Integrated Resource Planning
GHG reduction in California

EPRI 2017 Annual Seminar on Fuels, Power Markets and Resource Planning

Jenifer Hedrick P.E.

November 9, 2017

Energy for What's Ahead℠

SOUTHERN CALIFORNIA EDISON®

SCE Highlights

One of the nation's largest electric utilities

- 15 million residents in service territory
- 5 million customer accounts
- 50,000 square-mile service area

Significant infrastructure investment

- 1.4 million power poles
- 729,000 transformers
- 119,000 miles of distribution and transmission lines
- 3,200 MW owned generation

Above average rate base growth driven by

- Safety and reliability
- California's low-carbon objectives
  - Grid modernization
  - Electric vehicle charging
  - Energy storage
  - Transportation electrification (proposed)

Limited Generation Exposure

- Own less than 20% of its power generation
- Future needs via competitive solicitations

October 31, 2017
https://www.edison.com/content/dam/eix/documents/investors/everts-presentations/eix-october-2017-business-update.pdf

California Climate Policies – Future Timeline

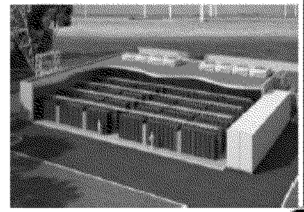
2017

- IOU Transportation Electrification proposals
- CARB Updated Scoping Plan
- Integrated Resource Plan

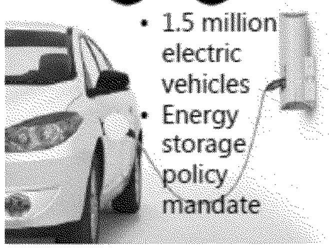
Pending GHG Legislation SB 100 accelerates GHG reduction targets

2020

- Reduce GHG emissions to 1990 levels
- 33% of electricity sales from renewables
- Once through cooling retires significant conventional generation
- New residential construction with zero net energy



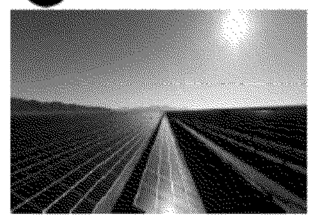
2025



- 1.5 million electric vehicles
- Energy storage policy mandate

2030

- Reduce GHG emissions to 40% below 1990 levels
- 50% of electricity sales from renewables
- 4.2 million electric vehicles CPUC target
- Post 2020 cap-and-trade program
- New commercial construction zero net energy
- Double statewide energy efficiency savings



2050

- Target reduction of GHG emissions to 80% below 1990 levels

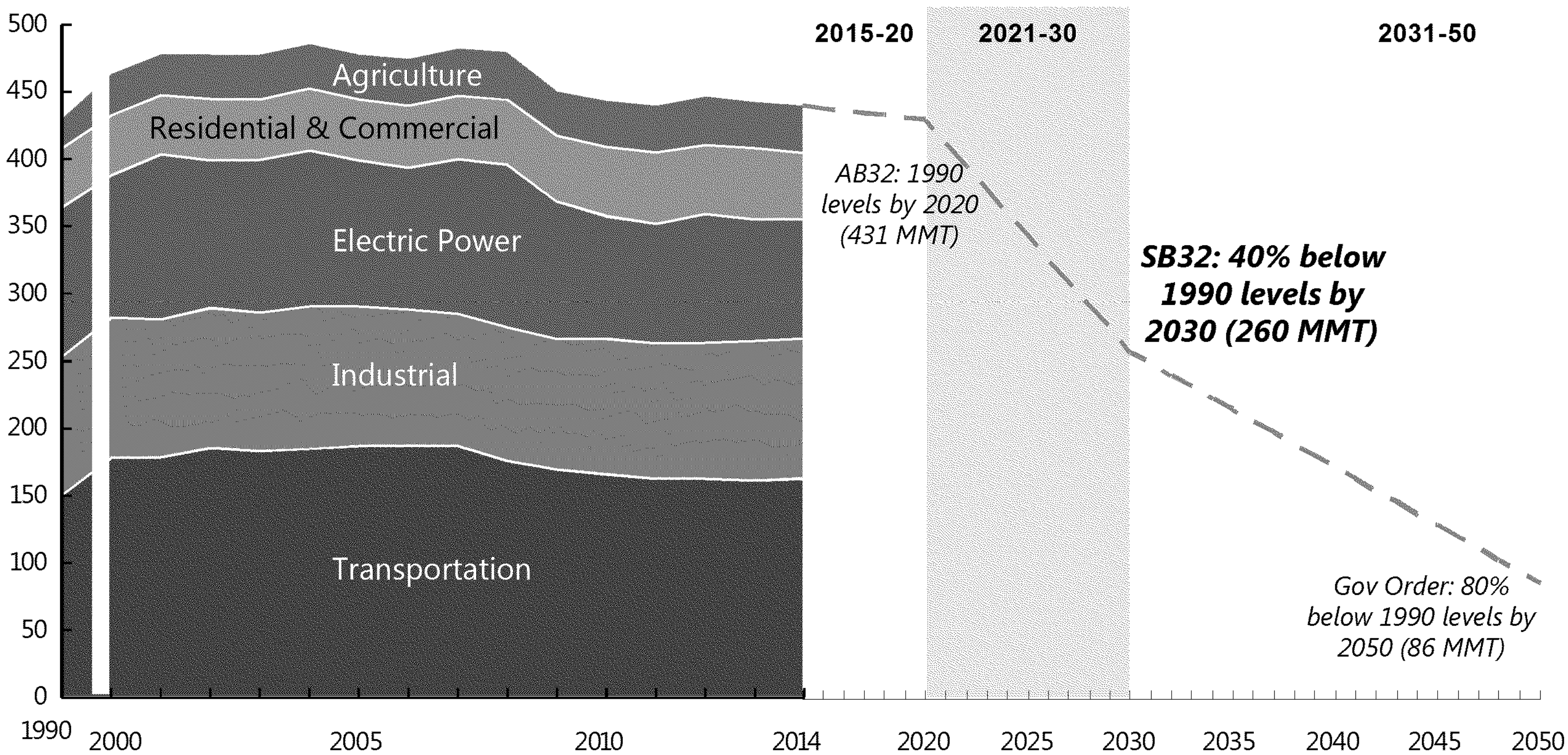
Achieving California's expansive energy and environmental policy goals will require taking foundational steps to evolve the electric grid and further develop new technologies

Source: http://www.edison.com/content/dam/eix/documents/investors/events-presentations/20170412-edison-insights-series-presentation.pdf

Achieving CA's SB32 targets in 2030 requires a dramatic acceleration of GHG emission reductions

California GHG Emissions[1]

million metric tonnes CO2 equivalent (MMT)



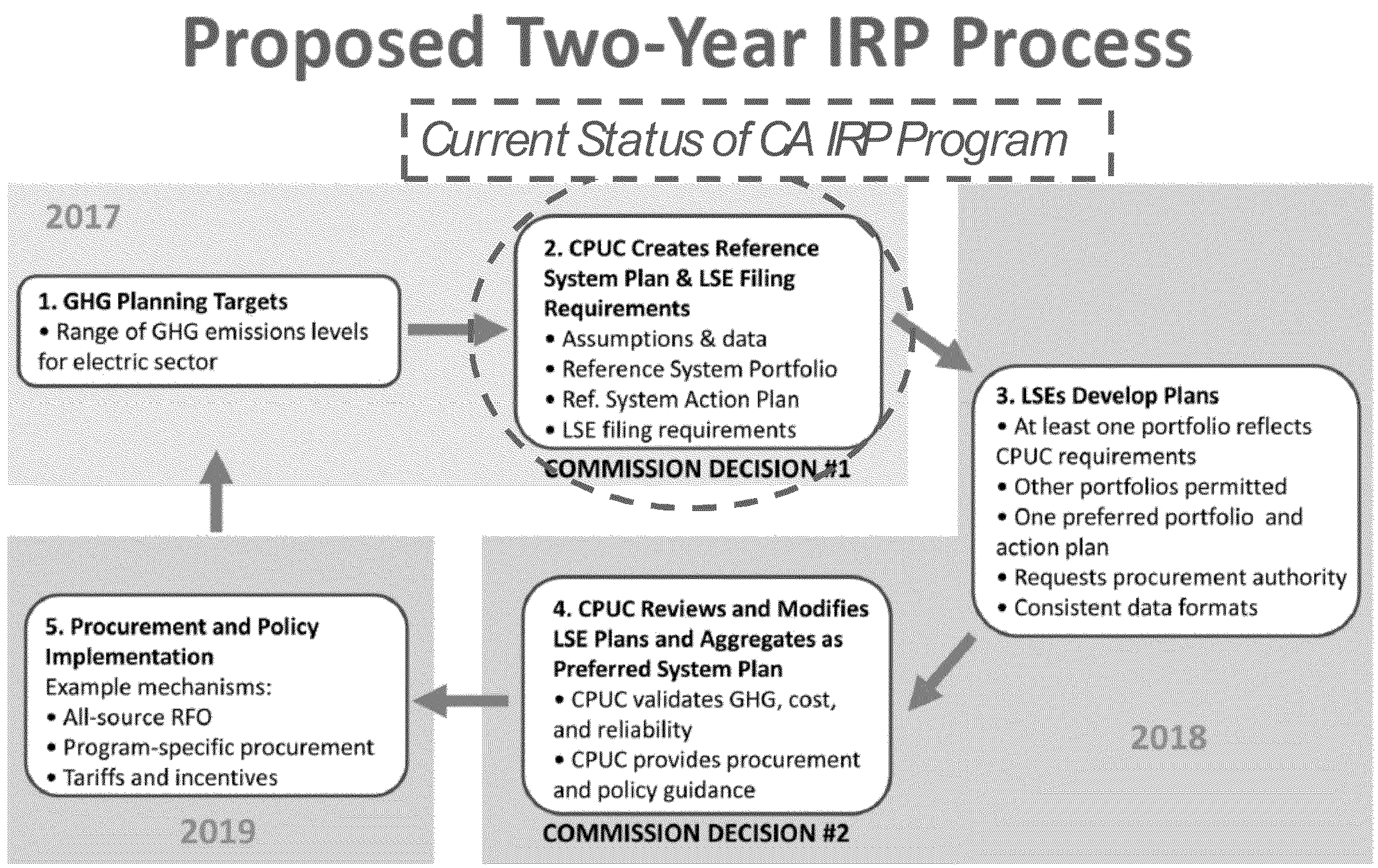
Source: www.arb.ca.gov/cc/inventory/data/data.htm

1) Total emissions excludes 54 MMT CO2 equivalent per AB32 definition (including portions of transportation and industrial as well as military)

California Air Resource Board Scoping Plan

Estimated GHGs by Sector [MMTCO2e]			
	1990	2030 Scoping Plan Ranges[66]	% change from 1990
Agriculture	26	24–25	-8 to -4
Residential and Commercial	44	38–40	-14 to -9
Electric Power	108	30–53[67]	-72 to -51
High GWP	3	8–11[68]	267 to 367
Industrial	98	83–90[69]	-15 to -8
Recycling and Waste	7	8–9[68]	14 to 29**
Transportation (Including TCU)	152	103–111	-32 to -27
Natural Working Lands Net Sink*	-7***	TBD	TBD
Sub Total	**431**	**294–339**	**-32 to -21**
Cap-and-Trade Program	n/a	34–79	n/a
Total	**431**	**260**	**-40**

California Public Utilities Commission lead IRP process for LSEs



Impact, Scope and Schedule of IRP

IRP has the potential to re-shape California's Electric Sector Way-of-Doing-Business

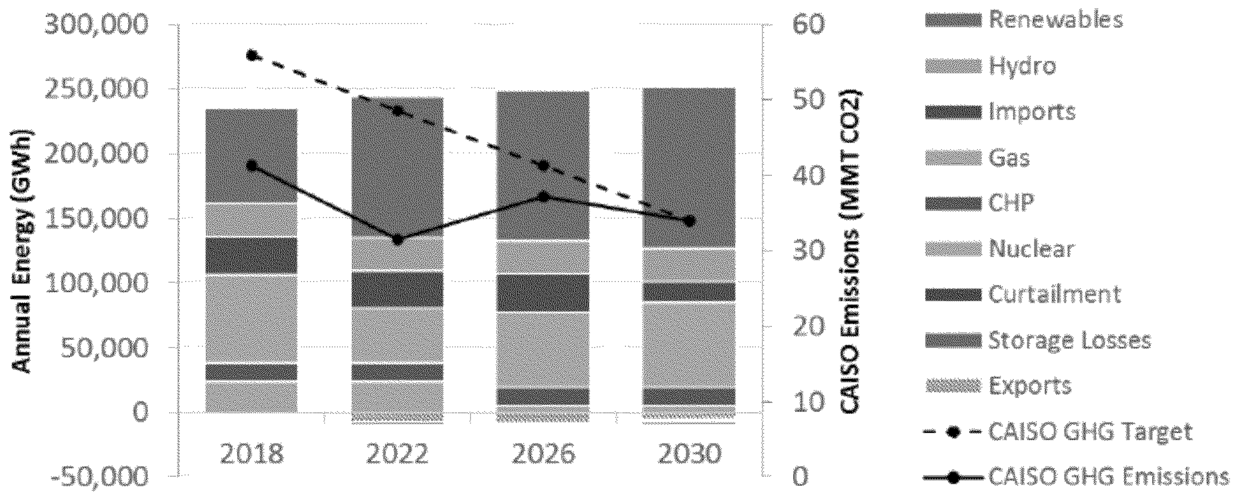
- IRP becomes the state's key resource decision-making forum
  - IRP reconstructs resource planning in California
  - Centralized, not piecemeal decision making
  - Process for transparent and comparative special studies of state interest
- 'Need' is 'de-constructed' and can be any system attribute or characteristic – e.g. flexibility, VARs, replacement of usable resources with low GHG resources, solar PV and curtailment correlations, wire vs DERs, etc
- All resources to be compared on a common cost effectiveness platform
  - Procurement adders & characteristics
  - Marginal cost from IRP used to compare all resources

CAISO Energy Balance
42 MMT Statewide Target

2. CPUC Creates Reference System Plan & LSE Filing Requirements
- Assumptions & data
- Reference System Portfolio
- Ref. System Action Plan
- LSE filing requirements

COMMISSION DECISION #1

- Additional near term renewable build displaces energy from gas and reduces GHG emissions below GHG target in 2018 & 2022
- Energy from gas rebounds by 2026 with Diablo Canyon closure, but imports decrease to meet GHG target by 2030
- RESOLVE results show imports decline relative to in-state gas use because the GHG emissions factor that CARB assigns to imported electricity is larger than California CCGT emission factors



IV. Preliminary Results

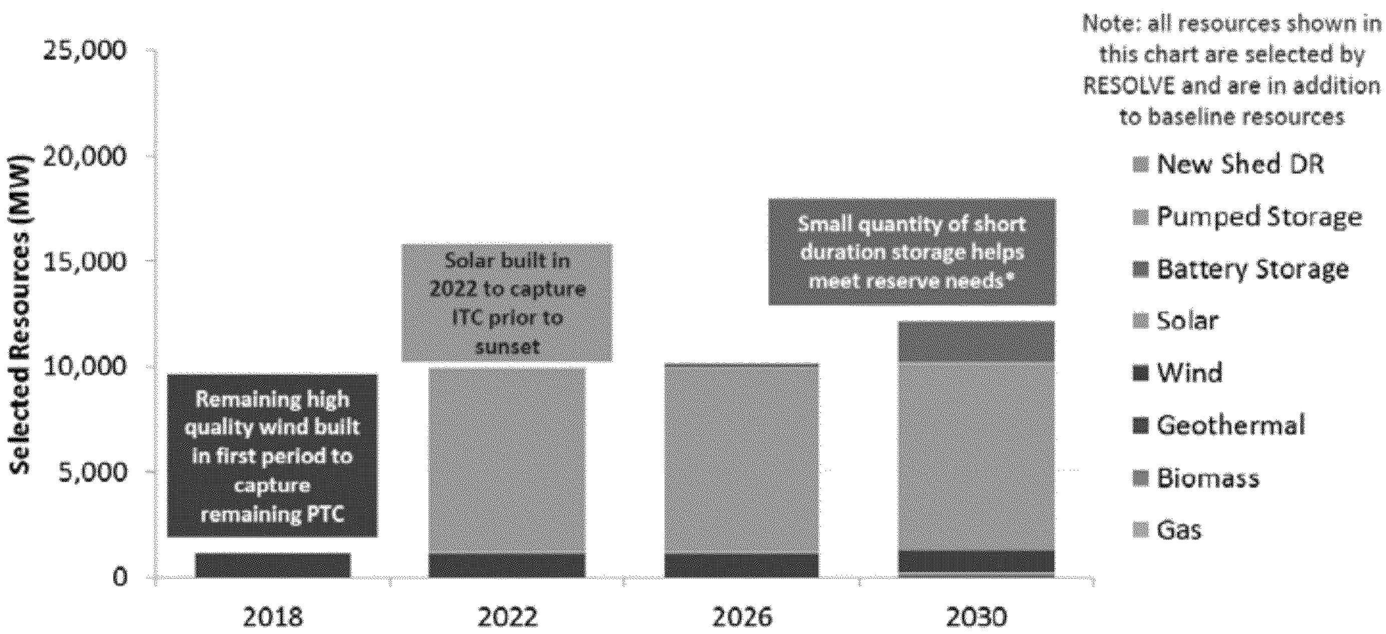
56

RESOLVE Output: Resources Selected in 42 MMT Case

2. CPUC Creates Reference System Plan & LSE Filing Requirements
- Assumptions & data
- Reference System Portfolio
- Ref. System Action Plan
- LSE filing requirements

COMMISSION DECISION #1

- Model selects ~9 GW of new utility-scale solar; 1,100 MW in-state wind; and 2,000 MW battery storage in addition to expected baseline of EE, DR, storage, renewables, hydro, gas, and nuclear
- Few additional resources needed for balancing (no new gas or pumped storage; 200 MW geothermal)
- Total incremental cost is $239 million/year, equivalent to approximately a 1% increase in system average rates by 2030



* Short-duration services could be provided by "Shimmy DR" resources, which were not modeled explicitly but may have resource potential up to 300 MW. The timing of the need for short duration services is based on a calculation of load-following reserve requirements outside of RESOLVE. There may be benefits to earlier procurement than shown here.

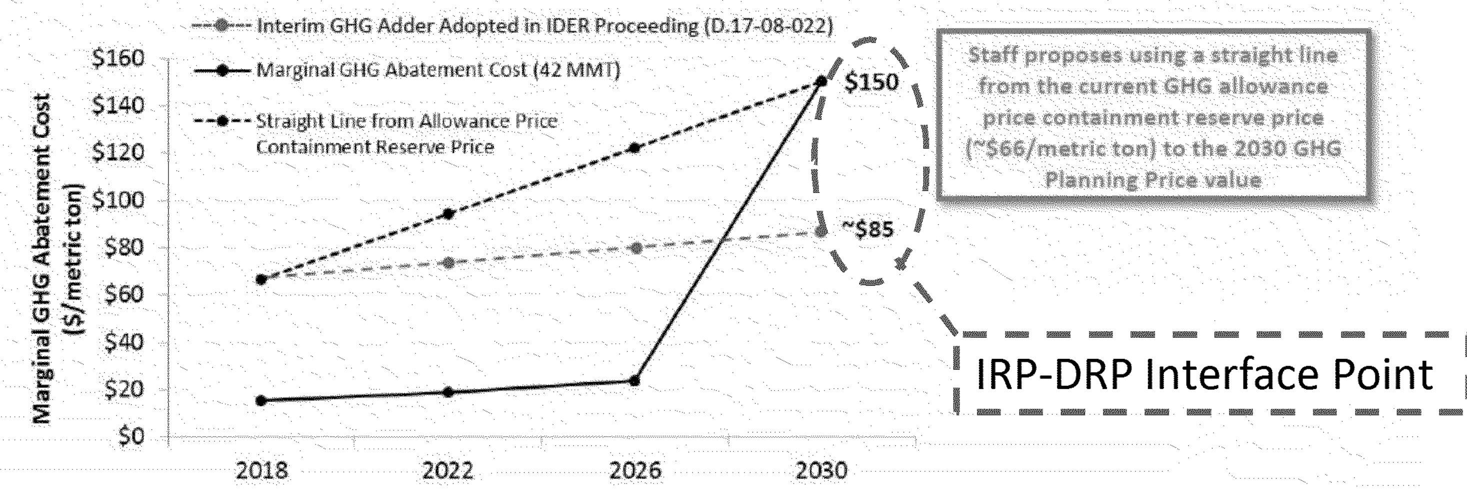
RESOLVE Output: Incremental Total Resource Cost (TRC) to Meet GHG Targets

- Incremental cost of the optimal portfolios ranges from **<u>$239 to $1,137 million per year</u>** for the 42 MMT and 30 MMT GHG targets, respectively
- Primary driver of incremental costs is **<u>new investment in renewables</u>**, whose zero-carbon generation displaces emissions from thermal generation and imports

		Incremental TRC ($MM/yr)		
		42 MMT	30 MMT	
Incremental Fixed Costs	*Renewables*	+$843	+$2,203	→ Increased investment in zero-carbon renewables is primary driver of incremental costs
	Storage	+$45	+$400	
	Thermal	—	—	No additional thermal or DR resources added to meet GHG goals
	DR	—	—	
	Transmission	—	+$41	→ Little to no new transmission construction
Incremental Variable Costs		-$650	-$1,507	→ Addition of renewables displaces generation from thermal resources, reducing operating costs
Incremental DSM Program Costs		—	—	Because demand-side assumptions are constant between scenarios, incremental costs are zero
Incremental Customer Costs		—	—	
Incremental Total Resource Cost		**+$239**	**+$1,137**	

GHG Planning Price

- **Recommended GHG Planning Price for IRP 2017-18: $150/MT in 2030**
  - Represents the CAISO system-wide marginal GHG abatement cost associated with achieving the 42 MMT planning target for the electric sector
  - The GHG Planning Price is an outcome of RESOLVE modeling, which constrains GHG emissions at the system level on an annual basis
  - LSEs would use the GHG Planning Price to develop their own portfolios and benchmark against resources in the Reference System Portfolio and an LSE-specific GHG Emissions Benchmark



17

IRP – DRP Interface

2. CPUC Creates Reference System Plan & LSE Filing Requirements
- Assumptions & data
- Reference System Portfolio
- Ref. System Action Plan
- LSE filing requirements

COMMISSION DECISION #1

R.16-02-007 JF2/jt2

IDER

[Integrated Distributed Energy Resources]

Conclusions:

- IRP has the ability to produce marginal abatement prices that reflect the system-wide marginal resource abatement cost associated with achieving certain targets, such as GHG or RPS targets

Implications:

- Other proceedings can use marginal abatement prices provided by IRP in their planning, valuation, and procurement processes

Action Items:

- IRP should determine how marginal abatement prices (i.e. the GHG Planning Price) should flow into IDER cost-effectiveness methodologies
- IRP should develop a Common Resource Valuation Methodology (CRVM) in close cooperation with IDER staff
- Staff should identify specific data needs and timing of information flows between IDER and IRP

IRP – DRP Interface

R.16-02-007 JF2/jt2

2. CPUC Creates Reference System Plan & LSE Filing Requirements
- Assumptions & data
- Reference System Portfolio
- Ref. System Action Plan
- LSE filing requirements

COMMISSION DECISION #1

DRP (1 of 2)

[Distribution Resources Plan]

Conclusions

There are two major interaction areas between IRP and DRP:

- Grid integration costs and benefits of DERs at system level need to be calculated
  - RESOLVE does not currently account for grid integration costs and benefits of DERs
  - DRP future refinements to the locational net benefit analysis (LNBA) include calculation of net DER integration costs at the Distribution Planning Area level, but calculation of a system level costs/benefits is not currently in scope of LNBA working group
- Transparent and consistent DER growth forecasts are needed for both IRP and DRP
  - IRP needs a clear set of planning assumptions in order to run scenarios on the impact of policy levers on each DER
  - DRP staff is coordinating CEC on development of DER growth scenarios, and ensuring the process will meet IRP needs
  - Currently discussing what adjustments may be needed to the IEPR demand forecast process to meet IRP and DRP needs

IRP – DRP Interface

2. CPUC Creates Reference System Plan & LSE Filing Requirements
- Assumptions & data
- Reference System Portfolio
- Ref. System Action Plan
- LSE filing requirements

COMMISSION DECISION #1

DRP (2 of 2)

[Distribution Resources Plan]

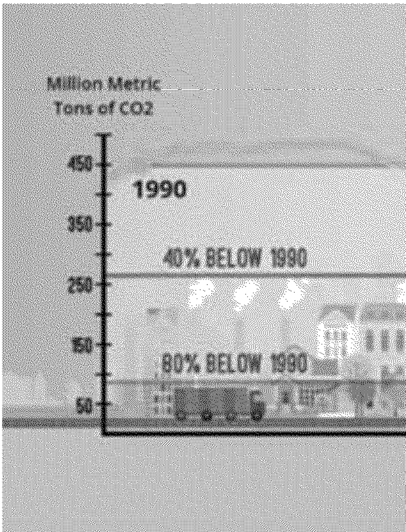
Implications:

- DRP and IRP comprise a feedback loop: DER growth depends on the cost-effectiveness of DER relative to other GHG free resources, which depends on costs of grid integration of DERs, which in turn depends on DER growth
- This feedback loop makes the assessment of DER growth and cost effectiveness complex, and by necessity an iterative process
  - DRP will not inform the 2017-2018 IRP planning cycle or vice versa, but results will be for the following cycle
  - IRP guidance from the optimized portfolio is expected to flow through to policy revisions in CPUC resource proceedings, and then the IEPR forecast, before becoming new DRP DER growth scenarios
- New analysis that pulls together results of LNBA in order to understand impacts at a system level may be needed

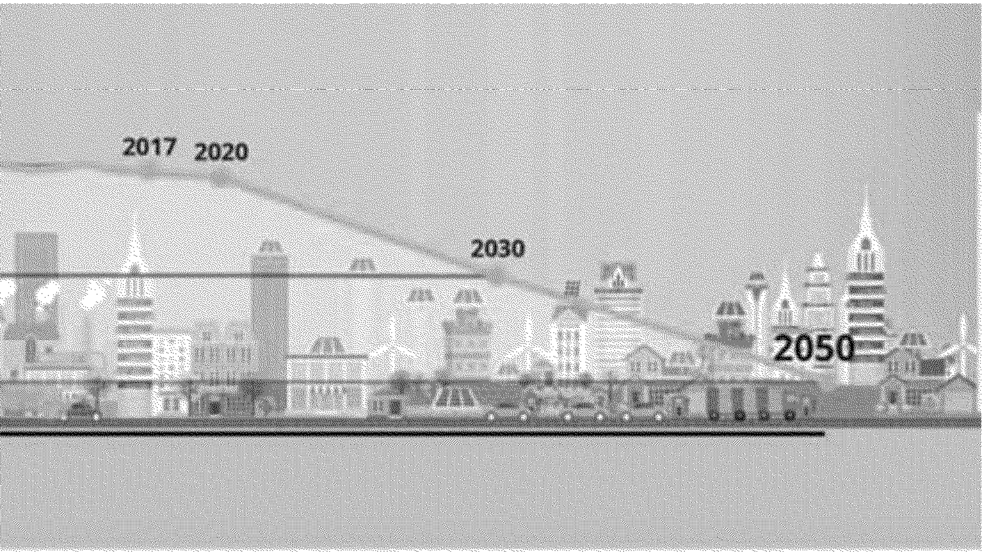
Action Items:

- DRP to develop a plan for determining system level grid integration costs/benefits
- DRP to work with CEC to define planning assumptions for DER growth
- DRP staff to determine how optimization of DERs in future IRP cycles will impact DER growth forecasts
- DRP to identify which DERs are driving specific grid needs, so that grid planning can adjust to changing market adoption rates

Questions?



The Clean Pow



ver and Electrification Pathway