The Western Interstate Energy Board hired E3 and DNV GL to investigate the adequacy of gas infrastructure to meet electric sector needs in the West.

**Phase 1:** Will there be adequate natural gas infrastructure to meet the needs of the electric industry in the West approximately 10 years in the future?

- What demand for natural gas—electric and non-electric—would be expected on the winter and summer peak days?
- Do regional pipelines and storage have sufficient capacity to meet demands?
- Do current market arrangements provide appropriate signals for expansion?

**Phase 2:** Will the gas system have adequate short-term operational flexibility to meet electric industry requirements?

- How large might hourly ramps in the demand for natural gas be?
- Is the gas system physically capable of operating in such a manner as to accommodate the magnitude of these swings?
- Do current market arrangements provide appropriate signals for more variable short-term operations?
E3 and DNV GL have worked closely with the Technical Advisory Group (TAG), a group comprising WIEB staff, industry experts, and representatives of government offices from around the Western Interconnection.

Consulting Team

- E3
- DNV GL

Technical Advisory Group

- Beth Musich, SoCal Gas & San Diego Gas & Electric
- Clint Kalich, Avista Energy
- Chris Worley, Colorado Energy Office
- James Wilde, Arizona Public Service
- Jan Caldwell, Williams Northwest Pipeline
- Melissa Jones, California Energy Commission
- Mia Vu, Pacific Gas & Electric
- Peter Larsen, Lawrence Berkeley National Laboratory
- Alaine Ginocchio, Western Interstate Energy Board
- Steve Ellenbecker, WIEB
- Thomas Carr, WIEB

Phase 1 report released March 17; Phase 2 work will conclude in June 2014.
E3 has broad experience in electric and natural gas policy, planning and markets:

- Technical assistance to Western Electric Coordinating Council for regional transmission planning
- WECC Energy Imbalance Market Benefits Study
- Flexible capacity modeling for California ISO
- Renewable energy support for California PUC
- Expert testimony on TransCanada mainline tariff issues
DNV GL have been providing network analysis software and services since 1970

- The vast majority of Western U.S. natural gas transmission and distribution companies model with DNV GL software

DNV GL have provided consulting services for many of the Western U.S. natural gas companies

Some of the Western U.S. DNV GL clients include:

- Alliance Pipeline
- Avista
- Encana
- Kinder Morgan
- Northwest Natural
- Pacific Gas & Electric
- Puget Sound Energy
- Questar
- San Diego Gas & Electric
- SoCalGas
- Southwest Gas
- TransCanada Pipelines Limited
- Williams Northwest Pipeline
- Xcel Energy
Electric and Gas Sector Planning

**Electric System**
- Electric systems are planned to meet a resource adequacy standard
  - E.g. one loss of load event in 10 years
  - Electric sector reliability analysis accounts for generator forced outages—but does not consider possible fuel interruptions
- Transmission expansion is lumpy and difficult
  - Significant visual and other environmental impacts
  - Lack of “exclusive use” due to network impacts

**Gas System**
- Gas transportation infrastructure has its own standards for “adequacy”
  - FERC-regulated pipelines build facilities to meet firm service obligations
  - California sized to meet “cold winter day” planning standards approved by CPUC
- Gas pipeline expansion is incremental and orderly
  - Open season leads to financial commitments
  - California intrastate systems conduct biannual assessments of system capacity
In the past two decades, the vast majority of new investments in generation have been in natural gas technologies, which now represent 42% of installed capacity in the Western Interconnection.

These resources are relied upon to maintain electric reliability.
While gas use in the power sector has expanded rapidly during this time, consumption in other sectors has remained relatively stable.

- Over the past fifteen years, the amount of natural gas consumed by the electric sector has nearly doubled.
- The power sector now accounts for between 30-40% of natural gas consumption in the Western Interconnection.
New England Power Sector’s Reliance on Interruptible Capacity

Gas infrastructure in New England is sized to meet winter heating needs of non-power customers, which leaves little capacity available to meet needs of growing electric loads

- Current wholesale power markets provide no incentive/requirement for generators to purchase firm service, and most rely on interruptible
- Regional demand in excess of pipeline capability has led to local gas shortages, resulting in market price “blow-outs”
- During these periods, back-up fuel has helped preserve reliability
Gas Supply Issues in the West

Recent curtailment of gas generators in southern California has highlighted potential gas supply issues

- High demands across North American continent caused diversions of supply from California in February 2014
  - With high prices in markets throughout the US, insufficient supplies flowed from Western production basins to southern California
  - Supply shortages led to curtailments of non-core customers, and CAISO issued a “Flex Alert” in response

Data source: SoCal Gas Envoy
Regional Gas Infrastructure

+ Western pipeline systems link production basins with major load centers

+ Storage facilities located in market areas provide additional load serving capability and flexibility
Overall Study Goals

+ Study scope is broad, both in geography and in questions it addresses
+ E3 and GL have focused on identifying potential challenges without attempting to characterize each one exhaustively
+ Study results and conclusions intended to serve as a bridge for more focused, detailed assessment of concerns
PHASE 1 INVESTIGATION
**Phase 1 Overview**

**PHASE 1:**

*Will there be sufficient natural gas infrastructure, including storage, to meet the needs of the electric industry in the Western Interconnection approximately ten years in the future?*

**Study goals:**

- Identify vulnerabilities where gas infrastructure may not be sufficient to meet electric needs
- Consider implications for long-term resource planning

**Study identifies and explores two vulnerabilities:**

1. Gas generators with interruptible service may not secure gas when capacity is needed by firm shippers
2. During gas infrastructure contingencies, the need to curtail firm gas customers may impact the electric sector
Scenarios, Sensitivities, and Contingencies

Study evaluates gas infrastructure adequacy over a wide range of scenarios, sensitivities, and contingencies.

**Scenarios**
- Base Case
- High Coal Retirements Case
- High Renewables Case
- High Exports Case

**Sensitivities**
- Gas Capacity Sensitivity
- Firm vs. Int Sensitivity

**Contingencies**
- Infrastructure Contingencies
- Extreme Weather Contingencies
The **Base Case** is constructed to reflect a plausible 10-year future for gas consumption the Western Interconnection considering current policy goals and industry trends

**Electric sector assumptions:**
- TEPPC 2022 Common Case used as foundation
  - States achieve RPS targets as currently legislated
  - Large portion of electric growth is offset by efficiency
- Several updates reflect evolution of electric industry
  - Retirement of SONGS and several announced coal plants

**Other sector assumptions:**
- Gas consumption grows at rates identified by LDCs in planning documents (e.g. IRPs)
- Implies relatively stable non-power demand in the coming decade
Based on discussions with TAG, the retirement of half of the coal capacity in the Base Case was chosen for the High Coal Retirements Case.

This reduction in coal generating capacity would represent a significant change for the electric sector:

![Installed Coal Generation Capacity (MW)]

<table>
<thead>
<tr>
<th>Case</th>
<th>Installed Coal Generation Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing (2010)</td>
<td>39,518</td>
</tr>
<tr>
<td>PC1 Common Case (2022)</td>
<td>35,182</td>
</tr>
<tr>
<td>PC6 Coal Replacement Case</td>
<td>29,812</td>
</tr>
<tr>
<td>Base Case</td>
<td>33,568</td>
</tr>
<tr>
<td>High Coal Retirements Case</td>
<td>16,543</td>
</tr>
</tbody>
</table>

TEPPC Study Cases (2022) vs. Gas-Electric Study Cases (2022)
State-specific RPS targets were adjusted upwards by increments determined by E3 and TAG.

Increased targets resulted in a need for approximately 50 TWh of additional renewable generation.

WECC-wide RPS is approximately 27%:
- 18% in Base Case

Additional renewable generation added to meet gaps was primarily wind & solar.
Overview of Analytical Steps

**Step 1:** Establish regional estimate of “load carrying capability”

**RESULT:** Total infrastructure capability

**Step 2:** Forecast demands for natural gas under winter conditions

**RESULT:** Firm/interruptible electric/end use loads

**Step 3:** Determine how much capacity will be used by firm shippers

**RESULT:** Capacity available for interruptible shippers

**Step 4:** Determine whether interruptible loads can be met with available capacity

**RESULT:** Possible curtailment of gas service to electric generators

**Step 5:** Translate curtailments to electric terms and compare to operational mitigation strategies
Evaluating adequacy is a question of the capacity of natural gas infrastructure to meet extreme demands.

Study focuses on evaluating vulnerabilities during a range of winter conditions.

Analysis focuses primarily on three different degrees of extreme winter weather:

- **1-in-2**: coldest day in two year period
- **1-in-10**: coldest day in ten year period
- **1-in-35**: coldest day in 35 year period
One of the major challenges faced by this study was determining the breakdown between gas generation served by firm and interruptible transportation service in the Western Interconnection.

This study relies on a nation-wide 2013 survey conducted by NERC to assess electric sector’s reliance on firm and interruptible transportation services. With WECC’s assistance, NERC obtained survey responses from a number of Western BAs, but a large portion of capacity is not accounted for.

- In its own study, NERC treated non-responses as interruptible generation; this study has used the same convention to ensure its conservatism.
SUMMARY OF PHASE 1
FINDINGS
1. The natural gas and electric industries are deeply linked such that events and conditions in one may have significant impacts on the other.

+ Power generation has become—and is positioned to remain—the single largest use of natural gas in the Western Interconnection.

+ Recent events in the West and beyond have highlighted vulnerabilities of electric sector.

+ Needs of the electric sector will continue to evolve over the coming decade.

+ Coordination and communication between the two industries will play a key role in ensuring adequacy of fuel supplies for electric sector.
2. Under the Base Case, gas transportation infrastructure will generally be adequate to meet the regional needs of the electric sector except under the most extreme winter weather conditions.

The relatively limited risk in most regions is a result of two factors:

1. The recent expansions of interstate pipeline networks in response to firm electric demands

2. Conservative planning standards on California’s intrastate systems

3. Gas generation that does not contract for firm transportation service may be subject to interruption during times of high gas demand.
4. The regions of the Western Interconnection are highly interdependent in their reliance on natural gas transportation and generation infrastructure

Example: California linked to Desert Southwest through imports of gas and electric power

- While most utilities in the DSW hold firm service, some merchant plants that traditionally export to California rely on interruptible service
- During periods of high demand, market forces could “push” the shortages of gas downstream to California

5. Regional coordination will play a key role in responding to gas generation curtailments during extreme weather

Robust interregional transmission may allow operators to increase electrical imports during constraints on gas system

- Operators may have other options at their disposal (e.g. demand response, back-up fuel, redispatch of non-gas generation)
Impacts of Extreme Events

6. Extreme events that affect multiple regions simultaneously could cause loss of electric load

- **Example #1**: extreme WECC-wide cold weather (December 22, 1990)
  - Gas infrastructure & operations face constraints in California and Desert Southwest
  - Gas generation in Pacific Northwest is operating near full capability
- **Example #2**: wellhead freeze-off in Desert Southwest (e.g. February 2011)

7. The loss of critical gas infrastructure presents a plausible risk not traditionally considered in electric sector reliability planning

- **Example**: loss of Sumas compressor station in the Pacific Northwest leads to curtailment of gas service to electric generators during winter weather conditions
Implications of Analysis for Electric Resource Planning

+ Electric systems are typically planned to meet a resource adequacy standard (e.g. one loss of load event in ten years)

+ Traditional reliability planning uses a stochastic approach to determine the appropriate reserve margin to meet this threshold given the low probabilities of extreme events

+ This study identifies two material vulnerabilities to the power sector that are not traditionally incorporated into this framework

Stochastic Variables in Reliability Modeling

- Electric Load
- Generation Forced Outages (non-fuel related)
- Transmission Outages
- Renewable Output
- Hydro Availability
- Import Availability
- Curtailment of Interruptible Gas Generators
- Gas Infrastructure Outage (impacts on gas generators)
8. Continued growth of the West’s natural gas generation fleet will require expansion of natural gas infrastructure to provide fuel security.

- Without expansion, frequency and magnitude of curtailments that result from replacement of coal plants with natural gas generation would increase relative to Base Case.

- While new infrastructure would be needed, there is not a technical reason to suggest it could not be built.
9. The impacts of new large loads on the adequacy of gas transportation infrastructure will depend on the extent to which those loads rely upon incremental expansions or existing pipelines

- New firm loads that trigger expansion would have limited impact on electric sector
- New interruptible loads could limit availability of capacity for electric sector

**NOTE:** this analysis focuses only on the adequacy of gas infrastructure—not on the adequacy of supply

- New large export volumes will also increase competition for gas in the Western Interconnection
Next Steps

1. Increase dialogue between gas and electric bulk system operators & regulators
2. Investigate long term mitigation strategies
3. Consider potential gas constraints in electric resource planning
4. Gather further information about services used by electric sector
5. Investigate potential West-wide conditions/contingencies and the ability of West to redispatch to meet needs of a given region
6. Study region-specific issues to address geographies at more granular level
7. Study intermediate years to determine how quickly some of the issues identified in this study can arise
8. Examine supply adequacy and market issues that could create challenges for electric sector