Hydraulic Flow and Transient Stability Modeling

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Agenda

- Goals for today – big picture - why are we doing this?

- Dynamics of Hydraulic Flow Modeling

- Interaction of Hydraulic Flow Model and Production Cost Model

- Hydraulic Flow Inputs and Scenarios

Who am I?

- Donald Brooks
  - Proud California native (from San Bernardino County)
  - Very aware of the impact of pollution on quality of life
  - Supervisor of Energy Resource Modeling team.
  - Coordinate multiple modeling and software platforms, for a variety of proceedings.
  - Attempt to be factual and impartial. We have not made any decisions yet, that is why we are modeling.
  - Seeking input at this point.

Power sector modeling taxonomy

Aside from the basic data tools that are commonly used such as Excel, access, and online databases, there are a host of advanced data tools used in energy system analysis.

1. Hydraulic Flow Models

2. Production Cost (Unit Commitment & Dispatch) Models

3. Network Reliability ("power flow") Models

Increasing spatial and temporal granularity

Requires expert modeler – to manage inputs, run the model, and interpret outputs.

Some models have more temporal (time) granularity and some have more spatial granularity – tradeoff depending on your objectives in modeling.

Hydraulic Flow Models

- Hydraulic flow models simulate flow of water (or natural gas) through a network of pipelines that connect receipt and injection points. Key metrics are speed and pressure of flow.

- Key output: Operating Pressure in all pipelines, receipt points, and delivery points. Objective – to maintain pressure at all points between minimum and maximum allowable operating pressure.

- Examples: Synergi-Gas, WinTran

Production Cost Models

- Simulate detailed economic commitment and dispatch of generating units to meet load and reserves, usually hourly time steps for a study year, given fixed portfolio and assumptions about the future

- Key output: operating cost and emissions, patterns of system conditions over all hours of year

- Examples: PLEXOS, SERVM, GridView

Network Reliability ("power flow") Models

- Simulate detailed static and dynamic physical behavior of grid over short time periods (e.g. 30 seconds)

- Key output: assessment of transmission system function under plausible stress conditions (will the system remain stable after sudden disturbances – large generator outage, lightning strike?)

- Examples: Positive Sequence Load Flow (PSLF), Power System Simulator for Engineering (PSSE)

Key Dynamics of Hydraulic Flow Modeling

- Model simulates flows over a pipeline network for 30 consecutive hours (6 hours before start of day to initialize, then 24 hours of a day).

- Line pack (operating pressure on pipelines in the network) must return to the same level it was at the beginning of the simulation. Reliable operation planning depends on each day not being impacted by the previous day or impacting the data after.

- Gas delivery is split between core and non-core.
  - Core – residential and commercial priority users
  - Non-core – electric generators, some large industrial customers
  - Peak usage of gas is not the peak electric generation periods – electric demand peaks in summer but gas usage peaks in winter.

Dynamics of Hydraulic Flow Modeling

Typical Gas Well Location

West Compressor Station

East Compressor Station
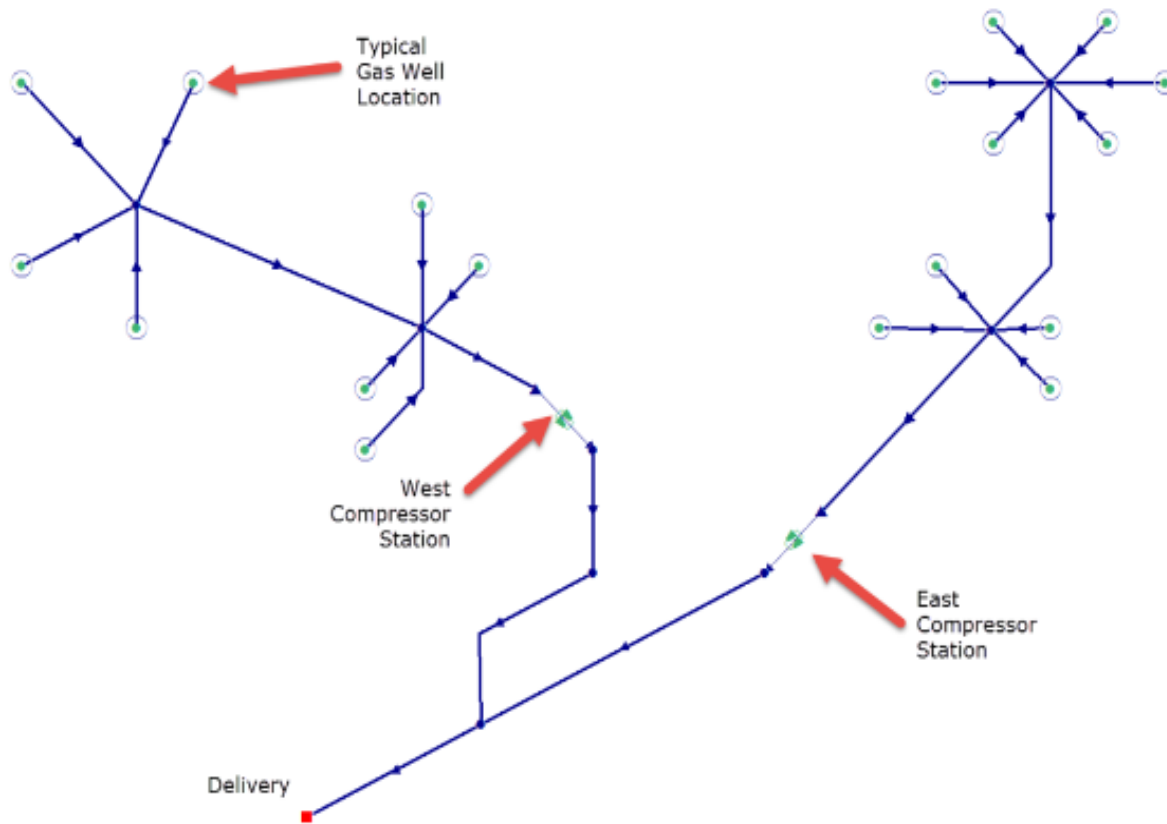
Delivery

This sample graphic is to illustrate the dynamics of how a gas system would be simulated.

- Each element of the gas transmission system impacts the function of the gas system
- Each element (delivery, receipt, pipelines, compressor stations) are simulated individually.
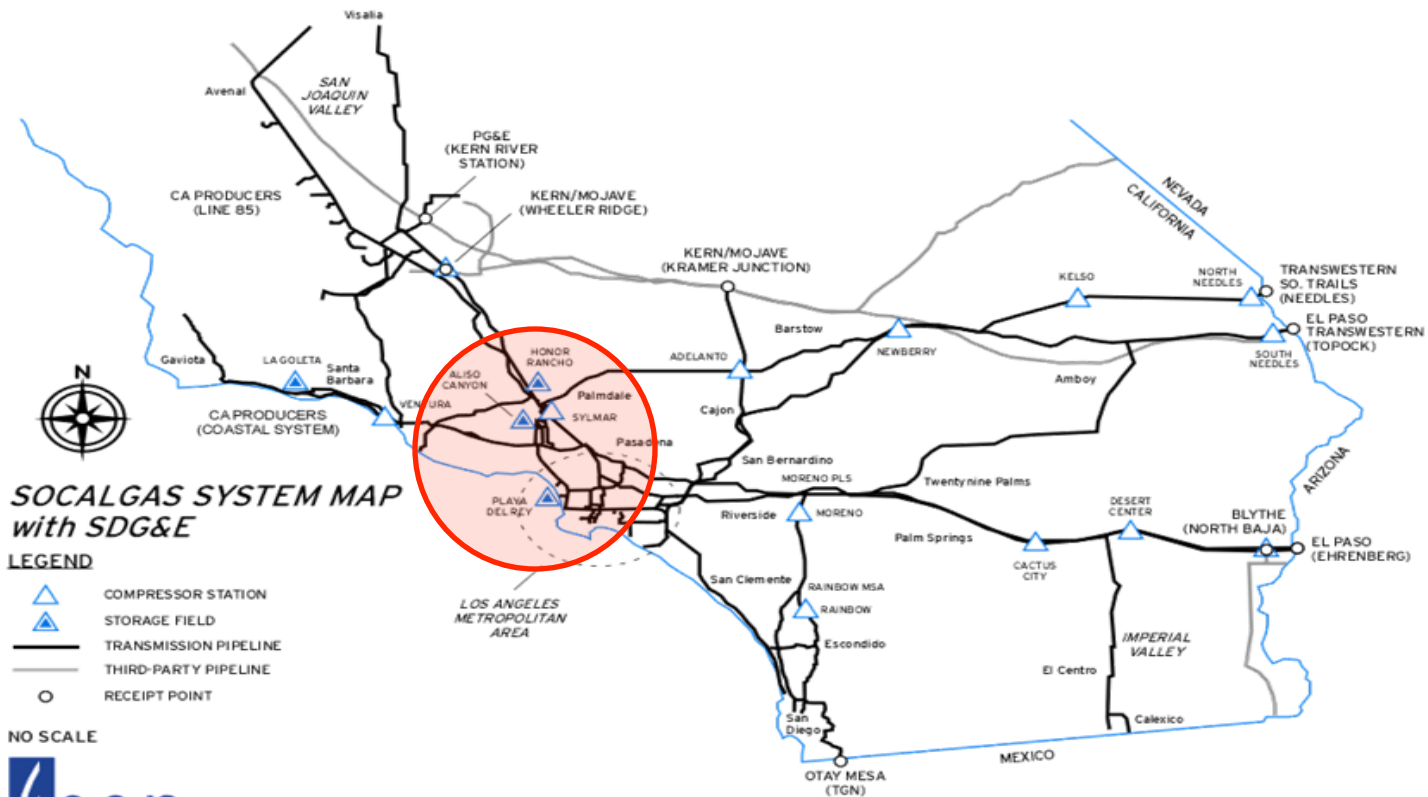- This model is very granular in location.

This graphic is taken from the DNV-GL website, linked here:
http://blogs.dnvgl.com/software/2015/11/synergi-gas-and-the-calibrate-feature/

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Geography of Affected System

SOCALGAS SYSTEM MAP with SDG&E

LEGEND

△ COMPRESSOR STATION
▲ STORAGE FIELD
— TRANSMISSION PIPELINE
— THIRD-PARTY PIPELINE
○ RECEIPT POINT

NO SCALE

SoCalGas
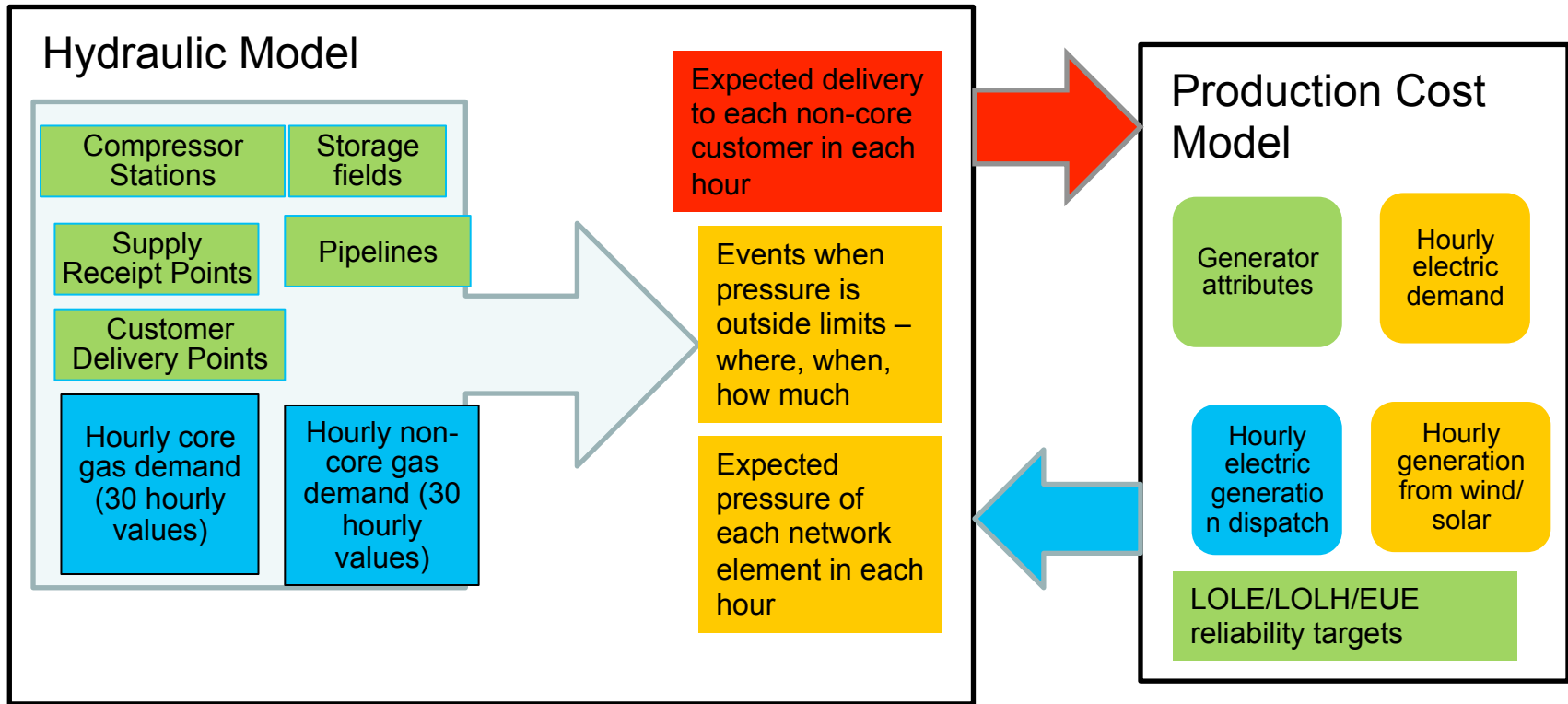A Sempra Energy utility

Jun 2015

Hydraulic Flow Model Inputs

- ## Inputs needed for the model:

- Modeling three types of day – 1 in10 Winter Peak, 1 in 35 extreme winter peak, and summer "average". Each day is 30 hours of continuous gas flow

- Each day includes

  - Core gas use by hour (residential and commercial gas customer use)

  - Core gas use hourly profiles are aggregated by zip code

  - A few large core customers are entered individually

  - Non-core gas use by hour (gas needed to support electric generation)

  - Each electric generator is entered individually and the profile of gas use is based on hourly electric generation

- System topology – pipeline capacities, compressor stations, location of each receipt point and delivery point in the system, location of pipeline interconnections

  - Items in blue above represent inputs flowing from Production Cost Model to Hydraulic Model

  - Items in red above represent inputs flowing from Hydraulic Model to Production Cost Model

  - Other inputs above are taken from a data request submitted to SoCalGas

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Interaction of Hydraulic Flow and Production Cost

Hydraulic Model

| Compressor Stations | Storage fields |

| Supply Receipt Points | Pipelines |

Customer Delivery Points

| Hourly core gas demand (30 hourly values) | Hourly non-core gas demand (30 hourly values) |

Expected delivery to each non-core customer in each hour

Events when pressure is outside limits – where, when, how much

Expected pressure of each network element in each hour

Production Cost Model

| Generator attributes | Hourly electric demand |

| Hourly electric generation dispatch | Hourly generation from wind/ solar |

LOLE/LOLH/EUE reliability targets

Hourly Inputs
Static inputs
Inputs from Production Cost
Inputs from Hydraulic Model

Model interaction is iterative – how much gas can be delivered reliably? How much electric generation from the affected plants is needed to minimize reliability risk?

Hourly electric gen is transformed to hourly gas use for each plant

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Pause for questions

Choosing Assumptions

- Goal:
  - To the extent possible, use forecasts that have been published and vetted

- Challenge:
  - We are in a time of flux
  - Updates to standard forecasts such as the California Gas Report (CGR) due in 2018

Hydraulic Model Scenarios

- Model in the near (2018), medium (2022), and long term (2027).

- Model at three Aliso inventory levels: 0, 715 report maximum, and iterate to minimum necessary.

- Model peak days based on the Winter Peak Day Demand and the Summer High Sendout Day Demand forecasts from the California Gas Report

Hydraulic Model Assumptions

- Forecast post-2022 demand using 0.6% expected annual rate of decline.

- 85% receipt point utilization

- Tubing-only flow from non-Aliso fields

Trends from the Comments

- Modeling dates:
  - 2019 instead of 2018
  - April-March: 2020, 2025, 2030
  - Annual
  - Model spring to capture highest ramp
  - Eliminate summer scenarios

Trends from the Comments (cont.)

- Process for determining minimum Aliso inventory level:
  - Model with Aliso at Maximum Allowable Operating Pressure (MAOP)
- Peak days vs. Historical Days
  - Most favored peak days
  - Several suggested modeling historical days to validate the model

Trends from the Comments (cont.)

- Using California Gas Report: Winter
  - Composite Winter Peak Day Demand should not be used
    - Use 1-in10 cold day and 1-in-35 cold day core-only forecasts
  - Use EG demand of 96 MMcfd from 2017 Technical Assessment
  - Include potential increases in demand response

Trends from the Comments (cont.)

- Is a 0.6% annual demand forecast decline for post-2022 years reasonable?
  - Decline will be faster because of demand response, energy efficiency, etc.
  - While average demand will decline, peak hour demand may increase due to the need to compensate for renewables.

Trends from the Comments (cont.)

- 85% receipt point utilization
  - Suggestions ranged from 60%-95%
  - Use actual in-state production rather than the posted in-state capacity

- Tubing-only flow
  - Unanimous agreement

Requested Clarification

- Clarify:
  - What constitutes a "significant impact" on reliability
  - Assumed inventory and withdrawal capacity of non-Aliso fields
  - Peaking factor to be used to forecast hourly demand
  - Assumptions about core's ability to replenish storage to maintain adequate inventory

Suggestions from the Comments

- Model non-status quo scenarios
- Require 5% daily balancing
- Assume core must balance to actuals
- Model 1-in-50 peak event
- Model four-day peak event
- Use CEC energy efficiency targets to be released 11/1/17

Questions

1. Are the proposed modeling dates reasonable?

2. Is the proposed process for determining the minimum Aliso inventory level reasonable?

3. Is the California Gas Report the appropriate source for gas demand forecasts?

Questions

4. Is it reasonable to estimate 2027 demand by reducing 2022 forecasts by 0.6% per year?

   a. Would additional mitigation measures result in more rapid decreases in demand?

   b. If so, what would be an appropriate way of forecasting gas demand in the long term?

Questions

5. Should historical gas days be modeled?

6. Is 85% gas receipt point utilization a reasonable scenario?

7. Is it reasonable to assume tubing-only flow?

8. What else should be considered?

Thank you!
For Additional Information:

www.cpuc.ca.gov
www.GoSolarCalifornia.ca.gov
www.CalPhoneInfo.com