



The Los Angeles 100% Renewable Energy Study

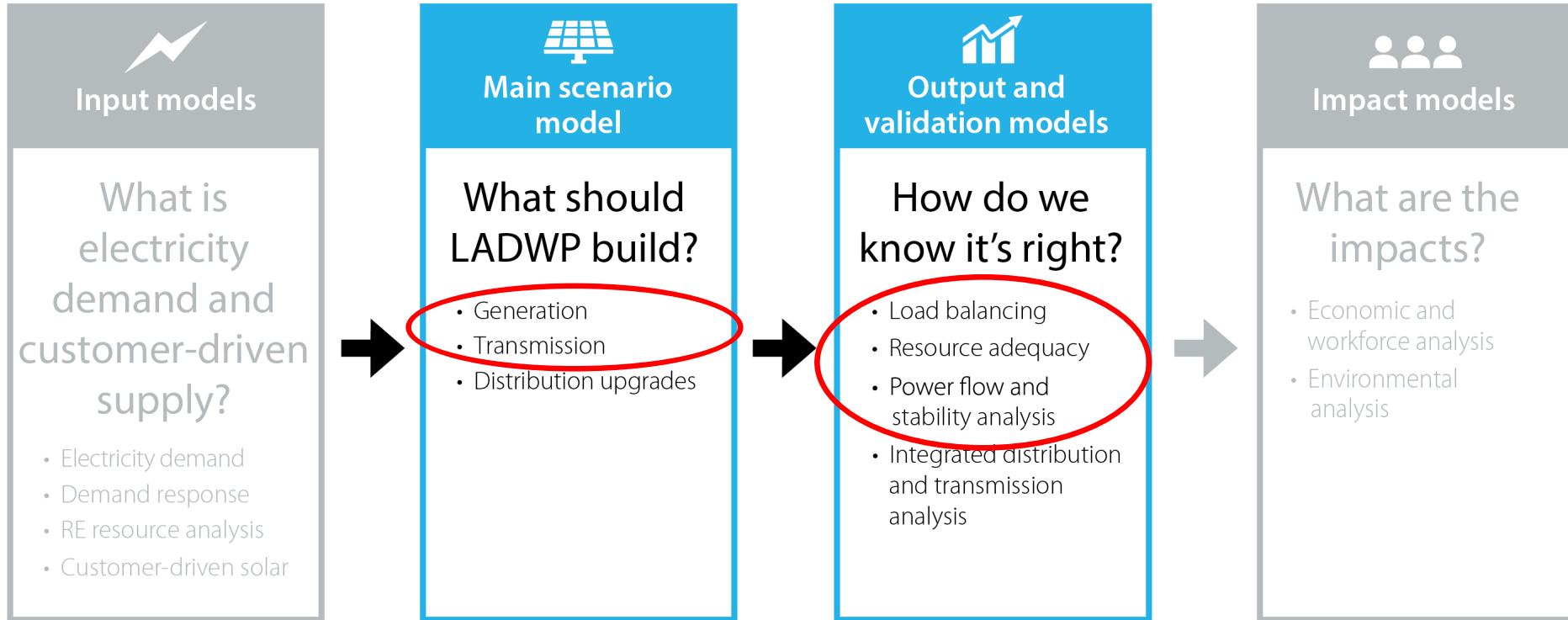
# SB100 Scenario, Initial Run Results

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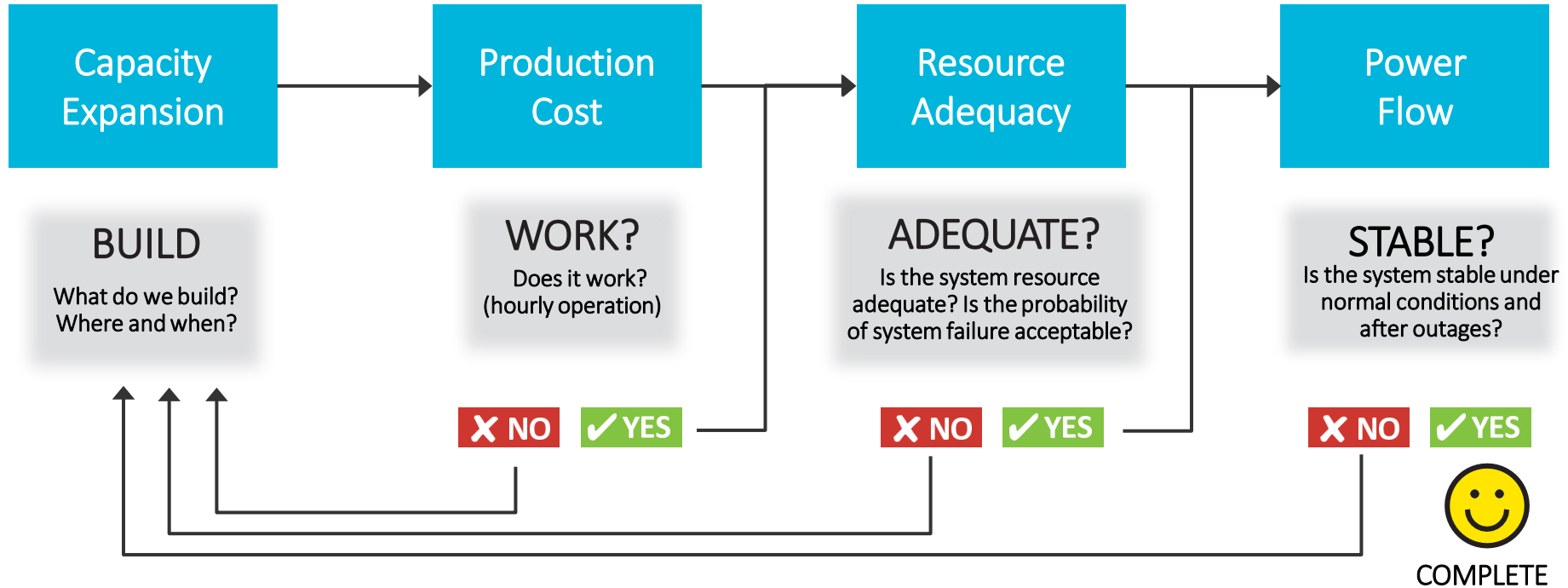
# Bulk Power Models



# Agenda for This Session

- Review bulk system modeling approach
- Pathway to 2045: SB100 Scenario, Initial Results:
  - Investment pathway
  - Operations: load balancing and resource adequacy
  - Power flow and system stability

# Bulk System Modeling Approach: Estimate, Then Refine



## Purpose within LA100

- Identify a set of bulk-system investment pathways to 2045
- Ensure that each identified future system is:
  - Operable
  - Resource adequate
  - Physically stable

# Initial Run (Today) vs. Final Run (June AG Presentation)

## What's **Included** in Initial Run

Electricity Demand: **Initial** Run

Evaluation of the impacts of **short-duration** outages of generation and transmission on resource adequacy

**Single** weather year

**Initial** cost and performance assumptions; **initial** constraints on in-basin resources

## What's **Not Included** Today but Will Be in Final Run

Electricity Demand: **Final** Run

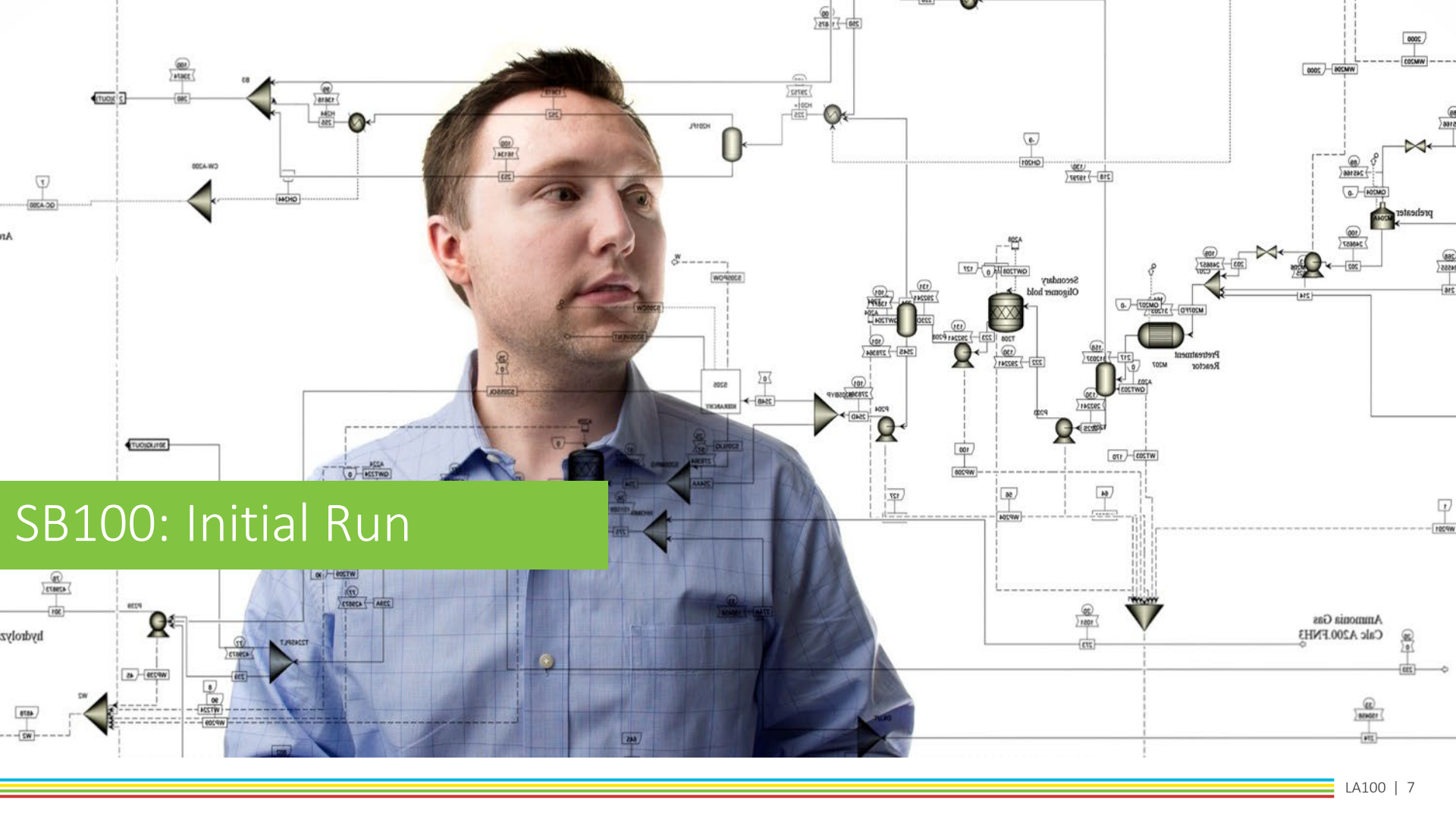
Evaluation of **long-duration** outages of generation and transmission on resource adequacy and system operations

**Multiple** weather-years

**Final** cost and performance assumptions; **revised** constraints on in-basin resources

Limits on transmission upgrades and new builds

Evaluation of power flow under steady-state and transient conditions



# SB100: Initial Run

# SB100 Scenario Specifics

- Energy targets are specified as a portion of **demand** (not supply):
  - 60% renewable energy by 2030
  - 100% carbon-free energy by 2045
- Renewable Energy Certificates (RECs) allowed for a portion of compliance through 2045
  - Must follow Compliance Period 3 Content Category Requirements: at least 75% Category 1 and no more than 10% Category 3
- OTC Units are *retired* by 2030; however, the non-OTC units, Apex, and IPP conversion remain online through 2045 (3 GW)



# California RPS Content Categories

- **Category 1:** Time-synchronous RECs and energy delivered to the LADWP balancing area
- **Category 2:** RECs and energy that cannot be delivered without technology substitution; firm and shaped contracts
- **Category 3:** Unbundled RECs (no energy purchased)

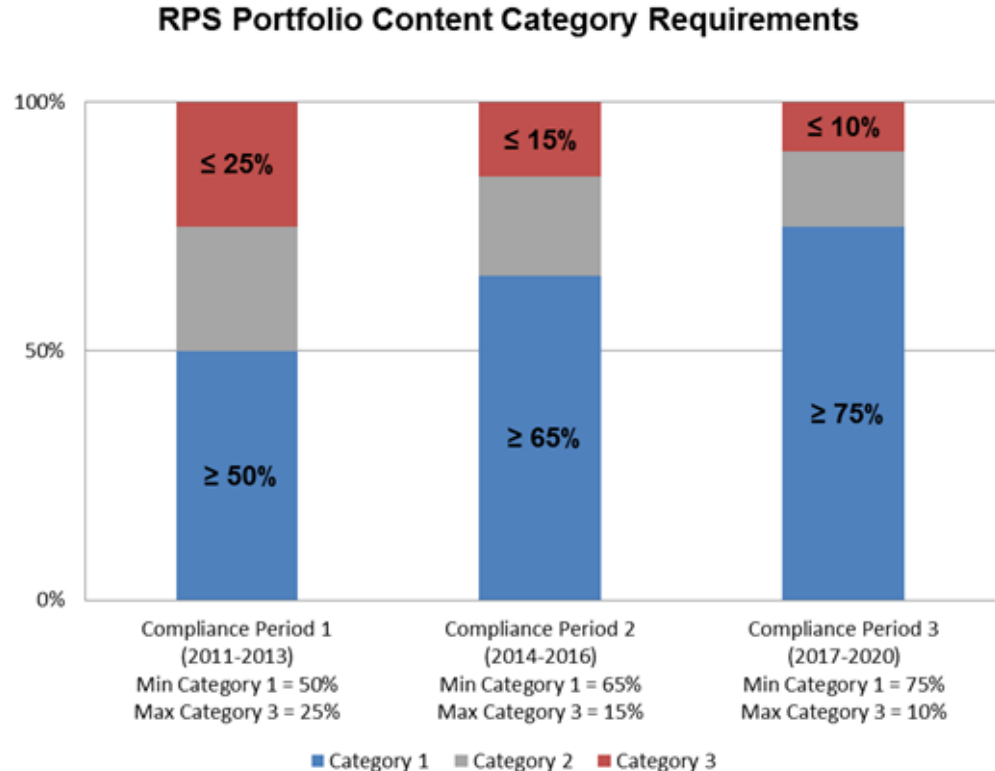


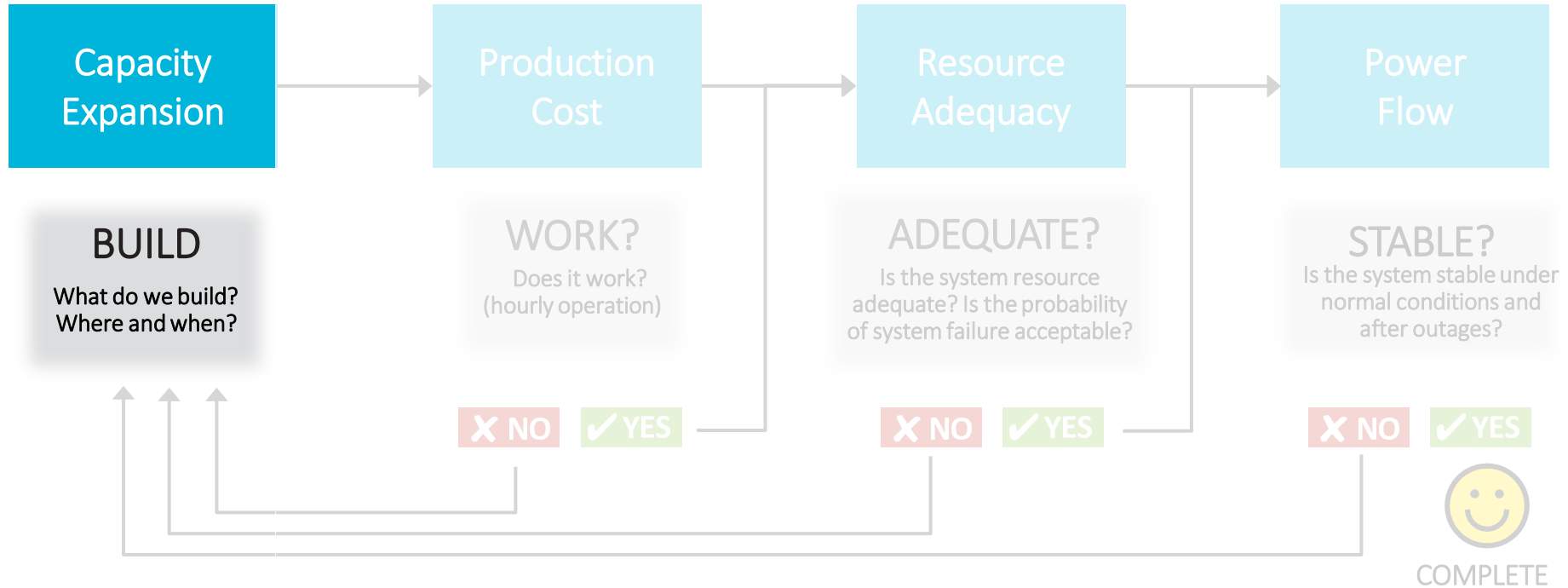
Figure Source: [https://www.cpuc.ca.gov/RPS\\_Procurement\\_Rules\\_50/](https://www.cpuc.ca.gov/RPS_Procurement_Rules_50/)



Investment Pathway:

Capacity Expansion Modeling

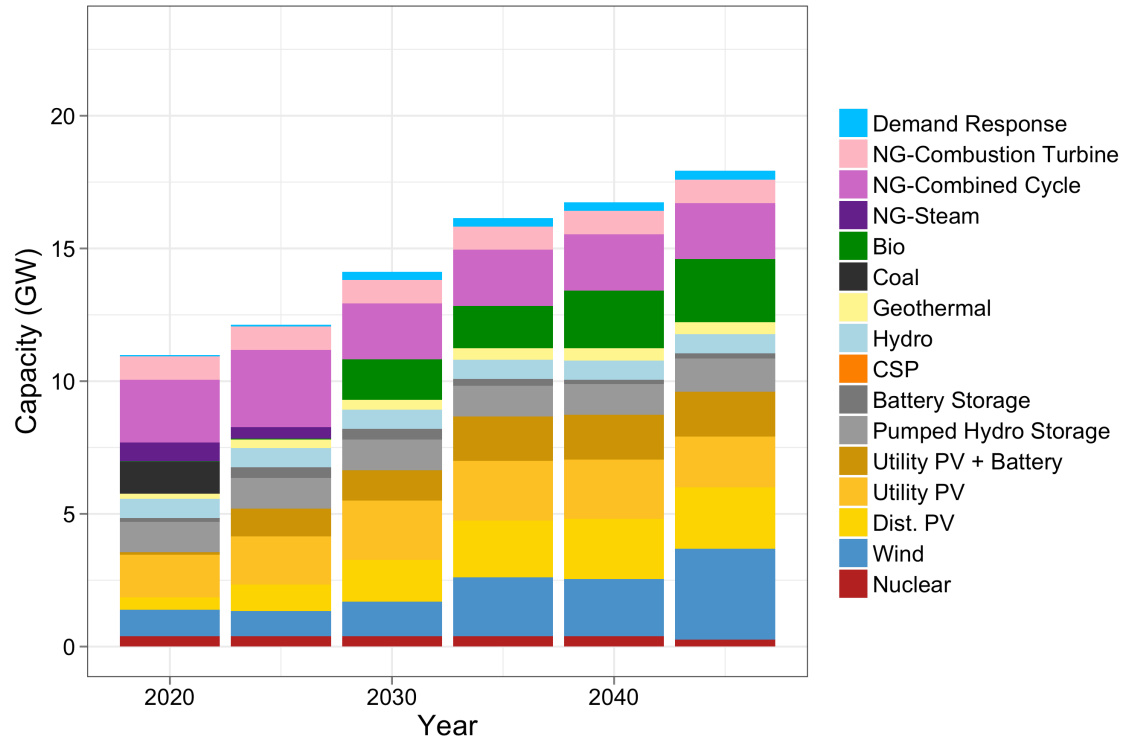
# Bulk System Modeling Approach: Estimate, Then Refine



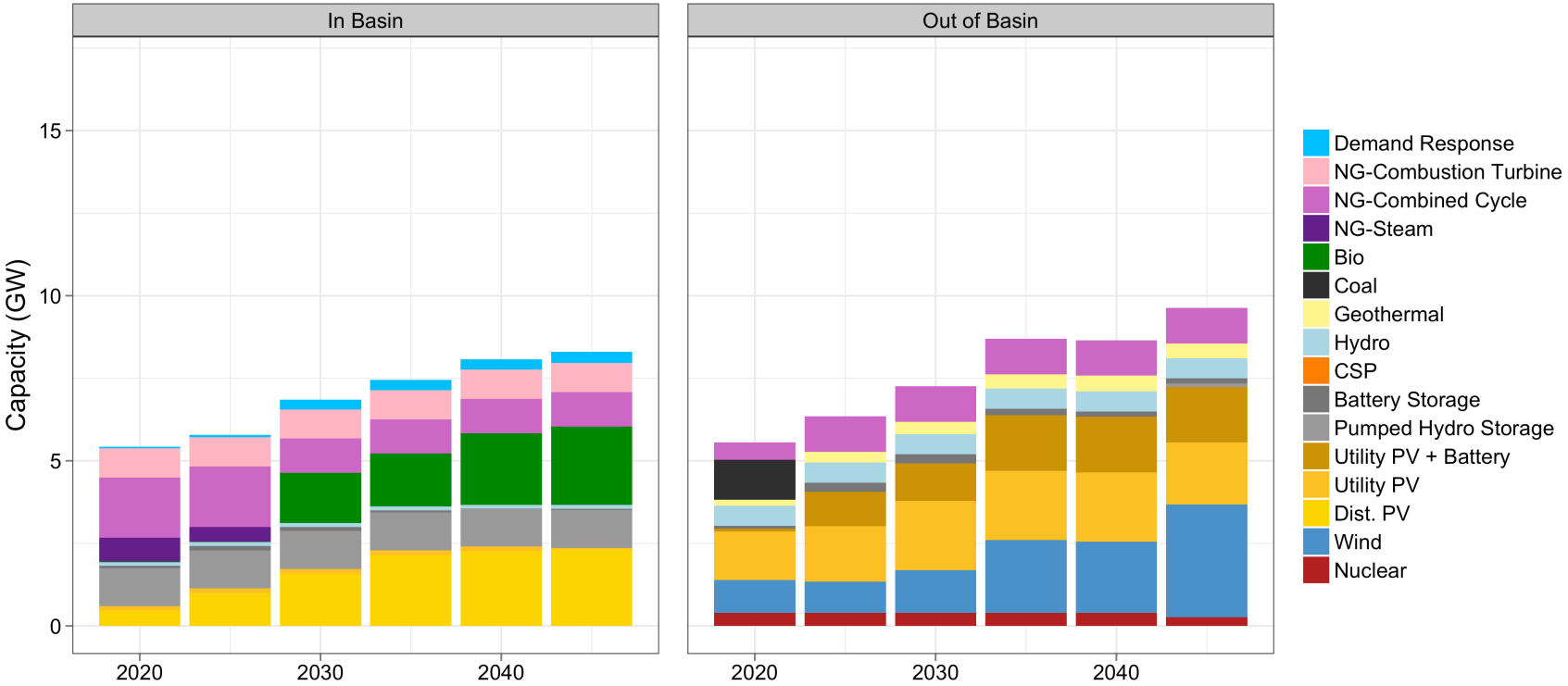
# Generation Investment

# SB100 Initial Run: Total Capacity

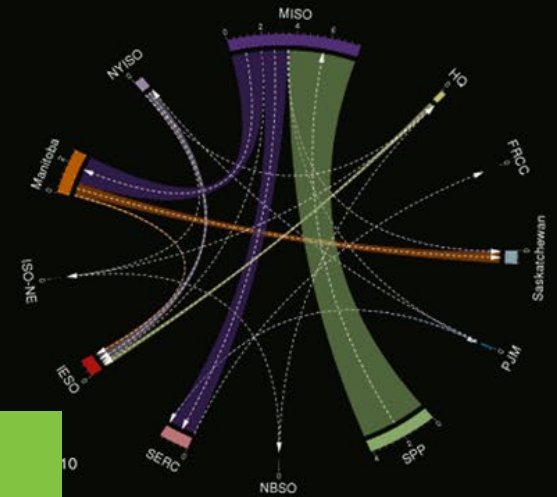
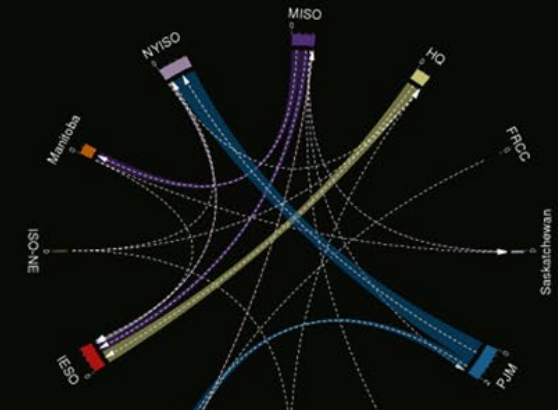
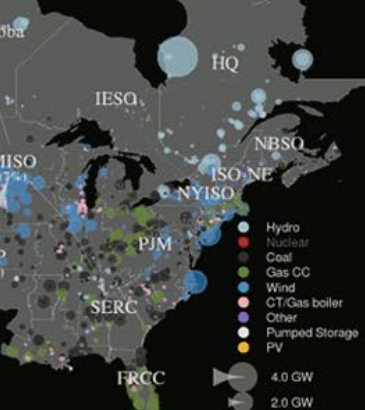
	2030	2045
Natural Gas	3 GW	3 GW
Wind	1.3 GW	3.4 GW
PV ( <i>portion w/ storage</i> )	3.4 GW (1.1 GW)	3.6 GW (1.7 GW)
Bio and Geo	1.9 GW	2.3 GW
Dedicated Storage	1.6 GW	1.5 GW



# SB100 Initial Run: Basin-level Capacity

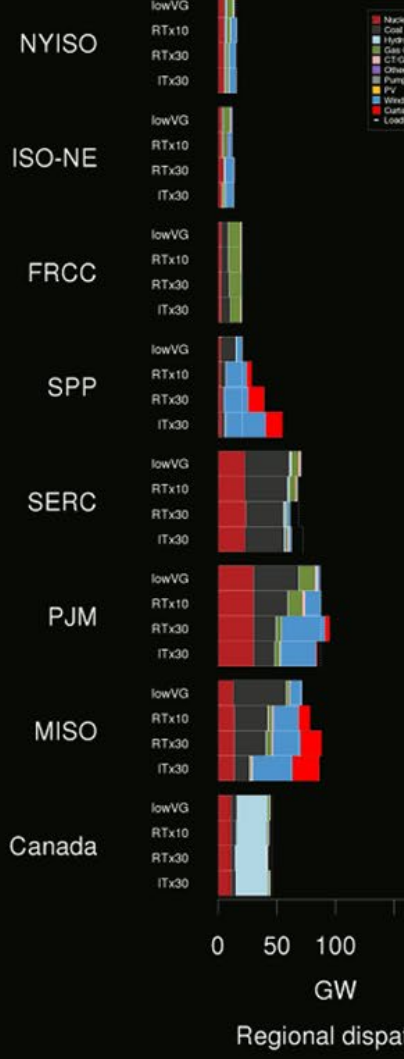
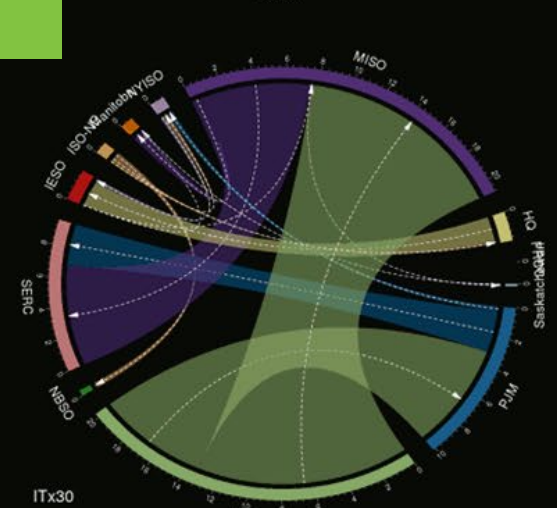
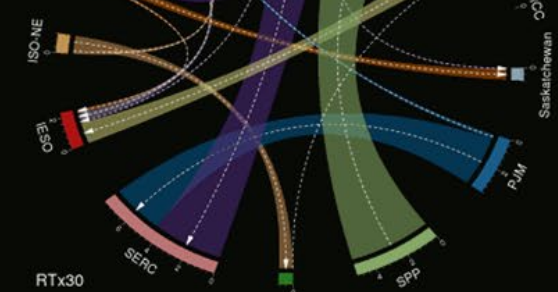


# Transmission Investment



# Operations/Energy Balancing &

# Resource Adequacy

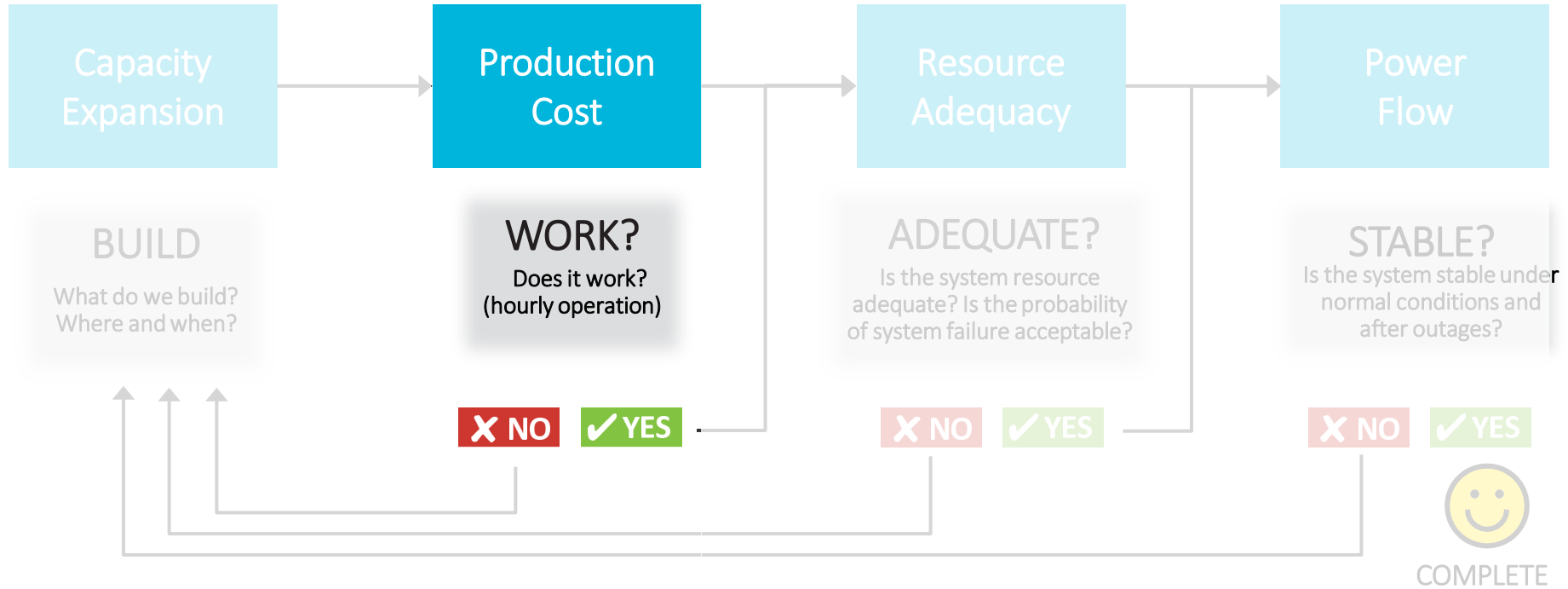


Net interchange

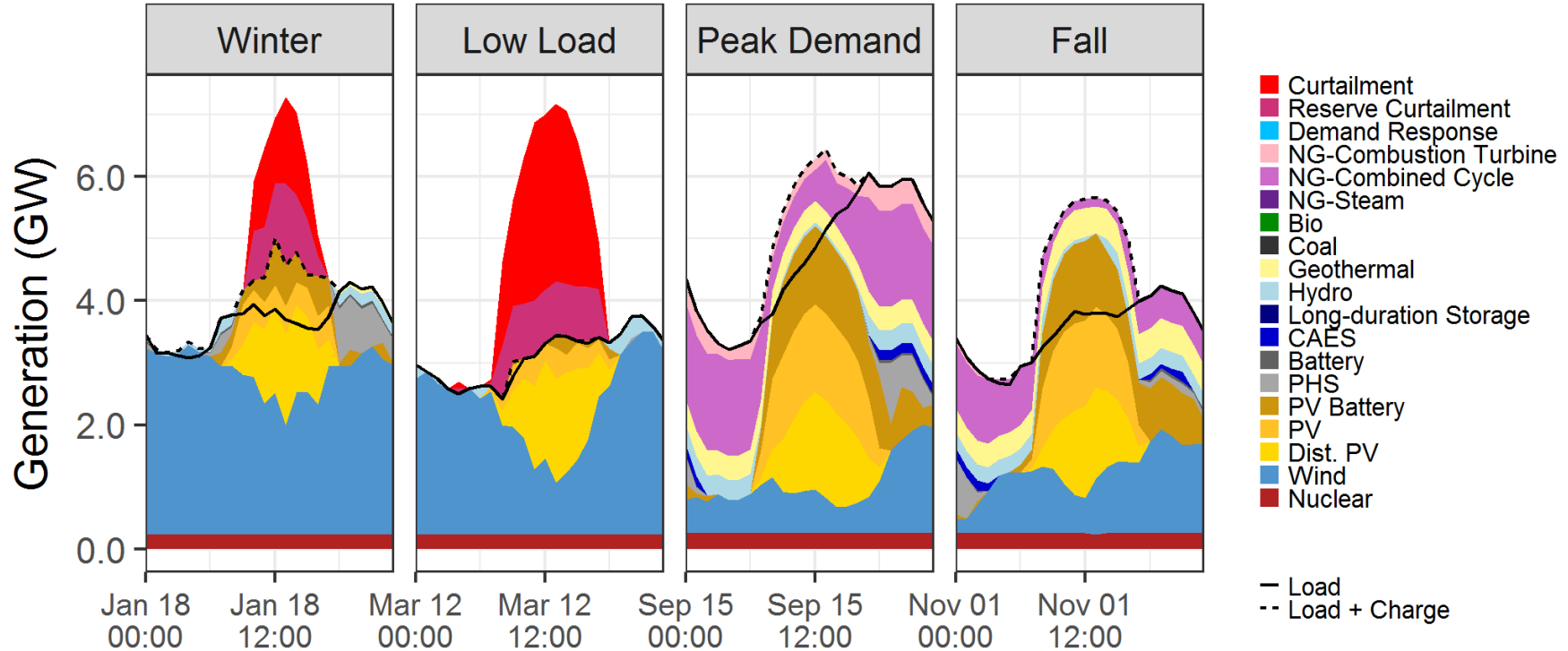
Regional dispatch



# Bulk System Modeling Approach: Estimate, Then Refine

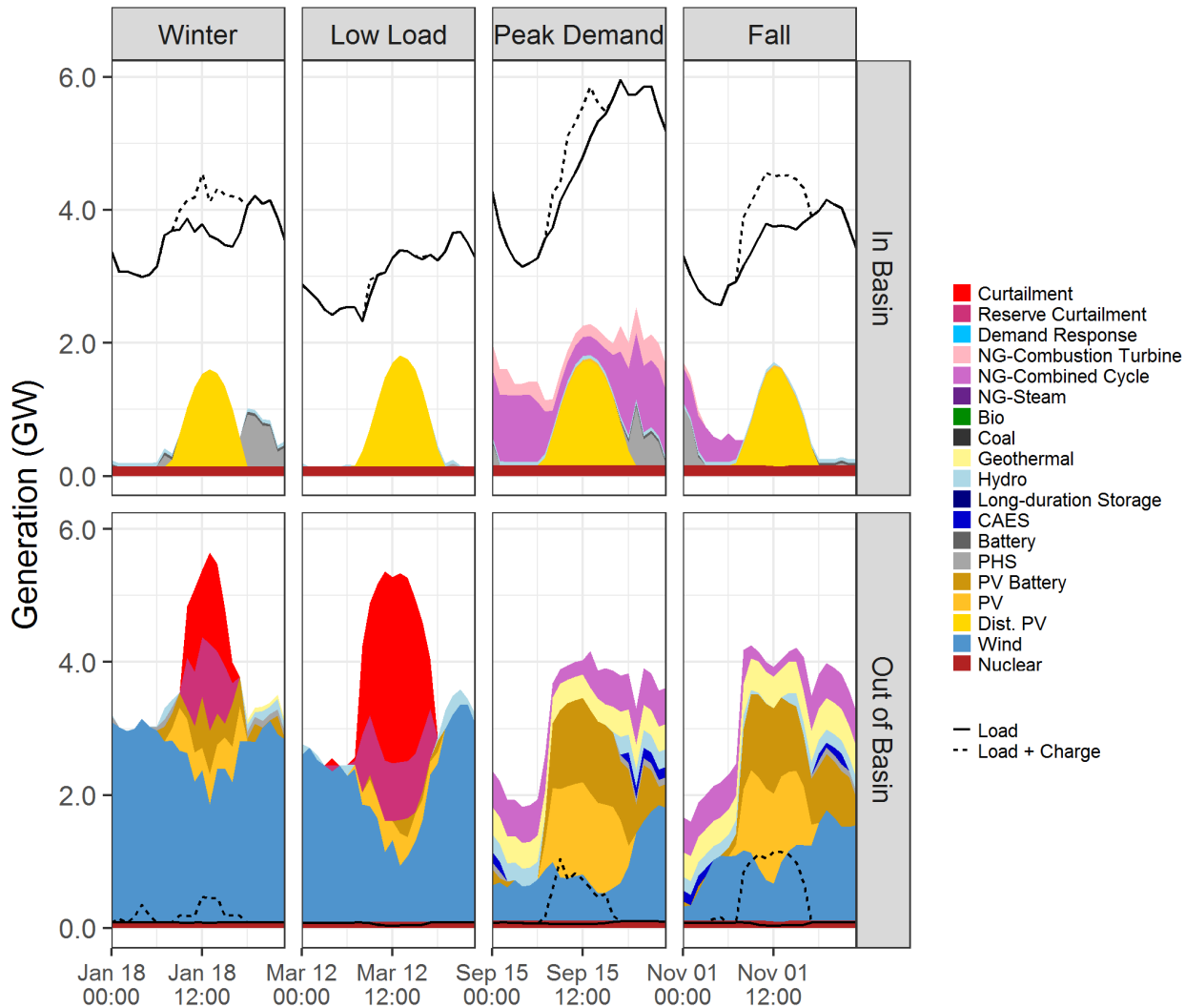


# SB100 Initial Run: Operations, 2045

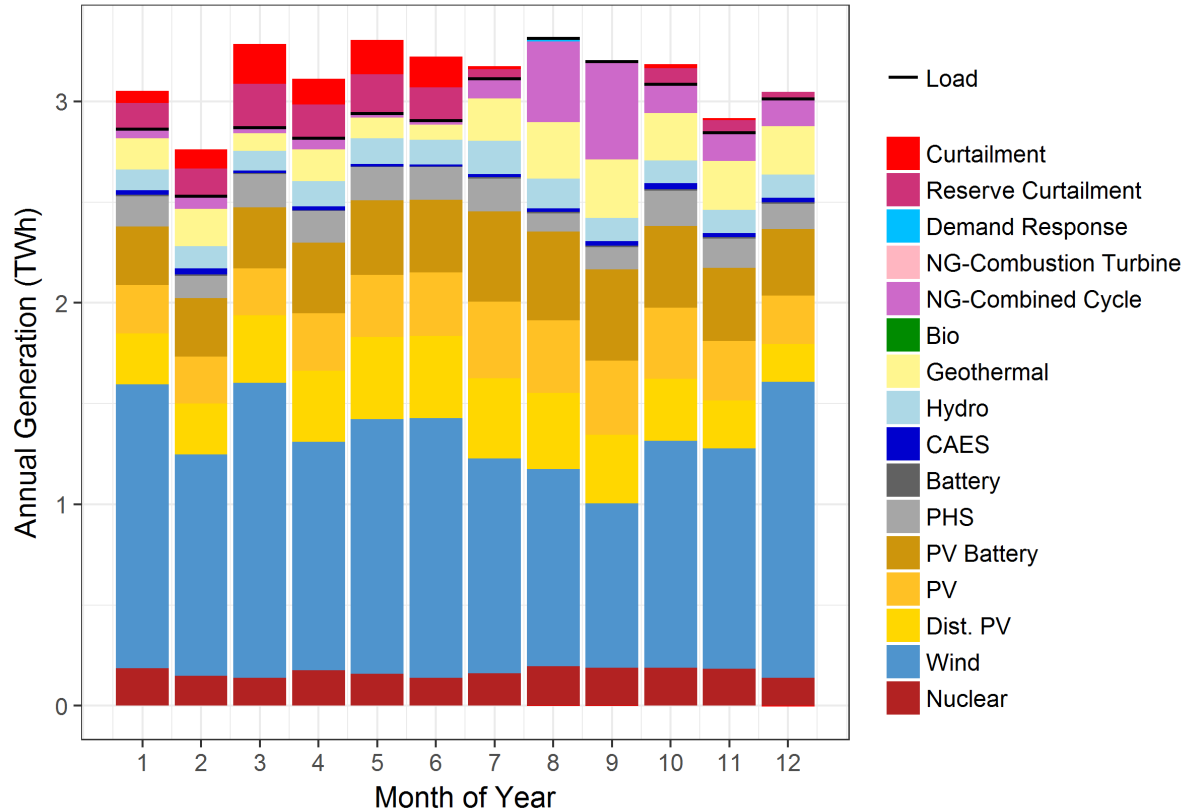


\*Note, load shown has load shifting embedded

# SB100 Initial Run: Operations, 2045, Basin-Level

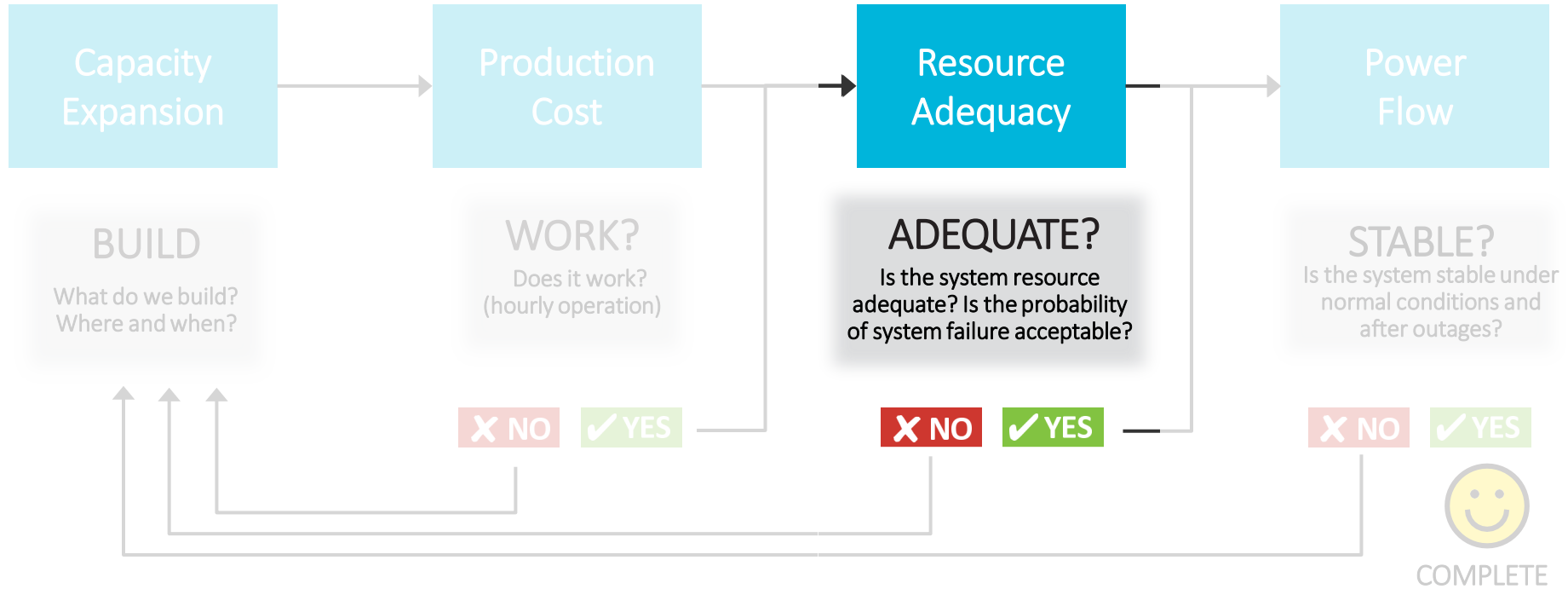


# SB100 Initial Run: Monthly Dispatch, 2045



# Visualization of Operations

# Bulk System Modeling Approach: Estimate, Then Refine



# What is Resource Adequacy?

Measures the ability of the bulk-scale generation and transmission system to serve electricity demand under all but the most extreme circumstances

*\*Note: most customer outages occur as a result of distribution system failures*

# SB100 Initial Run: Resource Adequacy Metrics

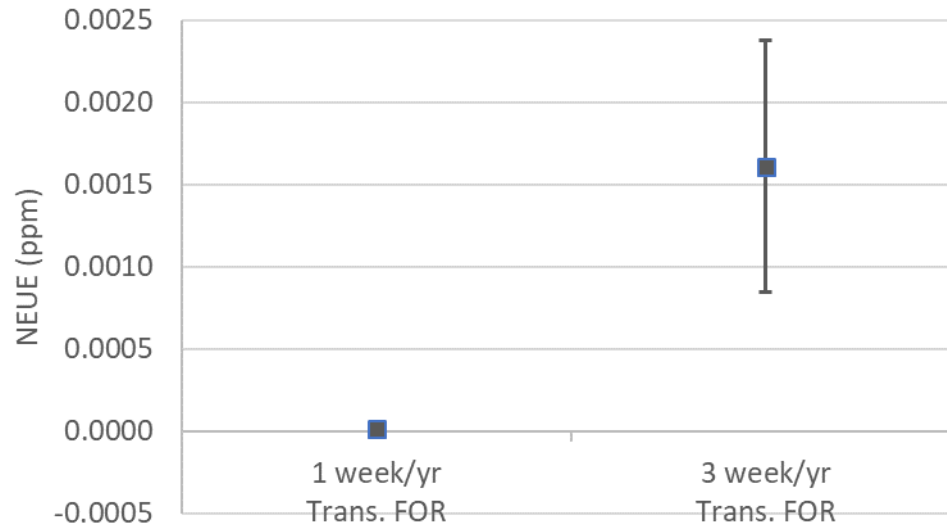
## Normalized Expected Unserved Energy (NEUE):

- Effectively measures both the **frequency** and **magnitude** of losses—i.e., how many customers and for how long
- Measured in parts per million (PPM)
- Our target is 10 PPM
  - This is equivalent to having 10 average customers out of every 1 million without power due to generator or transmission failures
  - Also means that on average, any individual customer will lose power for an hour every 11 years



# SB100, 2045 Initial Run: Resource Adequacy

Target: stay below 10 ppm



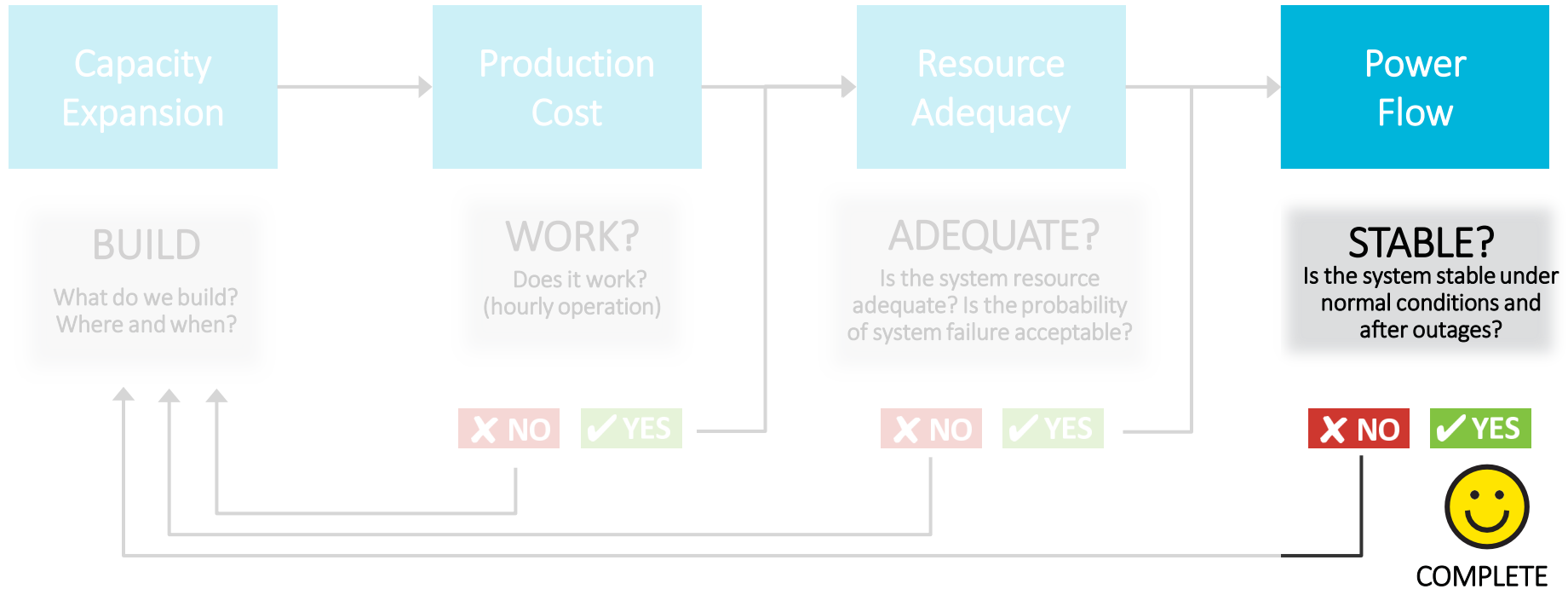
- Well below target of 10 ppm
- Only considers single weather year
- Initial load projections



Is the System Stable?

Power Flow Analysis

# Bulk System Modeling Approach: Estimate, Then Refine



# Objective

- Evaluate the **reliability of the system** designed by RPM and dispatched by PLEXOS
  - Evaluate under steady state, as well as post-contingency
- Identify if **changes in generation and/or transmission investments** are required to relieve any reliability violations

# System Costs



# Cost Categories

- **Capital** – capital and associated financing costs of new infrastructure
- **Fixed Operations and Maintenance (FOM)** – fixed costs of operating and maintaining assets
- **Fuel** – cost of fuel, including natural gas, uranium, coal, biofuel
- **Variable O&M (VOM)** – non-fuel variable costs of operating and maintain assets

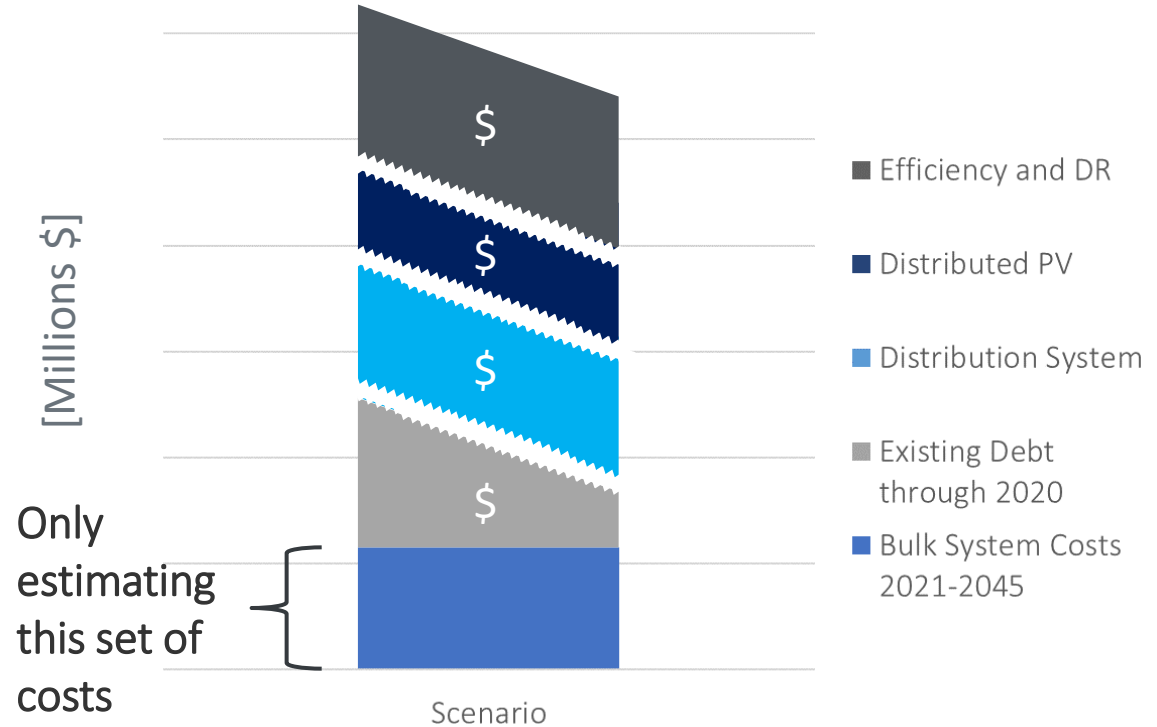
# Bulk Costs (To Date):

- **Includes:**
  - Bulk system (generation and transmission):
    - Capital and financing costs for new investments (2021-2045)
    - Fuel, VO&M, and FO&M for all assets
- **Excludes:**
  - Existing debt on capital expenses (made before 2021)
  - Distribution system costs (upgrades\* and O&M)
  - Capital cost and O&M for customer-owned distributed generation\*
  - Costs of energy efficiency and demand response programs

\* Will be included in Final Results

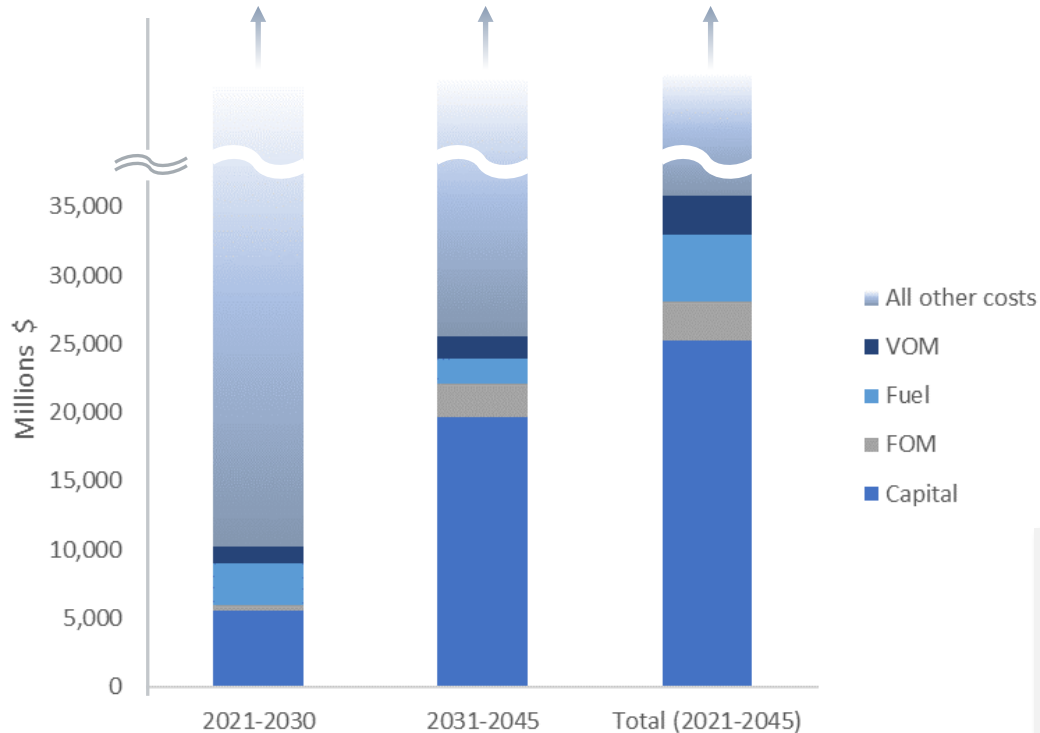
# Illustrative Cost Stack

Estimates only include capital and operational costs for bulk system generation and transmission





# SB100 Initial Run: 2021-2045 Annualized Bulk System-Only Costs



Bulk system generation and transmission cost\*

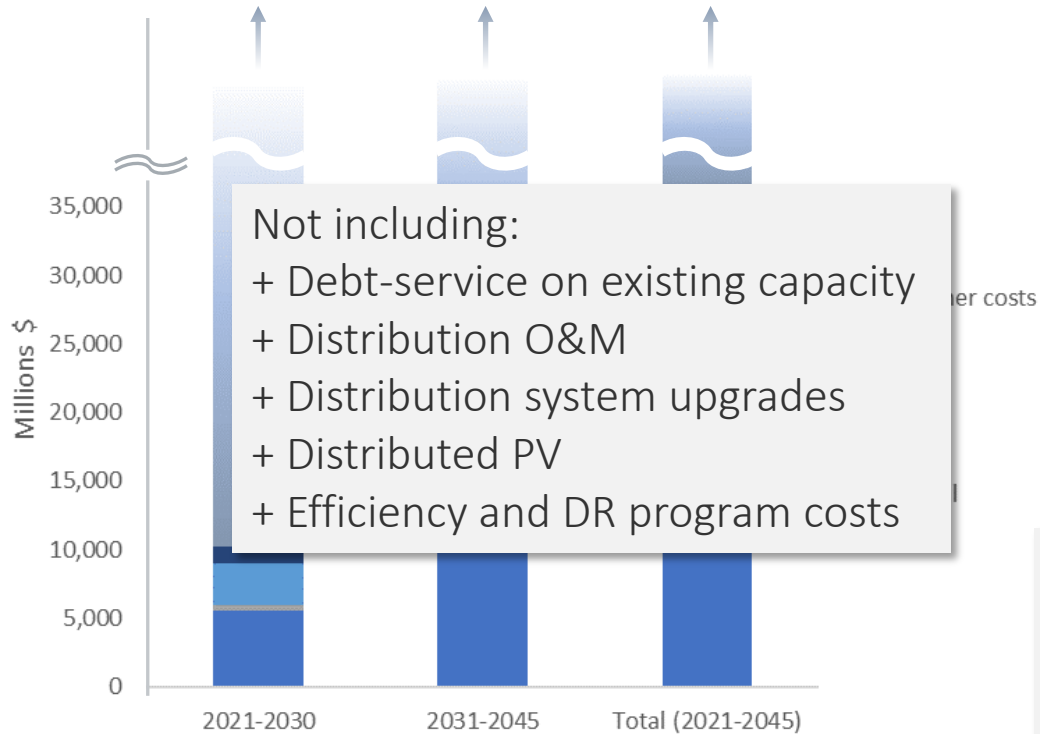
- 2021-2030: \$10 B
- 2031-2045: \$26 B
- **Total: \$ 36 B**

## Key Assumptions:

- Financial lifetime of 20 years for all assets
  - WACC of 5.5%, real
- [Assumptions will be updated with parameters from DWP]*

\*Note that these represent only a portion of total system costs; see slide 36

# SB100 Initial Run: 2021-2045 Annualized Bulk System-Only Costs



Bulk system generation and transmission cost\*

- 2021-2030: \$10 B
- 2030-2045: \$26 B
- **Total: \$ 36 B**

## Key Assumptions:

- Financial lifetime of 20 years for all assets
  - WACC of 5.5%, real
- [Assumptions will be updated with parameters from DWP]*

\*Note that these represent only a portion of total system costs; see slide 36

# Summary, SB100 Initial Run

- Growing energy needs, driven by increasing requirements for renewables and increasing load, are met with a **diverse set of renewable resources** (solar, wind, geothermal, and bio)
  - Feasibility of utility-scale biofuel generation has not been evaluated in depth
- Storage is used to **shift surplus generation** during mid-day hours to evening, night, and morning hours
- Remaining in-basin natural gas generation is relied on during **hours of low renewable resource quality** and during **hours of stress**
- Initial resource adequacy tests have **not identified any substantial issues** associated with short-duration outages

# Summary, SB100 Initial Run

- Future bulk-system costs are dominated by **capital costs associated with new generation, storage, and transmission capacity**; fuel costs decline as energy needs are increasingly met with renewable resources
  - Capital costs may be realized as either capital expenditures or variable costs depending on how new energy and storage assets are procured (e.g., owned assets vs. PPAs)
- Results will likely change:
  - **Changes in load projections** may lead to changes in required resources
  - Further operational, adequacy, and power flow simulations required to **validate system reliability**

Thank you

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