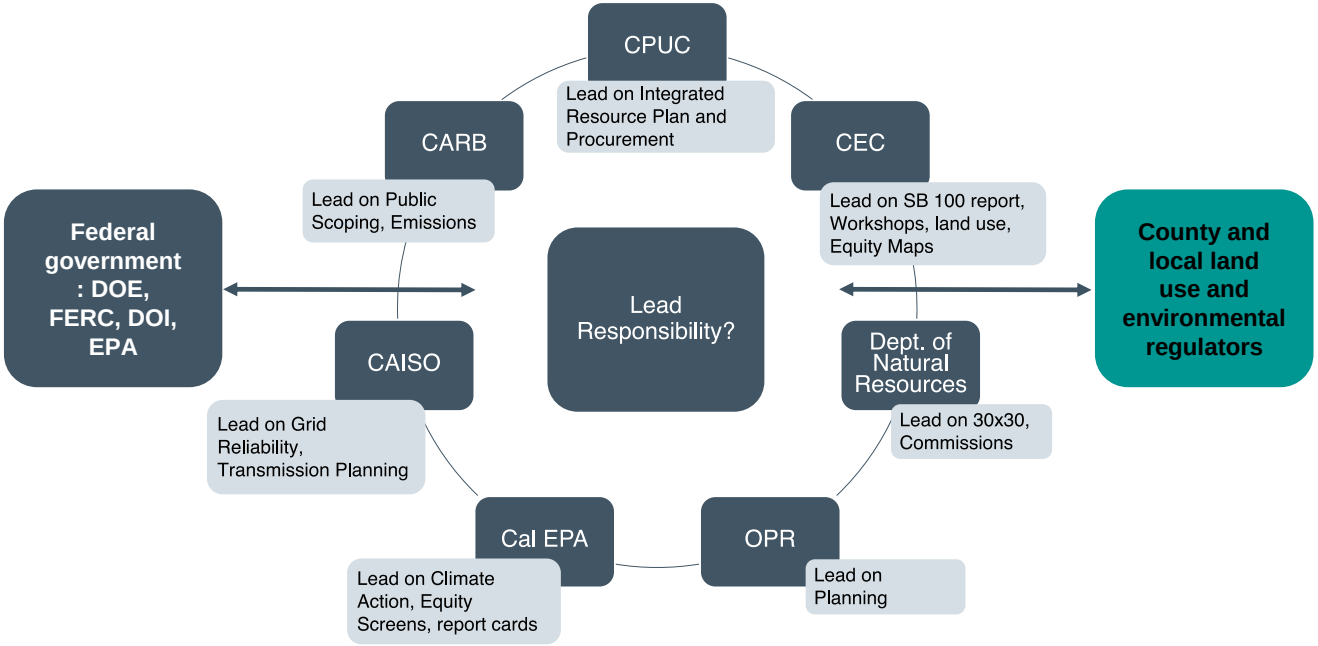
Transmission development often takes longer than anticipated



** Approval years and Original in-service date for projects approved prior to 2012 were taken from the 2011-2012 Transmission Plan, the oldest available on the California ISO's websi*

*** As of the 2021-2022 Transmission Plan, these projects were listed as "on hold" with no definite completion date.*

There is no designated authority on clean energy deployment



The following RECOMMENDATIONS offer a path to accelerate California's clean energy transition

- **Develop a Clean Energy Deployment Plan** with specific quantities, locations, and timing of new resource development and infrastructure expansion.
- **Assign a lead agency** the responsibility for achieving the state's clean energy goals.
- **Develop a dashboard** to publicly track progress.
- **Advance supportive policy** for planning, permitting, financing, and building clean energy infrastructure.
- **Engage the public** by continuing and strengthening California's current public engagement efforts.

Thank you!

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Finding the ways that work