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DECARBONIZATION PLANNING RESEARCH AND ANALYTICS

CEC 2021 IEPR: R&D and Gas Infrastructure Planning

May 20, 2021

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SoCalGas | ASPIRE 2045

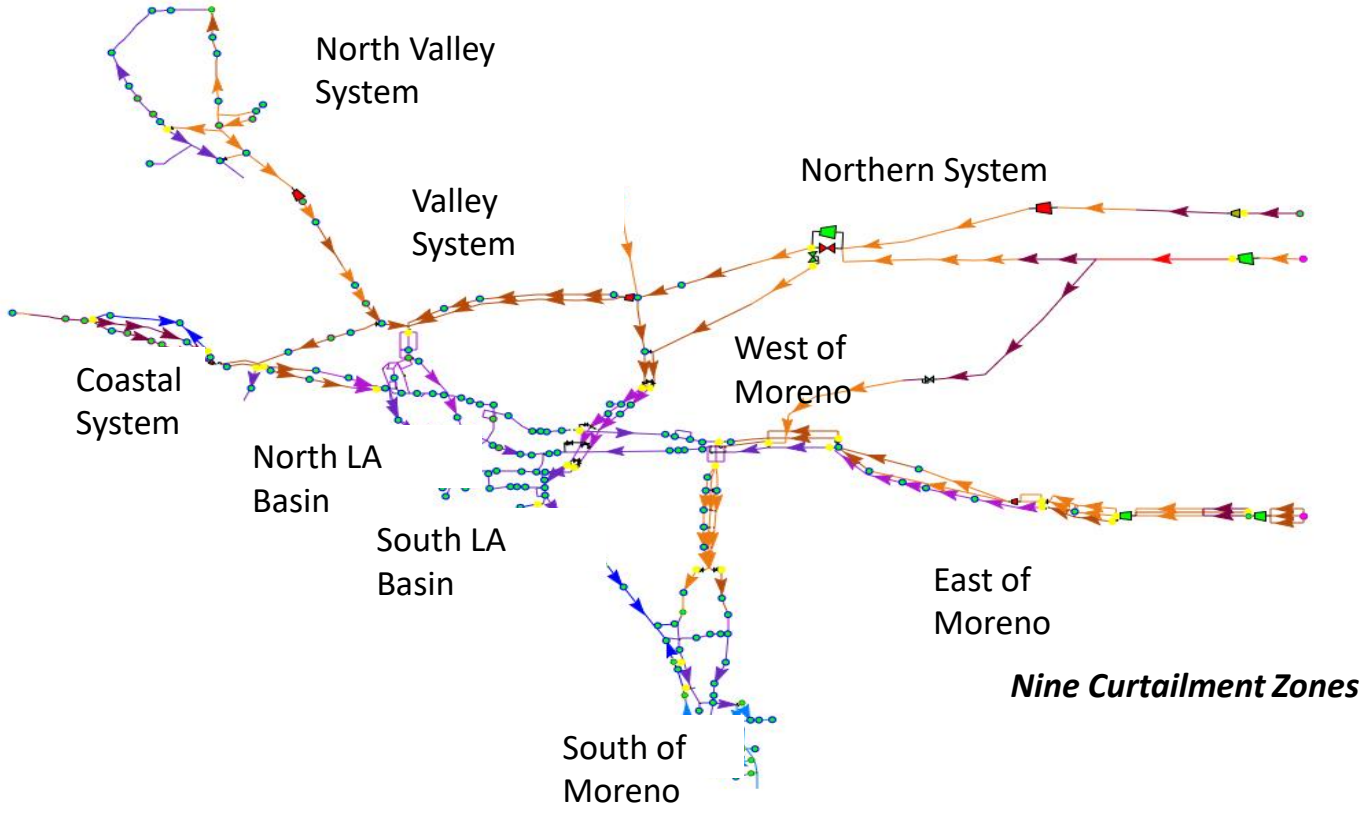
Commitment to be net zero emissions in our operations and delivery of energy by 2045

SoCalGas ASPIRE. https://www.socalgas.com/sites/default/files/2021-03/SoCalGas_Climate_Commitment.pdf

Integrated Forward-looking Model | Based on SoCal Gas Hydraulic Model

Planning tool provides granular view on system need and impact

- Models all interstate interconnects, segments, compressors, and storage fields
- Incorporates hourly core, industrial and power generation loads
- Evaluates potential curtailment by zone



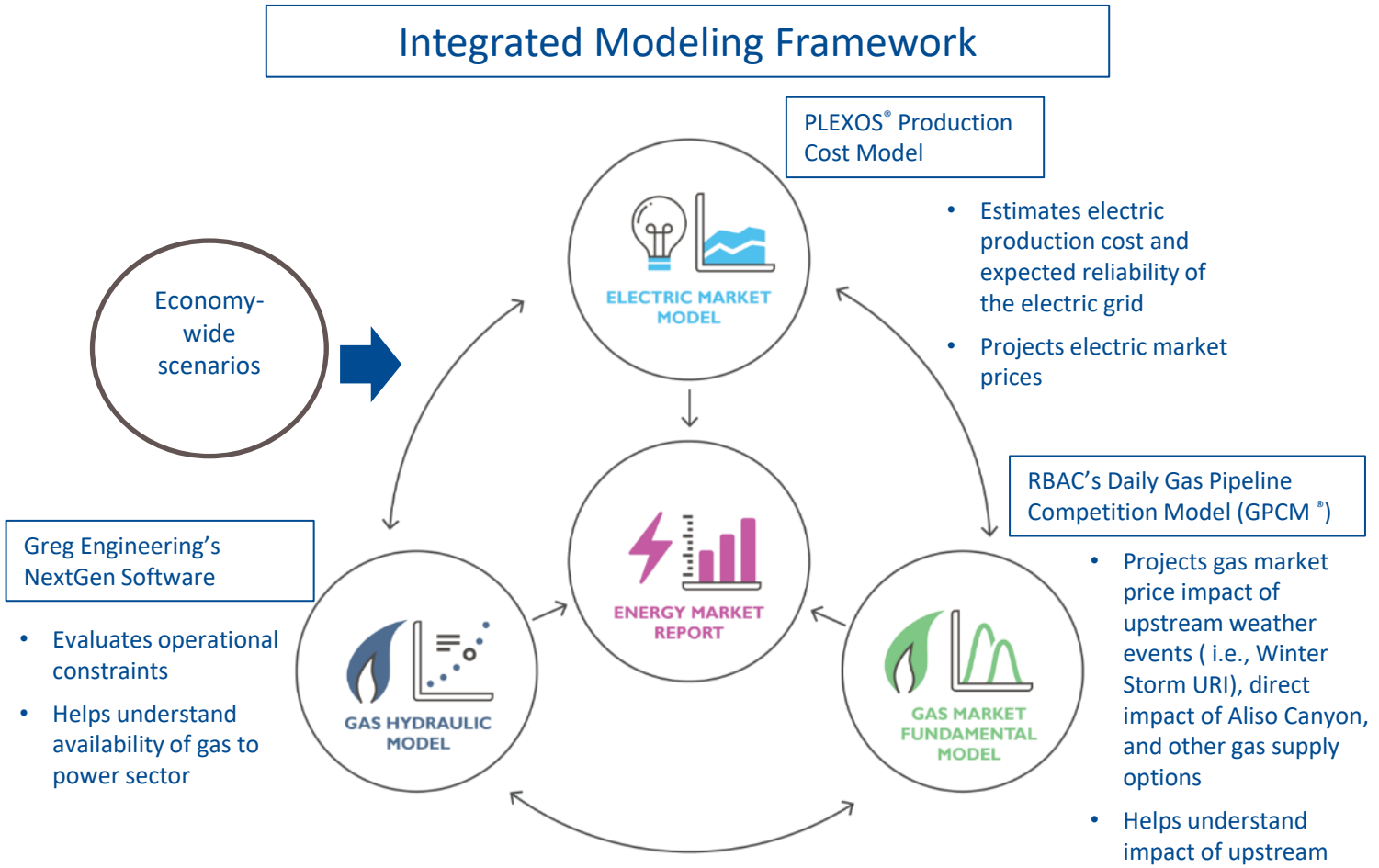
Nine Curtailment Zones

Gas System Planning OIR | Planning Framework

Track 2 will integrate decarbonization analysis into system planning to inform policy and infrastructure investment decisions

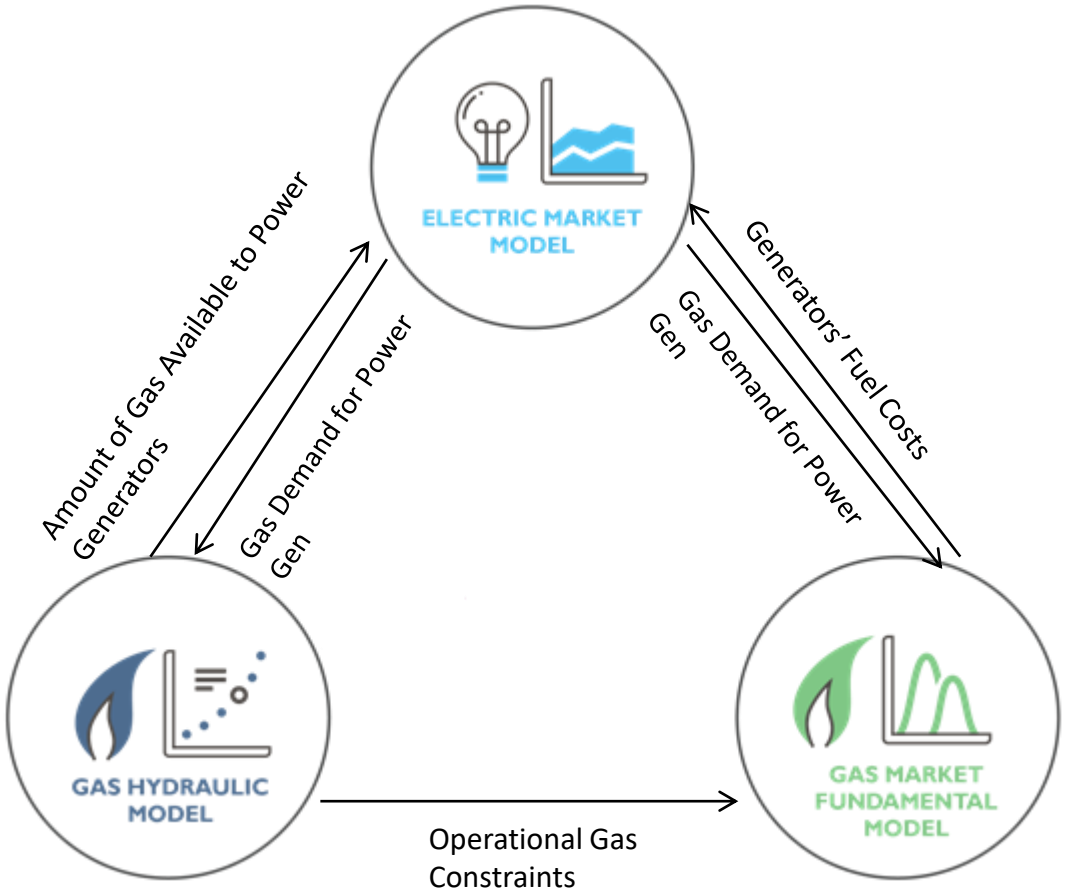
- In advancing potential 2045 scenarios, the trajectory for meeting the state's climate targets must be examined with a greater level of granularity to be of value to the planning process

- The SoCalGas Integrated Model will take a more granular look into the SoCalGas system evaluating the demand assumptions and supply outputs of the broader decarbonization models:
  - Analyze projections around EG ramps and electrification on gas systems
  - Analyze existing decarbonization demand scenarios
  - Analyze potential changes to gas composition and the potential impact of hydrogen blending on system reliability
  - Examine dedicating transmission segments for clean fuel delivery



Planning Framework | Infrastructure Planning

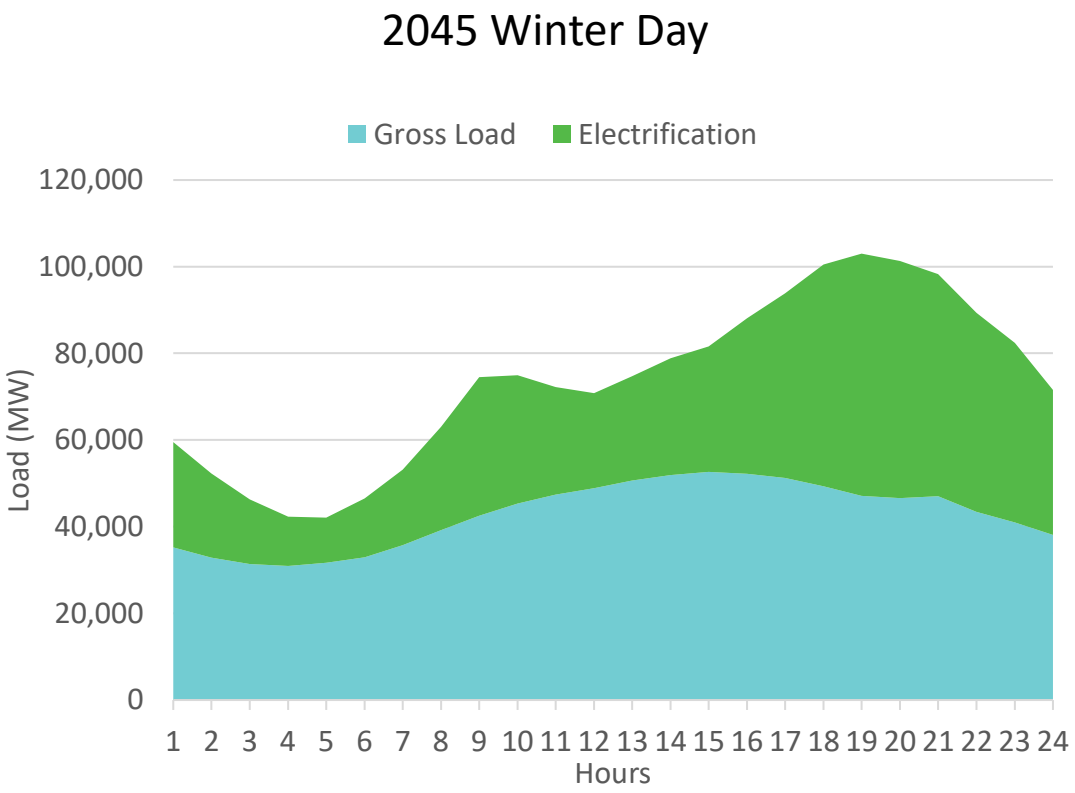
Interactive planning tool to assess and highlight key interdependencies of gas and electric market



- This Gas System Planning tool can examine the key interactions of gas and electric markets on:
  - Peak Winter and Summer Day
  - Monthly and Annual Average Day
  - Examines how Core, Non-Core, and EG will use the SoCal System in the future
  - Project the electric and gas market price impacts that can inform public policy decisions on decarbonization, and building electrification
  - Examines future system reliability needs, potential unexpected outages and future system risks

Public Policy Goals and Implications | Planning Analytics

Assessing the impacts of demand side electrification and varying flexible demand on gas system

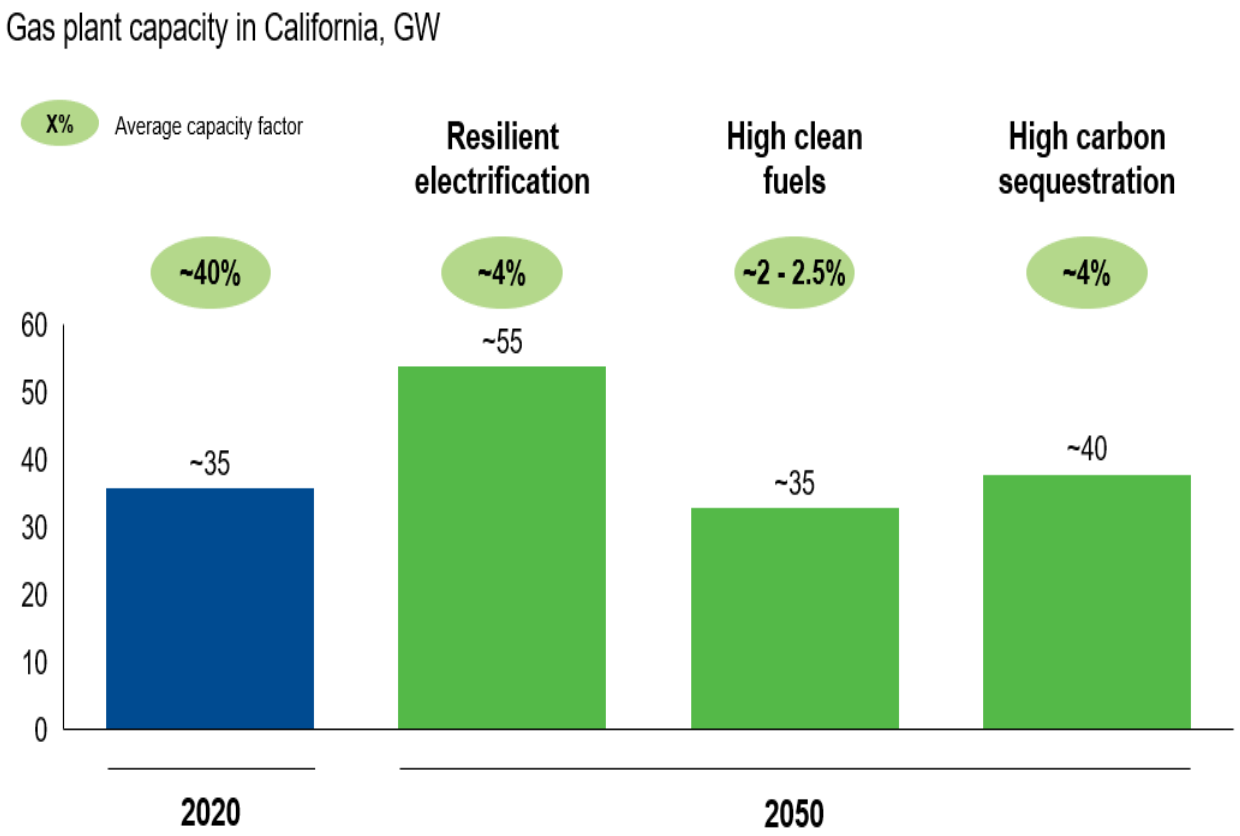


- Building Electrification and EV Charging can add incremental electric load during the early morning and afternoon ramp
  - Space heating and water heating usage typically occur in the early morning and late afternoon hours
  - EV charging patterns will continue to evolve, and residential charging can start once the cars are plugged in at home
- Natural Gas and/or Clean Fuel dispatchable generation will be needed to support the potential peak hour and ramping needs during the morning and late afternoon periods if renewable resources and energy storage is unavailable or insufficient

Preliminary Analysis | Electric Resiliency

The need for thermal generation capacity grows to meet increasingly larger swings and peaks to maintain electric system reliability under higher renewable penetration

- Modeling projects that across scenarios a minimum of ~35 GW of incremental gas capacity is expected in 2050 to provide system reliability.
- More thermal generation capacity is needed in higher electrification cases and corresponds to need for more sustained peaking capacity.
- While capacity factors remain low, capacity needs increase. Clean fuels and CCS enable the electric grid to rely on the operational characteristics of EGs with clean profile



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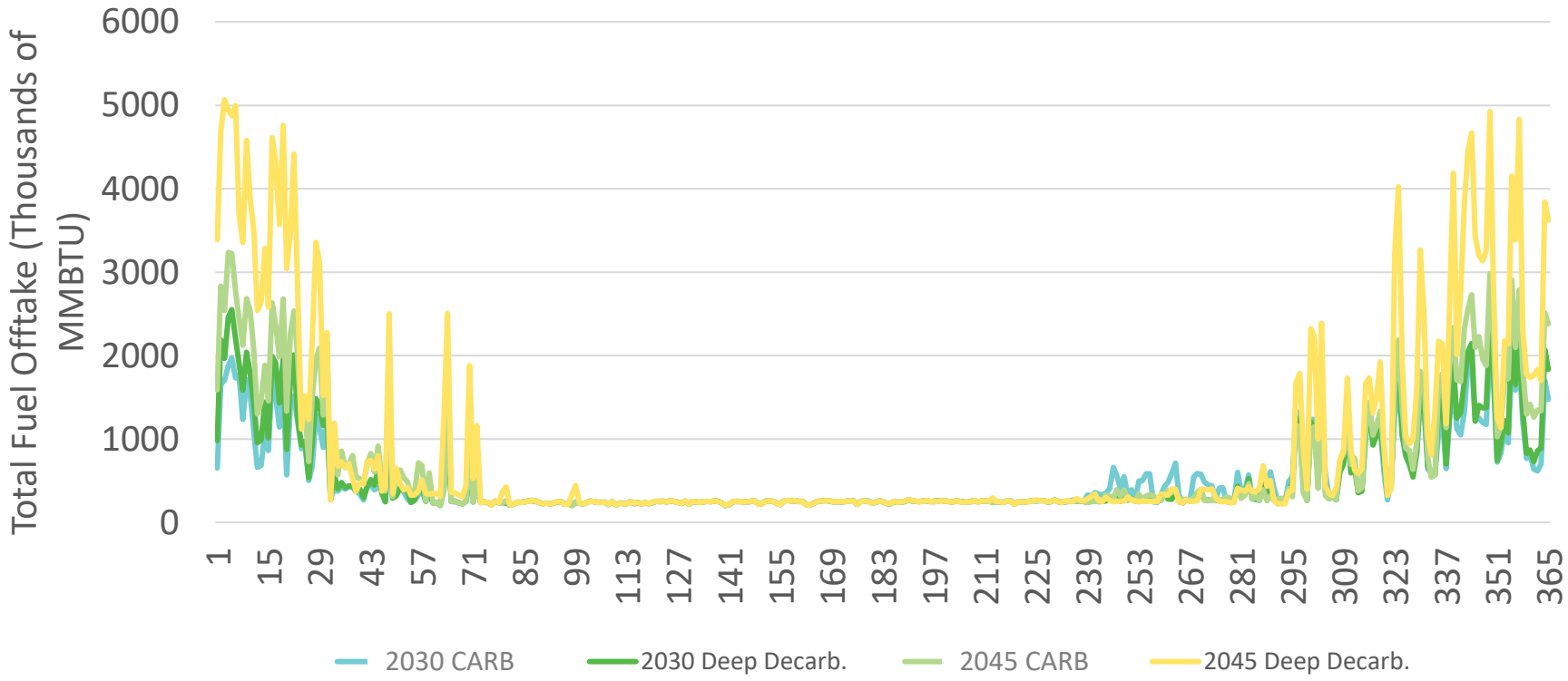
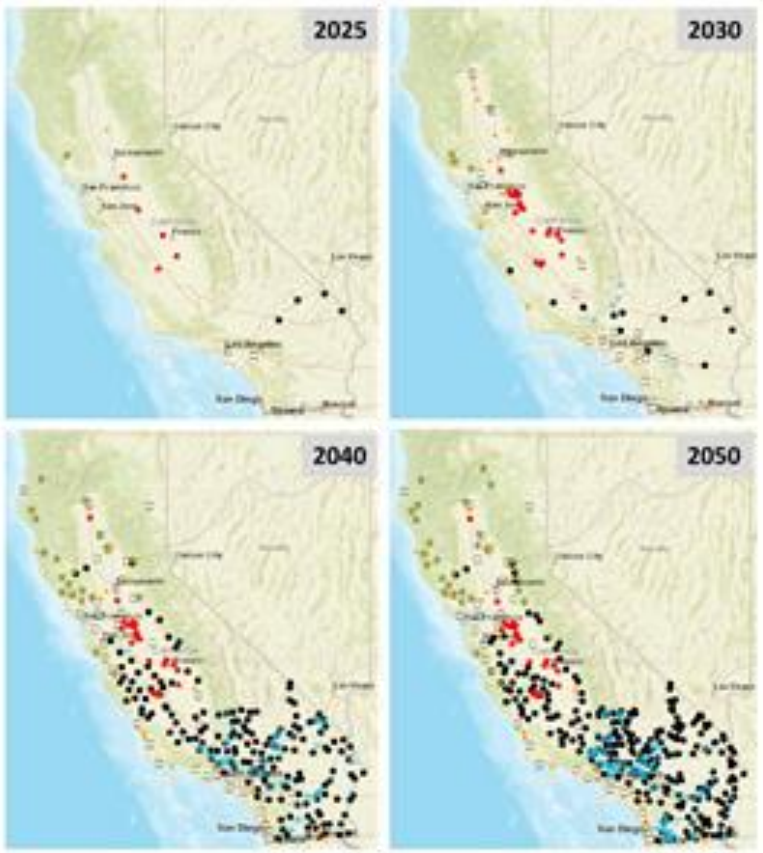
Resiliency | Daily EG Gas Burn Under Various Decarbonization Scenarios

Decarbonization analysis demonstrate increasing need for resilient gas grid



Gas Transformation Study (w/UCI) | Clean Fuels Dedicated H2 Transmission System Assessment



Technology Count by Year	2025	2030	2040	2050
Electrolyzer Solar	4	13	169	265
Electrolyzer Wind	1	6	72	113
Thermochemical	1	5	20	30
Dairy	5	24	28	28
Organic MSW	3	19	21	21
SMR	2	21	51	51

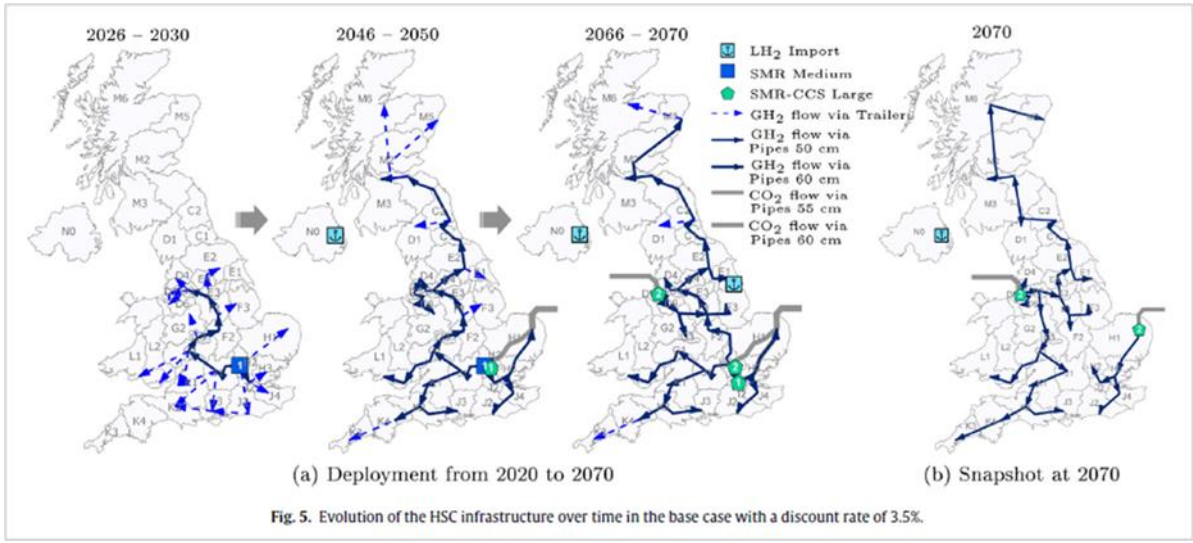
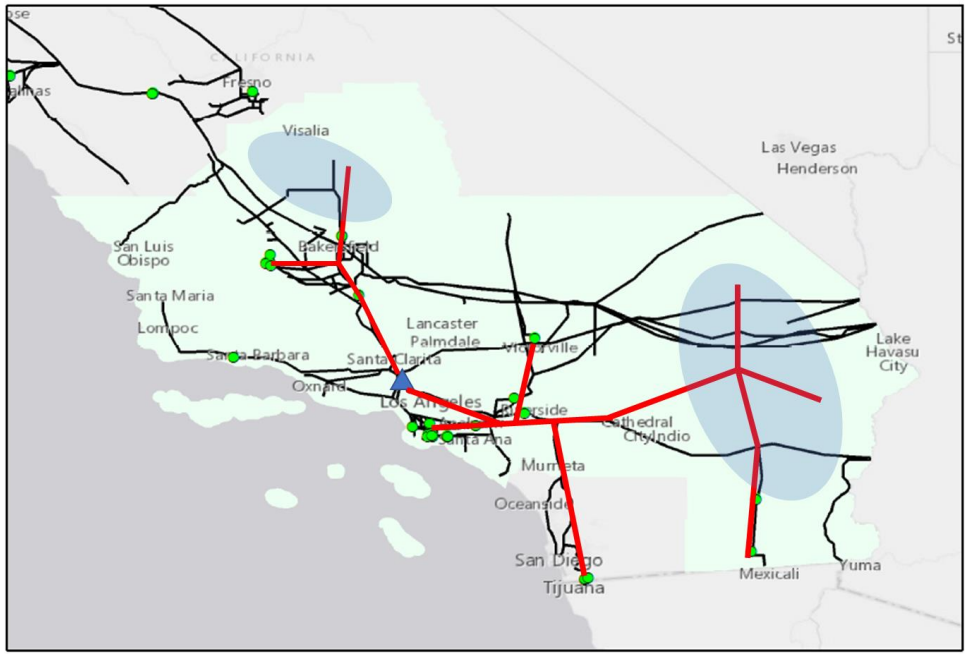


Fig. 5. Evolution of the HSC infrastructure over time in the base case with a discount rate of 3.5%.



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Gas System Research | Strategic Electrification

Back cast decarbonization studies project high levels of building electrification; implementation cost, feasibility and practicability are the subject of more recent research (with CEC)

- An examination of the feasibility and potential cost considerations around strategic electrification is needed, both near term considerations in developing a building electrification cost curves as well as future end state uses of the system that may be optimized to best support resiliency goals

- A deeper analysis of the SoCalGas system will be undertaken, factoring in topography, diversity of end uses, population density, wildfire risk and industrial customer demand to provide clarity on where electrification is cost effective and feasible, and where the fuels network will continue to be relied upon (with clean molecules) to provide critical resiliency (CEC pilot with RAND and GTI)

- Anticipate results from this effort to provide an important feedback loop into the system planning process and corresponding infrastructure needs

Ongoing Research Effort with CEC | Strategic Electrification and Decommissioning

Relationship between Electrification and Decommissioning

Factor	Bias towards maintaining gas infrastructure	Bias towards full electrification with gas decommissioning	Rationale
Current High or Very High wildfire risk, in non-urban areas	✓		Resiliency benefits; underground electrification still an option for urban areas in significant wildfire risk zones
Industrial customers	✓		Electrification not viable for many industrial applications due to high thermal requirements
Population density	High	Low	Higher total customer costs and complications associated with fuel-switching due to higher number of end-uses
Average pipeline replacement costs	High	Low	High replacement costs are indicative of higher decommissioning costs
Future wildfire risk	Very High	Low	Gas system provides resiliency benefits through dual-fuel system, with gas remaining on even when electricity is off
Electric capacity	Low	High	Low capacity relative to peak load increases likelihood that T&D upgrades will be required for full electrification
Topography complexity	High (mountainous)	Low (flat)	More complex terrain may increase costs to build up electric T&D capacity and to decommission pipelines
Diversity of end-uses	High	Low	May lead to more complications associated with fuel-switching due to wider range of appliance/equipment and building types to convert
Fraction of small-diameter pipe	Low	High	More expensive to remove large-diameter pipelines, making decommissioning more expensive
Pipeline O&M costs	Low	High	High cost to maintain pipelines – more cost effective to take out of service

☐ Factors weighted most heavily due to (1) customer vulnerability, and (2) relative magnitude of impact on cost

Contact Information | Strategic Business Transformation Workstream

» **N. Jonathan Peress**

Senior Director, SoCal Gas Business Strategy & Energy Policy

NPeress@socalgas.com

» **Despina Niehaus**

Director, Strategic Planning

DNiehaus@socalgas.com