



# **Technical Workshop #3**

## **Aliso OII I.17-02-002**

### **Overview of Hydraulic Modeling and Simulation 01**



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## Outline of Presentation – Simulation 01 Replication

- 1) 1-in-10 Hydraulic Modeling Cases: Simulation 01 – Simulation 06
- 2) Synergi Software Description
- 3) Simulation 01 Inputs
- 4) Results of Simulation 01
- 5) Conclusions
- 6) Questions and Answers



# Objectives of Presentation – Simulation 01

- 1) Introduce parties to Synergi model and key data used.
- 2) Discuss SoCalGas's (SCG's) Simulation 01 (Winter 2020).
- 3) Present Staff's replication of Simulation 01:
  - A. **Replicate Simulation 01** using data received from SCG and confirm results.
  - B. Perform **sensitivities** using SCG gas pipeline network information and substituting SCG Core and Electric Generation gas use profiles with CPUC-developed Core and Electric Generation gas use profiles.



# 1-in-10 Hydraulic Modeling Cases: Simulation 01 – Simulation 06

| Simulation | Study Year | Season | Weather Conditions           |
|------------|------------|--------|------------------------------|
| 1          | 2020       | Winter | 1-in-10 Reliability Standard |
| 2          | 2020       | Summer | 1-in-10 Summer Peak Day      |
| 3          | 2025       | Winter | 1-in-10 Reliability Standard |
| 4          | 2025       | Summer | 1-in-10 Summer Peak Day      |
| 5          | 2030       | Winter | 1-in-10 Reliability Standard |
| 6          | 2030       | Summer | 1-in-10 Summer Peak Day      |

Source: I.17-02-002 Phase 2: Further Hydraulic Modeling Explanation and Updates, posted May 27, 2020



# Simulation 01 Description

Simulation 01 was designed to create a realistic scenario of:

1. Supply
2. Demand
3. Pipeline infrastructure
4. Storage capabilities

Designed to test how the system would operate without withdrawals from Aliso Canyon on a 1-in-10 winter day.

Based on Scenarios Framework for Investigation 17-02-002 and May 27, 2020 Hydraulic Modeling Clarifications <sup>(a)</sup>.

CPUC replicated Simulation 01 to verify SCG's results and to perform sensitivities using the CPUC Core and Electric Generation profiles.

(a) <https://www.cpuc.ca.gov/AlisoOil/>



# Criteria for Success of Simulations

A hydraulic simulation is considered successful if:

1. The **pressure at all demand nodes is held above the minimum** operating pressure for the duration of the simulation.
2. All facilities must operate within established capacities (i.e. **demand is met and regulators operate within rated capacities**).
3. The **maximum pressure does not exceed the Maximum Operating Pressure (MOP)** at any point or time.
4. **“Linepack” is restored**, i.e. the amount of gas present in the pipeline at the end of the simulation is approximately equal to the amount of gas at the beginning of the simulation which guarantees each operating day does not impose any constraints on future days.
5. **Storage fields** can maintain the required withdrawal (or injection) capacity (mass flow rate).



## Synergi Software Description

- 1) Proprietary hydraulic flow model.
- 2) Enables a 24-hour day simulation.
- 3) Synergi models gas flow with different assumptions for infrastructure, customer demand, gas supply, and pressures.
- 4) Used by natural gas, oil, and water pipeline companies and regulatory agencies worldwide, including SCG and PG&E.
- 5) Website: <https://www.dnvgl.com/software/products/synergi-products.html>







# Types of Synergi Simulations

## Steady State Simulation

- 1) Runs at a single point in time and attempts to balance supplies with demand. If a solution is found, then the model is said to be balanced.
- 2) Controls some nodes for flow and some for pressure (boundary conditions).
- 3) Is the initial state of known flows and pressures to be used in time simulation (initial condition).

## Time Simulation

- 1) Runs in time steps representing a 24-hour period.
- 2) Determines whether the pipeline system has enough pressure and flow to keep running for 24 hours and to end with enough natural gas in the pipelines to be ready for the next day.



## Types of Inputs in Synergi

**Infrastructure:** Simulation 1 includes reduced pressure on Lines 235, 3000 and 4000 in the Northern Zone due to ongoing repairs since October 2017 and does not use Aliso Canyon. Simulation 1 modeled slightly more supply than last winter's actuals.

**Customer Demand and Usage Patterns:** Simulation 1 base case uses SCG's assumptions on hourly usage patterns, and the sensitivities use CPUC's assumptions on hourly usage patterns or profiles.

**Gas Supply (Flow):** Simulation 01 uses supplies from SCG's Summer 2019 Technical Assessment. Gas supply varies by what the receipt points can accept in the Northern, Southern, and Wheeler Ridge zones.



## Simulation 01 by SCG

- Process:
  - SCG completed a Winter 2020 Simulation 01 in Synergi and provided the outputs to the CPUC as part of the Data Request #3 response dated Nov. 22, 2019.
  - Staff replicated Winter 2020 Simulation 01 in Synergi
  - Staff added sensitivities using CPUC Core and EG profiles



# SCG SIMULATION 01 INPUTS DIRECTED BY CPUC

CPUC Directed the Following Inputs:

1. Demand:<sup>(a)</sup> 4,987 MMcfd
  - a) Core: 3,183 MMcfd
  - b) Elect Gen: 922 MMcfd
  - c) Non-Core Non-Elec Gen: 882 MMcfd
  
2. Supplies: 4,256 MMcfd
  - a) Flowing Supplies: 2,926 MMcfd. <sup>(b)</sup>  
Based on 3,295 MMcfd derated to assume pipeline utilization of
    - 85% - Northern and Southern Zones
    - 100% - Wheeler Ridge Zone
  - b) Inventory Withdrawal: 1,330 MMcfd maximum withdrawal rate from Honor Rancho, Playa Del Rey and La Goleta combined based on 90% maximum inventory levels. No use of Aliso Canyon.

(a) [https://www.socalgas.com/regulatory/documents/cgr/2018\\_California\\_Gas\\_Report.pdf](https://www.socalgas.com/regulatory/documents/cgr/2018_California_Gas_Report.pdf) Winter 2020 demand, p. 97

(b)

[https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/News\\_Room/NewsUpdates/2019/SoCalGas%20Summer%202019%20Technical%20Assessment%20040219.pdf](https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/News_Room/NewsUpdates/2019/SoCalGas%20Summer%202019%20Technical%20Assessment%20040219.pdf), p. 3



## SCG SIMULATION 01 INPUTS (CONT.)

3. Outages: Northern Zone capacity of 1,250 MMcfd <sup>(c)</sup> reflects pressure reductions on lines 235, 3000, and 4000. No other pressure reductions or outages. Simulation 1 modeled slightly more supply than last winter's actuals.
4. Hourly Demand Profiles: Winter profiles generated by SoCalGas.
5. Regulators and Compressor stations operate between Minimum Operating Pressures (MinOP) and Maximum Operating Pressures (MOP).

(c) SCG Summer 2019 Technical Assessment, p. 3

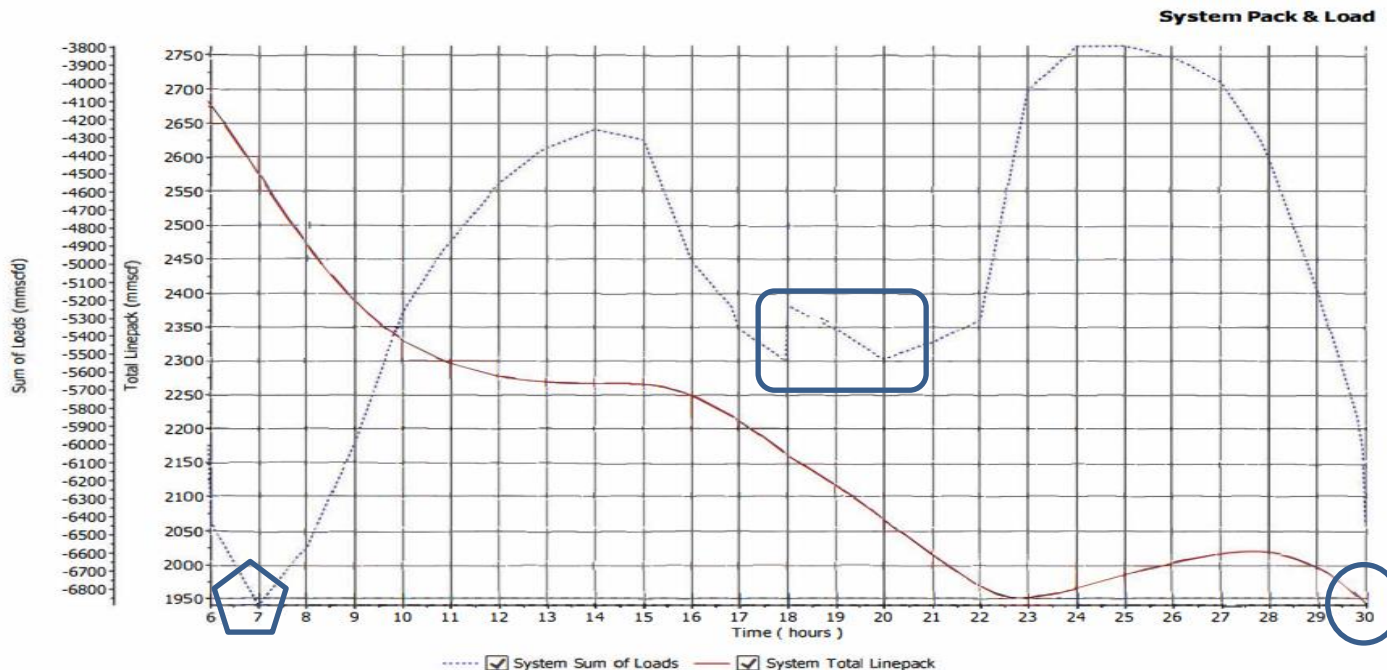


## SCG Simulation 01 - Results

- ❑ Criteria 1 – The pressure at all demand nodes is held above the minimum
  - Pressures at certain nodes fell below minimum operating pressures, indicating a failed simulation.
  
- ❑ Criteria 2 – All facilities must operate within established capacities
  - Demand was not met, indicating a failed simulation.
  - Load of 4,987 MMcfd exceeded supply of 4,256 MMcfd, a difference of 731 MMcfd.
  
- ❑ Criteria 3 – The maximum pressure does not exceed the Maximum Operating Pressure (MOP) at any point or time.
  - MOPs were not exceeded.
  
- ❑ Criteria 4 – Linepack restored
  - Linepack was not restored, indicating a failed simulation, as detailed on next slide.
  
- ❑ Criteria 5 - Storage fields can maintain the required withdrawal (or injection) capacity.
  - Withdrawal rates were maintained, but pressures dropped. Injection capacity was not used in this simulation.

# SCG Simulation 01 - Line Pack Results

- ❑ Criteria 4 – Linepack is not restored, indicating failed simulation.
  - **Red descending line** shows linepack is not restored by hour 30.
  - Dotted line represents customer demand in negative numbers.
  - Peak is at hour 7, consistent with winter morning demand for heating and cooking.
  - Evening peak between hours 18 and 20 (6 to 8 pm). Noncore load decreases at hour 18.
  - Outer left axis represents loads (MMcfd). Inner left axis represents linepack (MMscf).
  - X axis shows 24 hours from 6 am through 6 am the next day, represented by hour 30.





Pause for Questions and Answers





## CPUC Replication of Simulation 01

CPUC staff replicated the Winter 2020 model as follows:

- 1) Started with the Summer 2019 Synergi model provided by SCG.
- 2) Imported the Winter 2020 assumptions for customer demand by node, provided by SCG.
- 3) Entered the gas supply by zone from the Summer 2019 Technical Assessment.



# SCG SIMULATION 01 OPERATIONAL ACTIONS

- 1) Run Steady State analysis. Model indicates whether it is solved and feasible.
- 2) Set receipt point flows from steady state analysis as known flows.
- 3) Run Time Simulation analysis.
- 4) During the Time Simulation, run Synergi from one time step to the next, and change pressures or flows at certain facilities to replicate SCG's operational actions.

## Operational Actions

| Facility Type     | Attribute | Time   |        |      |      |   |   |        |      |    |
|-------------------|-----------|--------|--------|------|------|---|---|--------|------|----|
|                   |           | 0      | 1      | 2    | 3    | 4 | 6 | 18     | 23   | 25 |
| Storage Flow      | Flow      | MMscfd | MMscfd |      |      |   |   | MMscfd |      |    |
| Compressor        | Pressure  | psig   |        | psig |      |   |   |        |      |    |
| Regulator Station | Pressure  | psig   |        |      | psig |   |   |        |      |    |
| Regulator         | Pressure  | psig   |        | psig |      |   |   |        | psig |    |



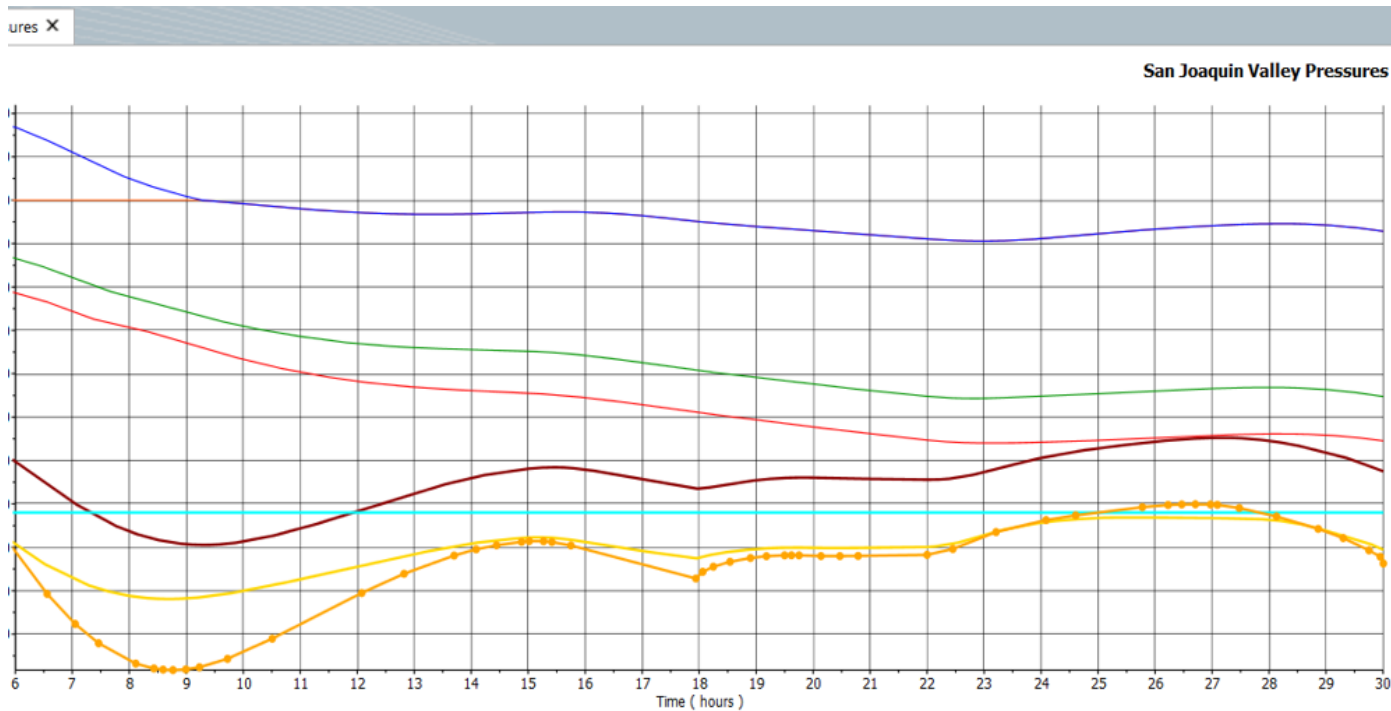
# CPUC Replication of Simulation 01 - Results

- ❑ Criteria 1 – The pressure at all demand nodes is held above the minimum.
  - Pressures fell below minimum operating levels, indicating a failed simulation. Details on next slide.
  
- ❑ Criteria 2 – All facilities must operate within established capacities.
  - Demand was not met, indicating a failed simulation.
  - Load of 4,987 MMcfd exceeded supply of 4,256 MMcfd.
  - Demand exceeded the maximum supply by 731 MMcfd, leading to failed simulation.
  
- ❑ Criteria 3 – The maximum pressure does not exceed the Maximum Operating Pressure (MOP) at any point or time.
  - MOPs were not exceeded.
  
- ❑ Criteria 4 – Linepack is restored.
  - Linepack was not restored, indicating a failed simulation, as detailed on upcoming slide.
  
- ❑ Criteria 5 - Storage fields can maintain the required withdrawal (or injection) capacity.
  - Withdrawal rates were maintained, but pressures dropped, and injection capacity was not used in this simulation.



# CPUC Replication of Simulation 01 – Pressure Results

- ❑ Criteria 1 – Pressures fell below minimum operating levels. Lowest orange line with circles shows pressures falling below minimum operating level at certain node.

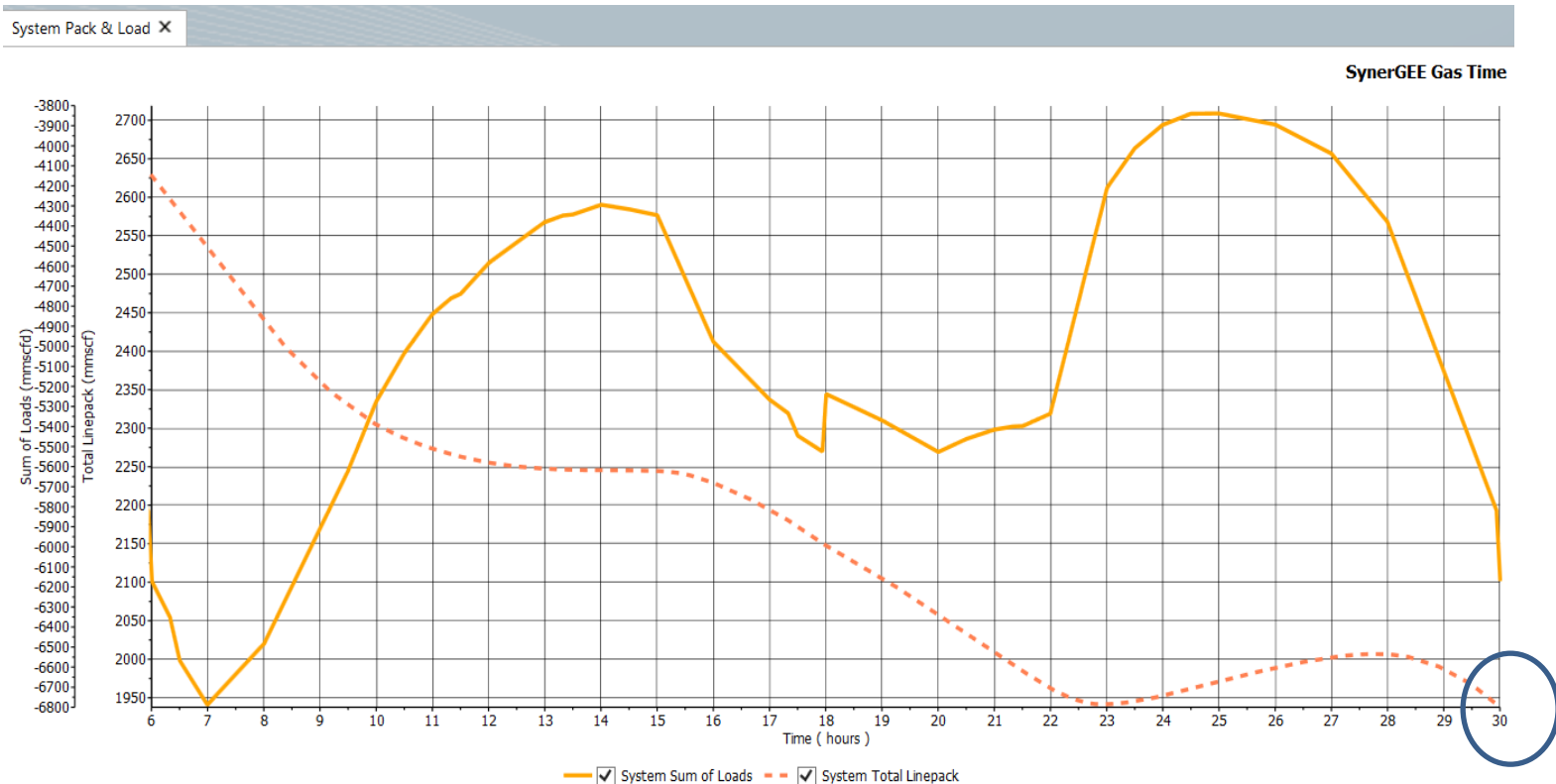


Node names and pressures confidential.



# CPUC Replication of Simulation 01– Linepack Results

**Criteria 4 – Linepack was not restored.** The CPUC’s replication of Simulation 01 resulted in a similarly shaped demand curve as SCG’s simulation and loss of linepack by hour 30.





## CPUC Sensitivities – Core and EG Profiles

- The CPUC added the following sensitivities as outlined in the Scenarios Framework.

### Sensitivity 1

- Used CPUC-created core customer usage profiles based on Advanced Metering Infrastructure (AMI) hourly data.
- CPUC staff derived the core demand shapes because hourly AMI data is not available for peak core demand conditions for a suitable number of historical years.

### Sensitivity 2

- Used CPUC-created Electric Generation (EG) profiles from production cost modeling.
  - CPUC staff used EG profiles that are based on the economically optimal production of electricity.
  - This sensitivity also employed the CPUC's core profiles.
- Details on development of these profiles will be presented separately.
  - Profiles for other customer classes same as in SCG base case.



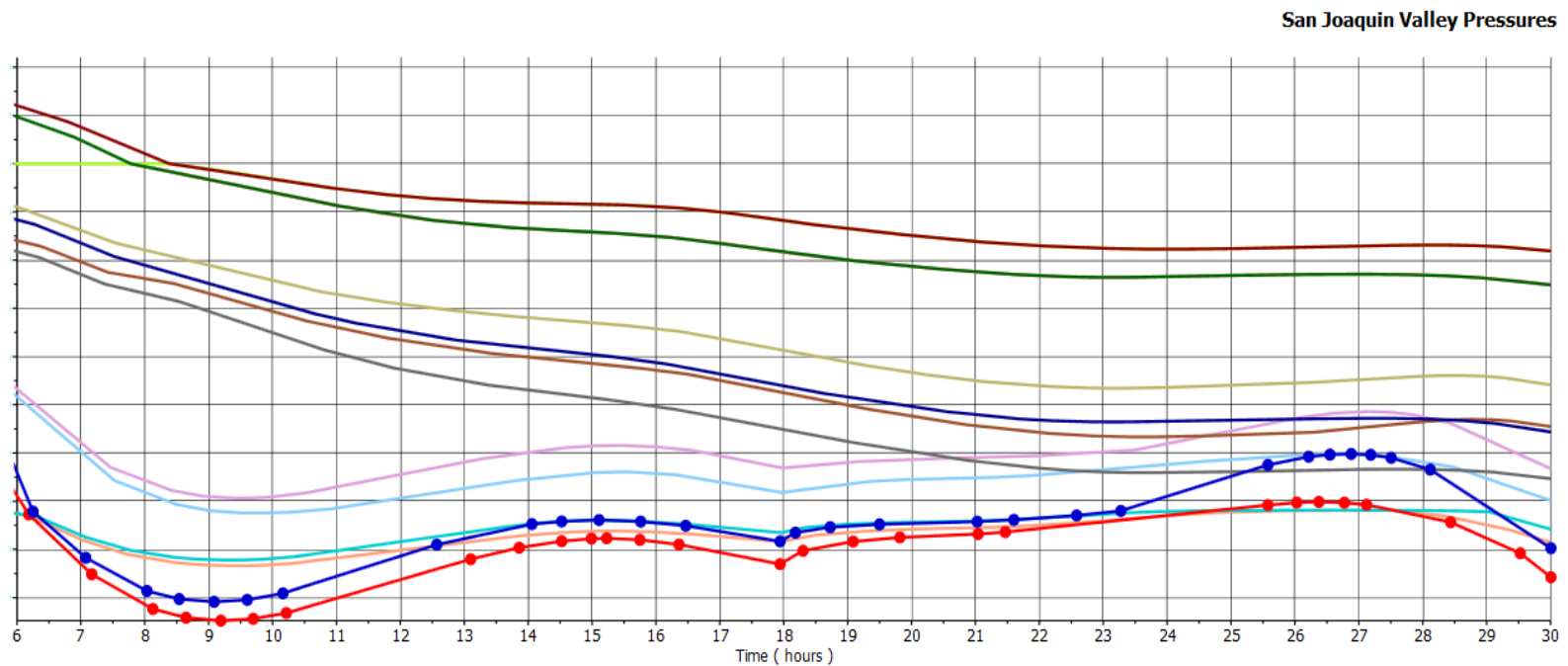
# CPUC Simulation 01 with Sensitivities Results

- ❑ Criteria 1 – The pressure at all demand nodes is held above the minimum.
  - Pressures fell below minimum operating levels, indicating failed simulations. Details on next slide.
  
- ❑ Criteria 2 – All facilities must operate within established capacities
  - Demand was not met, indicating failed simulations.
  - For the Core Profile sensitivity, demand of 4,981 MMcfd exceeded supply of 4,256 MMcfd by 725 MMcfd.
  - For the EG and Core Profile sensitivity, load of 4,871 MMcfd exceeded supply of 4,256 MMcfd by 615 MMcfd.
  
- ❑ Criteria 3 – The maximum pressure does not exceed the Maximum Operating Pressure (MOP).
  - MOPs were not exceeded.
  
- ❑ Criteria 4 – Linepack restored
  - Linepack was not restored, indicating failed simulations, as detailed on upcoming slide.
  
- ❑ Criteria 5 - Storage fields can maintain the required withdrawal (or injection) capacity.
  - Withdrawal rates were maintained, but pressures dropped. Injection capacity was not used in this simulation.



# Simulation 01 with Sensitivities – Pressure Results

- Criteria 1 – Pressures fell below minimum operating levels for sensitivities using CPUC Core and CPUC EG and Core profiles. Lowest lines with circles show pressures falling below MOPs at certain nodes using **CPUC Core profiles (red line)** and **CPUC EG and Core profiles (blue line)**. Includes all customer classes.



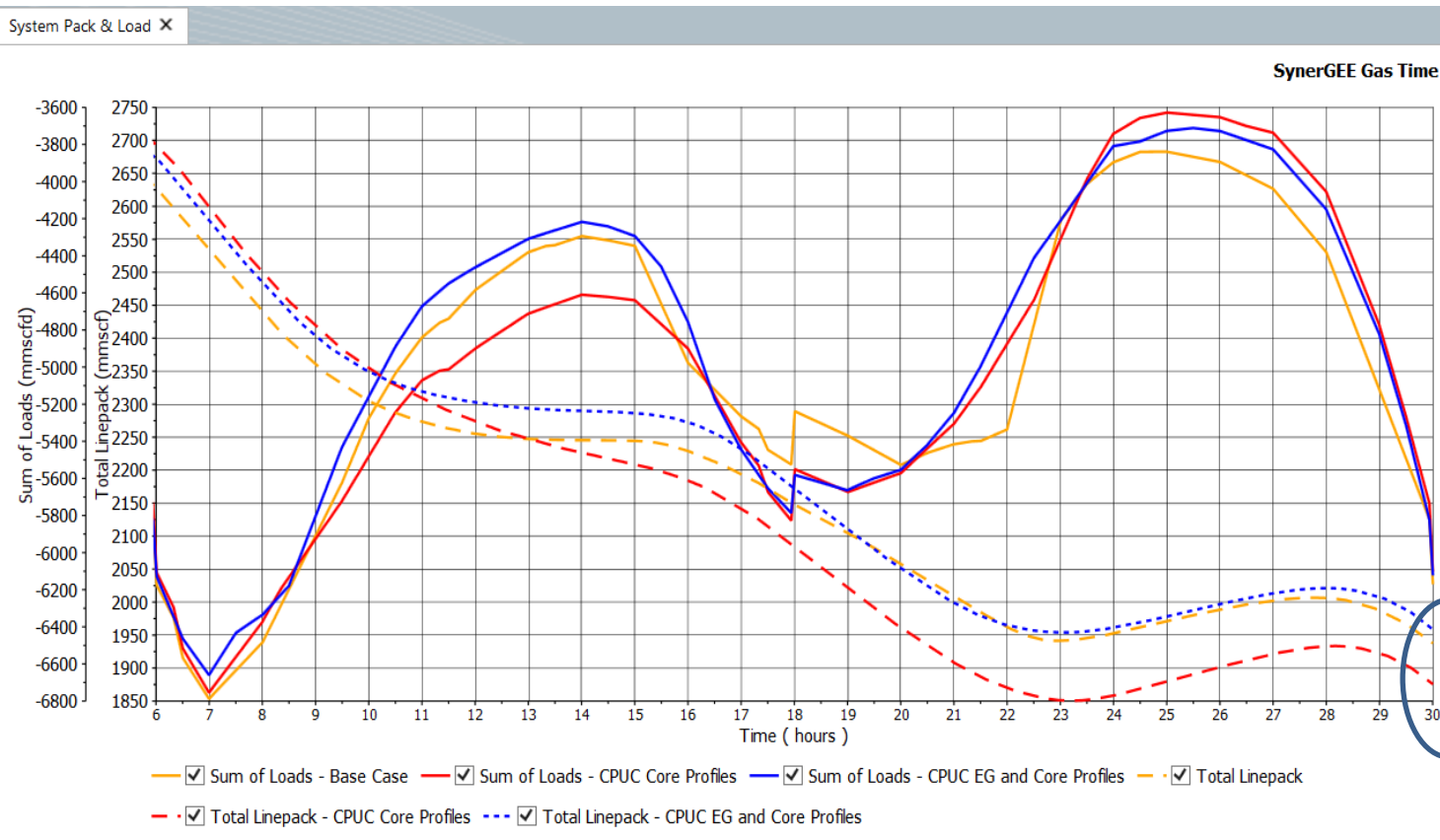
Node names and pressures confidential.





# Simulation 01 with Sensitivities – Linepack Results

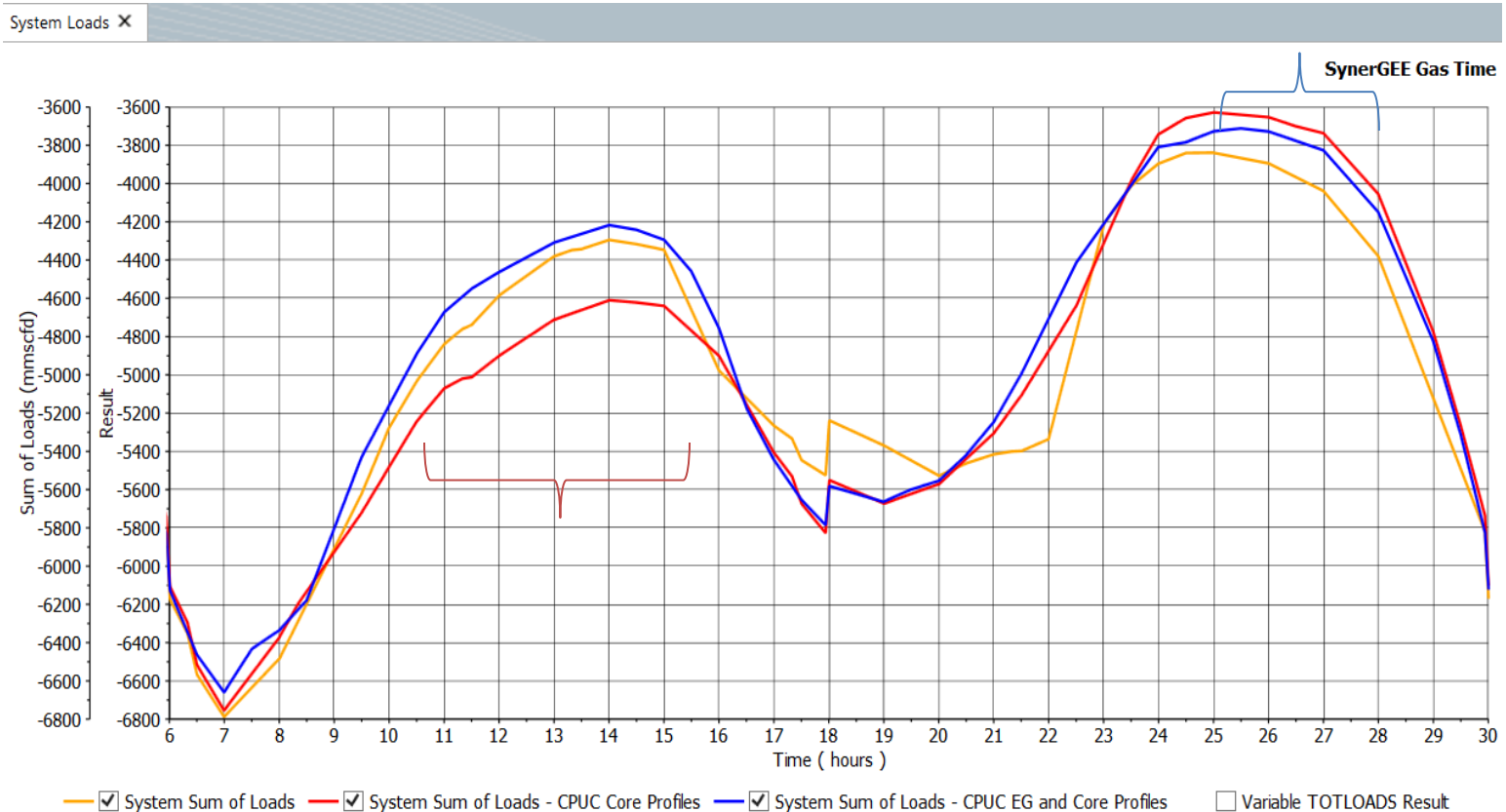
**Criteria 4** – linepack shown in dotted lines was not restored, indicating failed simulation. Loads using **CPUC Core profiles in red** and **CPUC\_EG plus Core profiles in blue** follow similar shapes as the **Base Case in yellow**. Each case includes all customer classes.





# Simulation 01 with Sensitivities - Loads

Loads using CPUC Core profiles in red were higher from hour 10 to 15 than the base case.  
Loads using CPUC\_EG plus Core profiles in blue were lower than base case from 1 to 4 am.





## Conclusions

1. Simulation 01 based on parameters from the CPUC and completed by SCG was a **failed simulation**.
  - a. Pressures fell below minimum operating levels
  - b. Demand was not met.
  - c. Linepack was not restored.
  - d. An additional 731 MMcfd of supply would be needed to meet the winter demand on this 1-in-10 day.



## Conclusions (cont.)

2. The CPUC **replicated** SCG's results for Winter 2020 Simulation-01 with similar results.
3. The **CPUC core profiles** sensitivity, based on AMI data, did not change the results significantly.
4. The **CPUC Electric Generation** sensitivity, based on production cost modeling data plus the core profiles, did not change the results significantly.



# Thank You



## Questions and Answers