Attachment B:
Consideration of Existing Thermal Generation in CPUC IRP

February 2019
Outline

• Introduction and Procedural Background
• Purpose of Thermal Generation Study
• Summary of 2017/18 IRP Thermal Generation Analysis
• Proposed 2019 IRP Thermal Generation Analysis
• 2019 IRP Criteria Pollutant Analysis
• Recommendations & Next Steps
Introduction

• The Commission is required, under Senate Bill 350, to:
  – “identify a diverse and balanced portfolio of resources needed to ensure a reliable electricity supply that provides optimal integration of renewable energy in a cost-effective manner” (Public Utilities Code 454.51); and
  – “adopt a process for each LSE... to file an IRP... to ensure that LSEs... (E) Ensure system and local reliability” (PU Code 454.52)

• Key considerations:
  – California currently relies upon approximately 40 GW of thermal generation and 10 GW of imports to maintain Resource Adequacy
  – PU Code 454.52 includes the following requirement, “Minimize localized air pollution and other GHG emissions, with early priority on disadvantaged communities.”
  – The passage of SB350 and SB100 and the issuance of Executive Order B-55-18 puts California on a path toward 100% zero carbon electricity
Procedural Background

• 2017: The Commission established the Reference System Plan, which was informed by ~200 scenarios and sensitivities, including age-based thermal generation retirements

• Dec-2018: Proposed Inputs & Assumptions for 2019-2020 IRP
  - Staff proposed two options:
    – Economic Retirement or Retention
    – Age-based Retirement

• Targeting 2019-2020 IRP Reference System Plan to be developed by summer of 2019
  – The proposed thermal generation study will be performed as part of the scenarios run to develop the 2019-2020 Reference System Plan.
PURPOSE OF 2019 IRP EXISTING THERMAL GENERATION STUDY
2019 Study Objectives and Use Cases

• Objectives
  – Better inform regulatory decisions regarding:
    • Level of thermal generation retention that minimizes ratepayer costs, as required by statute; and/or
    • What volume and type of thermal generation resources could retire without impairing system or local reliability
  – Address reliability issues, including those raised in LSEs’ IRPs and party comments in 2018:
    • Improve alignment with Resource Adequacy
    • Need for near-to-medium term renewable integration resources
  – Better quantification of air criteria pollutants associated with thermal generation under different policy futures examined in 2019 RSP
  – Better understand impact of system level emissions on Disadvantaged Communities (DAC)

• Use Cases
  – Least regrets near-term (next 5 yrs) IRP need authorizations
  – CAISO TPP – reliability, economic, policy portfolios for 2019-20 TPP
  – SB100’s 2045 carbon neutrality goal: assessing need for existing thermal generation to achieve 2045 goal

• Note
  – The Commission has authority over retention of resources through procurement authorization and whether those resources are included in or excluded from a utility’s portfolio.
Questions Guiding Analysis

Policy Question
• What are the economic and environmental costs and benefits of alternative thermal generation retention or retirement strategies, both in the near-term and in the long-term (2030+)? Depending on the results of the analysis, possible strategies include:
  1. Take no action and let the market determine which plants retire/are mothballed
  2. Take action to hasten the retirement of some plants if they are not needed for reliability in the short term
  3. Take action to retain some plants because they might be needed for reliability over the long term
Questions Guiding Analysis

Technical questions

• Reliability:
  - How much existing resource capacity should be retained to provide Local Resource Adequacy and what are the emissions and cost impacts of retaining that generation?
  - How much effective capacity is needed to provide System Resource Adequacy for each IRP resource planning year between 2020-2030, and what is the trajectory needed to reach 2045 goals?
    ▪ How does System RA need change under different policy futures (e.g., high electrification vs. low electrification)?
    ▪ How much effective capacity can solar, wind, and storage resources provide?

• Resource Portfolio Economics:
  - What is the incremental cost of the strategies to proactively retire or replace some plants compared to the “no action” alternative where the market decides?

• Emissions Impacts:
  - What are the environmental impacts of each strategy, e.g., CO2 & NOx emissions?
Out of Scope Issues

- Assessment and optimization of local resource alternatives (e.g. new transmission, generation or storage) to solve local reliability needs
- Identification of specific units for retirement
- Identification and quantification of potential revenue streams for thermal generation outside of CPUC jurisdiction
  - Example: RA contracts with non-CPUC jurisdictional entities
- Quantification of market revenues received by thermal generators for dispatch in CAISO and bilateral energy markets
- Explicit intra-hour modeling to inform operational flexibility needs outside of those already captured by RESOLVE
SUMMARY OF 2017/18 IRP
THERMAL GENERATION ANALYSIS
Outline

• 2017/18 RESOLVE reliability functionality
• Summary of 2017/18 thermal generation sensitivity results
• Outstanding questions for 2019-20 IRP
2017/18 RESOLVE Reliability - Functionality

- RESOLVE is a capacity expansion model, simulating investment in an optimal portfolio to minimize costs while meeting reliability, operability, and policy constraints.
  - RESOLVE considers system peak capacity needs by ensuring that there is enough capacity to meet 115% of a 1-in-2 system peak demand event. This is enforced by the planning reserve margin (PRM) constraint.
  - Though its constraints are designed to create reliable portfolios, RESOLVE does not calculate loss-of-load probability and cannot check that a 1-day-in-10-year reliability standard is met.
  - SERVM is used to calculate loss-of-load probability and assess whether a RESOLVE portfolio meets the desired reliability standard. SERVM is also used to assess emissions and operations with more fidelity.
  - This analysis was not performed for the Reference System Plan (RSP) portfolio in the 2017 IRP, but was performed by Staff for the 42 MMT RESOLVE portfolio updated with 2017 IEPR assumptions.
2017/18 IRP - Thermal Generation Retirement Sensitivities

- Assumed the thermal generation fleet was fully retained in core scenarios unless retirement had already been announced.

- CHP retirement sensitivity: All existing non-dispatchable CHP (1,600 MW) assumed to retire by 2030
  - Retirement of baseload CHP—an inflexible resource—increased operational flexibility and reduced the challenge of renewable integration. This sensitivity lowered electric sector costs, as fewer investments in renewables and storage were necessary to meet policy goals.
  - Decrease of $161 MM/yr in Total Resource Costs (TRC) as compared to 42MMT reference portfolio – but the value of useful thermal output from CHP facilities was not quantified

- Gas retirement sensitivity: An additional 12.7 GW of gas generation assumed to retire by 2030, reducing gas fleet to 13 GW
  - Accelerated retirement of gas resources drove significant increase in the total cost metric, mainly a result of the need to invest in new resources that can replace system resource adequacy provided by the retired gas capacity.
  - Increase of $370 MM/yr in TRC as compared to 42MMT reference portfolio
Key Findings:

• The widespread early retirement of gas resources sensitivity (12.7 GW retired) led RESOLVE to select mostly battery storage to replace capacity available at peak
  – 42 MMT GHG target: more than 5 GW battery, several hundred MW geothermal, and small amounts of shed DR incremental to 42 MMT reference case

• It might be less expensive to selectively retain a subset of existing gas plants rather than building new capacity

Outstanding questions for 2019/20 IRP:

• Thermal resources have different performance characteristics which impact the value of each plant to CPUC ratepayers. Which types of gas plants provide value across the studied resource years through 2030 and in 2045? Example attributes:
  ▪ Minimum generation level
  ▪ Fast ramping ability
  ▪ Thermal efficiency
  ▪ Location-specific considerations

• How does the value of each type of gas plant change under various energy futures, such as electrification?

• How should criteria air pollutants be better quantified or characterized?
PROPOSED 2019-20 IRP THERMAL GENERATION ANALYSIS
Outline of Staff Proposal

• 2019-20 IRP Default Assumption for Existing Thermal Generation

• **Step 1:** Ensuring local reliability under a system level analysis

• **Step 2:** Ensuring energy sufficiency under a deep decarbonization future

• **Step 3:** Incorporating economic retention functionality into Core Scenarios and Special Study Cases

• **Step 4:** Reliability Check on Reference System Plan

• Staff Recommendations
2019-20 IRP DEFAULT ASSUMPTION FOR EXISTING THERMAL GENERATION
Modeling Assumption Options for Existing Thermal Generation

• **Option 1:** Maintain 2017-18 IRP assumption – thermal generators remain online in perpetuity unless they have formally announced intentions to retire
  – A simplifying modeling assumption that may not be reflecting current market conditions

• **Option 2:** Develop retirement trajectory outside of economic optimization
  – An exogenous retirement schedule can be simple (e.g., retire thermal generators after 40 years), or more complex (e.g., fleet trajectory percentage by class type)
  – Parties have expressed concern with using a 40 year retirement assumption because plant age is only one part of a larger set of market dynamics and resource adequacy issues that impact thermal generator economics

• **Option 3:** Economic retention, defined as an optimization exercise in which existing generators are retained when doing so reduces overall system costs. The quantity retained is an output rather than a predetermined input.
  – An opportunity to explore more optimal amounts of capacity retention under various policy futures
Future System Capacity Supply and Demand Is Uncertain and Will Depend On Economics and Policy Choices

- Analyze how near and medium term retention or retirement of thermal generation aligns with long-term capacity needs, which may increase under transportation electrification and building decarbonization.

**Low Retention:**
High retirement of existing plants may create need for capacity later

**High Retention:**
Take action to keep some or all plants around, all fixed O&M costs are paid

- The proposed analysis will use the economic retention functionality to shed light on the tradeoffs between retaining and retiring resources.
Reliability Constraints Required to Move Forward with Economic Retention Assumption

• In the 2019-20 IRP, reliability checks will take place before the release of Reference System Plan.
  – Staff would use SERVM to conduct loss-of-load probability analysis for key retention case to confirm that each case meets accepted reliability standards.

• Moving forward with economic retention as the default option will require staff to have in place defensible reliability checks to address the following:
  1. **Local Capacity Requirement (LCR) areas:** retention and retirement decisions for thermal resources must include contribution to local reliability
     ▪ A minimum LCR value will need to be developed and implemented as an interim constraint in RESOLVE, until functionality can be developed to optimize capacity retention in local capacity areas
  2. **Energy Sufficiency:** Energy-limited resources, for example solar and storage, can provide significant peak capacity value, but with lower levels of thermal capacity it is possible that prolonged periods of low variable renewable output could result in energy shortages during non-peak hours
     ▪ Proper replacement of thermal generation with energy AND capacity resources are necessary to enable low retention scenarios

Note - Above two steps are addressed in the following two sections of the presentation
STEP 1:
ENSURING LOCAL RELIABILITY
UNDER A SYSTEM LEVEL ANALYSIS
Incorporation of LCR Contribution into RESOLVE

• 2017-18 IRP RESOLVE Modeling
  – RESOLVE was able to simulate only *incremental* LCR needs.
  – It was not necessary to quantify the contribution of existing thermal generators to local capacity requirements in the 2017-18 IRP because:
    • All existing thermal generation resources were modeled as remaining online in perpetuity unless retirement had already been announced.
    • CAISO provided incremental LCR needs that already included the contribution of existing thermal resources to local capacity requirements. Note: incremental LCR needs were found to be 0 MW.

• With the implementation of economic retention functionality, RESOLVE should incorporate the LCR contribution of resources.
  – Many plants that would potentially not be retained by RESOLVE are currently serving LCR needs
  – These resources need to be accounted for in retention/retirement decisions

• 2019-20 RESOLVE LCR Modeling
  – Option 1: Full retention of minimum local generation
  – Option 2: Retire and Replace LCR Resources
Option 1: Full Retention of Minimum Local Generation

• Description
  – Gas plants serving local capacity requirements must be retained

• 2019-20 RESOLVE Modeling
  – Exogenously quantify the existing LCR need satisfied by existing plants to set the minimum LCR value for each plant type
    • Data sources: 2018-19 CAISO Transmission Planning Process (TPP) includes an economic study of 22 of the 41 CAISO local areas and subareas
    • Outputs produced:
      – Local capacity requirements (LCRs) for each area/subarea
      – Generators serving LCRs
      – Transmission upgrades that may reduce the LCRs
    • Coordination with CAISO will be important to ensure proper translation of TPP study results
      – Requires the addition of one new constraint that does not allow the model to retire capacity below the estimated level for each plant type
Option 2: Retire and Replace

• Description:
  – The model can retire MW capacity by resource type in local areas but must replace it with new capacity or transmission

• Considerations:
  – Would allow for solving simultaneously of LCRs and system level, helping identify optimal transmission or non-wire solutions (storage, local DR, EE, BTM PV, new gas, etc.)
  – The extent to which replacement solutions can contribute to local requirements is uncertain and not yet closely studied
  – Staff would need to:
    • Identify the LCR MW provided by existing resources, as described above
    • Determine how effective each resource is in addressing local capacity requirements
    • Define the import transmission capability into the local area
    • Determine the cost of transmission alternatives to reducing or eliminating local deficiencies
Staff Recommends Option 1

• For 2019 IRP, “jump-start” process using available information to estimate the MW of each RESOLVE thermal plant type that should be retained in LCR areas.
  – For 2019 IRP, lack of detailed LCR optimization studies necessitates caution when replacing thermal capacity with non-wires or transmission solutions – the default assumption would be to retain most LCR thermal generation unless evidence suggests that retirement is likely
  – Requires:
    • Coordination with CAISO to develop minimum LCR retain values
    • Addition of constraint in RESOLVE

• Starting in 2019, study each LCR area in detail, producing a portfolio of existing resource retention, non-wires alternatives (storage, local DR, EE, BTM PV, new gas, etc.), and transmission solutions
  – LCR study results would be used to populate baseline resources and minimum thermal retention constraints for the 2021 IRP
**STEP 2:**
ENSURING ENERGY AND CAPACITY SUFFICIENCY WITH LOWER LEVELS OF THERMAL GENERATION CAPACITY
Analytical Challenges with Replacing Thermal Capacity

- Replacement of 24/7 dispatchable thermal capacity with energy storage, variable renewables, and other energy-limited resources becomes more challenging as more capacity is replaced
  - Thermal capacity has a dedicated fuel source that is available 24/7, whereas storage has limited duration and variable renewables have intermittent fuel availability. For variable resources, marginal ELCC generally declines as a function of penetration

![Graph showing load and peak load reduction](image_url)

For additional information: see “Session 5 - Solar+Storage as a Peaker Replacement - Derek Stenclik” at https://www.esig.energy/resources/2018-fall-technical-workshop/

- Current RA rules – which relate to peak capacity – do not ensure an acceptable level of reliability in a grid dominated by storage and variable renewables
- The IRP process is tasked with designing reliable and economically optimal portfolios in a potentially highly renewable + storage grid. New analytical methods may be necessary to ensure both economic and reliability goals are met in this type of future.
Analytical Challenges with Replacing Thermal Capacity (continued)

• Results of previous studies (HI¹, CA², etc), suggest that portfolios that rely heavily on storage and variable renewables to meet reliability requirements must be checked with a loss-of-load model such as SERVM or RECAP.

• Below a threshold level of thermal generation, additional constraints – in addition to the system RA / peak demand constraint – must be added to the capacity expansion model to produce reliable portfolios.
  – The threshold is system-specific because the interaction of dispatch/energy limited resources with other resources and load profiles can significantly impact portfolio reliability

• Analysis in the 2019-20 IRP will:
  1) Demonstrate whether energy sufficiency is a challenge for deeper retirement cases
  2) If challenges are identified, mitigate by:
     – Adding energy sufficiency constraints to the RESOLVE portfolio selection
     – And/or manually adding capacity (thermal or non-thermal) back to the portfolio until it is reliable

RESOLVE Energy Sufficiency Constraints

- The 2019-20 IRP version of RESOLVE includes optional constraints (not used by default) that ensure the system has enough energy to sustain multi-hour to multi-day periods of low renewable production.
- Example constraint - for every 8 hour window across the year:
  + average wind + solar + hydro production
  + storage capability across window (here 8 hours for full capacity credit)
  + thermal generation capacity
  + firm import capacity
  >= average load
- Example result: model builds longer duration storage and/or retains thermal capacity to ride out “dark doldrums” – periods of very low wind and solar production.
Implementation of Energy Sufficiency Constraint

- Staff need to populate the energy sufficiency constraint in RESOLVE with appropriate values
  - Timing and duration of deficiencies
- Staff proposes to identify the values by conducting a loss of load analysis on a portfolio of resources that is likely to push the boundaries of reliability – a case with a low installed capacity of thermal generation capacity.
  - Recycle 2017-18 IRP portfolio identified under the Gas Retirement Sensitivity where in addition to the announced retirements, 12.7 GW of gas generation was assumed to retire by 2030, reducing gas fleet to 13 GW
Summary: 2019 IRP Schedule and Coordination Between RESOLVE and SERVM

**STEP 1**
Develop RESOLVE minimum LCR constraints and MW of each generator class to retain

1. Staff will use CAISO data to develop minimum LCR constraints (MW to be retained by generator class)
2. Include constraints in all subsequent analysis

**STEP 2**
Ensure portfolio reliability under higher thermal retirements

**RESOLVE**
- **1st step** - Force retirement of high amount of thermal resources by 2030 and identify resource portfolio
- **3rd step** - Populate RESOLVE energy and capacity sufficiency constraints if necessary

**SERVM**
- **2nd step** - Reliability check on forced high retirement portfolio
  - Result 1: Level of retirements above which PRM constraint is not sufficient to ensure reliability
  - Result 2: Information about deficiencies - timing (winter/summer), and number of hours

*Ensure portfolio reliability*

R.16-02-007 ALJ/JF2/ilz
STEP 3: INCORPORATING EXISTING THERMAL GENERATION ANALYSIS INTO CORE SCENARIOS AND SPECIAL STUDY CASES
Summary: 2019 IRP Schedule and Coordination Between RESOLVE and SERVM

(STEP 1) Develop RESOLVE minimum LCR constraints and MW of each generator class to retain

1) Staff will use CAISO data to develop minimum LCR constraints (MW to be retained by generator class)
2) Include constraints in all subsequent analysis

(STEP 2) Ensure portfolio reliability under higher thermal retirements

RESOLVE:
1st step - Force retirement of high amount of thermal resources by 2030 and identify resource portfolio
3rd step - Populate RESOLVE energy and capacity sufficiency constraints if necessary

Ensure portfolio reliability

Update RESOLVE

SERVM:
2nd step - Reliability check on forced high retirement portfolio
Result 1: Level of retirements above which PRM constraint is not sufficient to ensure reliability
Result 2: Information about deficiencies - timing (winter/summer), and number of hours

(STEP 3) RSP Analysis

RESOLVE: Run Core Cases and Special Study Cases in RESOLVE using economic retirement functionality
- All RSP RESOLVE runs include energy sufficiency constraints (if deficiencies found in SERVM)
Proposed 2019 IRP Existing Thermal Generation Analysis

After integration of the minimum LCR constraint and an appropriate energy sufficiency constraint, staff can use the economic retirement functionality in RESOLVE as the default assumption for core scenarios. Additionally, a high retention and low retention special study would be conducted across the GHG targets to compare the resource build out and total resource cost under various retention futures through 2045.

<table>
<thead>
<tr>
<th>Economic Retention (Default for all Core Scenarios)</th>
<th>30 MMT</th>
<th>38 MMT</th>
<th>46 MMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the economically optimal amount of existing thermal generation that should be retained?</td>
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</table>

<table>
<thead>
<tr>
<th>High Retention (Special Study)</th>
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<tbody>
<tr>
<td>What is the cost of retaining additional existing thermal generation plants as a risk hedging strategy against high load growth?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Low Retention (Special Study)</th>
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<tbody>
<tr>
<td>What is the cost of allowing the retirement of more existing generation than economically optimal in order to meet other state goals?</td>
</tr>
</tbody>
</table>
Economic Retention Case in RESOLVE

- An optimization exercise in which the quantity retained is an output rather than a predetermined input. RESOLVE retains existing generators when doing so reduces overall system costs.

- RESOLVE functionality has been augmented since the 2017 IRP to enable economic retention of existing generators
  - New data needed: fixed O&M data by plant type (CT, CCGT, Steam)
  - E3 updated the Review of Capital Costs for Generation Technologies in January of 2017 and found that natural gas resource costs remained stable since the 2014 version.

High Retention: Take action to keep some or all plants around, all fixed O&M costs are paid

Low Retention: High retirement of existing plants may create need for capacity later
High Retention Case in RESOLVE

- Maintain all existing generation in perpetuity unless retirement has already been announced.
- Fixed O&M costs must be paid to maintain existing generators.
- Reflects how existing generators were modeled in 17-18 IRP
- May not represent the optimal if cost of retention is larger than benefits of retention
- This case would be modeled for cost comparison purposes. It is unlikely to occur without directed policy action. It is a bookend.
Low Retention Case in RESOLVE

- **Used as a bookend case to:**
  - Identify system reliability issues under the most stringent circumstances
  - Assess the need to add more energy resources to completely replace thermal generation
  - Compare key portfolio metrics such as costs and GHG emissions to that of the portfolio under economic retention

- **Staff will develop a retirement schedule that is used as an input to RESOLVE**
  - This retirement schedule would only be used for IRP analytical purposes and would not represent Commission policy

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**Economic Retention:**
Retain optimal amount to reduce system costs

**Retention:**
Take action to keep some or all plants around, all fixed O&M costs are paid

**Low Retention:**
High retirement of existing plants may create need for capacity later
Low Retention Case in RESOLVE

• Staff will develop and incorporate into RESOLVE a retirement schedule by plant class type.

**STEP 1:** Evaluate plants based on potential criteria and create a retirement schedule as demonstrated in the illustrative table below:

- Generator age
- Efficiency relative to similar generating units
- Within/outside local capacity areas
- Located in a special transmission area (LCR, Diablo retirement, etc.)
- Inside/outside a disadvantaged community

<table>
<thead>
<tr>
<th>Plant Type</th>
<th>Proportion to be retired</th>
<th>MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peaker 1</td>
<td>x%</td>
<td>y MW</td>
</tr>
<tr>
<td>Peaker 2</td>
<td>x%</td>
<td>y MW</td>
</tr>
<tr>
<td>CCGT 1</td>
<td>x%</td>
<td>y MW</td>
</tr>
<tr>
<td>CCGT 2</td>
<td>x%</td>
<td>y MW</td>
</tr>
</tbody>
</table>

**STEP 2:** Remove plant type MW in RESOLVE according to the retirement schedule while maintaining reliability constraints.
STEP 4: RELIABILITY CHECK ON REFERENCE SYSTEM PLAN
Summary: 2019 IRP Schedule and Coordination Between RESOLVE and SERVM

**STEP 1** Develop RESOLVE minimum LCR constraints and MW of each generator class to retain

1) Staff will use CAISO data to develop minimum LCR constraints (MW to be retained by generator class)
2) Include constraints in all subsequent analysis

**STEP 2** Ensure portfolio reliability under higher thermal retirements

**RESOLVE**

1st step - Force retirement of high amount of thermal resources by 2030 and identify resource portfolio

3rd step - Populate RESOLVE energy and capacity sufficiency constraints if necessary

**SERVM**

2nd step - Reliability check on forced high retirement portfolio

Result 1: Level of retirements above which PRM constraint is not sufficient to ensure reliability

Result 2: Information about deficiencies - timing (winter/summer), and number of hours

**STEP 3** RSP Analysis

**RESOLVE**: Run Core Cases and Special Study Cases in RESOLVE using economic retirement functionality
- All RSP RESOLVE runs include energy sufficiency constraints (if deficiencies found in SERVM)

**STEP 4** Reliability Check on RSP

**SERVM**: Staff will validate system reliability as well as overall GHG emissions, operating costs of key RSP cases with a LOLE study
CRITERIA POLLUTANT ANALYSIS
2017 IRP Criteria Pollutant Analysis Conclusions

• Conclusions from 2017 examination of the impact of resource portfolios on criteria air pollutant emissions
  – The vast majority of electric sector criteria pollutant emissions are a result of CCGT usage because they run more hours of the year
  – As the electric sector GHG planning target becomes more stringent, new increased amounts of renewables and storage displace more CCGT use outside of daytime hours
  – The largest opportunity to reduce air pollutant emissions from the electric sector lies in reducing the use of CCGTs
2019 IRP Criteria Pollutant Analysis

• Improvements in 2019-20 IRP Cycle
  – Running RESOLVE portfolios through SERVM earlier in process will allow analysis to take into account how often individual generators are running, starting, stopping, and contributing to total system emissions
  – Clean Net Short Calculator functionality will be bolstered to provide emissions intensities for criteria pollutants (last cycle only provided for carbon)
RECOMMENDATION & NEXT STEPS
Staff Recommendations & Next Steps

1. Staff recommends using the economic retirement functionality for all core scenario and sensitivity RESOLVE runs conducted for the 2019-20 IRP.

2. Staff recommends implementation of the minimum LCR constraint to ensure that retention and retirement decisions for thermal resources located in LCR areas include the contribution of those resources to local reliability
   - In 2020 conduct detailed local capacity area optimizations, producing a portfolio of existing resource retention, non-wires alternatives, and transmission solutions

3. Using a high retirement special study, iterate between RESOLVE runs and SERVM reliability assessments to surface energy sufficiency issues. If necessary, implement energy sufficiency constraint in RESOLVE.

4. Run all scenarios in RESOLVE using the economic retirement functionality and a model calibrated with appropriate reliability constraints (LCR minimum, energy sufficiency threshold, and 15% PRM)

5. Conduct a SERVM reliability check on key portfolios up for consideration for the Reference System Plan