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Docketed Date:	10/31/2023

SB 100 Analytical Framework Workshop
October 31, 2023

Workshop Agenda

1:00pm Welcome

1:05pm Comments from the Dais

1:25pm Analytical Framework Presentation

1. Report Background and Process
2. Scenario Construction
3. Electricity System Modeling

2:25pm Questions from the Dais

2:40pm Questions from the Public

3:10pm Public Comment

Workshop Objective

1. Provide additional background on the SB 100 process and opportunities for engagement
2. Describe and provide opportunity for feedback on the approach for the construction of modeled SB 100 scenarios.
3. Describe and provide opportunity for feedback on the approach for electricity system modeling of SB 100 scenarios.

Report Background and Process

2025 Report Timeline

Anticipated Timing	Workshop	Topics
Today	Analytical Framework	Approach to scenario construction and modeling framework
2024 Q1	Inputs & Assumptions	Detailed draft inputs and assumptions to be used to develop and model SB 100 scenarios
2024 Q1	Non-Energy Benefits and Land Use Methods	Proposed methods for non-energy benefit and land use impacts of the scenarios
2024 Late Q2	Draft Modeling Results	Draft scenario modeling results
2024 Early Q3	Draft NEB and Land Use Results	NEB and land use impact results based on the draft scenario modeling results
2024 Late Q3	Final Analysis Workshop	Final scenario modeling and evaluation
2024 Q4	Report and Recommendations Workshop	Draft report recommendations
2024 Q4	Submit Report the Legislature	

2025 Report Kickoff Workshop Comment Highlights

- Support of the pathways approach and capturing tradeoffs
- Emphasis on the importance of affordability
- Support for land use and NEB analysis
- Support for the proposed reliability analysis
- Clearly define "zero carbon resources"
- Include various technologies including geothermal, non-lithium battery solutions, long duration energy storage, alternative fuels such as hydrogen
- Do not include hydrogen combustion
- Include higher levels of DERs across all scenarios
- Include all costs related to DERs
- Address infrastructure requirements
- Support for working groups and informal stakeholder engagement

SB 100 Report Requirements

California Energy Commission (CEC), California Public Utilities Commission (CPUC), and California Air Resource Board (CARB) to issue a joint-agency report every four years including the following:

A. **A review of the policy** (technical, safety, affordability, reliability)

B. **Reliability benefits and impacts**

C. **Financial costs/benefits**

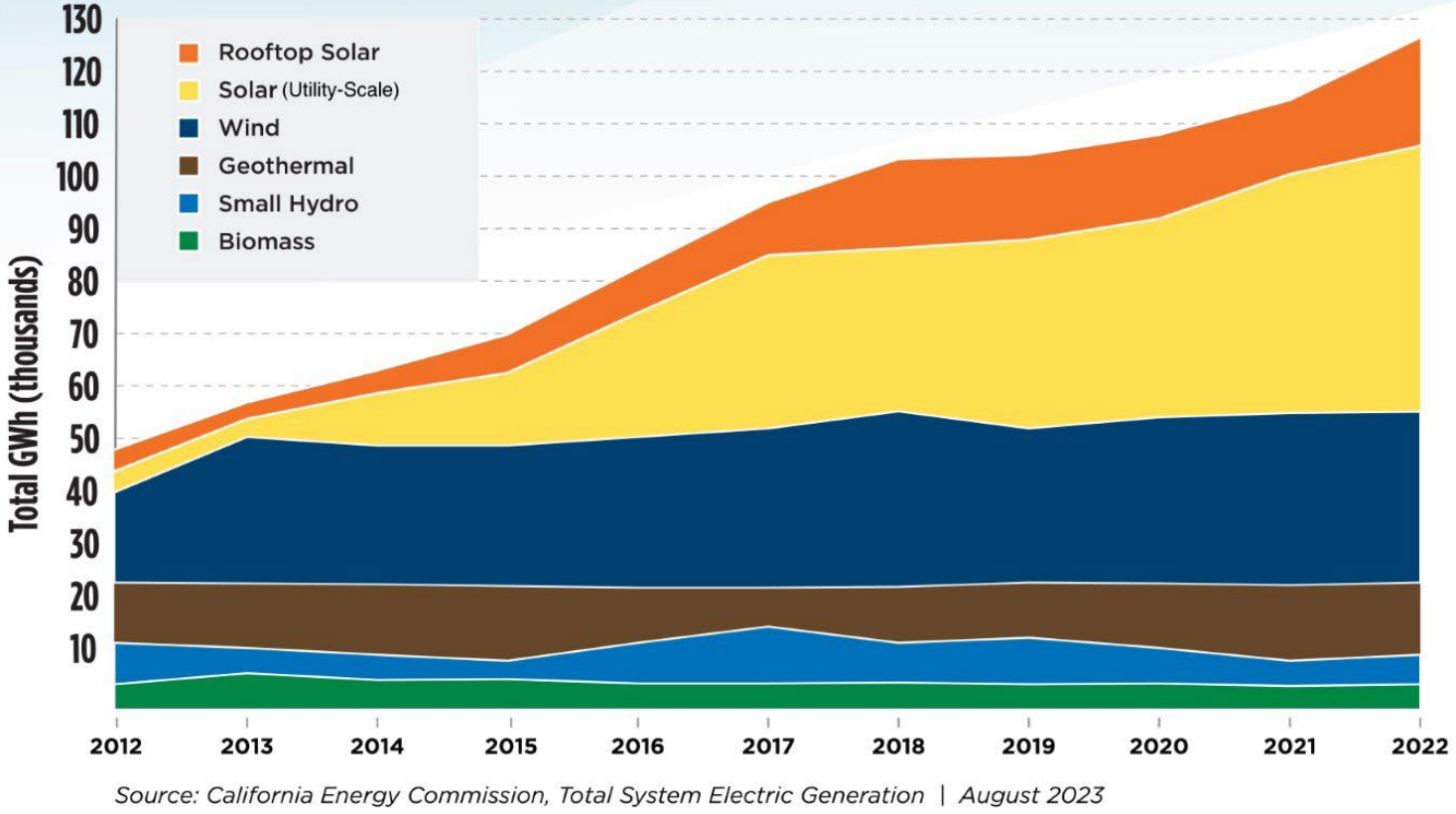
D. **Barriers/Benefits of achieving the policy**

E. **Alternative scenarios and costs/benefits of each**

The Opportunity of the 2025 SB 100 Report:

- Is to report on current statewide efforts toward clean electricity progress and identify opportunities to enhance state efforts.
- Study alternate scenarios to understand the impact of uncertainty in cost, technology innovation, and project development on achieving SB 100

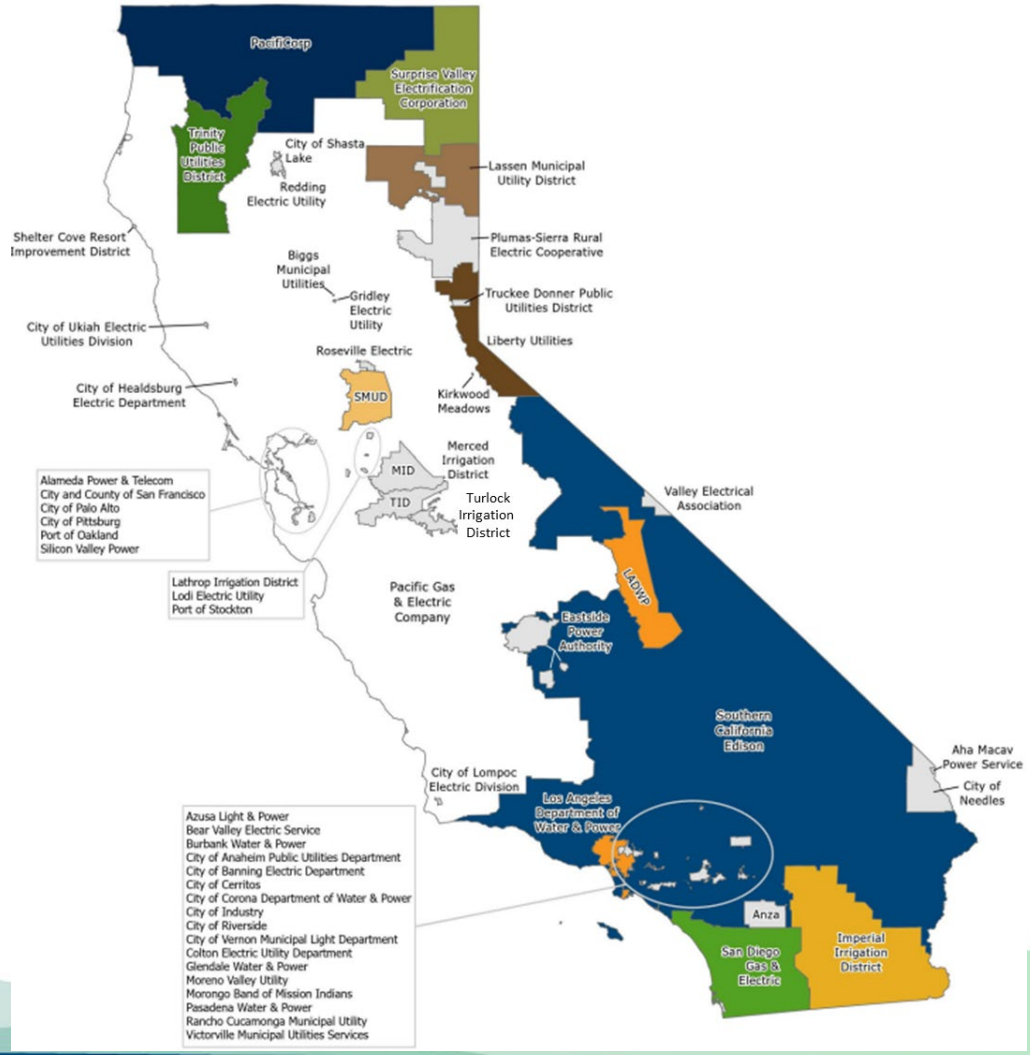
SB 100 Report Will Review Progress Towards 100% Clean Electricity



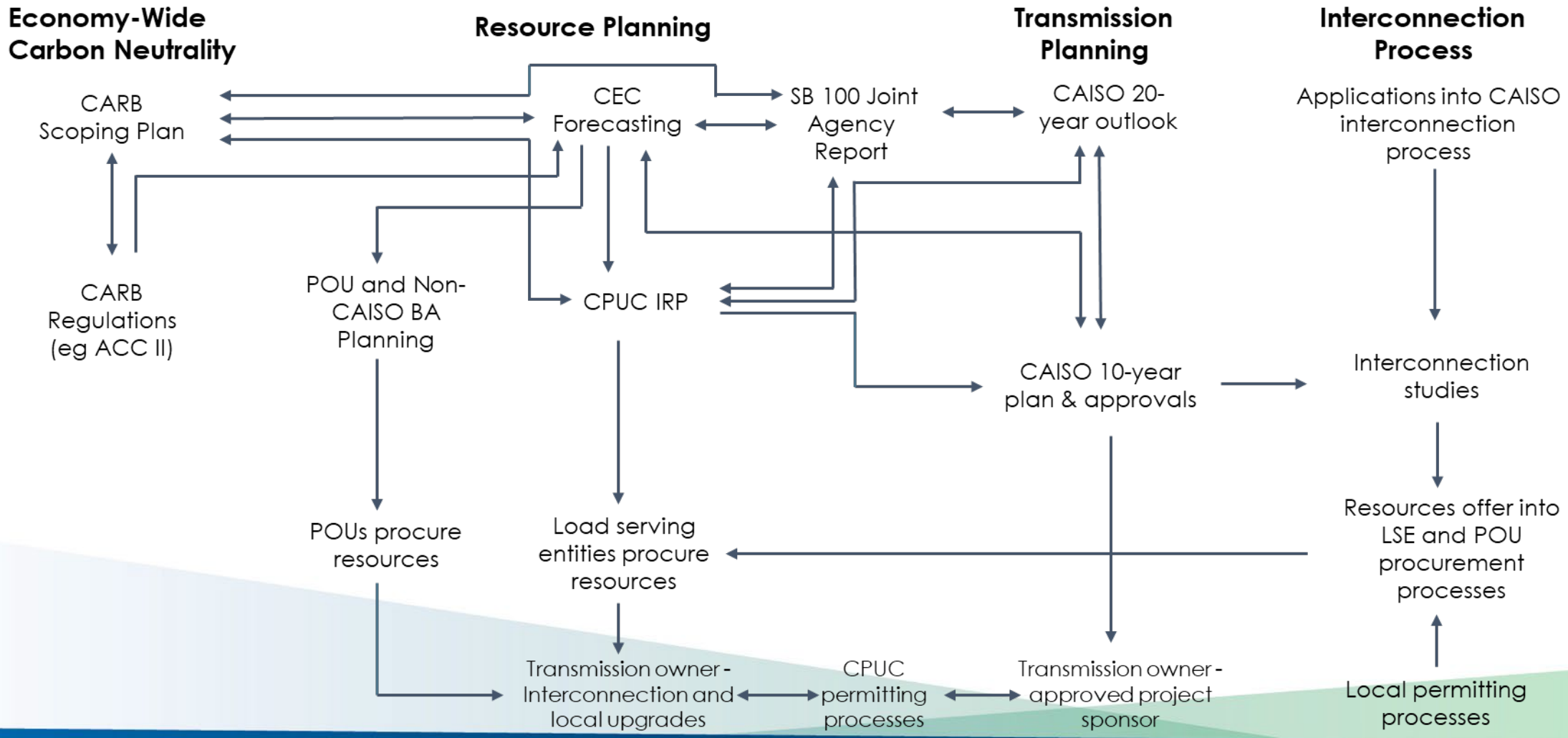
- In 2021 electric generation was 59% zero carbon
- Bulk Grid Storage grew from 200 MWs in 2019 to 5,600 MWs at the start of July 2023
- Over the last decade:
  - Solar generation surged 20x
  - Wind generation expanded by 63%
  - Natural Gas usage declined by 20%

SB 100 Report Will Review Progress Towards 100% Clean Electricity

- **80+ electric retail sellers includes –**
- 40+ Load-Serving Entities (LSEs) – electric investor-owned utilities (IOUs), community choice aggregators (CCAs) and energy service providers (ESPs) – operating in the 3 large electric IOU territories (PG&E, SCE & SDG&E)
- 40+ publicly owned electric utilities



SB 100 Report Will Review Progress Towards 100% Clean Electricity



Adapted from the California Independent System Operator

SB 100 Report Will Review Progress Towards 100% Clean Electricity

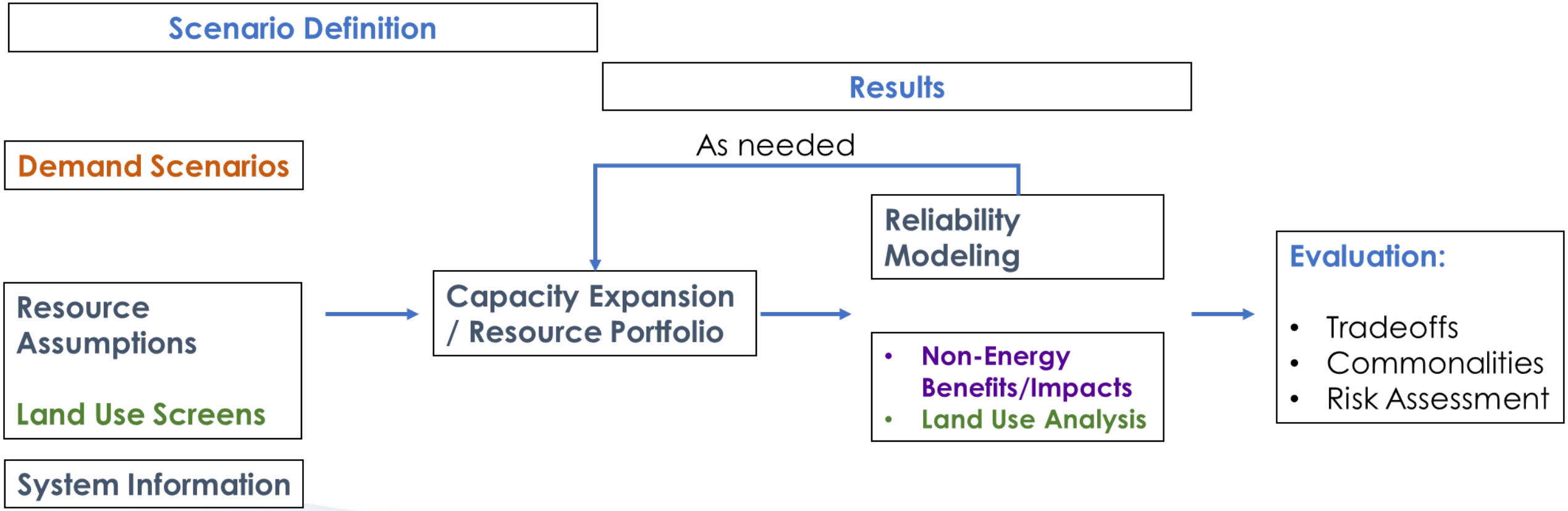
- Review progress to 100% clean electricity
- Review existing processes
- Incorporate state policies
- Provide directional information to support planning processes

Proposed Scenarios

Reference	Least cost model based on current demand scenario and resource cost projections.
Current Resource Plans	Existing resource plans replace the base resource, including the CPUC's Preferred System Plan through 2039, and POU Resource Plans.*
DER Focus	Higher levels of distributed energy resources, including BTM and FTM generation and storage resources, and demand flexibility.
Resource Diversification	Procurement and technology advancements for a variety of existing and emerging zero-carbon resources.
Geographic Diversification	Expanded regional transmission allowing for greater energy exchanges between California and the rest of the WECC.
Combustion Resource Retirement	Transition from combustion power plants to only non-combustion power plants.

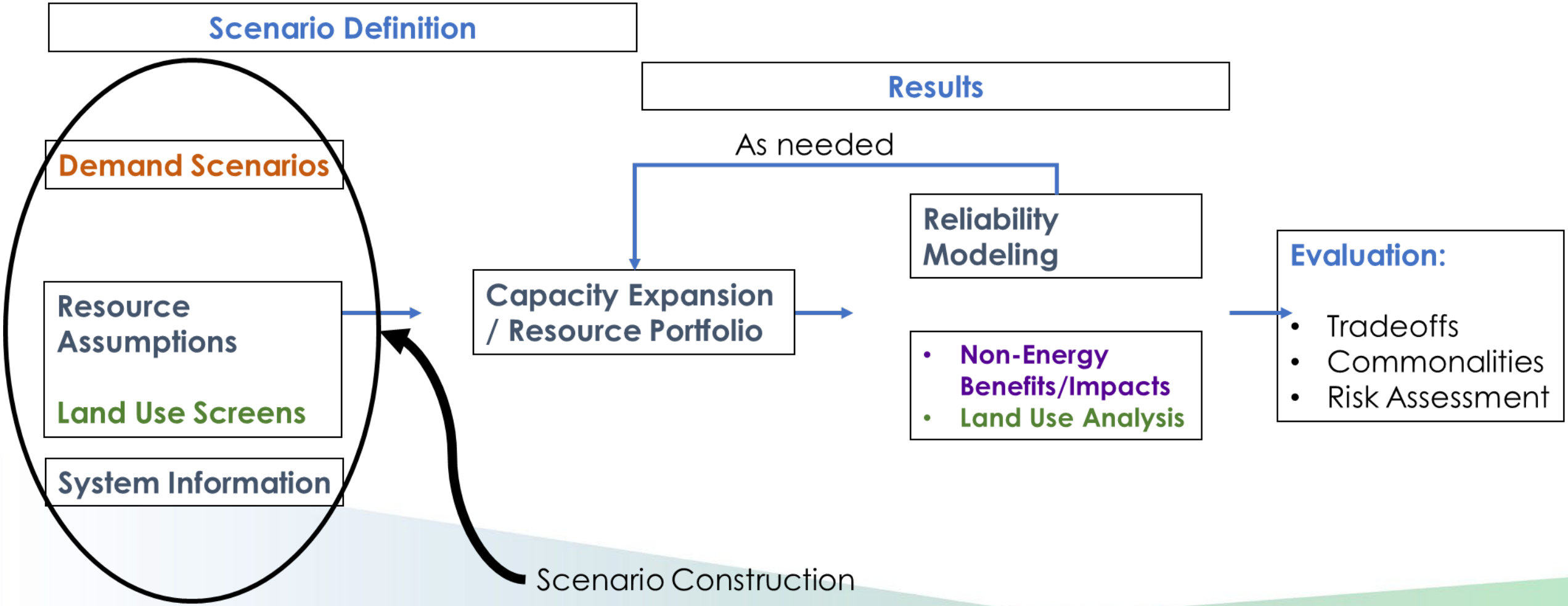
*All scenarios will include existing ongoing procurements

Scenario Analysis



Scenario Construction

Scenario Analysis



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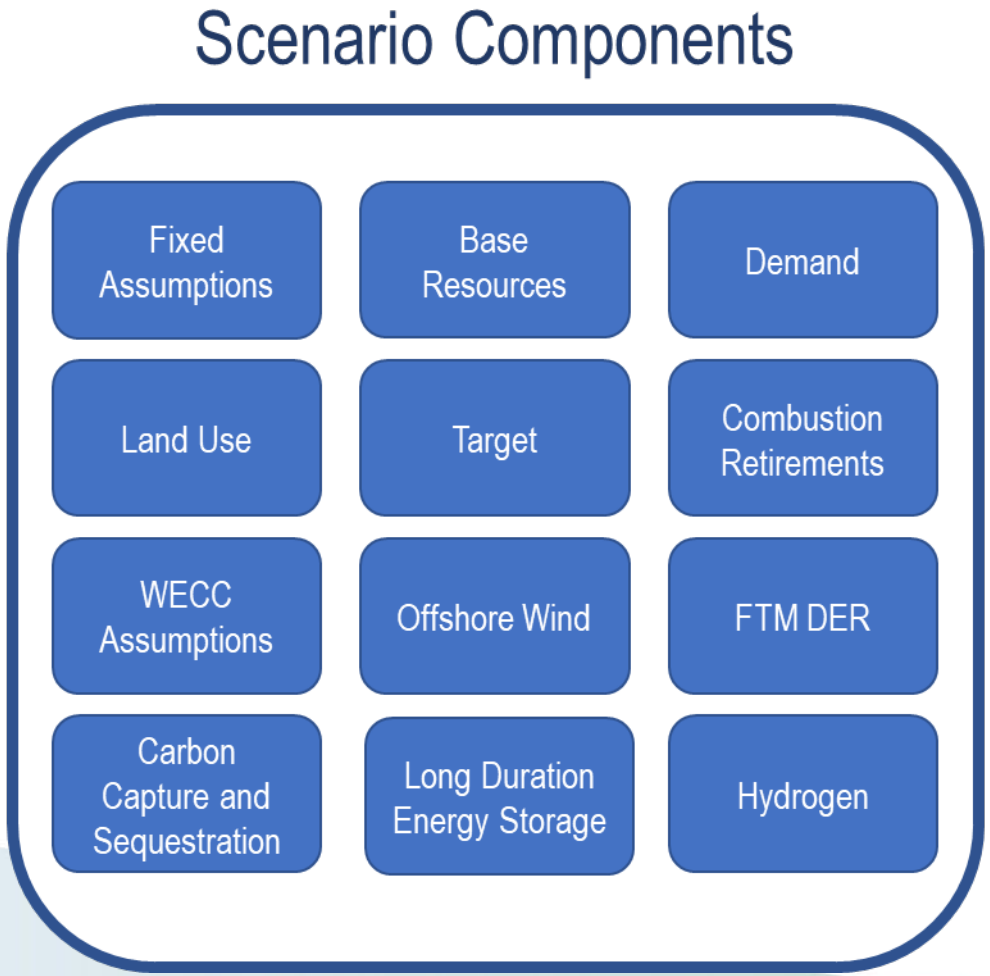
Overview of Scenarios

Gold indicates changes from the Reference Scenario

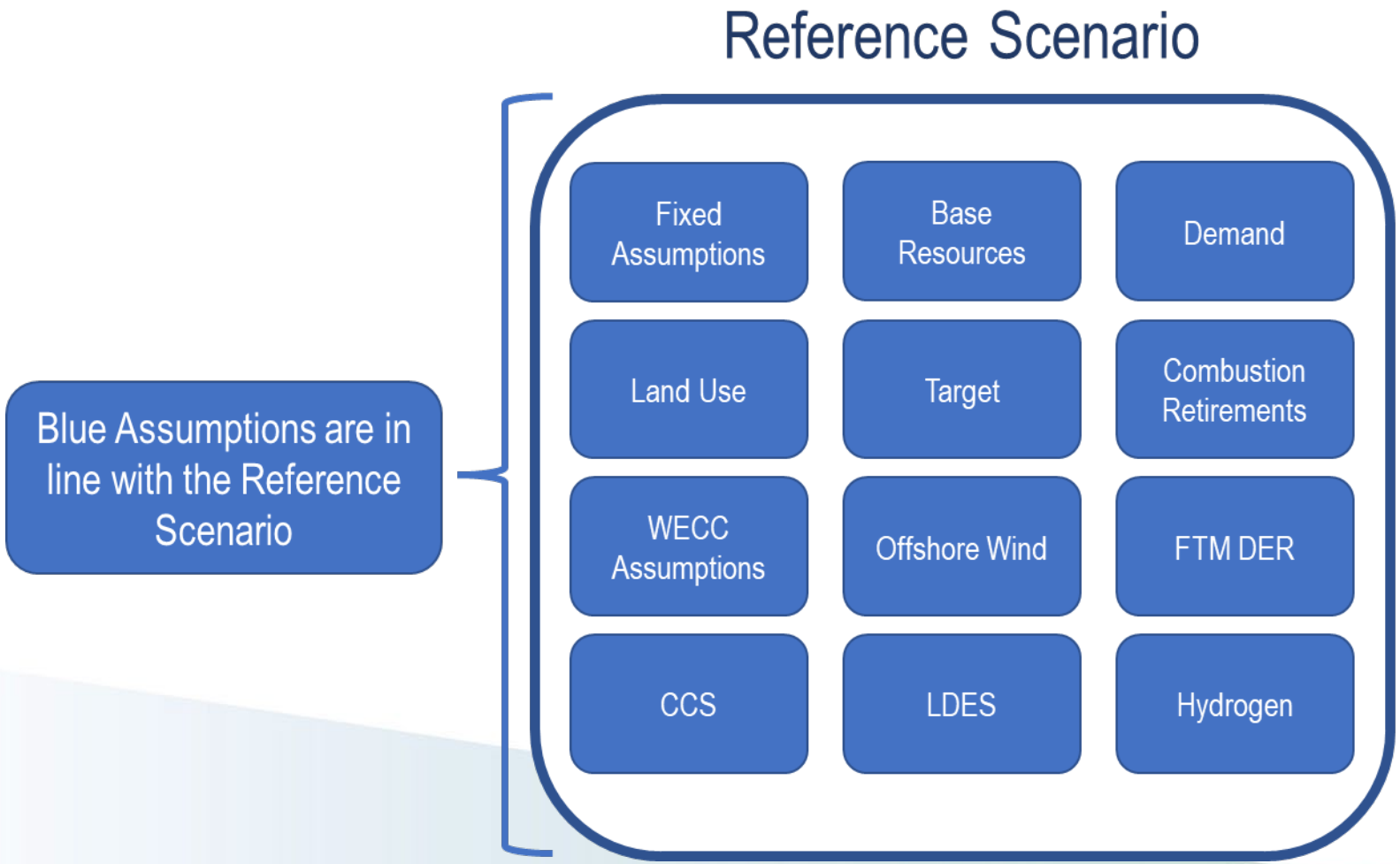
Assumption Category	Reference	Current Resource Plans	DER Focus	Resource Diversification	Geographic Diversification	Combustion Resource Reitrement
Fixed Assumptions	Base	-	-	-	-	-
Base Resources	Resource Plans to 2030	Resource Plans as far as adopted PSP to 2039	-	-	-	-
Demand	Policy Compliance High Electrification Scenario	-	Policy Compliance High Electrification Scenario, augmented by high DER, DR, and Load Flexibility	-	-	Policy Compliance High Electrification Scenario, augmented by high DER, DR, and Load Flexibility
Land Use	Core Land Use Screen	-	Terrestrial Climate Resiliency study	-	-	-
Target	SB 100	-	-	-	-	Expanded Load Coverage
Combustion Retirements	Planned and Economic	-	-	-	-	All Combustion Retires by 2045
WECC Assumptions	Economic Transmission Assumptions	-	-	-	Increased Interstate Transmission, Reduced Hurdle Rates	-
Offshore Wind	Economic Additions	-	-	Increased Offshore Wind	-	Increased Offshore Wind
FTM DER	Standard FTM DER	-	Increased FTM DERs	-	-	Increased FTM DERs
Carbon Capture and Sequestration	Economic Additions	-	-	Increased CCS Adoption	-	-
Long Duration Energy Storage	Economic Additions	-	-	Increased LDES	-	Increased LDES
Hydrogen	Economic Additions	-	-	Increased H2	-	Increased H2 Fuel Cells

Scenario Components

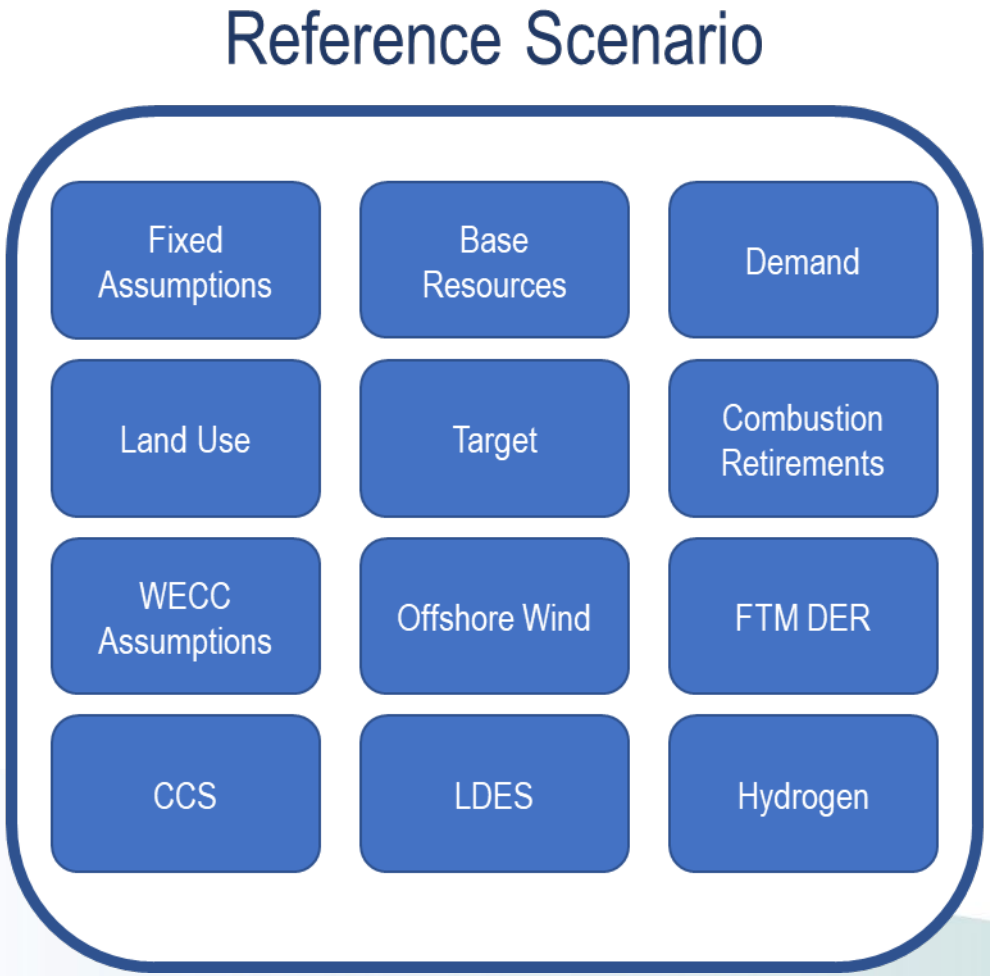


Note: This diagram has been updated from the Kickoff Workshop to better align with the "levers" being adjusted to construct the scenarios and to streamline language.

Reference Scenario is the Base Case



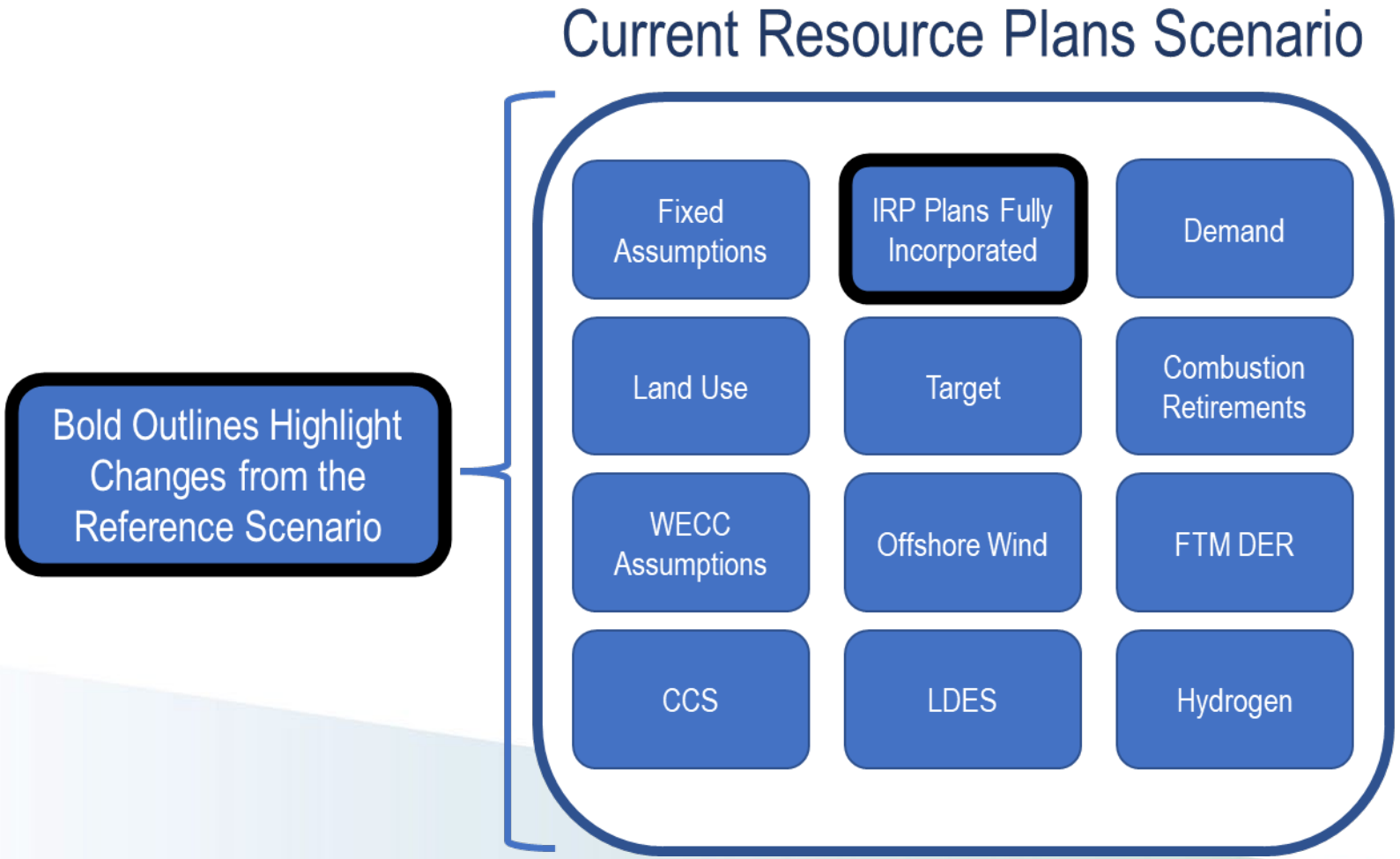
Reference Scenario



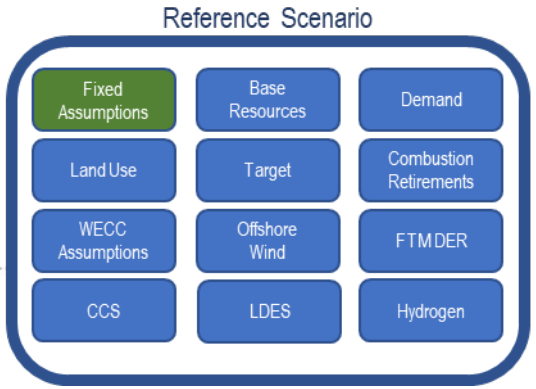
- The Reference Scenario will use the core assumptions.
- Differences in assumptions for each scenario will be characterized in relationship to the Reference Scenario.
- Available new resources will be selected economically on top of existing plans beginning in 2030.

- Today will focus on the approach for constructing each scenario.
- Detailed inputs and assumptions will be provided for input in early 2024.

Changes from the Reference Scenario are Outlined in Bold

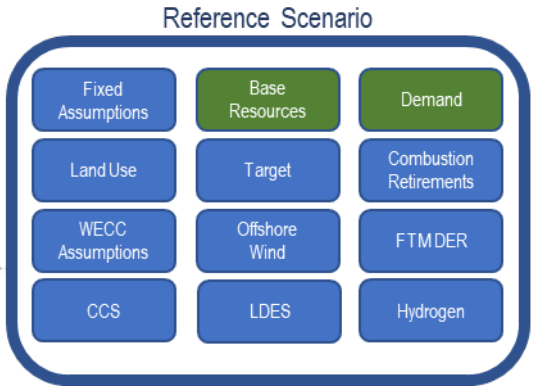


Fixed Assumptions



- Technology related costs
- System costs
- Fuel costs
- Power plant and energy storage operating characteristics
- System topology
  - What regions we model
  - What level of detail is included for each region
  - Base transmission between regions
- Wind and solar generation profiles

Base Resources and Demand



Base Resources

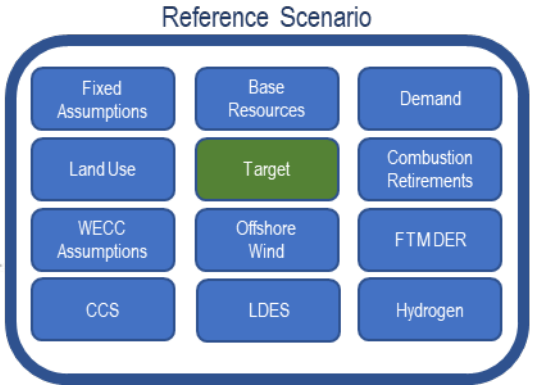
- Use of published plans through 2030
- Planned retirements
  - Includes once through cooling retirements.
- Sources:
  - Published Publicly Owned Utility Plans
  - CPUC adopted Preferred System Plan
  - WECC Anchor Dataset for out of state resources

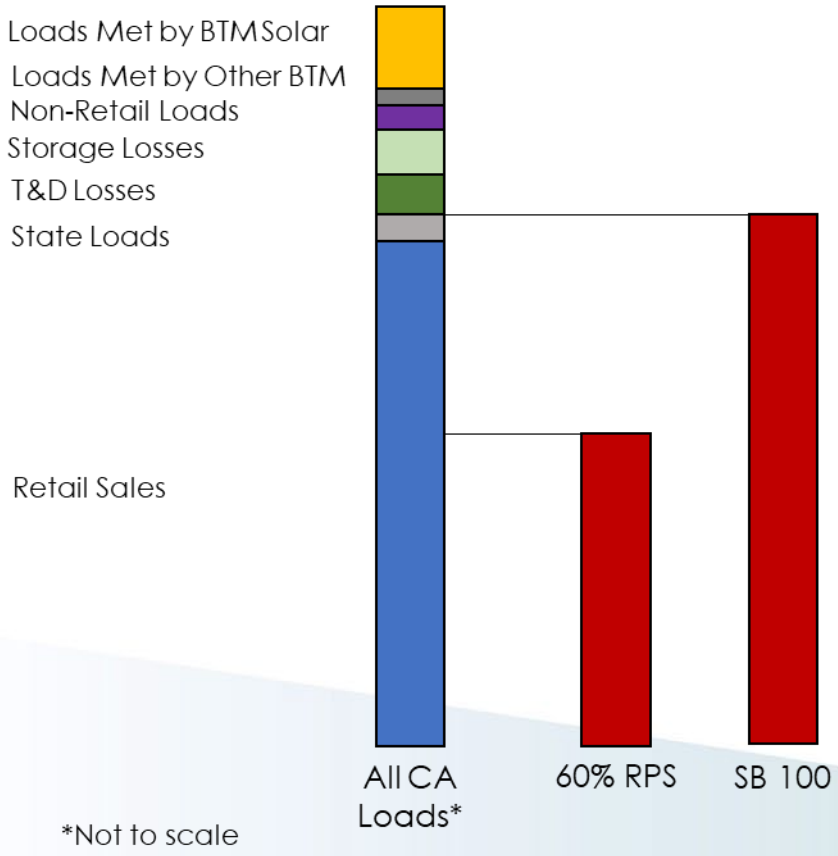
Demand

- Policy Compliance High Electrification Scenario, includes:
  - Demand profiles
  - Demand Response
  - Distributed Energy Resources (BTM)
  - Load Flexibility
- Source:
  - CEC Demand Scenarios[1]

[1] Workshop tentatively planned for Q1 2024

Accounting for SB 100 and SB 1020 Targets





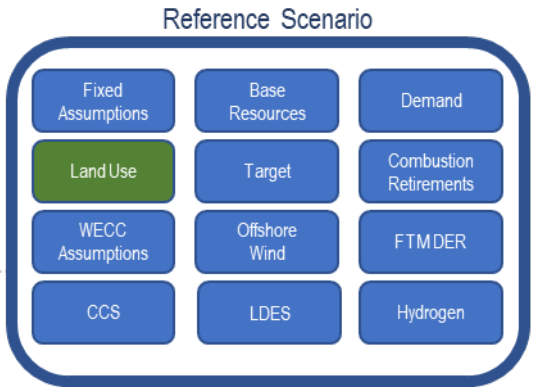
$$SB\ 100\ Progress = \frac{Generated\ SB\ 100\ Energy}{SB\ 100\ Energy\ Need}$$

Renewable and Zero Carbon Target

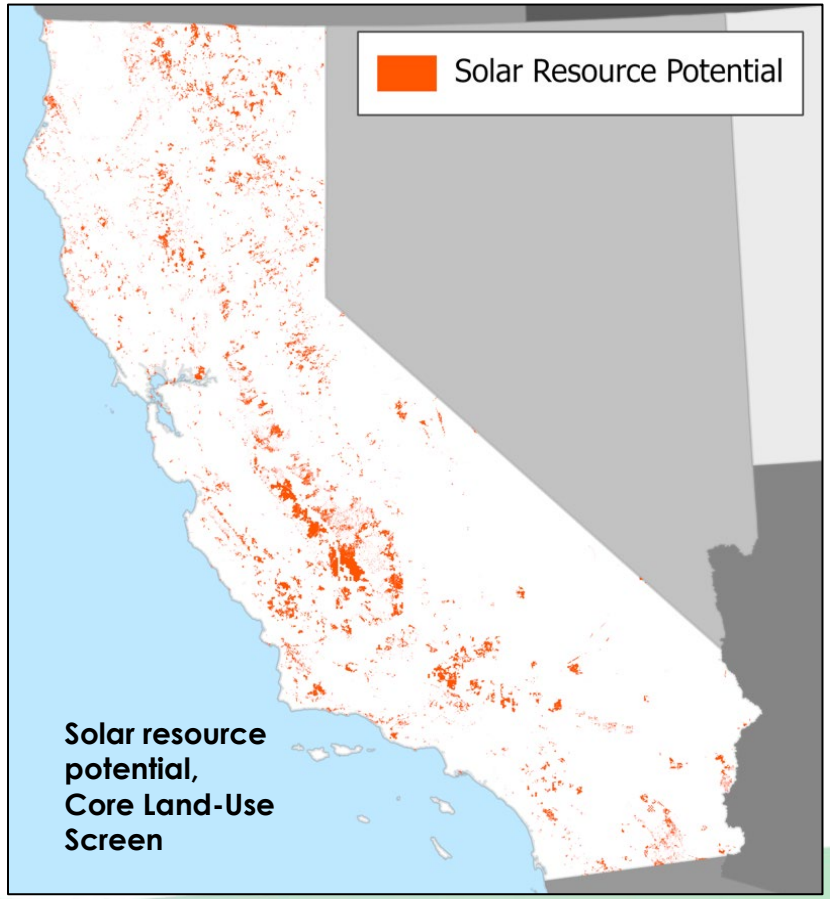
Year	Retail Sales	Energy Procured for State Loads
2030	N/A	N/A
2035	90%	100%
2040	95%	100%
2045	100%	100%

Note: The 60% RPS will be enforced for all years.

Land Use

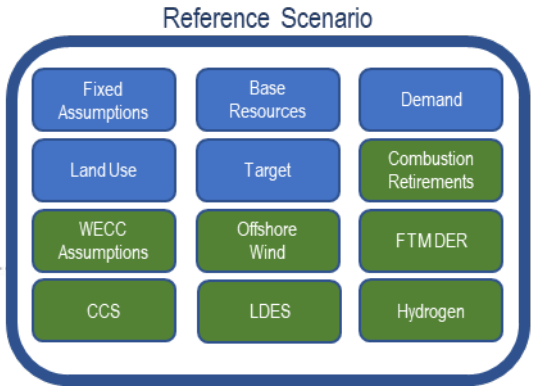


- Land-use screens are used to inform resource potential estimates for land-based wind, solar, and geothermal resources.
- In California: Core Land-Use Screen
- OOS: WECC Environmental Data Task Force, Risk Class Categories 3 and 4
- CEC, in close collaboration with the CPUC, recently completed a one-and-a-half-year public and interagency process to update the screens. More information can be found here: Land Use Screens



Solar resource potential, Core Land-Use Screen

New Resource Assumptions



- New generation, storage, and transmission will be economically selected.
- Resource retirements will be economically driven, except for announced retirement plans or expected plant useful life.
- FTM distributed energy resources will be modeled as utility scale resources but separated for reporting results, land use analysis and non-energy benefit analysis.

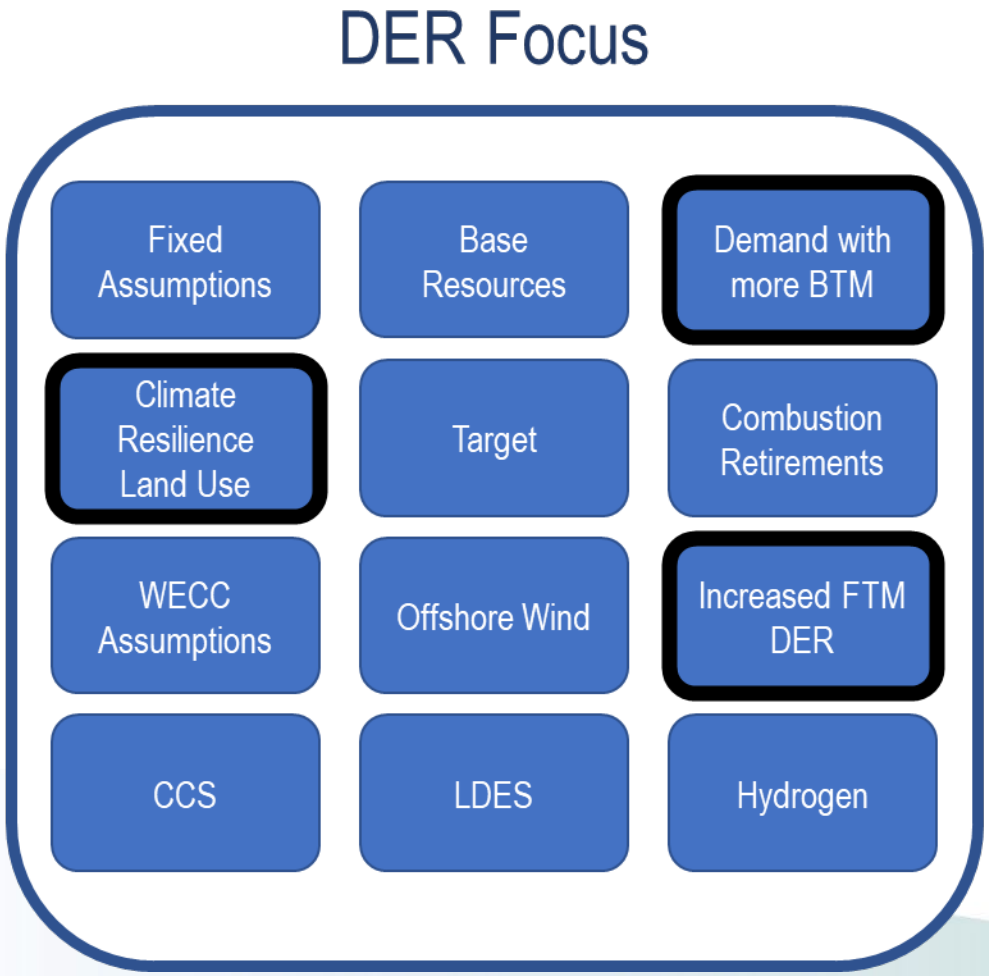
Current Resource Plans Scenario

The Current Resource Plans Scenario incorporates the published utility plans:

- CPUC PSP through 2039, consistent with the transmission planning process resource submittals.
- POU IRPs included out as far as they have been adopted by the utility.

The model may select additional resources to meet demand scenario load.

DER Focus Scenario

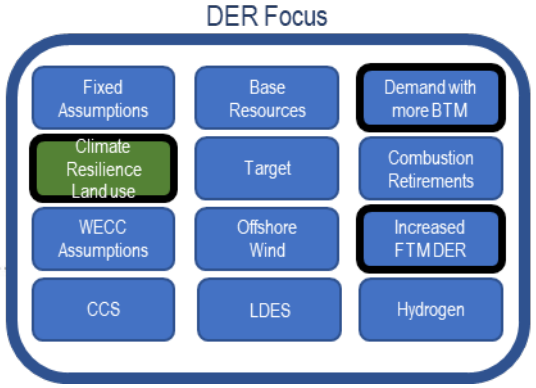


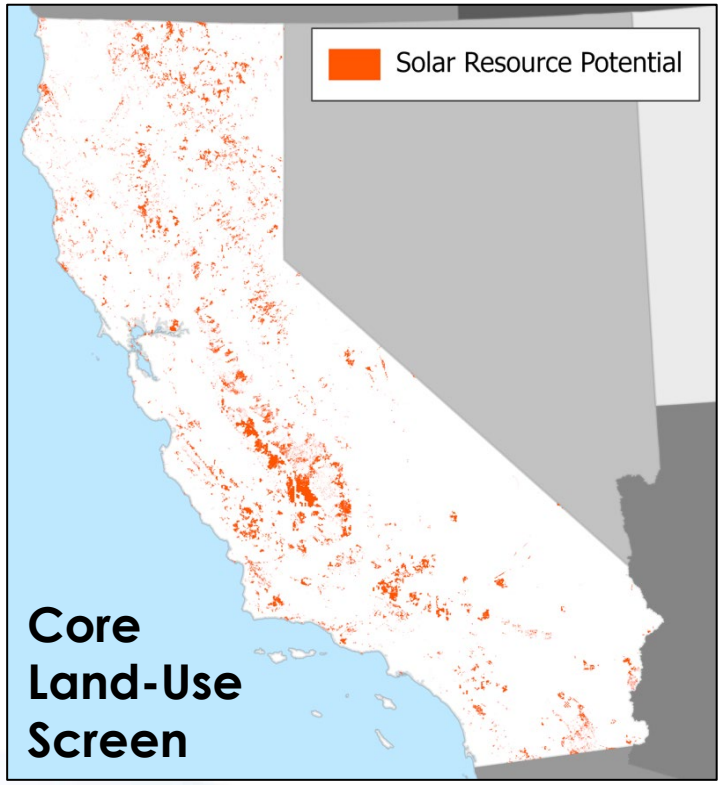
Demand: Increased DER, DR and Load Flex incorporated in the Demand Scenario.

FTM DER Resources: Increased adoption of in-front-of-the-meter distributed resources.

Land Use Screen: Climate Resilience Land Use Scenario.

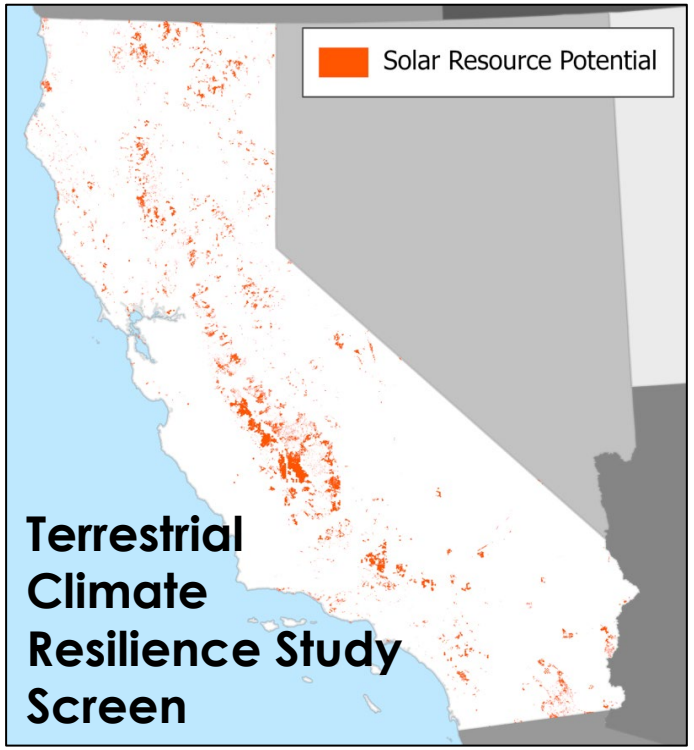
DER Focus Scenario Land Use



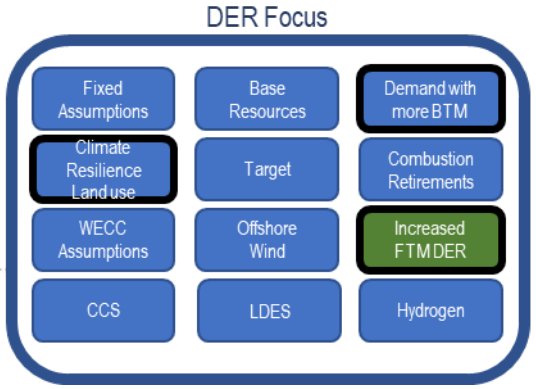


Use a more restrictive land use screen

In this screen, less land meets the screening criteria; therefore, the resource potential estimates for land-based wind and solar are lower.



DER Focus Scenario FTM Resources



Objective: Include an ambitious, but feasible level of FTM distributed energy resources based on:

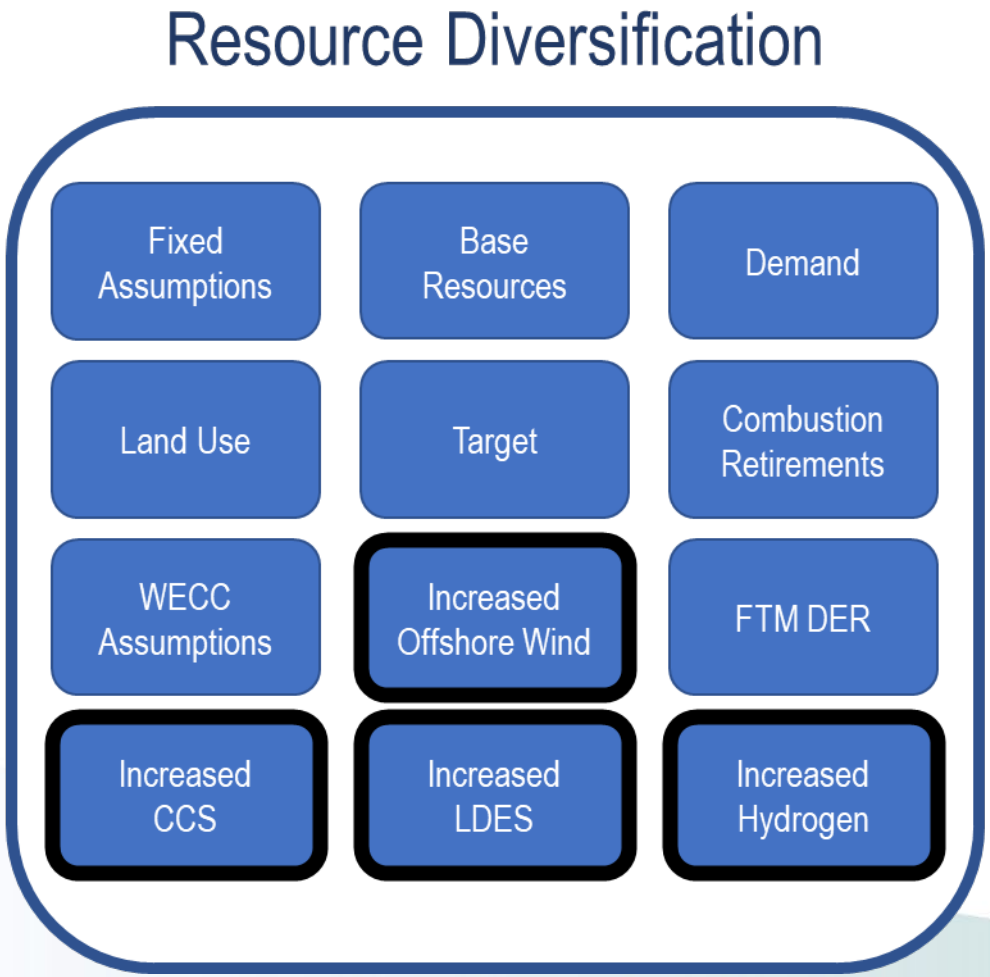
- Current state policies and programs
- Economic selection in the Reference Pathway
- Resource feasibility, economic impact and diminishing returns of adding additional resources

Modeled as utility-scale resources and allocated in post-processing as a in front of the meter distributed energy resource.

Stakeholder Question

- What assessments, reports, policies and/or programs should the joint agencies consider when determining what level of FTM distributed energy resources to include in the DER Focus Scenario?

Resource Diversification Scenario

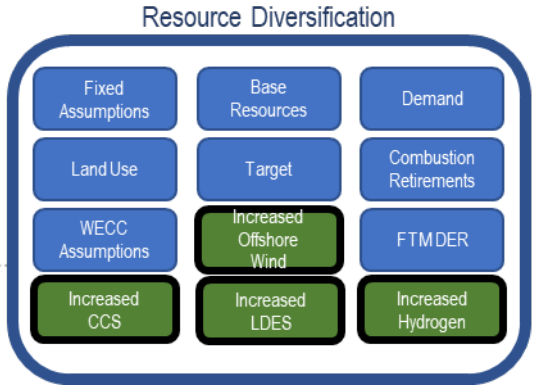


Increased Adoption of:

- Offshore wind
- Generation with carbon capture and sequestration
- Long duration energy storage
- Hydrogen for electricity generation

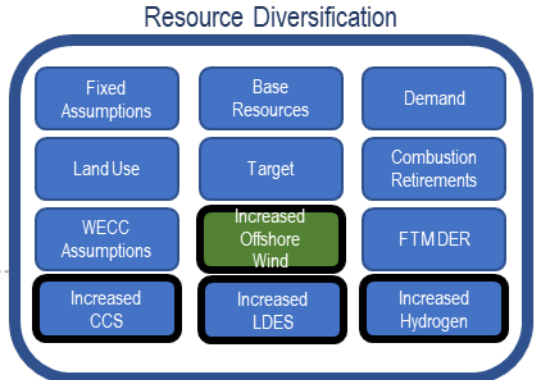
Minimum adoption levels of these resources will be set above the economic selection for the Reference Scenario. The remaining resources will be selected economically.

Increasing Resource Adoption



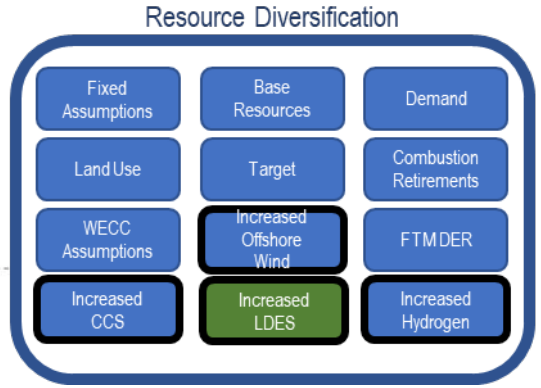
- **Objective:** Include an ambitious, but feasible level of OSW, LDES, CCS and Hydrogen resources based on:
  - Current state policies and programs
  - Economic selection in the Reference Scenario
  - Resource feasibility, economic impact and diminishing returns of adding additional resources

Increased Offshore Wind



- Increase OSW to 25 GW based on the statewide planning goal
  - Proposed mapping of the 25 GW shown on right.
- **First 20 GW:** Mapping the first 20 GW of offshore wind is guided by the *2045 Scenario for the Update of the 20-Year Transmission Outlook* (link). Which was informed by the 23-24 TPP portfolios and ongoing North Coast analysis led by CEC for AB 525.
- **Last 5 GW:** Add 1 GW to the Morro Bay WEA and the remaining 4 GW to areas along the North Coast.

Increased LDES

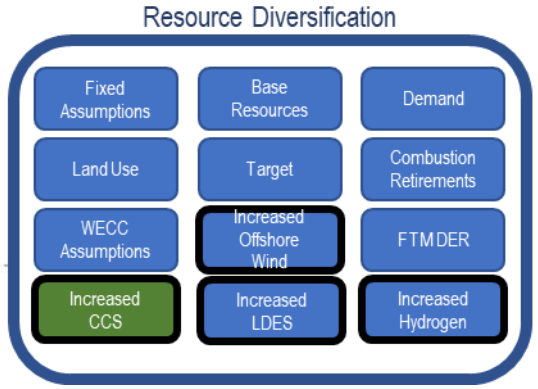


- **Objective:** Include an ambitious, but feasible level of long duration energy storage resources based on:
  - Current state policies and programs
  - Economic selection in the Reference Scenario
  - Resource feasibility, economic impact and diminishing returns of adding additional resources

Stakeholder Question

- What assessments, reports, policies and/or programs should the joint agencies consider when determining what level of long duration energy storage to include in the Resource Diversification Scenario? (e.g. CEC's Long Duration Energy Storage program)

Increased CCS

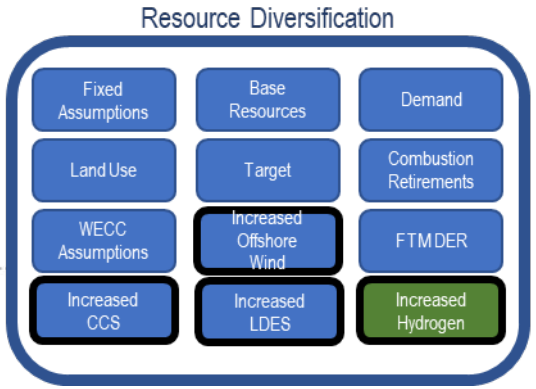


- **Objective:** Include an ambitious, but feasible level of natural gas generation with CCS based on:
  - Current state policies and programs
  - Economic selection in the Reference Scenario
  - Resource feasibility, economic impact and diminishing returns of adding additional resources

Stakeholder Question

- What assessments, reports, policies and/or programs should the joint agencies consider when determining what level of CCS to include in the Resource Diversification Scenario? (e.g. Governor's July 2022 letter asking for carbon removal targets, AB 1279, SB 905)

Increased Hydrogen

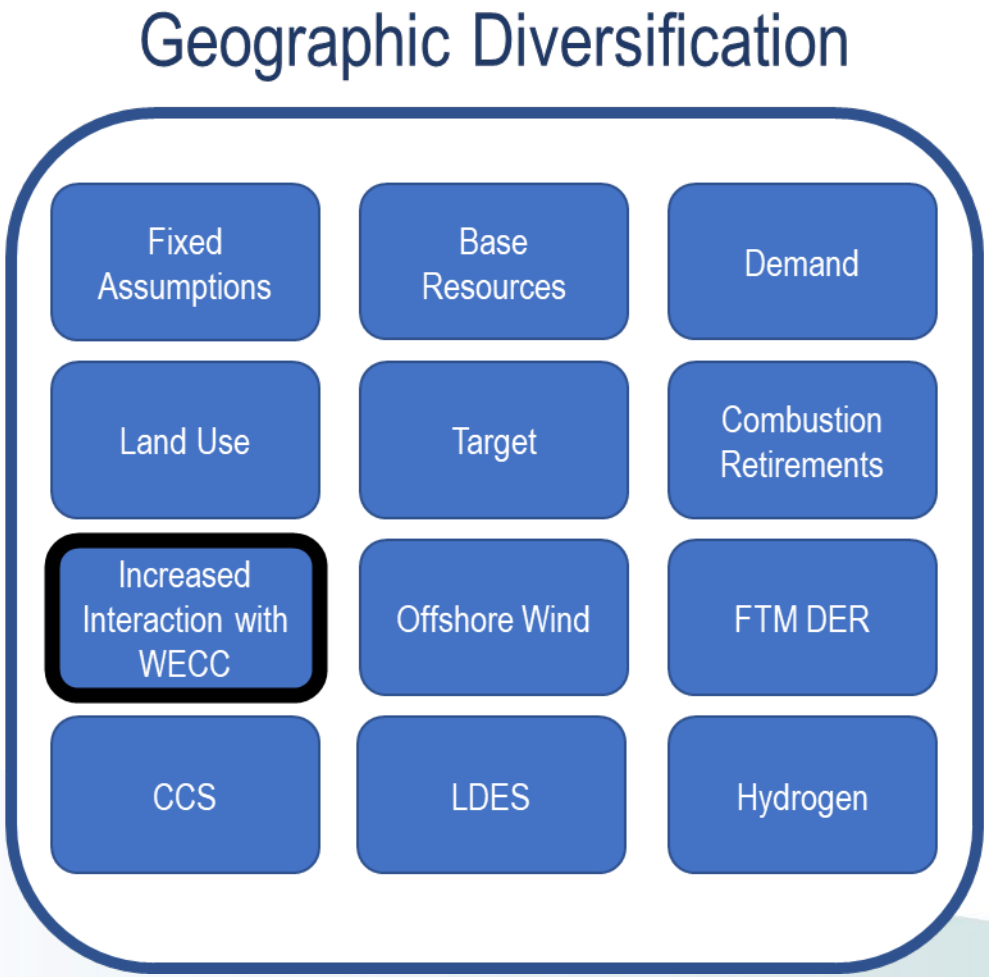


- **Objective:** Include an ambitious, but feasible, level of hydrogen resources based on:
  - Current state policies and programs
  - Economic selection in the Reference Scenario
  - Resource feasibility, economic impact and diminishing returns of adding additional resources

Stakeholder Question

- What assessments, reports, policies and/or programs should the joint agencies consider when determining what level of hydrogen to include in the Resource Diversification Scenario? (e.g. SB 1075, ARCHES, H2 use in the Scoping Plan, current utility plans)

Geographic Diversification Scenario



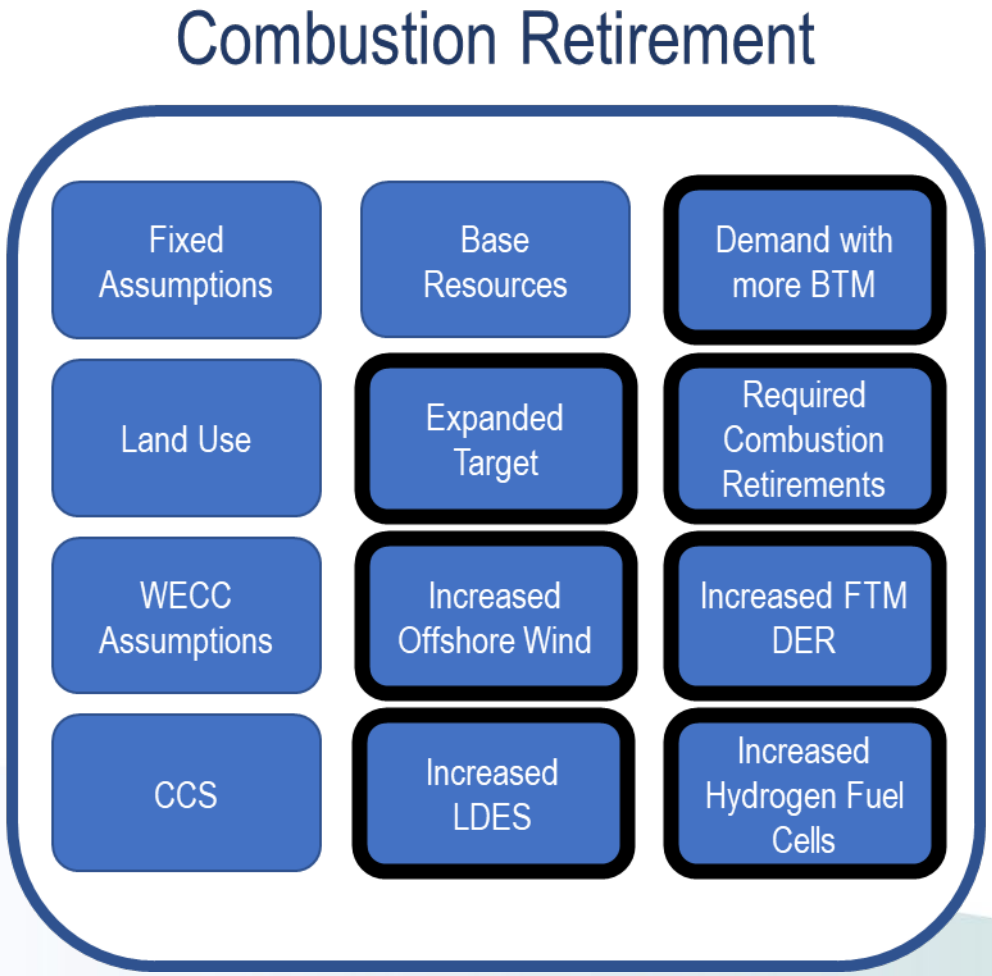
Increase interactions between California and the rest of WECC driven by:

- Increase OOS resource build
- Increased interstate transmission build
- Reduced hurdle rates

Stakeholder Question

- What assessments, reports, policies and/or programs should the joint agencies consider when designing the Geographic Diversification Scenario? (e.g. State-Led Market Options Study)

Combustion Retirement Scenario



Demand: Increased DER, DR and Load Flex incorporated in the Demand.

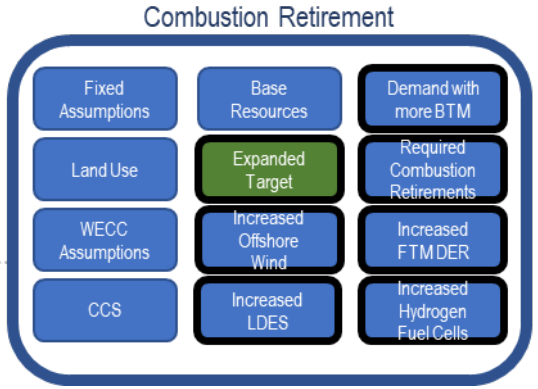
Target: Expanded load coverage target

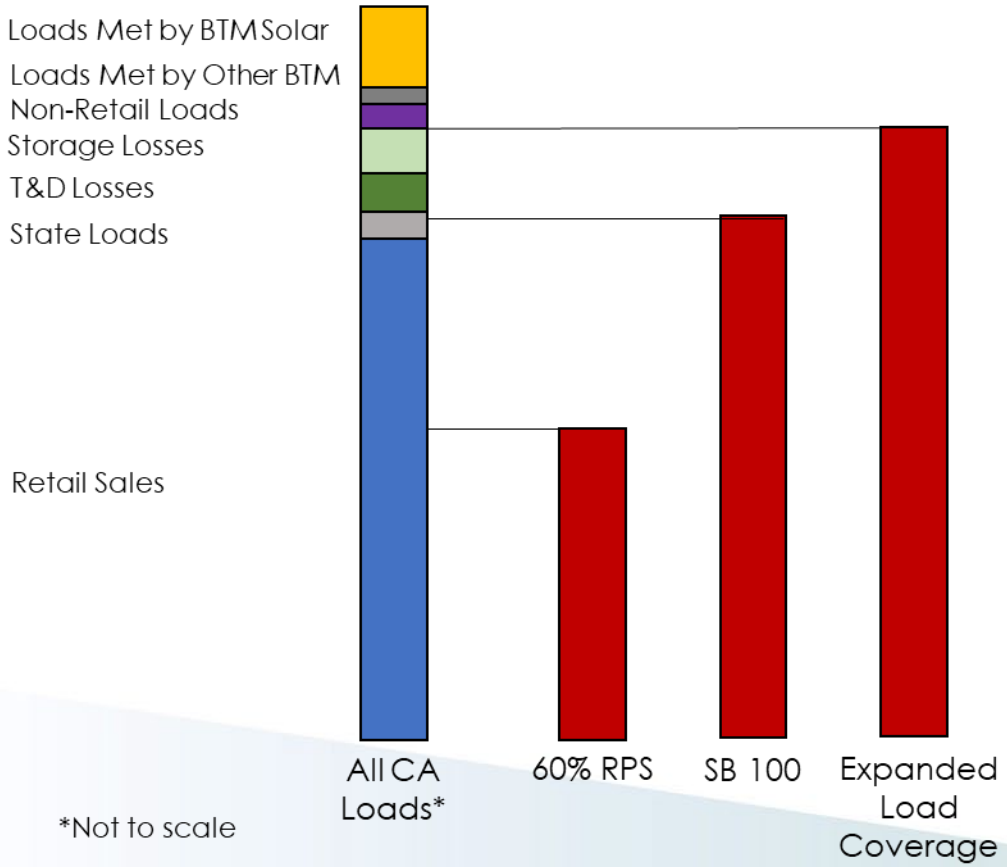
Combustion Retirement: Required retirement schedule

Increased Adoption of:

- Offshore wind (25 GW, as above)
- FTM Distributed Resources
- Long duration energy storage
- Hydrogen fuel cells for electricity generation

Expanded Load Coverage





$$SB\ 100\ Progress = \frac{Generated\ SB\ 100\ Energy}{Expanded\ Load\ Coverage}$$

Renewable and Zero Carbon Target

Year	Storage and T&D Losses	Retail Sales	Energy Procured for State Loads
2030	N/A	N/A	N/A
2035	90%	90%	100%
2040	95%	95%	100%
2045	100%	100%	100%

Note: The 60% RPS will be enforced for all years.

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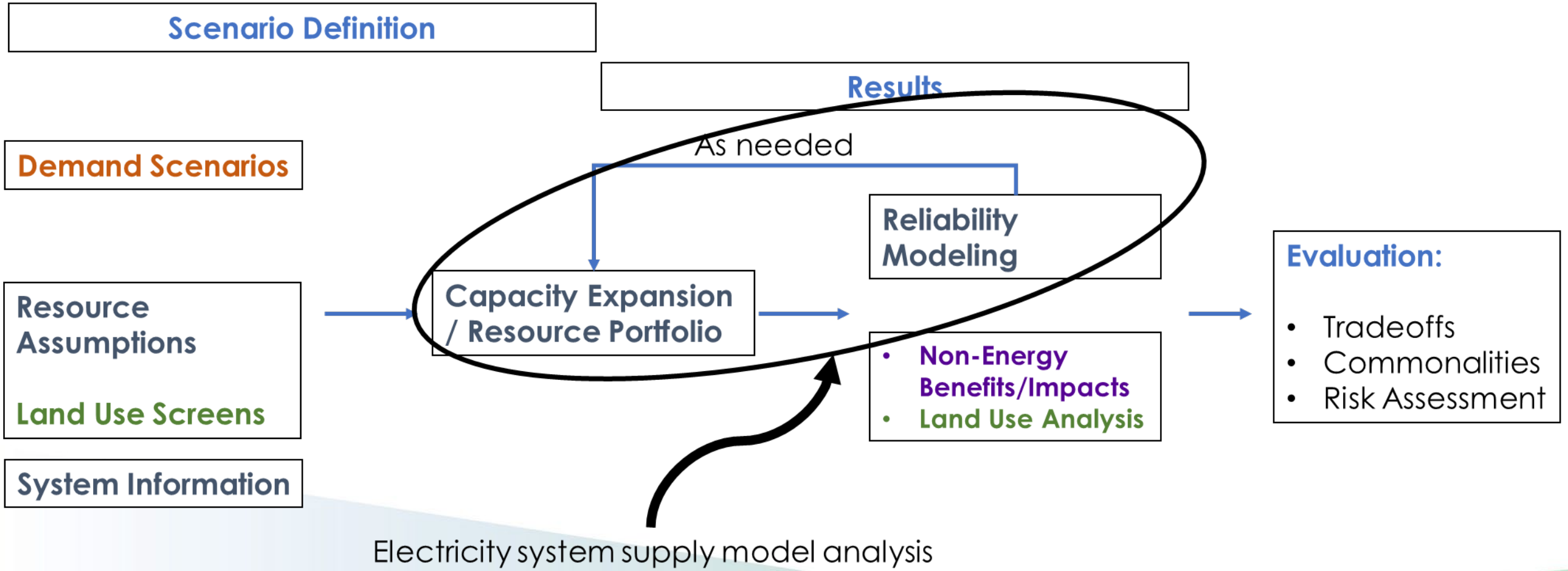
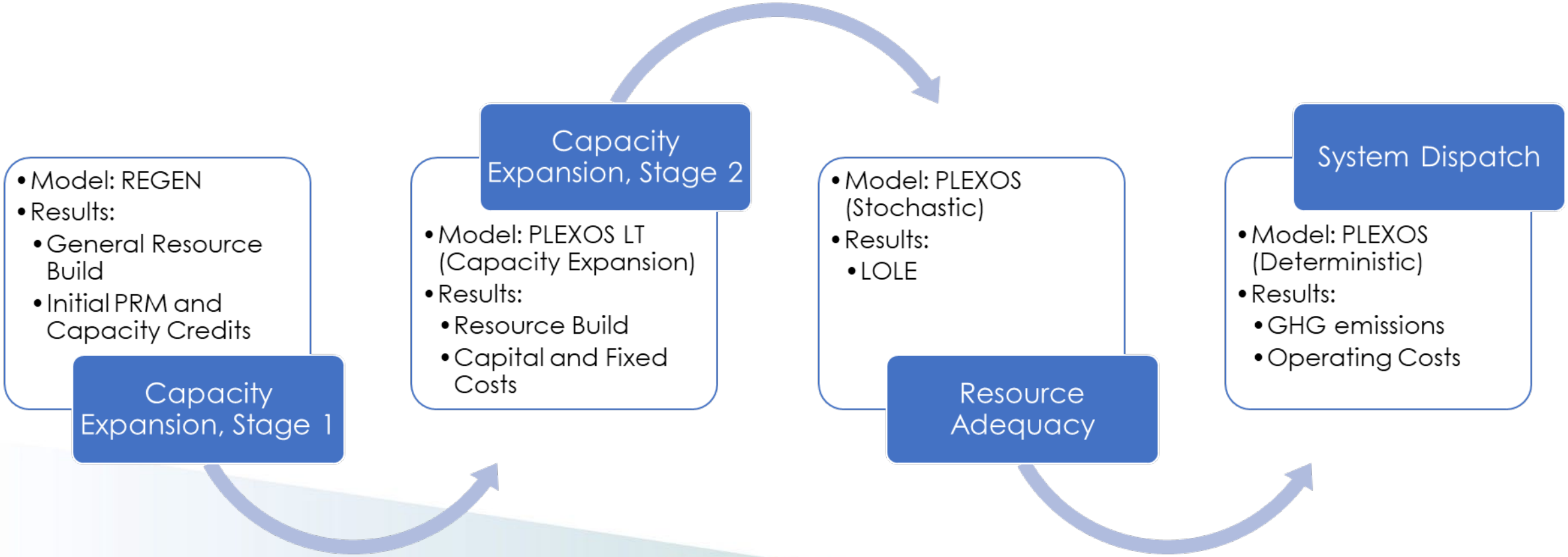
Land Use	Core Land Use Screen	-	Terrestrial Climate Resiliency study	-	-	-
Target	SB 100	-	-	-	-	Expanded Load Coverage
Combustion Retirements	Planned and Economic	-	-	-	-	All Combustion Retires by 2045
WECC Assumptions	Economic Transmission Assumptions	-	-	-	Increased Interstate Transmission, Reduced Hurdle Rates	-
Offshore Wind	Economic Additions	-	-	Increased Offshore Wind	-	Increased Offshore Wind
FTM DER	Standard FTM DER	-	Increased FTM DERs	-	-	Increased FTM DERs
Carbon Capture and Sequestration	Economic Additions	-	-	Increased CCS Adoption	-	-
Long Duration Energy Storage	Economic Additions	-	-	Increased LDES	-	Increased LDES
Hydrogen	Economic Additions	-	-	Increased H2	-	Increased H2 Fuel Cells

Electricity System Modeling

Scenario Analysis



Electricity System Supply Model



Capacity Expansion, Stage 1

- Model: REGEN
- Results:
  - General Resource Build
  - Initial PRM and Capacity Credits

Capacity Expansion, Stage 1

Model: REGEN

Purpose:

Identify a least cost set of capacity by technology capable of serving the hourly energy and power demands of California.

Failure Condition(s):

Violation of constraints, such as SB 100 target, or infeasibilities in the model.

Results

- Selected technology capacity by region (such as, balancing authority or planning region).
- Estimated planning reserve margins and capacity credits for stage 2.
- Resource characteristics for fine tuning candidates in state 2.

Capacity Expansion, Stage 2

Capacity Expansion, Stage 2

- Model: PLEXOS LT (Capacity Expansion)
- Results:
  - Resource Build
  - Capital and Fixed Costs

Model: PLEXOS LT

Purpose:

Identify a least cost set of potential power plants capable of serving the hourly energy and power demands of California.

Failure Condition(s):

Violation of constraints, such as SB 100 target, infeasibilities in the model, or significant variations in results from stage 1.

Results

- Selected candidate power plant, transmission, and energy storage by region.
- Capital and fixed operating costs for the system.

Resource Adequacy

- Model: PLEXOS Stochastic
- Results:
  - LOLE

Resource Adequacy

Model: PLEXOS (Stochastic)

Purpose:

Evaluate the reliability of the selected resource mix under a variety of supply and demand conditions.

Failure Condition(s):

Loss of load expectation significantly exceeds planning standards across California or component regions.

Results

- Resource adequacy metrics for each region, including:
  - Loss of load expectation (LOLE)
  - Expected unserved energy (EUE)
  - Event duration

System Dispatch

System Dispatch

- Model: PLEXOS Deterministic
- Results:
  - GHG Emissions
  - Operating Costs

Model: PLEXOS (Deterministic)

Purpose:

Evaluate how the system may operate under typical conditions and produce the remainder of the system model results.

Failure Condition(s):

Insufficient eligible generation, any unserved energy, or results that are inconsistent with capacity expansion assumptions.

Results

- Estimated greenhouse gas emissions
- Operating costs
- Fuel consumption
- Other operating characteristics

All results will be by region, and when appropriate by resource type.

Modeling Stakeholder Question

- SB 100 modeling does not currently plan to directly model local reliability. What approaches should be considered to address local reliability needs and impacts in this report process?

2025 Report Timeline

Anticipated Timing	Workshop	Topics
Today	Analytical Framework	Approach to scenario construction and modeling framework
2024 Q1	Inputs & Assumptions	Detailed draft inputs and assumptions to be used to develop and model SB 100 scenarios
2024 Q1	Non-Energy Benefits and Land Use Methods	Proposed methods for non-energy benefit and land use impacts of the scenarios
2024 Late Q2	Draft Modeling Results	Draft scenario modeling results
2024 Early Q3	Draft NEB and Land Use Results	NEB and land use impact results based on the draft scenario modeling results
2024 Late Q3	Final Analysis Workshop	Final scenario modeling and evaluation
2024 Q4	Report and Recommendations Workshop	Draft report recommendations
2024 Q4	Submit Report the Legislature	

Comments Due November 14th

- Submit Comments to Docket: 23-SB-100

- Questions:
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  - Mark Kootstra: mark.kootstra@energy.ca.gov