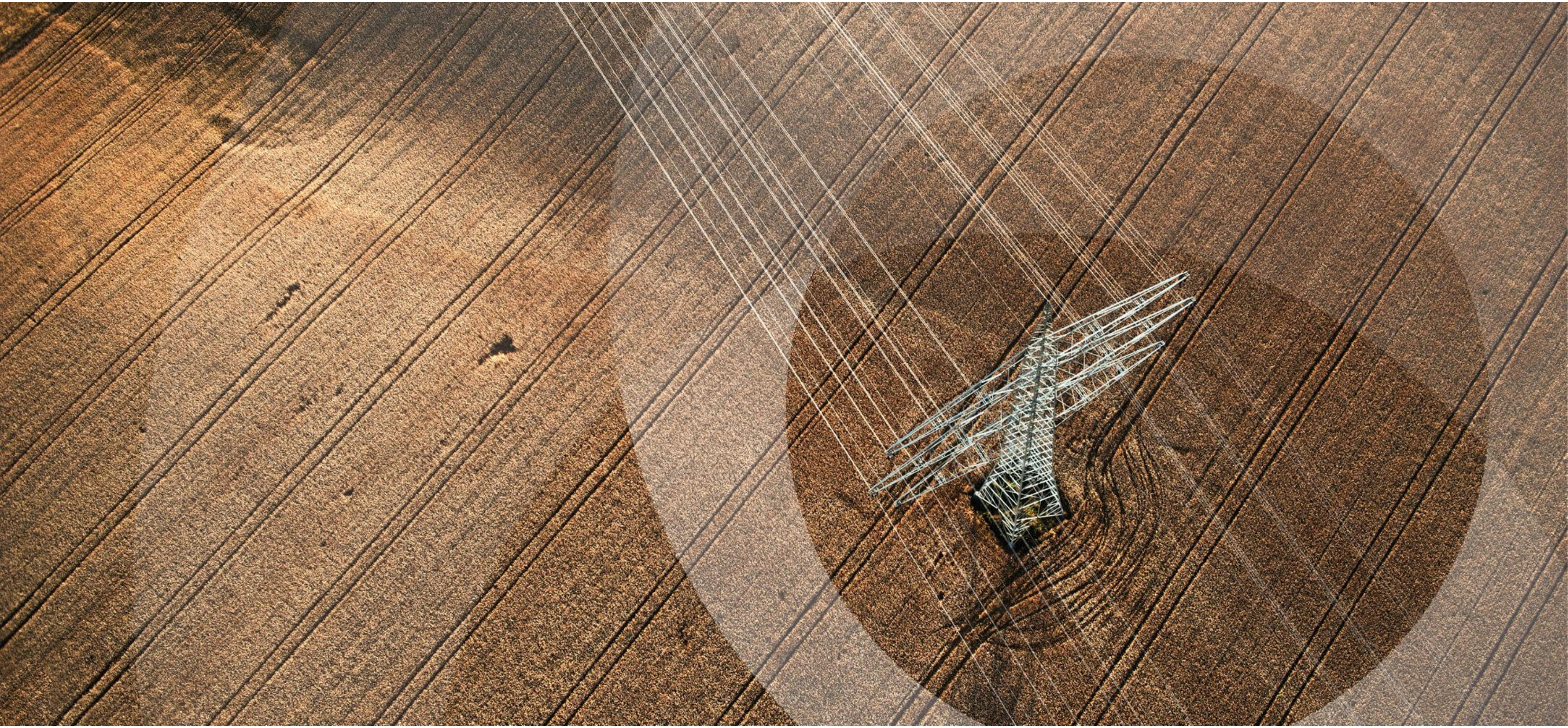
# Gas – Renewables Integration Risks & Solutions

## 2020 GAS/ELECTRIC PARTNERSHIP CONFERENCE

**February 5, 2020**



# Agenda

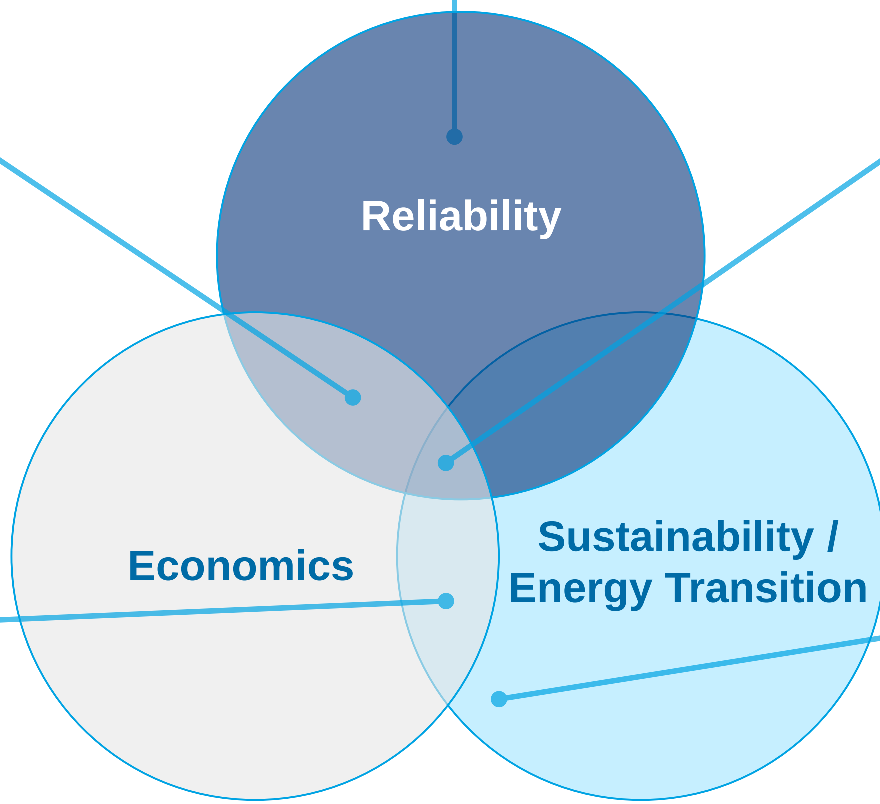
**Drivers of Gas-Renewables Integration & The Resilience of Gas**

Integration Risks & Mitigation:  WECC Gas-Electric Interface Study

The Path Forward

# Gas-electric integration challenges have traditionally been driven by economics and reliability, but sustainability is increasingly important

- Utility IRPS with support of State PUCs historically ensured system reliability




- Coal historically the cheapest option
- Gas now abundant and cheap

- Solar and wind economics continue to improve
- Industry setting renewable energy targets to support transition

- Coal to gas switching supporting power sector carbon intensity reductions, but market / regulatory limits

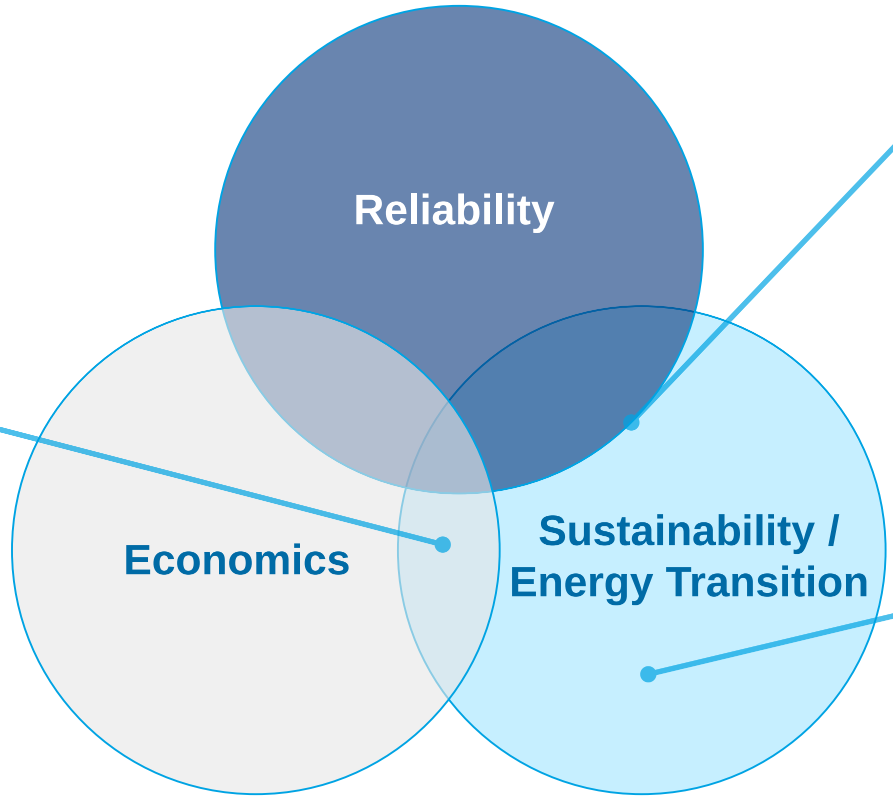
- Gas $CO_2$ and $CH_4$ emissions creating resistance for gas
- Consumers demanding cleaner energy solutions
- States setting mandates for > 50 % renewable power generation

Source: Wood Mackenzie

# Economics and stakeholder pressure are driving industry players and policy-makers to set increasingly aggressive clean energy goals

## How are we as an industry working to balance all three factors?

- NRG and Duke targeting zero emissions by 2030
- Southern Company targeting 50% GHG reduction by 2030
- SoCalGas targeting 20% RNG by 2030




- Stakeholder pressure to close critical baseload / peaking infrastructure e.g. Aliso Canyon, coal / oil / nuclear gen
- Regulatory hurdles to build pipes & CCGTs e.g. CA, Northeast

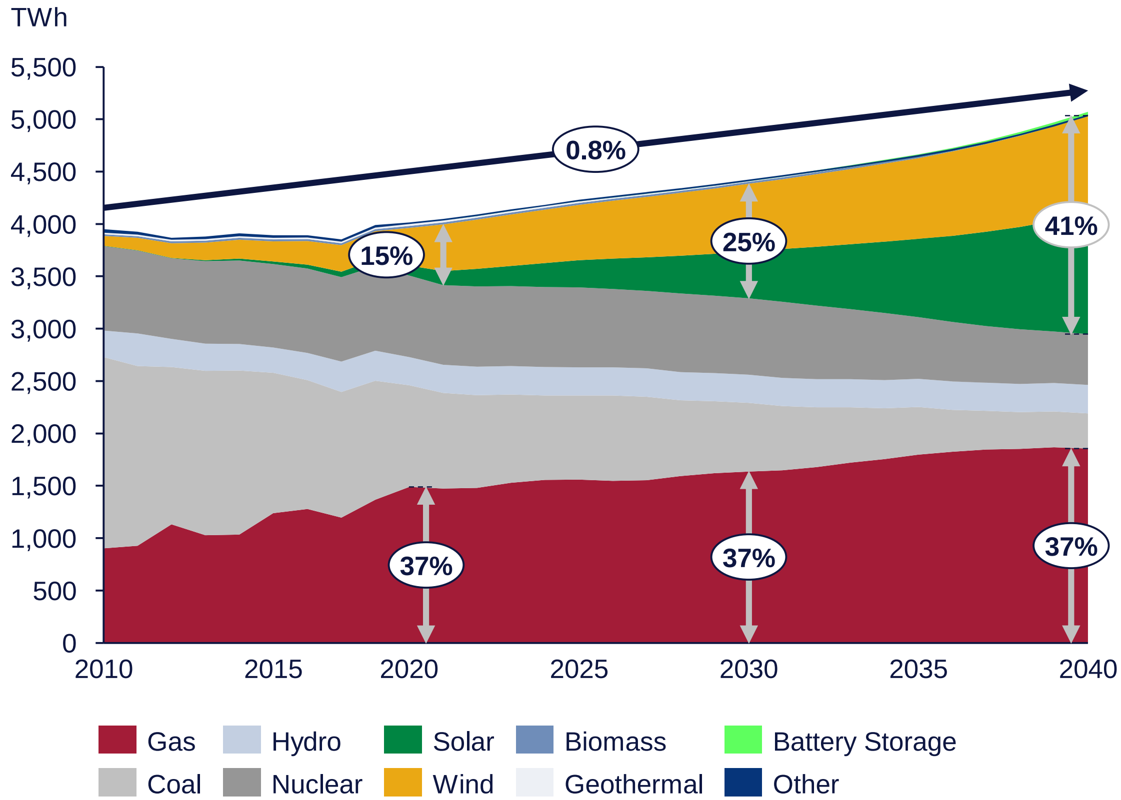
- CA targeting 100% clean energy by 2045
- 15 other states / districts / territories, and hundreds of cities and counties are targeting 100% clean energy by 2050

Source: Wood Mackenzie

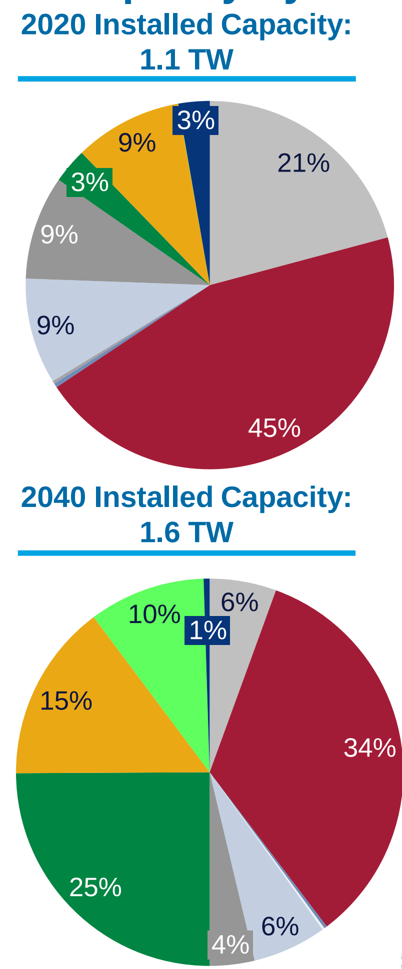
# Gas is a key part of the long-term solution playing a critical role enabling the continued transition to a cleaner power system

Solar, wind and battery storage are the fastest growing generation sources in the WM outlook, reflecting ~40% of power generation and ~50% of installed capacity by 2040

## US Power Generation by Fuel (TWh)




## Installed Capacity by Fuel (TW)




Source: Wood Mackenzie H2 2019 North America Power Tool

# Agenda

Drivers of Gas-Renewables Integration & The Resilience of Gas

**Integration Risks & Mitigation: WECC Gas-Electric Interface Study**

The Path Forward

# Overview of The WECC Gas-Electric Interface Study

## Challenge

Identify potential threats to grid reliability at present and in the future under two major energy transition events: baseload plant retirement and increasing renewable energy penetration on power generation

## Approach

Together with E3 and Argonne National Laboratory, Wood Mackenzie has derived the potential solutions for WECC through the following methodology:

- Assess gas and power market dynamics in Western Interconnection and model 10 natural gas disruptions scenarios and impact on bulk power system (BPS)
- Evaluate capability and cost of potential mitigation options as well as provide actionable recommendations to improve current operation, procedures, and protocols

## Lessons Learned

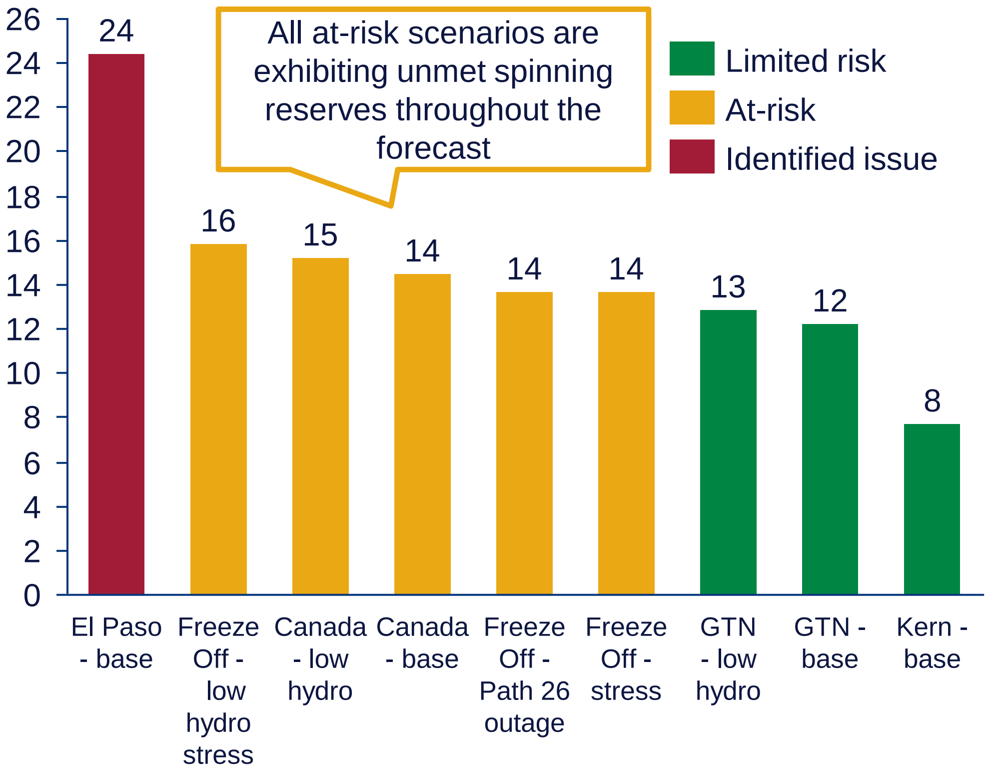
- Decommissioning baseload generation, in addition to Aliso Canyon retirement, would create reliability issues with the potential to result in load losses across the Western Interconnection in severe events
  - Desert Southwest and Southern California are the most vulnerable to major gas disruptions due to heavy reliance on gas generation to meet peak demands and limited gas storage capability
- Other WECC regions, such as Pacific Northwest, are more resilient, but still at risk to gas system disruption due to increasing market-area gas storage and more robust interstate transmission connectivity
- A portfolio of regional mitigation solutions will be necessary to address the reliability risk
  - To include the following initiatives: gas infrastructure expansions, dual-fuel generation capability, renewable energy and energy storage (batteries) deployment, demand response programs, winterization of key gas supply infrastructure (processing, etc.) and fuel assurance vs. firm generation reporting and other gas-electric coordination opportunities
- As a regional entity, WECC has the capability to foster gas-electric coordination amongst key regional stakeholders while also influencing policymakers in implementing mitigation solutions in the Western Interconnection to maximize compensation capability for handling future disruptions

Source: WECC Gas-Electric Interface Study, June 2018, led by Wood Mackenzie with collaboration from E3 and Argonne National Labs

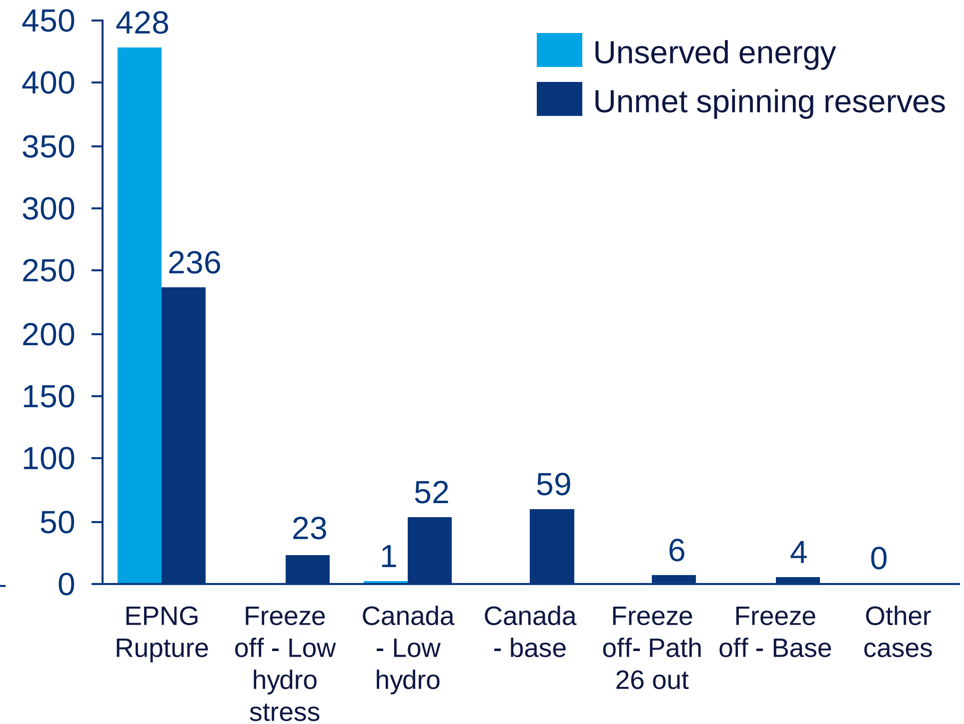
# A number of gas-electric disruption scenarios modelled across the Western Interconnection resulted in material economic impact

## Unserved energy in the key EPNG and freeze-off scenarios results from the configuration of the gas network, which limits deliverability to isolated "islands" of plants in Phoenix & SoCal

### Outage nameplate capacity (GW)




### Unserved energy & unmet reserves[3] (GWh)

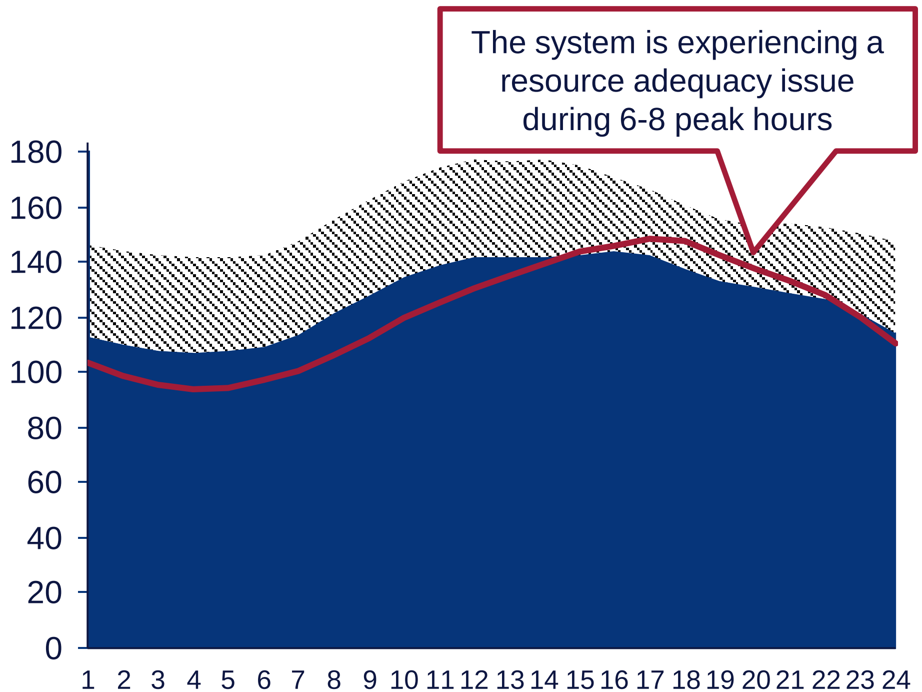



| | EPNG Rupture | Freeze off - Low hydro stress | Canada - Low hydro | Canada - base | Freeze off- Path 26 out | Freeze off - Base | Other cases |
|---|---|---|---|---|---|---|---|
| **Unrisked Economic Impact[1] ($US bn)** | $27.4 | $2.2 | $3.4 | $3.7 | $0.8 | $0.6 | $0 |
| **Risked Economic Impact[2] ($US bn)** | $1.1 | $0.27 | $0.002 | $0.02 | | $0.6 | $0 |

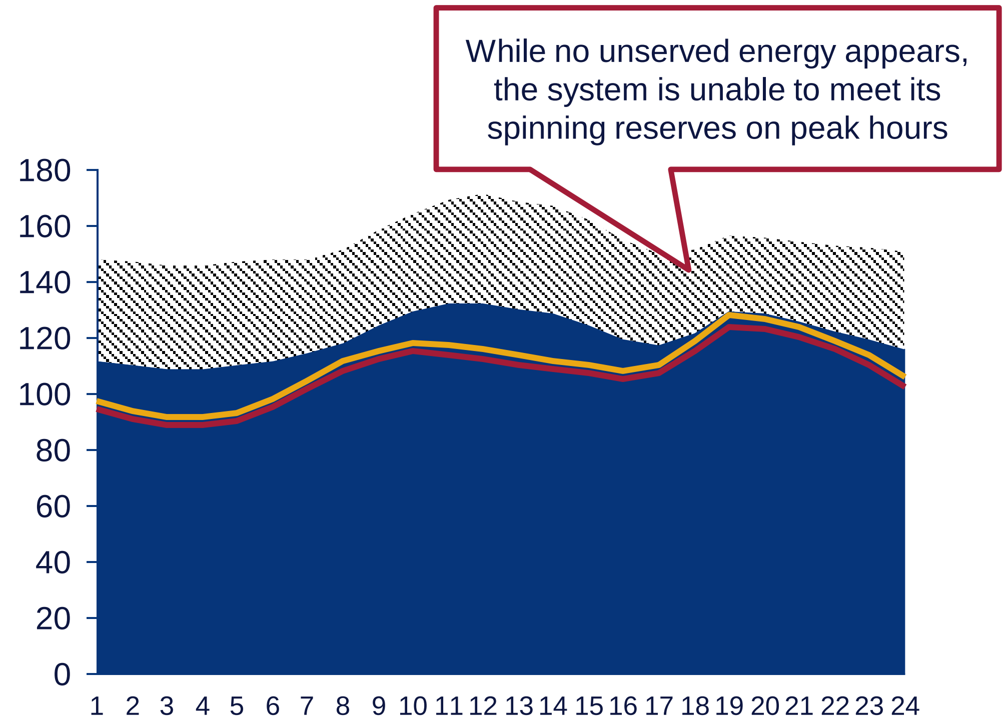
Notes : (1) Economic impact estimated based on cost of unserved energy in each state for each type of demand sector
(2) Risked Economic Impact estimated based on probability of each disruption
(3) Unmet spinning reserves in GWh representing the addition of all unmet reserves in MW for each hour
Source: Wood Mackenzie, E3, Argonne National Labs

# Resource adequacy problems: an EPNG rupture results in unserved energy while a severe freeze-off exhibits unmet spinning reserves

## August 6 2026 – EPNG Base case Western Inter. Load and Gen. Capability (GW)




## December 28, 2026 – Freeze-off low hydro case Western Inter. Load and Gen. Capability (GW)




| | August 6 2026 – EPNG Base case | December 28, 2026 – Freeze-off low hydro case |
|---|---|---|
| **Unserved Load (GWh)** | 428 | 0 |
| **Unmet spinning reserves[1] (GWh)** | 236 | 23 |

Base Generation Capability
Generation capability post-disruption
Load
Spinning reserves

Source: Argonne National Labs , E3, Wood Mackenzie
(1) Unmet spinning reserves in GWh representing the addition of all unmet reserves in MW for each hour

# Reconciliation and improvement of natural gas/electric coordination will be key to maximizing ability to manage increasing gas demand

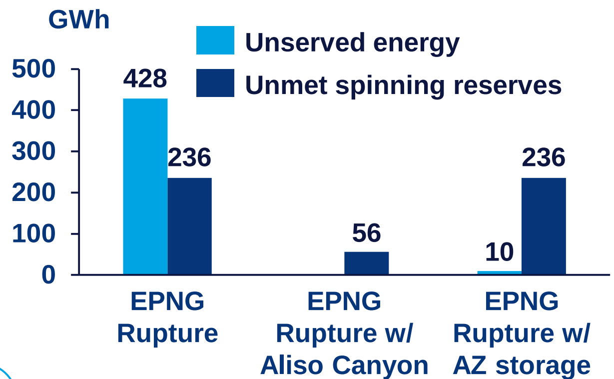
| | Recommendations | Benefits |
| --- | --- | --- |
| **Resource Adequacy Accounting** | • Report all firm contracts and explicitly link to power plants served in IRP process and other firm reserve reports | • Allows for more robust planning processes, especially as gas and power capacity dynamics tighten |
| **Curtailment Priorities** | • Re-visit classification of electric generation as "non-core" end-use<br>• Designation of plants critical to grid reliability as core end-use | • Ensuring that critical power plants are not the first to be curtailed allows for additional flexibility for compensation via transmission |
| **Improved Regional Coordination** | • Conduct regional contingency planning exercises led by WECC to prepare for a number of disruption scenarios | • Maximizes compensation ability for utilities across the Western Interconnection |
| **Forecasting & Execution** | • Require intra-day LDC core load balancing to ensure fair implementation of OFOs and penalties<br>• Additional clarity around interstate pipeline curtailment protocol | • Higher accountability for prior-day forecasting allows easier utility operation<br>• Explicit interstate curtailment protocols allow for better contingency planning |
| **Gas-Electric Day Mismatch** | • Split weekend nomination period into daily blocks, resulting in a 7-day nomination cycle | • A feasible step for both gas and electric sides that would minimize response lead times over the weekend period |

Source: Wood Mackenzie, E3, Argonne National Labs

# Meeting the future needs of the Western Interconnection across economics, reliability & sustainability requires a portfolio of mitigants

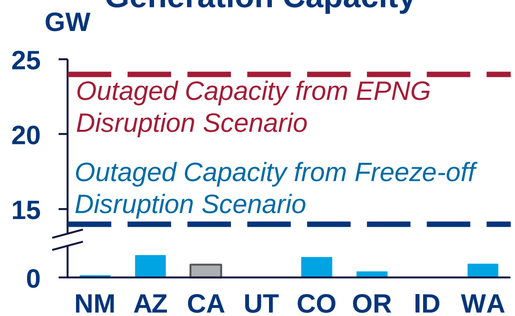
## 1 Gas System Expansion

### Unserved Energy & Unmet Reserves



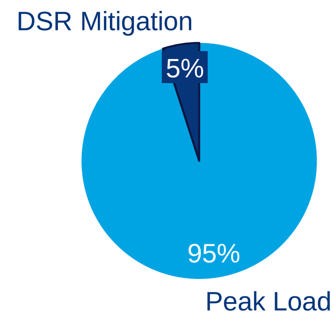

## 2 Duel Fuel Capacity

### Estimated Available Dual-Fired Generation Capacity[1]

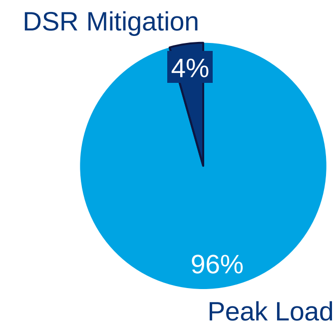



## 3 DSR

### APS DSR Mitigation (2004)

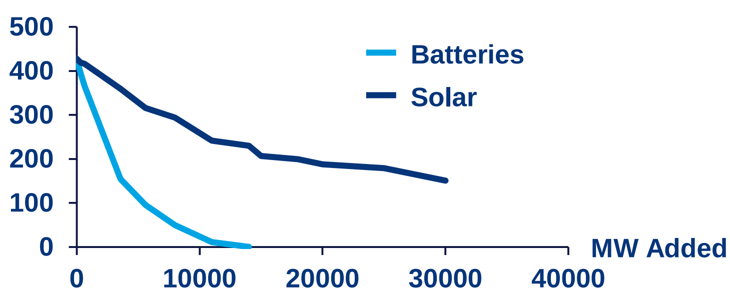



### SCE DSR Mitigation (2017)



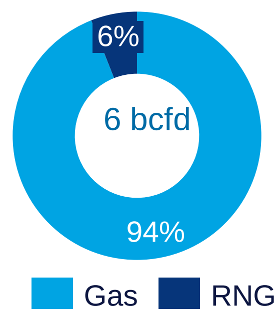

## 4 Renewable Power, Batteries, Renewable Gas, and Hydrogen

### Mitigation Capability of Battery & Solar Additions[2]



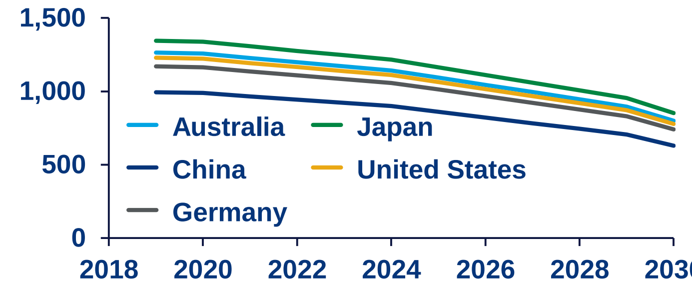

### Maximize Potential for RNG

CA RNG Potential as % Share of 2019 Gas Demand




### Accelerate Green Hydrogen Cost Curve

2 MW Electrolyzer CAPEX Forecast By Country $/kWh




Source: Wood Mackenzie, E3, UC Davis, Argonne National Lab

1. Verified on best-efforts basis
2. Analyzed for EPNG disruption scenario

# The energy transition is accelerating, while initiatives are just getting kicked off on WECC & national gas-electric interface issues

## Energy Transformation and Clean Energy Reform

- **Jan -18**: **Arizona Energy Modernization Plan (AEMP)** ACC mandated for 80% clean energy-based power generation by 2050
- **Mar -18**: **Arizona gas plant moratorium**
- **Jul -18**: **CPUC ordered to minimize / eliminate Aliso Canyon gas storage**
- **Sep -18**: **SB100 was approved** 100% carbon-free electricity by 2045 in California
- **Dec -18**: **WECC region: a total of 2.5 GW power plant capacity retired in 2018** 53% are gas-fired plants
- **Jan -19**: **PG&E filed bankruptcy**
- **Mar -19**: **ECA LNG gets US Non-FTA approval for exports**
- **May -19**: **Record low for SoCalGas & PG&E gas storage volume**
- **Jan -20**: **LA County calls for expedited closure of Aliso Canyon**
- **Feb -20**: **PG&E files an updated restructuring plan and aims to exit bankruptcy by Jun 30**

## ISO and Regulatory Reliability Initiatives

- **Jun-18**: WECC published **Gas-Electric Study** by Wood Mackenzie
- **Sep -18**: SPP provided **Reliability Coordinator (RC) Services** to Western Interconnection
- **Oct -18**: CAISO launched **Resource Adequacy Enhancement**
- **Dec -18**: NERC launched the **Generation Retirement Scenario**
- **Feb -19**: NERC formed the **Electric-Gas Working Group**
- **On-going**: SoCalGas is seeking for **expanding Aliso Canyon gas storage utilization**

# Agenda

Drivers of Gas-Renewables Integration & The Resilience of Gas

Integration Risks & Mitigation:  WECC Gas-Electric Interface Study

**The Path Forward**

# The Path Forward – Final Thoughts

- Increasing clean energy utilization requires a balanced portfolio (energy and capacity) to achieve renewable standards, counter intermittency and sustain grid reliability in the face of regional vulnerabilities – other NERC regions face key risks (e.g., NE-ISO, NYISO)

- There is no silver bullet – a balanced perspective around economics, reliability, and sustainability is necessary to drive maintenance and new investments in gas & electric infrastructure to ensure the system can reliably meet bulk power system capacity needs

- The success of the Energy Transition will require collaboration amongst policy-makers, regulators and gas-power industry participants to conduct gas-electric vulnerability assessments and adapt regulatory/commercial constructs to incentivize investment

# Disclaimer

## Strictly Private & Confidential

Verisk™


**Europe** +44 131 243 4400
**Americas** +1 713 470 1600
**Asia Pacific** +65 6518 0800
**Email** contactus@woodmac.com
**Website** www.woodmac.com


Wood Mackenzie™, a Verisk business, is a trusted intelligence provider, empowering decision-makers with unique insight on the world's natural resources. We are a leading research and consultancy business for the global energy, power and renewables, subsurface, chemicals, and metals and mining industries. **For more information visit: woodmac.com**