2018/2019 Winter Assessment
Introduction

- NOAA forecasts a warmer than average winter.

- Regional pipeline constraints in New York City, Boston, and Los Angeles increase the risk of price volatility.

- Winter reserve margins exceed the reference margins this winter for all assessment areas.

- Fuel security remains an area of focus given the increasing use of natural gas-fired generation capacity.
Recap of 2018 Winter Weather Events

The Eastern Interconnection experienced cold weather during the Bomb Cyclone from December 26 to January 8.

- ISO-NE, NYISO, PJM, and MISO experienced high but not record loads.
- Natural gas prices reached record levels.
- There was a notable increase in oil-fired generation.
- Generator outages contributed to tight electric supplies.
- Wholesale electricity prices were at high levels throughout this cold period.
- MISO South and SPP approached a short-term capacity shortage.
Forecasts Predict Warmer than Normal Winter

Source: National Oceanic and Atmospheric Administration
Natural Gas Storage Well Below Five-Year Average

Source: U.S. Energy Information Administration
Natural Gas Futures in New England Top $11 for 2018-2019 Winter

Source: InterContinental Exchange
Futures prices are the average January and February contract price of each year as of Oct. 1.
11 Bcfd of New Capacity Expected Online This Winter

Total Pipeline Capacity Additions
2016 to 2018: 25.5 Bcfd
Winter 2018-19: 10.9 Bcfd

Sources: Office of Energy Projects, Bentek Energy
Gas Infrastructure Restrictions May Stress California Energy Markets

Discovery of Aliso Canyon Leak

Source: SoCalGas
Most Gas-Oil Switching Occurs in the Eastern Interconnection

Sources: Derived from ABB Velocity Suite data.
Northeast Dual-Fuel Generators Hedge Gas Volatility

Sources: Platts Gas Daily Indices; Bloomberg, EIA
Fuel Oil prices are Month Ahead Bloomberg Fair Value Prices
Anticipated Reserve Margins Meet Reference Margins in All Regions


Note: WECC and NPCC includes U.S. portion only
New Plants and Retirements Continue Shift Toward Natural Gas and Renewables

Source: U.S Energy Information Administration, Form No. 860M, June 2018
Natural Gas Has a High Share of Capacity in RTO and Non-RTO Regions

Source: Resource to BAA mappings are as reported by EIA in Form 860M, June 2018.
Note: Percentages based on net winter capacity; excludes AK, HI, and resources that do not report a BAA. Includes resources with status of operating and standby.
ISO-NE’s Capacity Market Was Modified in Response to Fuel Delivery Issues

- Dependence on natural gas for power generation continues to increase.
- Pipeline capacity is limited and frequently operates at maximum capacity during cold weather.
- New England has limited natural gas storage capacity.
- Price responsive demand is fully integrated into the daily energy market.
- Pay-for-performance capacity market incentives take effect, replacing the Winter Reliability Program.
National Slides
NOAA November 2018 Through January 2019 Outlook

Three-Month Outlook
Temperature Probability
0.5 Month Lead
Valid NDJ 2018
Made 18 Oct 2018
Cumulative HDDs by City
October 2018

Source: Bloomberg Weather (daily data summed)
### 2018 Spot Power Prices ($/MWh)

- **NP 15**
  - Price: $40
  - Percent: 4%
- **Palo Verde**
  - Price: $40
  - Percent: 18.1%
- **Mid-Columbia**
  - Price: $34
  - Percent: 32%
- **Indiana Hub**
  - Price: $38
  - Percent: 8.5%
- **SPP North**
  - Price: $29
  - Percent: 15.5%
- **PJM West**
  - Price: $42
  - Percent: 26.2%
- **NYISO ZJ**
  - Price: $46
  - Percent: 23.2%
- **Mass Hub**
  - Price: $48
  - Percent: 38.9%
- **Into Southern**
  - Price: $31
  - Percent: 3%
- **ERCOT North**
  - Price: $42
  - Percent: 56%

$ = Average YTD 2018 monthly day-ahead on-peak price

% = Percent increase from 2017 YTD

Source: RTO/ISO data and SNL Day-ahead Prices
Spot Natural Gas Prices Average ($/MMBtu) October 2018

- Pricing Point
  - BOLD – This Year
  - Green – % increase from previous year
  - Red – % decrease from previous year

Source: Platts

Updated Nov-2018
National Natural Gas Market Overview: U.S. Supply and Consumption

U.S. NG Supply and Demand

November 2016 – October 2017 vs November 2017 – October 2018

US Natural Gas Supply
Total Change in Supply: 9.9%

- LNG Imports: 11.1%
- Canadian Imports: 2.1%
- Net Dry Gas Production: 10.4%

US Natural Gas Demand
Total Change in Demand: 8.6%

- LNG Exports: 62.4%
- Mexican Exports: 12.3%
- Power Generation: 12.3%
- Industrial: 4.2%
- Residential/Commercial: 8.8%

Note: Balance includes all amounts not attributable to other categories.
Source: Derived from Bentek Energy data

Updated Nov-2018
Regional Imports from Canada

Source: Derived from Bentek Energy data

Updated Nov-2018
Total U.S. Natural Gas Demand All Sectors

Source: Derived from Bentek Energy data, derived from interstate pipeline flow and modeled data.

Updated Nov-2018
U.S. Natural Gas Consumption for Power Generation

Source: Derived from Bentek Energy data

Updated Nov-2018
EIA National Storage Inventories

Source: Derived from Bloomberg Data

Updated Nov-2018
National Natural Gas Market Overview: Natural Gas Storage Inventory

EIA Regional Storage Inventories

Source: Derived from Bloomberg Data

Updated Nov-2018
Note: Prior to July 2010, chart was derived from a combination of EIA and Bentek Energy data
Source: Derived from Bentek Energy data
National Natural Gas Market Overview: Rig Count by Type

Rigs by Type

Oil Rigs

Gas Rigs

Notes:
Source: Derived from Bloomberg data
Updated: Nov-2018
National Natural Gas Market Overview: Competing Fuels

Competing Fuels

Source: Derived from Bloomberg data

Notes:

Updated Nov-2018
Daily Gas Sendout from Existing U.S. LNG Facilities

Notes: Everett data includes flows onto the AGT and TGP interstate lines, plus estimates of flows to the Mystic 7 power plant, KeySpan Boston Gas, and LNG trucked out of the terminal. Excludes flows to the Freeport LNG which flows via intrastate pipelines and flows to the Mystic 8 and 9 power plants.

Source: Derived from Bentek Energy data

Updated: Nov-2018
Notes: Everett data includes flows onto the AGT and TGP interstate lines, plus estimates of flows to the Mystic 7 power plant, Keyspan Boston Gas, and LNG trucked out of the terminal. Excludes flows to the Freeport LNG which flows via intrastate pipelines and flows to the Mystic 8 and 9 power plants.

Source: Derived from Bentek Energy data

Updated: Nov-2018
National Natural Gas Market Overview: World LNG Landed Prices

World LNG Estimated Landed Prices: Oct-18

Note: Includes information and Data supplied by IHS Global Inc. and its affiliates ("IHS"); Copyright (publication year) all rights reserved. Landed prices are the monthly average of weekly trades from the prior month.
Historical and World Gas Futures Prices

- Henry Hub
- TZ6 NY
- Algonquin Citygates
- UKNBP
- Japanese LNG Spot Price

$/MMBtu

Notes:
Source: Derived from Bloomberg data

Updated Nov-2018
WTI vs Brent Crude Oil Price

Source: Derived from Bloomberg data

Updated Nov-2018
National Natural Gas Market Overview: Nymex Futures Curve

Nymex Futures Curves

Source: Derived from Bloomberg data

Updated Nov-2018
Infrastructure Report

Office of Energy Projects Energy Infrastructure Update
http://www.ferc.gov/legal/staff-reports.asp
(see “Energy Infrastructure” tab)
# Natural Gas Highlights

## Natural Gas Activities through September 30, 2018

### January through September 30, 2017

<table>
<thead>
<tr>
<th>Status</th>
<th>No. of Projects</th>
<th>Storage Capacity (Bcf)</th>
<th>Deliverability (MMcf/d)</th>
<th>Capacity (MMcf/d)</th>
<th>Miles of Pipeline</th>
<th>Compression (HP)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pipeline</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placed in Service</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>through September 30, 2017</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certificated</td>
<td>42</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>through September 30, 2017</td>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Placed in Service</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>through September 30, 2017</td>
<td>1</td>
<td>7.5</td>
<td>600.0</td>
<td></td>
<td></td>
<td>9,500</td>
</tr>
<tr>
<td>Certificated</td>
<td>4</td>
<td>3,600.3</td>
<td>152.0</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>through September 30, 2017</td>
<td>1</td>
<td>0.0</td>
<td>10.0</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td><strong>LNG (Import &amp; Export)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placed in Service (Export)</td>
<td>1</td>
<td>0.0</td>
<td>825.0</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>through September 30, 2017</td>
<td>2</td>
<td>0.0</td>
<td>793.0</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Certificated (Import/Export)</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>through September 30, 2017</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Staff Database
## Electric Generation Highlights

### New Generation In-Service (New Build and Expansion)

<table>
<thead>
<tr>
<th>Primary Fuel Type</th>
<th>September 2018</th>
<th>January – September 2018 Cumulative</th>
<th>January – September 2017 Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Units</td>
<td>Installed Capacity (MW)</td>
<td>No. of Units</td>
</tr>
<tr>
<td>Coal</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>0</td>
<td>0</td>
<td>68</td>
</tr>
<tr>
<td>Nuclear</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Oil</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Water</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Wind</td>
<td>3</td>
<td>363</td>
<td>32</td>
</tr>
<tr>
<td>Biomass</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Geothermal Steam</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Solar</td>
<td>9</td>
<td>339</td>
<td>310</td>
</tr>
<tr>
<td>Waste Heat</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Other *</td>
<td>1</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>702</strong></td>
<td><strong>469</strong></td>
</tr>
</tbody>
</table>

*“Other” includes purchased steam, tires, and miscellaneous technology such as batteries, fuel cells, energy storage, and fly wheel.

Sources: Data derived from Velocity Suite, ABB Inc. and The C Three Group LLC. The data may be subject to update.
Electric Transmission Highlights

Transmission Projects Completed

<table>
<thead>
<tr>
<th>Voltage (kV)</th>
<th>September 2018</th>
<th>September 2017</th>
<th>January – September 2018 Cumulative</th>
<th>January – September 2017 Cumulative</th>
<th>High Probability of Completion</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤230</td>
<td>0.0</td>
<td>6.0</td>
<td>231.7</td>
<td>329.3</td>
<td>762.3</td>
<td>2,076.5</td>
</tr>
<tr>
<td>345</td>
<td>0.0</td>
<td>0.0</td>
<td>413.2</td>
<td>218.5</td>
<td>1,882.6</td>
<td>4,030.6</td>
</tr>
<tr>
<td>500</td>
<td>0.0</td>
<td>0.0</td>
<td>69.4</td>
<td>0.0</td>
<td>371.0</td>
<td>1,227.4</td>
</tr>
<tr>
<td>Total U.S.</td>
<td>0.0</td>
<td>6.0</td>
<td>714.3</td>
<td>547.8</td>
<td>3,015.9</td>
<td>7,334.5</td>
</tr>
</tbody>
</table>

Sources: Data derived from Staff Database and U.S. Electric Transmission Projects ©2018 The C Three Group, LLC.
# Installed Generating Capacity and Proposed Additions

## Total Available Installed Generating Capacity

<table>
<thead>
<tr>
<th>Fuels Type</th>
<th>Installed Capacity (GW)</th>
<th>% of Total Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>268.17</td>
<td>22.55%</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>522.59</td>
<td>43.95%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>107.66</td>
<td>9.05%</td>
</tr>
<tr>
<td>Oil</td>
<td>41.67</td>
<td>3.50%</td>
</tr>
<tr>
<td>Water</td>
<td>100.49</td>
<td>8.45%</td>
</tr>
<tr>
<td>Wind</td>
<td>91.67</td>
<td>7.71%</td>
</tr>
<tr>
<td>Biomass</td>
<td>16.26</td>
<td>1.37%</td>
</tr>
<tr>
<td>Geothermal Steam</td>
<td>3.79</td>
<td>0.32%</td>
</tr>
<tr>
<td>Solar</td>
<td>34.63</td>
<td>2.91%</td>
</tr>
<tr>
<td>Waste Heat</td>
<td>1.38</td>
<td>0.12%</td>
</tr>
<tr>
<td>Other*</td>
<td>0.78</td>
<td>0.07%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,188.09</strong></td>
<td><strong>100.00%</strong></td>
</tr>
</tbody>
</table>

## Proposed Generation Additions and Retirements by October 2021

<table>
<thead>
<tr>
<th>Primary Fuel Type</th>
<th>No. of Units</th>
<th>Installed Capacity (MW)</th>
<th>No. of Units</th>
<th>Installed Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>1</td>
<td>17</td>
<td>74</td>
<td>19,255</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>291</td>
<td>79,351</td>
<td>112</td>
<td>11,945</td>
</tr>
<tr>
<td>Nuclear</td>
<td>8</td>
<td>8,021</td>
<td>8</td>
<td>8,040</td>
</tr>
<tr>
<td>Oil</td>
<td>18</td>
<td>728</td>
<td>22</td>
<td>166</td>
</tr>
<tr>
<td>Water</td>
<td>252</td>
<td>14,896</td>
<td>19</td>
<td>633</td>
</tr>
<tr>
<td>Wind</td>
<td>494</td>
<td>89,880</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>Biomass</td>
<td>57</td>
<td>593</td>
<td>24</td>
<td>124</td>
</tr>
<tr>
<td>Geothermal Steam</td>
<td>22</td>
<td>1,076</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Solar</td>
<td>2,020</td>
<td>61,623</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Waste Heat</td>
<td>6</td>
<td>96</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other*</td>
<td>88</td>
<td>690</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,257</strong></td>
<td><strong>256,971</strong></td>
<td><strong>265</strong></td>
<td><strong>40,215</strong></td>
</tr>
</tbody>
</table>

Sources: Data derived from Velocity Suite, ABB Inc. and The C Three Group LLC. The data is subject to update.

*“Other” includes purchased steam, tires, and miscellaneous technology such as batteries, fuel cells, energy storage, and fly wheel.