

A Changing Paradigm: Integrated Resources Planning in California

Antonio Alvarez, Ben Moradzadeh, Will Dong, and
Carl Nolen
Integrated Resource Planning
PG&E





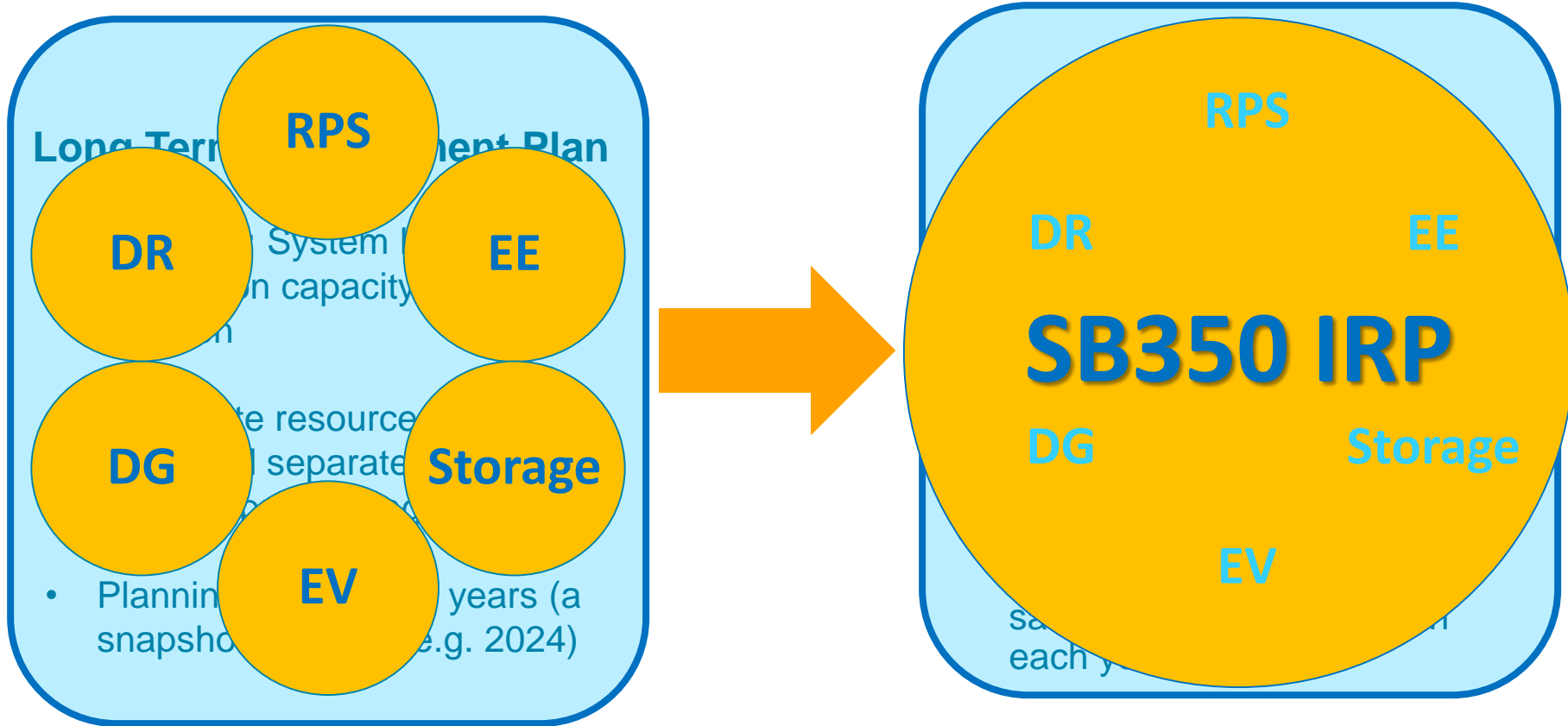
SB350: Clean Energy & Pollution Reduction Act

The commission shall adopt a process for each load-serving entity (LSE) to file an integrated resource plan (IRP), to ensure that LSEs

- I. Meet the greenhouse gas emissions reduction targets**
- II. Procure at least 50 percent eligible renewable energy resources by December 31, 2030**
- III. Minimize impacts on ratepayers' bills**
- IV. Ensure system and local reliability**



Resource Planning in California



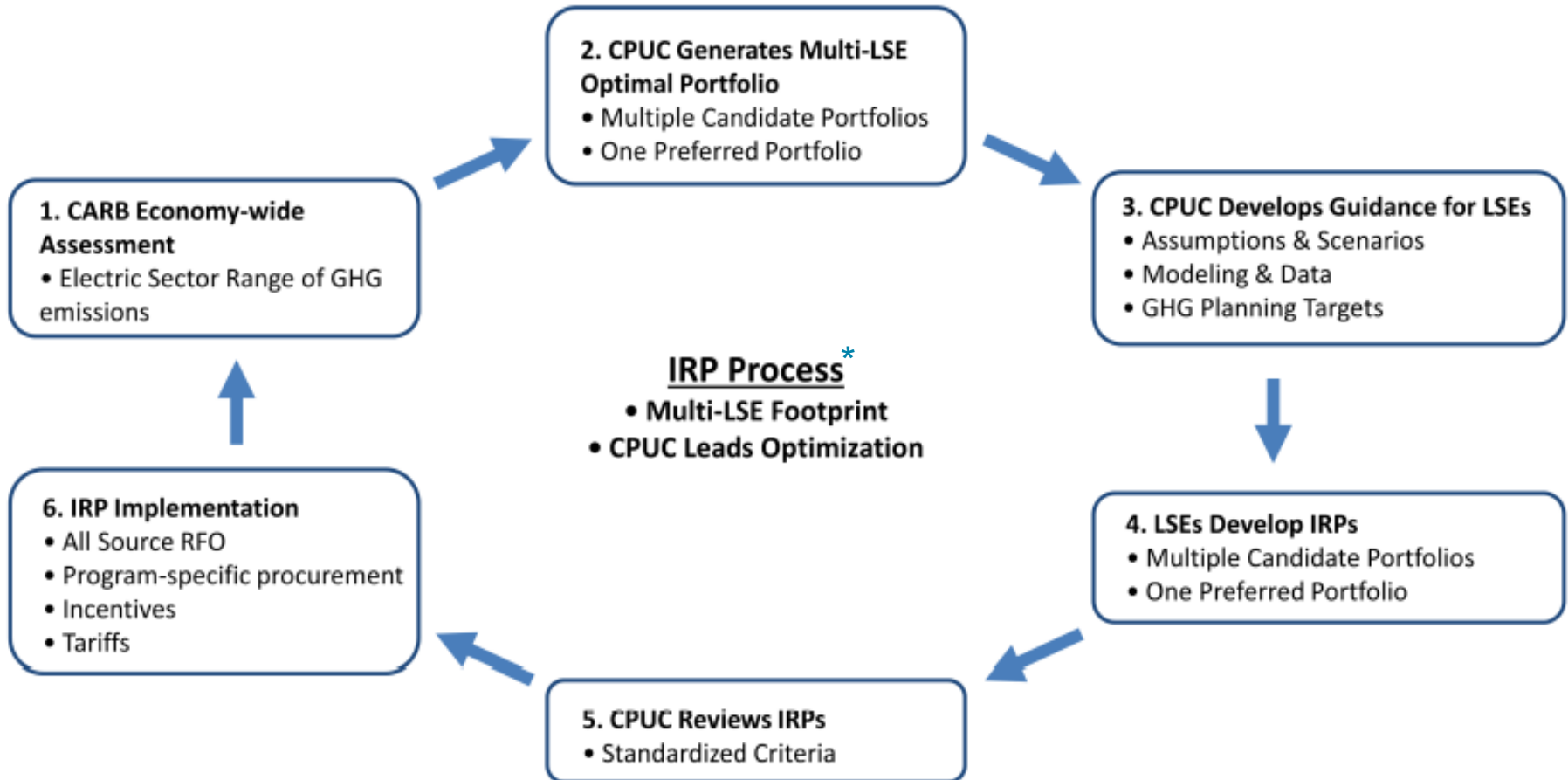


SB350 IRP

- **Objective**
 - **Purpose: Least-cost solution to meet GHG, RPS, and reliability constraints**
 - **Candidate resource pool includes both transmission and distribution-connected resources**
- **Major Constraints**
 - **GHG emission targets**
 - **System and local reliability**
 - **RPS goals**
- **How: Selecting optimal set of candidate resources to meet the constraints**



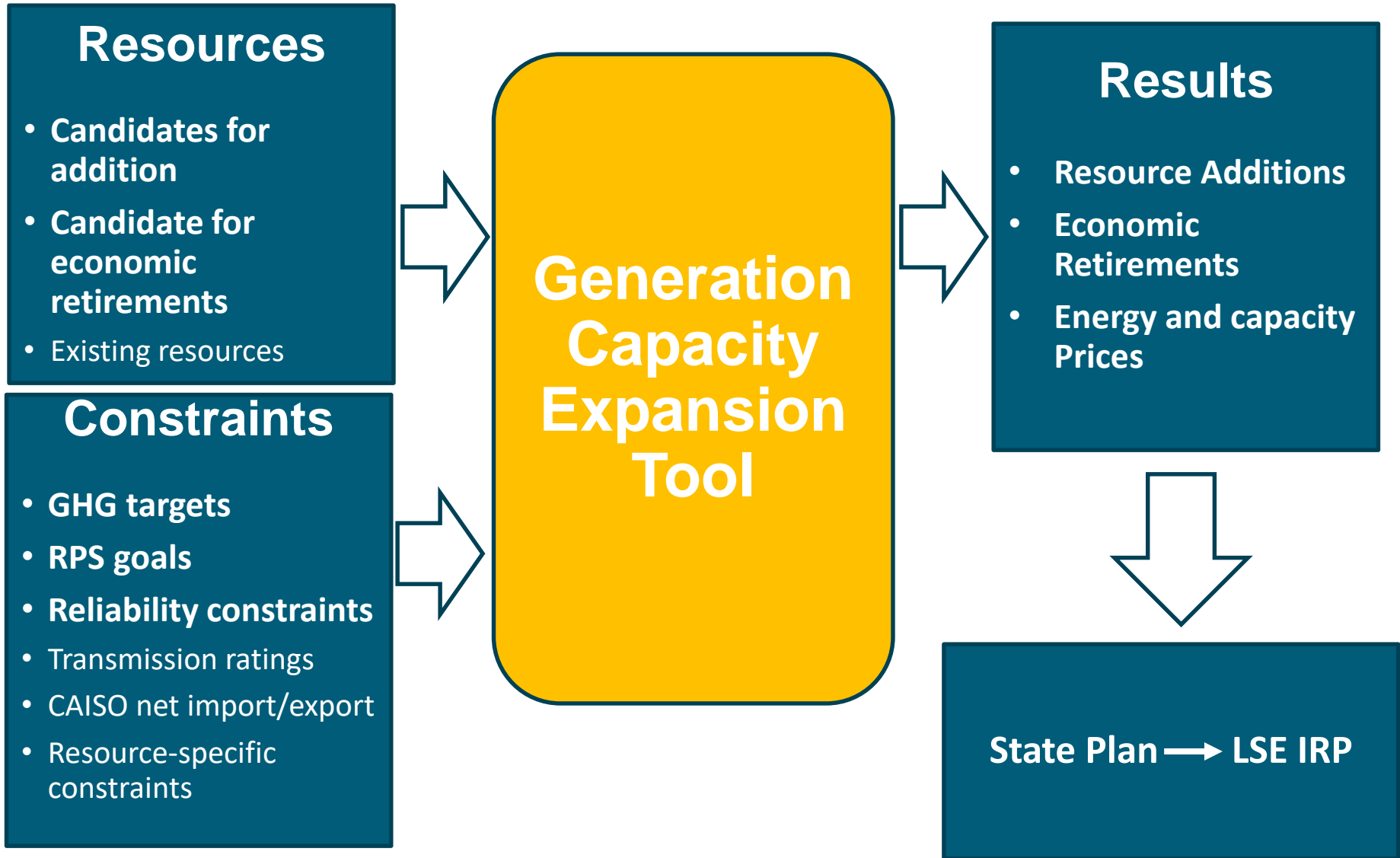
IRP Cycle



* Source: CPUC Staff Concept Paper on Integrated Resource Planning, August 11, 2016.



IRP Modeling Framework





From State Plan to LSE IRP

California ISO Footprint

- Deterministic optimization to obtain least-cost portfolio to meet GHG reduction target, RPS goals, and system and local reliability



Risk Assessment

- Monte Carlo Simulations to evaluate optimal CAISO portfolio under uncertainties such as load, wind, solar, fuel price, and hydro



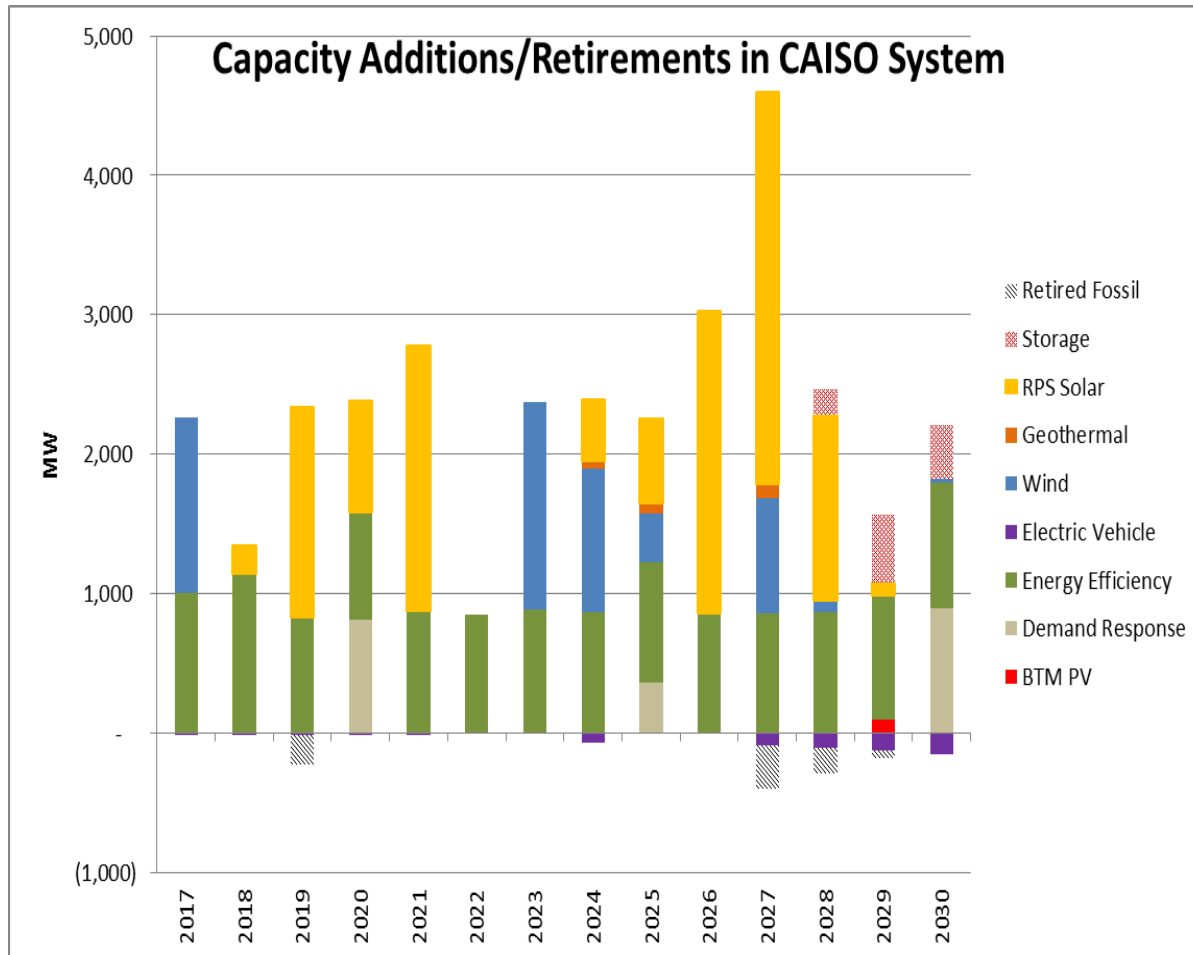
LSE Portfolio Optimization

- Detailed modeling of LSE resources/contracts and bundled load
- An Efficient Frontier optimization provides least cost portfolio at given risk levels
- Optimal LSE portfolio to meet GHG, RPS, and reliability constraints



Illustrative Results

- System least-cost resource additions/retirements
- An LSE integrated resource plan



Is It All Worth It?



The GOOD

- Lower customer cost: Least cost GHG solution
- Consistent evaluation of candidate resources
- LSEs have fair shares of GHG reduction
- Shape future policy (e.g. NEM, 100% RPS)

The BAD

- IRP landscape is complex
- Lots of work to get ready/prepare IRP

The UGLY

- The outcome is uncertain