Equity and Resilience in Storage Modeling & Planning

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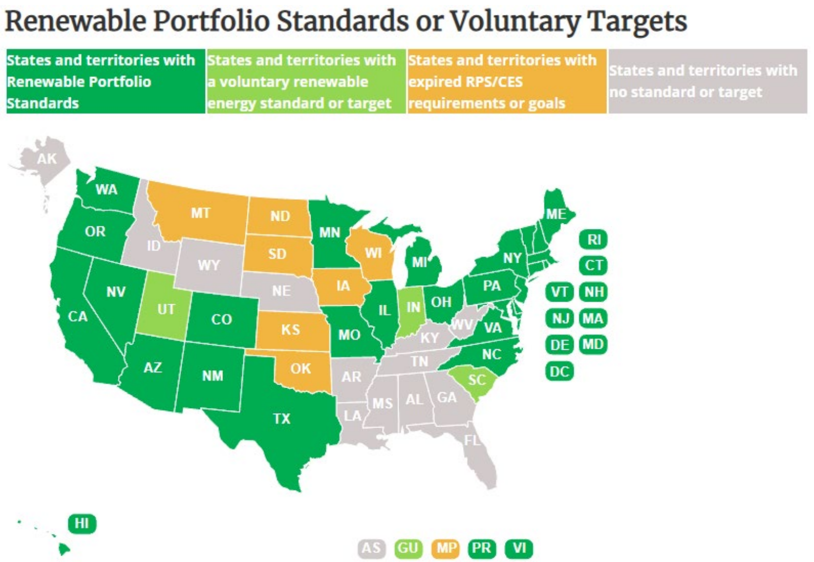
Outline

- Motivation and Need
- Modeling Approach
- Equity and Resilience: Case Study and Considerations
- Overview of FY22 Research Activities
- Next Steps

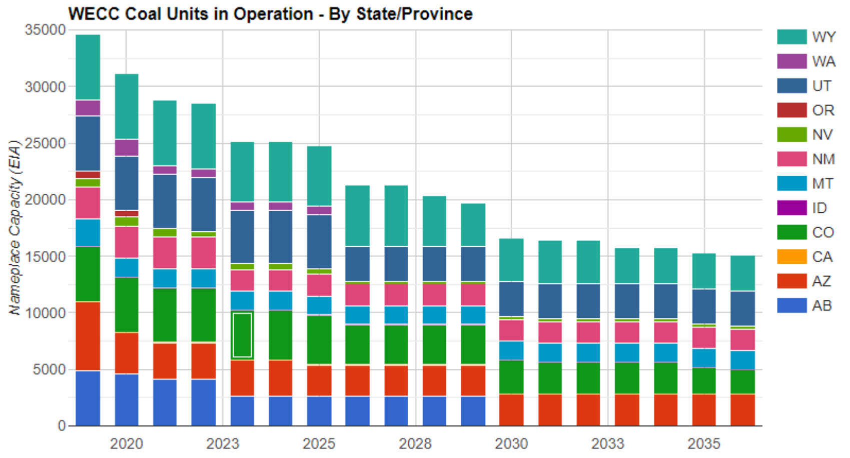
Motivation and Need

1. How do we think about energy storage in the future? 2030, 2040, 2050?
   - How much storage will we need to ensure reliability as flexible generation retires and is replaced by intermittent renewables?
   - What capacity? What duration? What type of technology?
   - How do we deploy it (across time and space- where and when)?

2. What policies will this ensure optimal(?) deployment?
   - How do we incorporate equity in these policies?
   - How do we consider resilience?



Source: https://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx



Source: https://www.nwcouncil.org/news/coal-retirements

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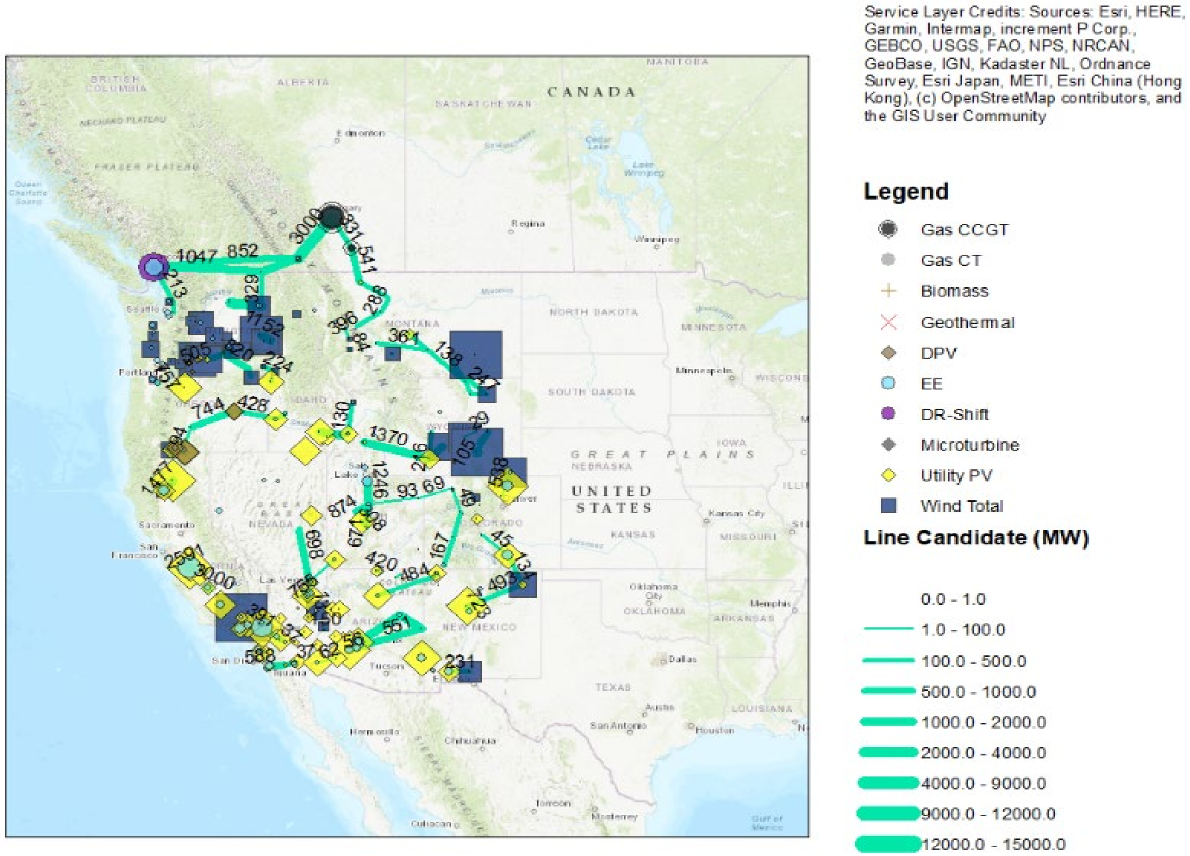
Modeling Approach

Capacity expansion planning (CEP)

- Linear and mixed integer linear program
- Used to determining the optimal timing, size, and location of new investments (transmission and generation)
- Typical objective function: minimize capital and operational costs
- Standard DC power flow

	Invested Capacity (GW) by year		
Technology	**2018**	**2024**	**2030**
Distributed PV	0.8	0.9	0.2
DR shift - New	0.0	0.0	1.5
EE - New	2.8	3.0	3.2
Gas CCGT - New	0.0	0.0	1.1
Gas CT - New	0.0	0.0	0.0
Geothermal - New	0.0	0.0	0.0
Solar PV-Distributed Utility-Fixed Tilt - New	3.7	9.5	43.1
Wind	18.6	9.4	6.2
Generation Total	25.9	22.9	55.3
Transmission	80.0	9.7	11.5



IA State Model: 2036 cumulative generation and transmission investments

Capacity Expansion Planning

- By its nature, CEP is a complex modeling effort that requires careful consideration of trade-offs between model details and solve times

- Energy storage challenges the typical CEP formulation
  - Storage across multiple time slices (e.g. multi-day durations)
  - Multiple services (generation and transmission)

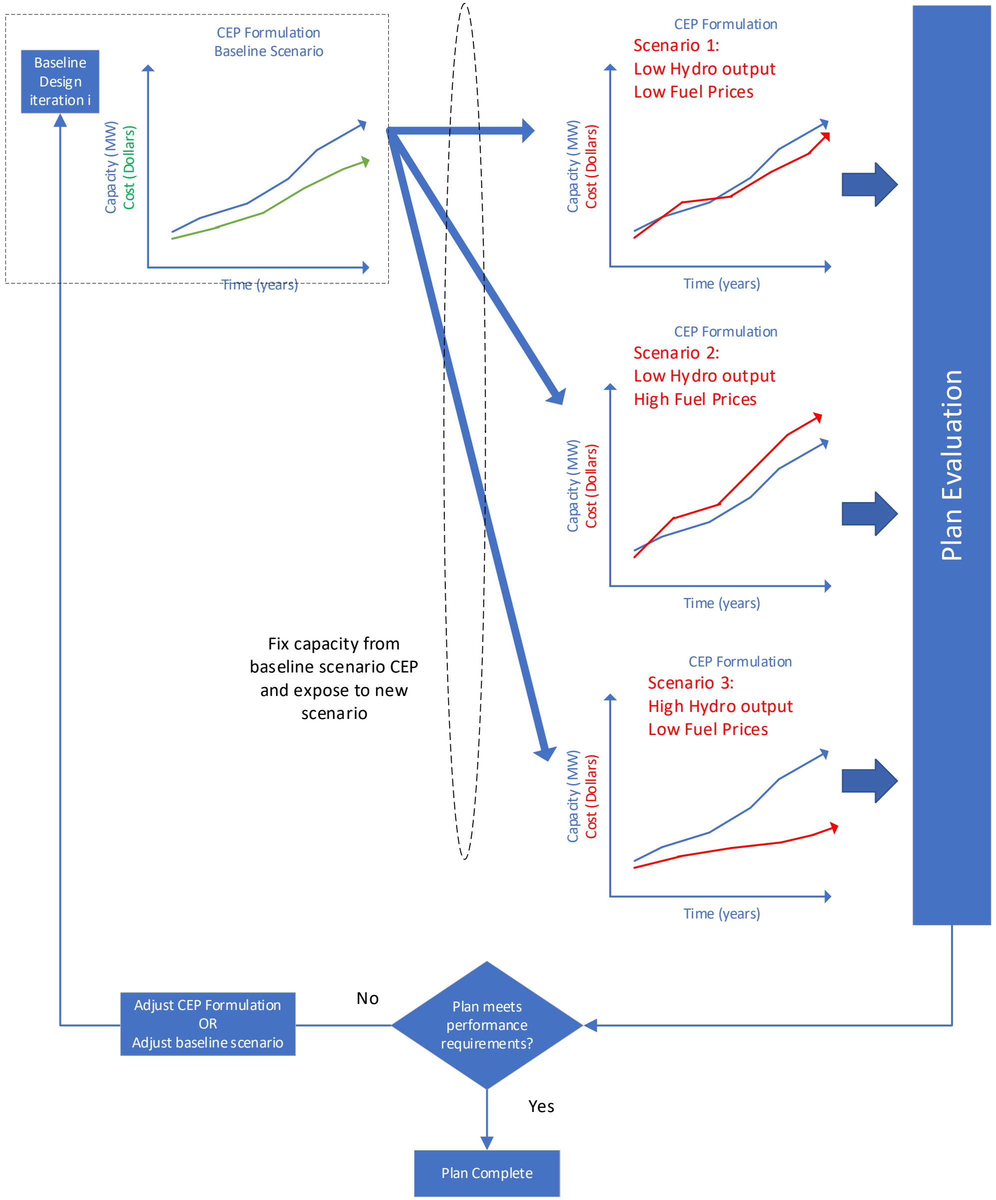
- Model
- Solve time
- Storage representation
- Intra-year time slice representation (operational setpoints per year)
- Renewable capacity value implementation
- End effects
- Unit retirements
- Representation of uncertainty

Significant CEP model features that impact investment decision such as storage

Analysis Drivers

In addition to a consideration of cost and reliability inherent in expansion modeling, we consider:

- Equity considerations with resource deployment
- System Resilience



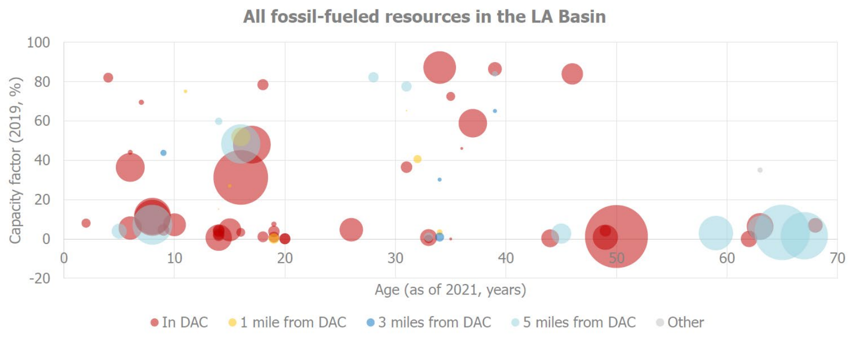
Case Study: Energy Storage to Replace Peaker Plants in Disadvantaged Communities

The LA Basin has a unique opportunity for storage

- California has ambitious energy and environmental goals that will require reduced dependence on fossil infrastructure
- The Los Angeles Basin currently relies on 7.5 GW of low-capacity factor fossil peaking resources that could be replaced by storage
- Due to other emergent issues, the CPUC is not able to study this opportunity unless there is a credible case for fossil fuel plant replacement

Inputs & Assumptions

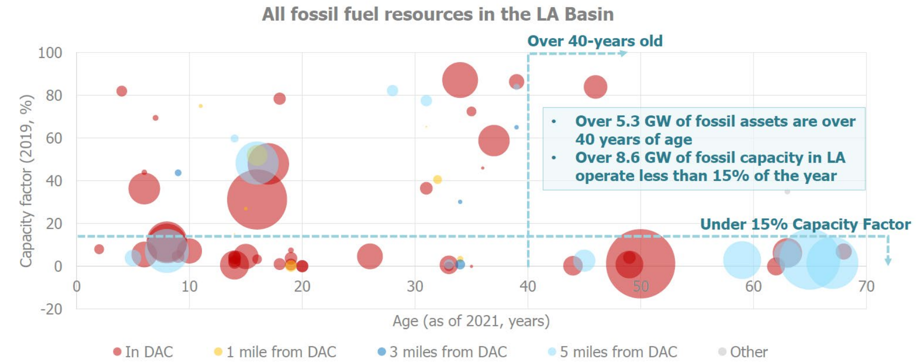
Nearly all of the fossil assets in the LA Basin are within 5 miles of a disadvantaged community



99.5% of the installed capacity within the LA Basin is at least 5 miles away from a DAC

Inputs & Assumptions

Over 8.8 GW of capacity could be retired due to age or capacity factor

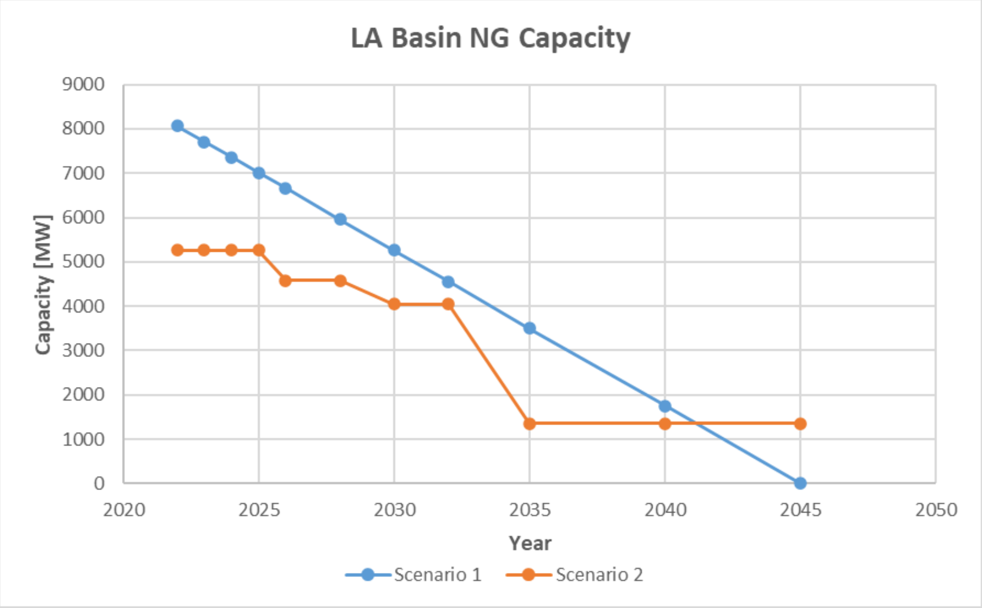


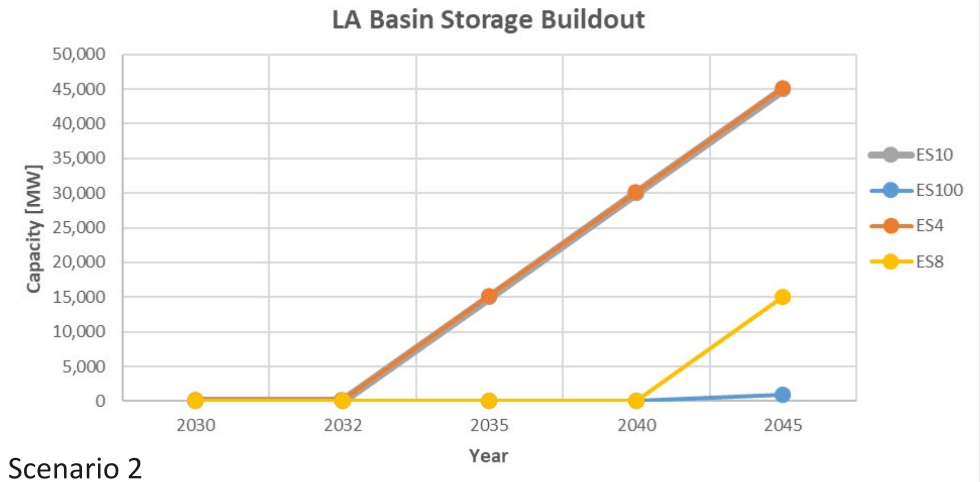
8.8 GW fulfill at least one of these criteria, 5.1 GW fulfill both criteria

Equity in Modeling

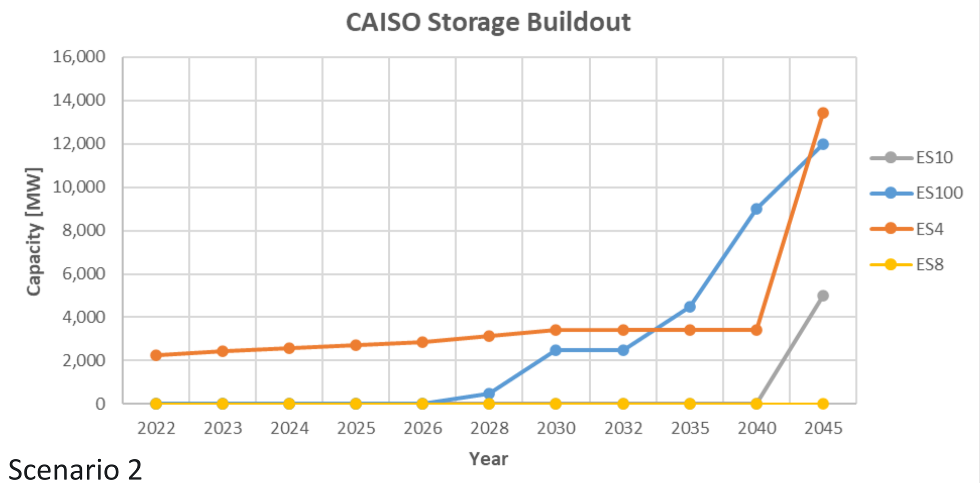
ES4 – 4-hour storage
ES8 – 8-hour storage
ES10 – 10-hour storage
ES100 – 100-hour storage

- Retiring low-capacity factor natural gas plants located in dense urbanized (disadvantaged) communities
- Maintain system reliability by replacing with energy storage





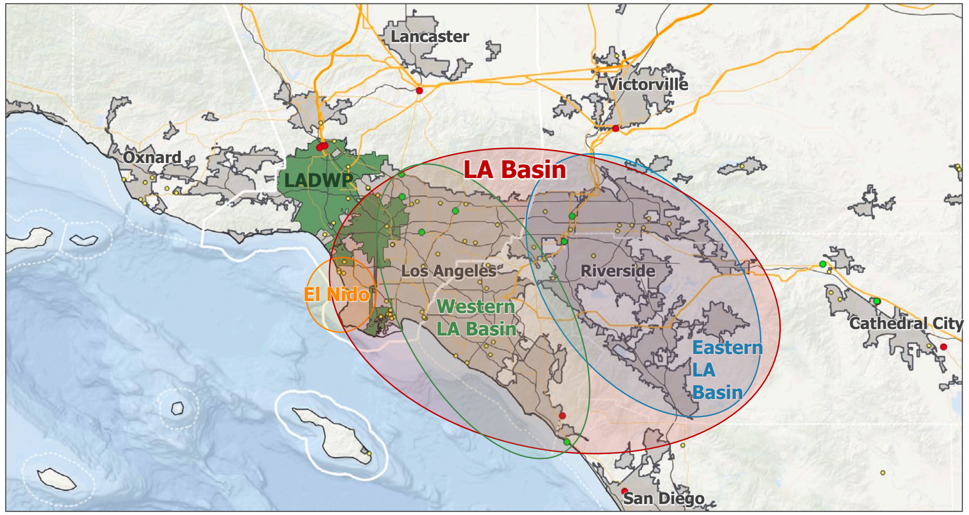
Scenario 2



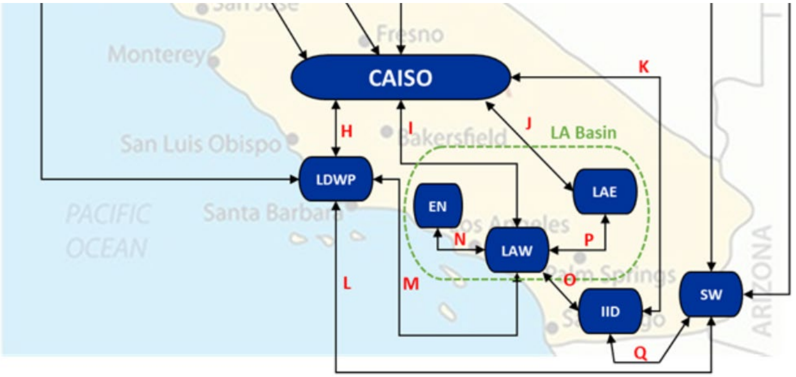
Scenario 2

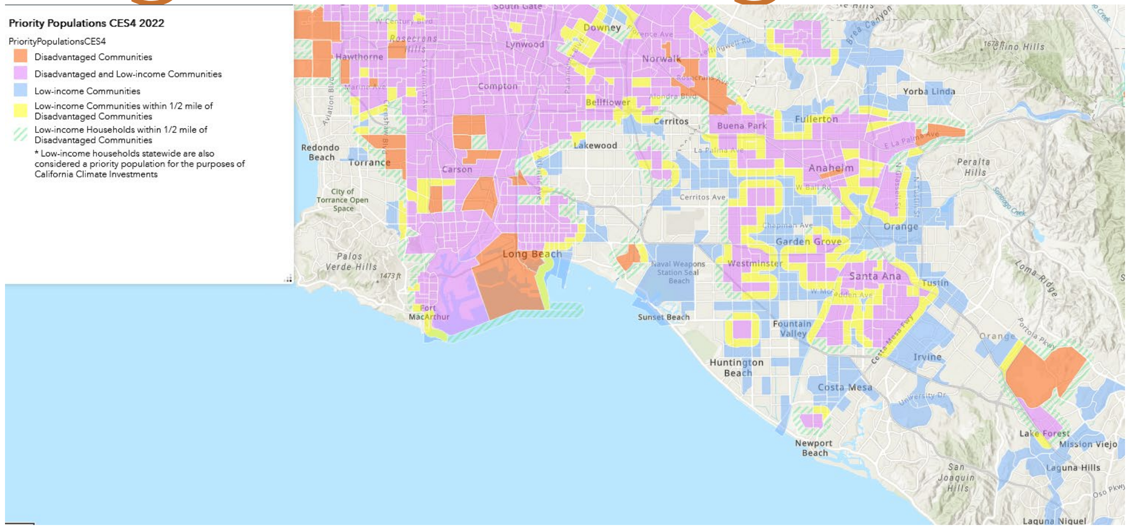
Equity in Modeling – Challenges

Where do the investments go?

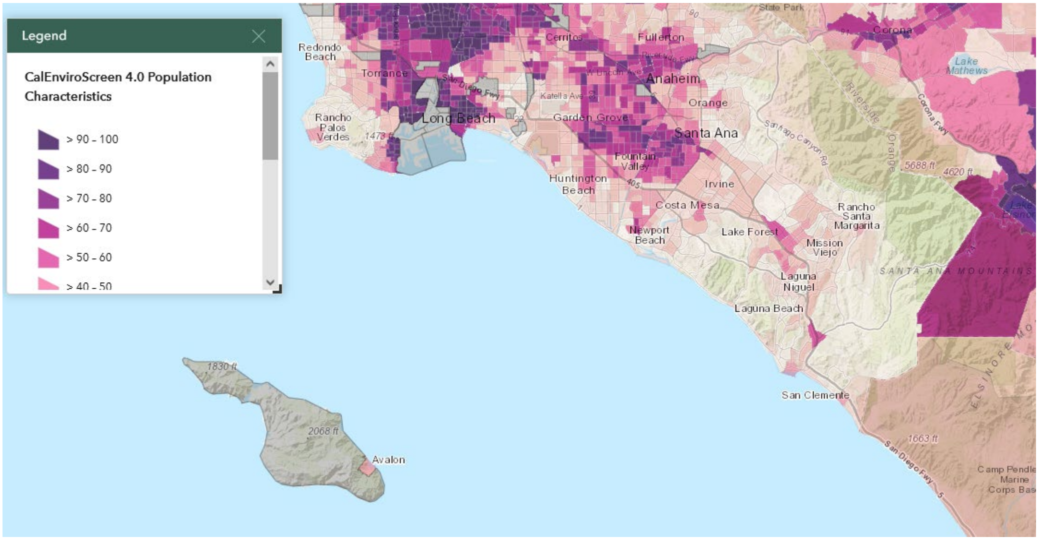


LA Basin 3 bus system: West, East and El Nido





Disadvantaged and Low Income Communities *California Air Resources Board*



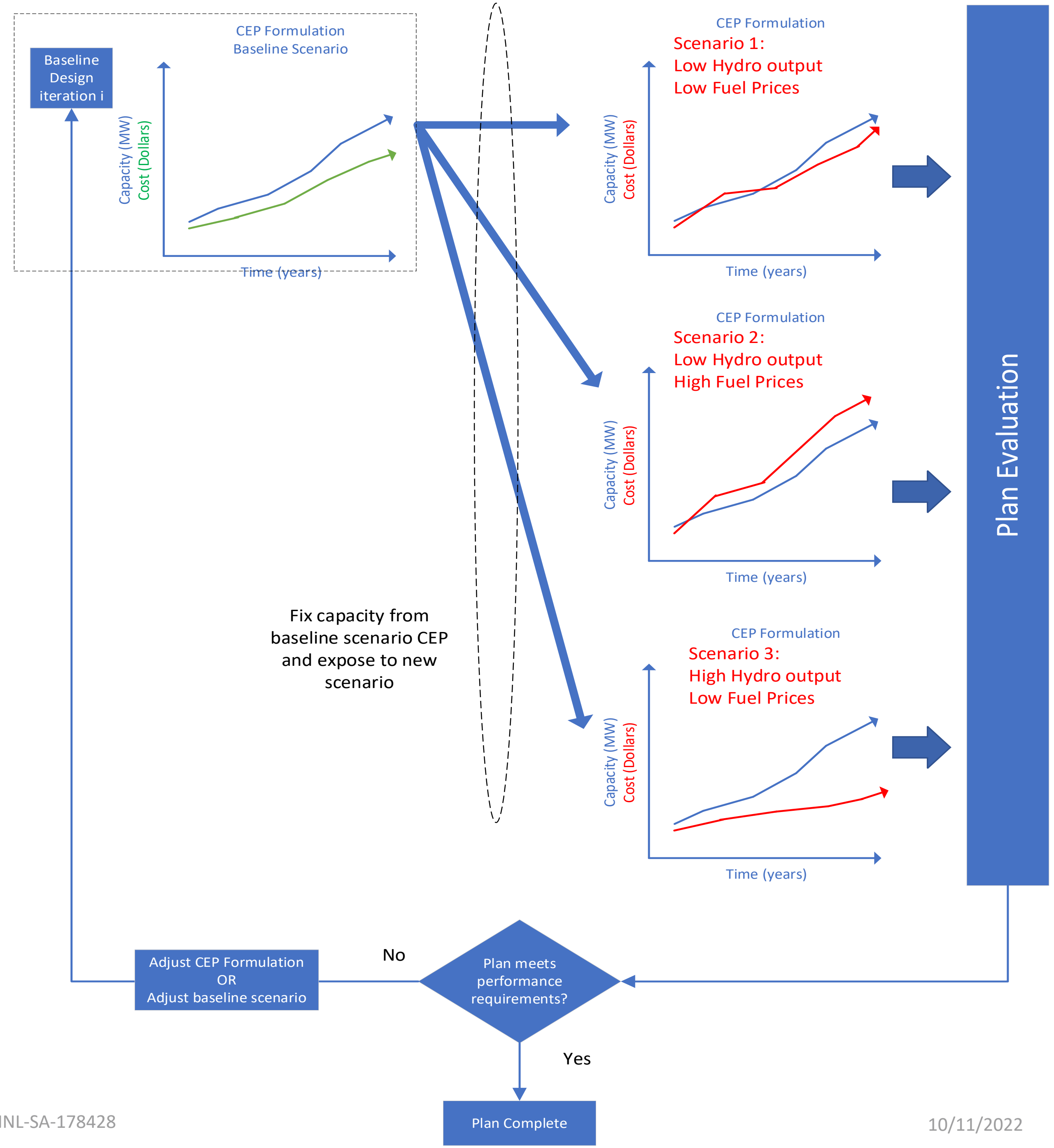
Population Characteristics (Sensitivities) *CalEnviroScreen*

Equity in Modeling – Challenges

1. We need 100GW+ of storage in LA Basin and CAISO. Where does it go?
   - Build near load centers?
   - Use new transmission?
2. Who pays for it? How do the cost of this deployment get distributed fairly?
3. How do we incorporate these elements into planning efforts?
   - State integrated resource plans
   - Transmission development
   - Regional coordination?
4. What are the impacts we don't foresee? Are there unintended consequences?
5. How does this get translated to system planners and policymakers?

Resilience in Modeling

- An approach to resilience: generate plan, expose plan to uncertainties to evaluate performance, evaluate plan, and re-plan with adjusted CEP formulation or adjusted baseline scenario



Resilience in Modeling – Challenges

1. How do we sufficiently capture resiliency? That is, how do we capture all the possible permutations of events?
   a. Wildfires
   b. Heat waves
   c. Droughts
   d. Earthquakes
   e. Hurricanes
2. Local vs. system resiliency?
   a. Bulk system
   b. Distribution system
3. What is sufficient resiliency?
4. How do we incorporate the challenge of resilience with equity in planning? Again, how does this get shared with planners and policymakers?

Capturing Resilience

Transmission outages
Generation derates or shutdowns
Limitations to the hydro system
Increased storage parasitic load requirements

FY22 Research Activities

Capacity Expansion

- Built a detailed California system model within GridPath
- Modeling and analysis
  - LA Basin natural gas peaker replacement in partnership with Strategen Consulting
  - Initial steps on WECC system model for future analyses (e.g., Oregon and Washington long duration storage needs)

Energy Storage and Hydropower

- Built a model to evaluate the use of battery systems for
  - Environmental considerations
  - Equity considerations
  - Economics: revenue, operations & maintenance (goal)
- In collaboration with multiple utilities *(publish pending)*

Continuing Work

- Continue to develop expansion planning capabilities for modeling the deployment of energy storage; incorporating
  - **Equity and resilience,** with a focus on informing policy
  - Inputs from Joint Global Climate Change Research Institute's GCAM (Global Climate Adaptation Model) multi-sectoral market equilibrium model
  - Budling on PNNL research in resilience, hydropower, transmission planning, offshore wind, electric vehicle integration, others
- Support system studies of storage deployment
- Evaluate alternative approaches to identifying future storage needs
- Refine model on storage and hydropower

Acknowledgments

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Mission – to ensure a resilient, reliable, and flexible electricity system through research, partnerships, facilitation, modeling and analytics, and emergency preparedness.

https://www.energy.gov/oe/activities/technology-development/energy-storage

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Thank You

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