Draft Sources for 2019-20 IRP Supply-Side Resources

OVERVIEW

This document lists the categories and sources of the assumptions proposed for use in Integrated Resource Planning (IRP) capacity expansion modeling activities in 2019. This is a draft, high-level outline meant to provide transparency into Energy Division's IRP process. An overview of this information was presented during the March 1, 2018 Modeling Advisory Group (MAG) Webinar. Below you can find a brief overview, followed by a draft of proposed data sources for 2019 assumptions, and finally, three sets of questions seeking stakeholder input. Stakeholders have 15 business days to submit comments in response to this document. The deadline for submittal is close of business on Tuesday, April 17th, 2018.

This document focuses on supply-side resource assumptions such as:

- Conventional
- Hydroelectric
- Solar PV (not BTM PV)
- Wind
- Geothermal
- Biomass
- Storage resources
    - Long duration: pumped hydro
    - Short and medium duration: Li ion and flow batteries
- Demand Response

Demand-side resource assumptions and load will largely be based on the 2018 IEPR. The updated IEPR demand forecast is expected to be available in January 2019. We will discuss demand-side updates at a later time in 2018.

This document is an update to the previous version of this document[1] that was used to develop inputs for the RESOLVE model in the 2017-18 IRP cycle. It will be used to develop numerical updates to the:

- RESOLVE User Interface
- RESOLVE Inputs and Assumptions Document

[1] http://www.cpuc.ca.gov/General.aspx?id=6442451329

DRAFT SOURCES FOR 2019 IRP ASSUMPTIONS

1) Existing & Planned Resources

Overview: Composition of generation fleet (and associated individual plant characteristics) of all resources (existing & planned) that will be treated as committed for the purposes of Integrated Resource Planning.

1.1. Conventional Generation

1.1.1. Planned Capacity

- **Description:** Existing generating resources that provide energy to the CAISO, either internally located or imported. In addition, modeling resources outside of California is required to ensure that import assumptions are reasonable.
- **Data needs:** Installed capacity (MW), in each year of the analysis, for each category of generation modeled in RESOLVE, accounting for planned additions and retirements. Categories of generation modeled in RESOLVE include nuclear, coal, gas cogeneration, gas combined cycle turbines (multiple classes), gas combustion turbines (multiple classes), gas steam turbines, and gas reciprocating engines.
- **Primary data sources:**
    - CAISO Master Control Area Generating Capability List[2] (we will use most recently published version)
    - Final Net Qualifying Capacity Report for Compliance Year 2018[3] (or most recently published version)
    - TEPPC 2026 Common Case v2.0 Generation Database or the WECC 2028 Anchor Data Set (ADS) if available.
- **Additional data sources:**
    - CPUC decisions authorizing future procurement
    - State Water Resources Control Board (for OTC compliance schedule)
    - Notices from plant owners of planned retirements

1.1.2. Operational Characteristics

- **Description:** Operational characteristics of existing generating resources.
- **Data needs:** Operational parameters for each category of generation in RESOLVE include:
    - Dispatchability
    - Maximum capacity (Pmax), MW
    - Minimum capacity (Pmin), MW
    - Ramp rate, MW/hr
    - Start cost, $/start
    - Heat rate (@ Pmin and Pmax), Btu/kWh
    - Minimum up & down times, hrs

[2] Available at: http://www.caiso.com/Documents/GeneratingCapabilityList.xls
[3] Available at: http://www.caiso.com/Documents/NetQualifyingCapacityReport_ComplianceYear-2018.xlsx

    - Variable O&M, $/MWh
- **Primary data sources**
    - TEPPC 2026 Common Case v2.0 Generation Database or the WECC 2028 Anchor Data Set (ADS) if available.

1.2. Hydro (Large) Generation

1.2.1. Operational Characteristics

- **Description:** Operational parameters limiting the capability of the hydro generation fleet in each RESOLVE region (each region's hydro fleet is modeled in aggregate). Within this representation, Hoover's capabilities are allocated among CAISO, LADWP, and the Southwest regions in proportion to their respective contractual ownership shares.
- **Data needs:** for each day simulated in RESOLVE, the hydro fleet in each region is characterized by four main parameters:
    - Maximum potential output, MW
    - Minimum potential output, MW
    - Daily energy budget, MWh
    - Ramping capability, MW/hr
- **Primary data sources:**
    - CAISO historical hourly hydro generation
    - For outside CAISO, an analysis of historical monthly hydro generation reported on EIA Form 906/923

1.3. Renewable Generation

1.3.1. Planned Capacity

- **Description:** RESOLVE groups existing and planned renewable generation into five categories: (1) biomass (includes biogas plants); (2) geothermal; (3) small hydro; (4) solar (includes both solar PV and solar thermal); and (5) wind.
- **Primary data sources:**
    - CPUC IOU Contract Database
    - CEC POU Contract Reports
    - CEC Statewide Renewable Net Short spreadsheet (used to cross-check and supplement the other data sources for CA entities)
    - TEPCC 2026 Common Case v2.0 Generation Database (used for renewable resources under contract to non-California entities)
    - Data provided by CCAs

1.3.2. Operational Characteristics

- **Description:** Assumed operating characteristics for planned renewable generation fleet.
- **Data needs:**
    - For "baseload" technologies (biomass, geothermal, and small hydro), no specific information is needed, as these resources are modeled as flat baseload profiles
    - For solar and wind plants, hourly profiles are needed

- **Primary data sources:**
    - NREL Solar Prospector
    - NREL WIND Toolkit

2. Policy Constraints

Overview: Requirements that will be treated as constraints on the development of candidate portfolios.

2.1. RPS Requirements

- **Description:** RPS targets for LSEs in each year of horizon.
- **Primary source:** RPS Decision D.16-12-040, adopting compliance periods and procurement quantity requirements for compliance with SB 350; statutory dates.

2.2. GHG Planning Target

- **Description:** GHG planning targets applicable to LSE portfolios.
- **Primary source:**
    - SB 350 Greenhouse Gas Planning Targets for the IRP Process, established in coordination with ARB[4]

2.3. Storage Requirements

- **Description:** Requirements for new storage capacity to comply with state requirements.
- **Primary sources:**
    - The 2018 Unified RA/IRP Inputs and Assumptions document[5] or its successor document
    - October 2013 Storage Target Decision[6]
    - February 2017 Decision on Track 2 Energy Storage Issues[7]
    - IOU responses to CPUC staff data request on procured energy storage to date (updated annually)

2.4. Local Capacity Requirements

- **Description:** Minimum quantity of additional local capacity necessary to meet forecasted Local Capacity Requirement criteria within the IRP planning horizon.
- **Data needs:** Forecasted additional local capacity (MW) needed by local area and year needed.
- **Primary data sources:**
    - CAISO Near-Term and Long-Term Local Capacity Technical Analysis (2019, 2023, 2028) anticipated to become available by Q4 of 2018
    - CAISO 2017-2018 Transmission Plan

[4] https://www.arb.ca.gov/cc/sb350/sb350.htm
[5] http://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/ElectPowerProcurementGeneration/irp/2018/1Unified_IA_main_draft_20180220.pdf
[6] http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M079/K533/79533378.PDF
[7] http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M184/K630/184630306.PDF

- CEC's Local Capacity Area Assessment Tool (LCAAT)

3. Candidate Resources

Overview: Characterization of new resources potentially used to meet policy constraints and system needs, as well as resources identified as economic investments. A capacity expansion model chooses from candidate resources to fulfill any unmet reliability needs or other constraints in an optimal manner.

3.1. Conventional

3.1.1. Gas Generators

- **Description:** Cost and performance assumptions for potential new gas facilities (CCGT, CT, ICE).
- **Data needs:**
  - Cost inputs:
    - Capital cost, $/kW
    - Fixed O&M, $/kW-yr
    - Variable O&M, $/MWh
    - Financing assumptions (cost of capital, capital structure, contract duration etc.)
    - Tax assumptions
  - Performance assumptions:
    - Pmax, MW
    - Pmin, MW
    - Ramp rates, MW/min
    - Start cost, $/start
    - Heat rate (@ Pmin and Pmax), Btu/kWh
    - Minimum up/down times
    - Maintenance outage rate
    - Forced outage rate
- **Primary data sources:**
  - CEC Cost of Generation Report[8]
  - E3's 2014 review of capital costs for WECC[9] Updated in 2017
  - NREL Annual Technology Baseline[10]
  - Renewable Power Generation Costs (IRENA)
- **Additional data sources:**
  - TEPCC 2026 Common Case v2.0 Generation Database (for performance characteristics) or the WECC 2028 Anchor Data Set (ADS) if available.
  - Industry market research and literature review

[8] http://energy.ca.gov/2014publications/CEC-200-2014-003/ (an update will be available "Estimated Cost of New Renewable and Fossil Generation in California: 2017 Update")
[9] https://www.wecc.biz/Reliability/2014_TEPPC_Generation_CapCost_Report_E3.pdf?Web=1; https://www.wecc.biz/Administrative/2017-01-31%20E3%20WECC%20Capital%20Costs%20v1.pdf
[10] https://atb.nrel.gov/electricity/2017/

3.1.2. Gas Retrofits

- **Description:** Cost and performance assumptions for retrofits of existing gas generators.
- **Data needs:**
    - Cost inputs:
        - Capital cost, $/kW
        - Fixed O&M, $/kW-yr
        - Variable O&M, $/MWh
        - Financing assumptions (cost of capital, capital structure, contract duration etc.)
        - Tax assumptions
    - Performance assumptions:
        - Pmax, MW
        - Pmin, MW
        - Ramp rates, MW/min
        - Start cost, $/start
        - Heat rate (@ Pmin and Pmax), Btu/kWh
        - Minimum up/down times
- **Primary data sources:**
    - CEC Cost of Generation Report
    - E3's 2014 review of capital costs for WECC[11] Updated in 2017
- **Additional data sources:**
    - Industry market research and literature review
- **Questions/issues:**
    - Lack of public data sources
    - Do parties have recommendations on public data sources that capture the costs and operational characteristics of retrofitted power plants?

3.2. Renewables

3.2.1 Baseload (Biogas, Biomass, Small Hydro, Geothermal)

- **Description:** Supply curve representing baseload renewables in California and the WECC available to California utilities to meet policy goals.
- **Data needs:**
    - Renewable potential (MW) by CREZ/WREZ
    - Present-day cost, performance, and financing assumptions (used to develop projections of PPA prices, $/MWh):
        - Capital cost, $/kW
        - Fixed O&M, $/kW-yr
        - Capacity factor, %
        - Financing inputs (WACC, capital structure, etc.)
        - Tax credits (PTC, ITC)
        - Contract duration

[11] https://www.wecc.biz/Reliability/2014_TEPPC_Generation_CapCost_Report_E3.pdf?Web=1; https://www.wecc.biz/Administrative/2017-01-31%20E3%20WECC%20Capital%20Costs%20v1.pdf

- **Primary sources:**
    - Start with existing cost and potential data embedded in RESOLVE, which were based on analysis by Black & Veatch intended to populate RPS Calculator v.6.3[12] and other market information as available.
- **Additional source:**
    - CEC Cost of Generation Report[13]

3.2.2. Solar PV

- **Description:** Supply curve representing solar resources in California and the WECC available to California utilities to meet policy goals.
- **Data needs:**
    - Renewable potential (MW) by CREZ/WREZ.
    - Present-day cost, performance, and financing assumptions (used to develop projections of PPA prices, $/MWh):
        - Capital cost, $/kW
        - Fixed O&M, $/kW-yr
        - Capacity factor, %
        - Financing inputs (cost of capital, capital structure, contract duration etc.)
        - Tax credits (PTC, ITC)
    - Assumed future cost reductions for solar PV technology (multiple levels of cost reduction will be examined)
    - Hourly profiles corresponding to multiple years of weather, for each region (CAISO and non-CAISO) for each candidate solar resource in RESOLVE
- **Primary sources:**
    - Start with existing cost and potential data embedded in RESOLVE, which were based on analysis by Black & Veatch intended to populate RPS Calculator v.6.3 and updates by E3 based on current market data
    - NREL Solar Prospector[14] (hourly historical irradiance data used to simulate hourly profiles)
- **Additional sources:**
    - CEC Cost of Generation Report
    - LBNL Tracking the Sun[15]
    - LBNL Utility-Scale Solar[16]
    - California Solar Initiative[17]
- **Issues/questions:**

[12] Although Black & Veatch prepared an analysis intended for the RPS Calculator v6.3, no v6.3 was ultimately developed because its function is replaced by the IRP process

[13] http://energy.ca.gov/2014publications/CEC-200-2014-003/ (an update will be available "Estimated Cost of New Renewable and Fossil Generation in California: 2017 Update")

[14] NREL's Solar Prospector can be accessed here: https://maps.nrel.gov/solar-prospector/ or https://maps.nrel.gov/nsrdb-viewer/

[15] https://emp.lbl.gov/publications/tracking-sun-10-installed-price

[16] https://emp.lbl.gov/utility-scale-solar

[17] https://www.californiadgstats.ca.gov/charts/

- Current assumptions of technology mix for solar PV are 25% fixed tilt and 75% single axis tracking, both with inverter loading ratio of 1.3. What assumptions should be made for the configuration and Inverter Loading Ratio (ILR) of future solar PV facilities?
- How should high- and low-cost trajectories for future PV costs be developed?

3.2.3. Wind

- **Description:** Supply curve representing wind resources in California and the WECC available to California utilities to meet policy goals.
- **Data needs:**
  - Renewable potential (MW) by CREZ/WREZ.
  - Present-day cost, performance, and financing assumptions (used to develop projections of PPA prices, $/MWh):
    - Capital cost, $/kW
    - Fixed O&M, $/kW-yr
    - Capacity factor, %
    - Financing inputs (cost of capital, capital structure, contract duration etc.)
    - Tax credits (PTC, ITC)
  - Assumed future cost reductions for wind technology
  - Hourly profiles corresponding to multiple years of weather for each region for each candidate wind resource in RESOLVE
- **Primary source:**
  - Start with existing cost and potential data embedded in RESOLVE, which were based on analysis by Black & Veatch intended to populate RPS Calculator v.6.3 and updates by E3 based on current market data
  - NREL WIND Toolkit[18] (hourly wind profiles)
- **Additional sources:**
  - CEC Cost of Generation Report
  - LBNL Wind Technologies Market Report[19]
- **Issues/questions:**
  - NREL WIND Toolkit is the most current source for wind profiles, but its assumptions on power curves and hub height result in capacity factors that don't accurately capture performance of older existing wind plants

3.3. Available Transmission Capacity

- **Description:** Available FCDS and EO capacity to interconnect new resources, and costs to increase capacity.
- **Data needs:** By RESOLVE transmission zone, available FCDS and EO remaining capacity (MW). Cost to increase capacity and by how much.
- **Primary data sources:**
  - CAISO supplemental analysis based on the current year's TPP work

[18] NREL's WIND Toolkit can be accessed here: http://www.nrel.gov/grid/wind-toolkit.html
[19] Available at: https://emp.lbl.gov/wind-technologies-market-report

3.4. Storage

3.4.1. Battery

- **Description:** Options for new battery technologies.
- **Data needs:**
    - Assumed operational parameters for each technology option:
        - Storage duration (hrs)
        - Round-trip losses (%)
        - Ability to contribute to reserve requirements (spin/frequency response/regulation/load following)
        - Point of interconnection
        - Ramping limitations, if applicable (MW/min)
        - Online date
        - Capacity (MW)
        - Other operational limits such as minimum time to switch from charge to discharge
    - Current cost, performance, and financing assumptions (used to develop forward-looking projections of levelized capacity cost, $/kW-yr):
        - Capital cost, $/kW (power block) and $/kWh (reservoir)
        - Fixed O&M, $/kW-yr
        - Financing inputs (cost of capital, capital structure, contract duration etc.)
        - Tax credits (PTC, ITC)
    - Assumed future cost reductions for battery technology (multiple levels of cost reduction will be examined)
- **Primary sources:**
    - Lazard's Levelized Cost of Storage 3.0 or later
    - Industry market research and literature review
- **Issues/questions:**
    - Do parties have recommendations on how to distinguish between specific battery technologies in an emerging market?
    - What sources should be considered in developing recommended battery costs for use in IRP?
    - How should Multiple Use Applications of battery storage by modeled?
    - How should high- and low-cost trajectories for future battery costs be developed?

3.4.2. Pumped Storage

- **Description:** Options for new pumped storage facilities.
- **Data needs:**
    - Assumed operational parameters for candidate pumped storage facilities:
        - Available potential capacity (MW)
        - Storage duration (hrs)
        - Round-trip losses (%)
        - Point of interconnection
        - Ramping limitations, if applicable (MW/min)

        - Other operational limits such as minimum time to switch from charge to discharge
        - Ability to contribute to reserve requirements (spin/frequency response/regulation/load following)
    - Current and future projections of cost, performance, and financing assumptions (used to develop forward-looking projections of PPA prices, $/MWh):
        - Capital cost, $/kW (power block) and $/kWh (reservoir)
        - Fixed O&M, $/kW-yr
        - Financing inputs (WACC, capital structure, etc.)
        - Tax credits (PTC, ITC)
- **Primary sources:**
    - Lazard's Levelized Cost of Storage 3.0 or later
    - Industry market research and literature review
- **Issues/questions:**
    - How should pumped storage costs be represented given that they are highly site-specific and difficult to estimate on a generic basis?
    - To what extent are new pumped hydroelectric facilities able to contribute to primary frequency response?

3.5. Demand Response

- **Description:** Additional Demand Response potential
- **Data needs:**
    - Cost, potential, and characteristics of candidate "shed" demand response programs, including:
        - Cost ($/kW-yr)
        - Potential (MW)
        - Operational constraints (#/frequency/duration of calls)
    - Cost, potential, and characteristics of candidate "shift" demand response programs, including:
        - Cost ($/kWh-yr)
        - Potential (MWh)
        - Operational constraints (daily and hourly availability)
    - Cost, potential, and characteristics of candidate "shimmy" demand response programs, including:
        - Cost ($/kW-yr)
        - Potential (MW)
        - Operational constraints (how it would participate and operate in ancillary service market)
- **Issues/questions:**
    - Are there other data sources that should be considered for additional DR cost and potential, beyond the latest version of the California Demand Response Potential Study?
- **Primary data source:**

- Latest version of California Demand Response Potential Study[20]

4. Price Forecasts

Overview: Forecast of future commodity prices whose levels will impact costs of operating power sector (and by extension, retail rates).

4.1. Fuel Prices

- **Description:** Burner-tip fuel price forecasts used to simulate cost-based dispatch of Western energy system
- **Data needs:** 20-year forecasts of gas, coal, uranium, biomass prices for various delivery points in WECC footprint
- **Primary source:**
  - Most recent available CEC IEPR fuel price curves[21]
- **Additional source:**
  - TEPPC 2026 Common Case v2.0 Generation Database (for coal, uranium prices) or the WECC 2028 Anchor Data Set (ADS) if available.

4.2. GHG Allowance Price

- **Description:** Carbon price forecasts reflecting the cost of allowances under California's cap & trade program.
- **Data needs:** 20-year forecasts of carbon price in California
- **Primary source:**
  - Most recent available CEC IEPR GHG Price Projections[22]

QUESTIONS FOR STAKEHOLDERS

Data Source Criteria

Data sources should meet these criteria:

- Publicly available
- Technically credible
- Cost data reflects future costs
- Cost data can be used to develop all-in technology costs
- Resource potential data is geographically specific at level of transmission zones used in RESOLVE

In addition, data sources to update or create new candidate resources should meet these criteria:

- Resource must have plausible trajectory to commercial availability within planning time horizon

[20] Available at: http://www.cpuc.ca.gov/General.aspx?id=10622
[21] For example: http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6559
[22] For example: https://efiling.energy.ca.gov/getdocument.aspx?tn=208931

- Magnitude of potential impact on future portfolio costs and composition must be sufficient to justify changes to model functionality and run-time

Questions

Below you can find three sets of questions to which CPUC staff is seeking stakeholder input. The first set consists of questions pulled directly from pages 1 – 11 for your convenience. Next is a set of remaining questions on resource potential, followed by as set of remaining questions on resource costs. Please respond to questions in the order they are presented.

Data Sources (Questions pulled from pages 1-11)

3.1.2. Gas Retrofits

Question 1: Do parties have recommendations on public data sources that capture the costs and operational characteristics of retrofitted power plants?

3.2.2. Solar PV

Question 2: Current assumptions of technology mix for solar PV are 25% fixed tilt and 75% single axis tracking, both with inverter loading ratio of 1.3. What assumptions should be made for the configuration and Inverter Loading Ratio (ILR) of future solar PV facilities?

Question 3: How should high- and low-cost trajectories for future PV costs be developed?

3.4.1. Battery

Question 4: Do parties have recommendations on how to distinguish between specific battery technologies in an emerging market?

Question 5: What sources should be considered in developing recommended battery costs for use in IRP?

Question 6: How should Multiple Use Applications of battery storage by modeled?

Question 7: How should high- and low-cost trajectories for future battery costs be developed?

3.4.2. Pumped Storage

Question 8: How should pumped storage costs be represented given that they are highly site-specific and difficult to estimate on a generic basis?

Question 9: To what extent are new pumped hydroelectric facilities able to contribute to primary frequency response?

Resource Potential

Question 10: Are there any new resource types (not described in your responses to Questions 1 – 9) that Energy Division should prioritize including as a candidate resource in the 2019 IRP? Describe how the new resource type satisfies the new candidate resource criteria listed above. List the data

sources available for quantifying the cost and potential of the proposed resource type and describe how the data sources satisfy the data source criteria listed above.

Question 11: Are there data sources (not described in your responses to Questions 1 – 9) that should be considered for modifying the candidate resource potential assumed in IRP? Please describe and provide a link for any suggested data sources. Explain how the data source meets the data source criteria listed above.

Resource Costs

Question 12: Are there any additional sources of capital cost, operating cost, and performance projections (not described in your responses to Questions 1 – 9) that should be considered for solar PV or wind? Please describe and provide a link for any suggested sources. Explain how the data source meets the data source criteria listed above.

Question 13: How should import tariffs on solar PV modules be represented?

Question 14: Should any of the cost and financing assumptions in RESOLVE's LCOE calculations be modified, for example assumptions related to state and federal tax incentives, the cost of capital, and financing lifetime? Explain and support any recommended changes using publicly available information, to the greatest extent possible.