Moving to Zero Carbon

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MANY FACTORS INFLUENCE PROVIDING POWER 24/7/365

- Customer Demands
- The Energy Transition Act
- Plug-In electric vehicles
- Energy Efficiency
- Increased Peaks and Lower Use
- Technology
- Production of Generation Resources
### REVIEW OF THE ETA REQUIREMENTS

#### 2020 (Est.) 2023 2025 2030 2032 2040

<table>
<thead>
<tr>
<th>Metric</th>
<th>2020 (%)</th>
<th>2023 (%)</th>
<th>2025 (%)</th>
<th>2030 (%)</th>
<th>2032 (%)</th>
<th>2040 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable Portfolio Standard</td>
<td>20%</td>
<td>40%</td>
<td>50%</td>
<td>80%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of retail sales</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Carbon Emissions-Free Generation</td>
<td>47%</td>
<td></td>
<td></td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>% of generation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Intensity (lbs/MWh)</td>
<td>1,113</td>
<td>400</td>
<td>200</td>
<td>0</td>
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</tbody>
</table>

*Metrics for 2020 estimated based on PNM’s current portfolio*

- Senate Bill 489, Energy Transition Act, passed on 3/12/2019
- Expands Renewable Portfolio Standards
- Creates Carbon Standards
WHERE WERE WE IN 2019 AND WHERE WE WILL BE AFTER SAN JUAN CLOSURE?

**2019 PNM CAPACITY (MW)**
- Wind, 16%
- Solar, 8%
- Gas, 27%
- Nuclear, 18%
- Storage, 0%
- Geo, 0%

**2025 PNM CAPACITY (MW)**
- Wind, 20%
- Solar, 21%
- Gas, 36%
- Nuclear, 12%
- Storage, 6%
- Coal, 6%

**2019 PNM ENERGY (GWH)**
- Nuclear, 3,167
- Solar, 397
- Wind, 952
- Storage, 1
- Geo, 51
- Gas, 976

**2025 PNM ENERGY (GWH)**
- Nuclear, 3,167
- Solar, 1,825
- Wind, 2,287
- Storage (52)
- Geo, 77
- Coal, 1,157
- Gas, 1,607
RESOURCE PLANNING BECOMES MORE DIFFICULT POST 2030

Expected technology progression to meet RPS and CO2 requirements. If technologies mature quicker they will be considered earlier in time based on cost-effectiveness. This is not an exhaustive list, the list of technologies is still growing and evolving. At this point nothing should be prematurely excluded.

<table>
<thead>
<tr>
<th>2020-2030</th>
<th>2030-2040</th>
<th>2040+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>Compressed Air Storage</td>
<td>Hydrogen</td>
</tr>
<tr>
<td>Solar PV</td>
<td>Pumped Hydro Storage</td>
<td>Synthetic Gas (Non-Carbon Emitting)</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>Thermal Storage</td>
<td></td>
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<tr>
<td>Lithium Ion (2-6 hr)</td>
<td>Liquified Air Storage</td>
<td></td>
</tr>
<tr>
<td>Transmission</td>
<td>Flow Batteries</td>
<td>Small Modular Reactors</td>
</tr>
<tr>
<td>Demand Response</td>
<td>Gravitational Storage</td>
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</table>
THE DISTRIBUTION SYSTEM IS EVOLVING

There are many discussions about the impacts to the resource mix and the bulk electric system impacts due to zero carbon goals. But how might that affect the grid edge?

Distribution System innovation drivers:
- Customer desires for green technologies
  - Distributed Generation
  - Electrification and increased usage
- Energy Storage
- Utility grid operations
MODERNIZING THE GRID

There is still much to do on the distribution system to move toward a 2-way operation with sufficient situational awareness.
DATA AND INFORMATION

Figure 5-7. Logical Model of Legacy Systems Mapped onto Conceptual Domains for Smart Grid Information Networks

NIST Smart Grid Interoperability Standards, Release 3.0
It is going to be an exciting time to be a utility Engineer. The grid is already undergoing a big transition, is ripe for much more, and will continue to be a place for innovation and evolution.
Thank you