Arizona Renewable Energy Standard

- Annual renewable goals increase 1% each year to 15% in 2025
  - 8% in 2018
- At least 30% of total from distributed generation
  - One of the highest in the nation

**TEP’s Commitment**

- TEP plans to reach 30% by 2030
- Currently 340 MW solar & wind
  - Additional 250 MW of DG
- Planned additions of 800-1000 MW over next 10 years
- 1,000 MW Winter / 2,500 Summer

*Does not include DG*
Diversifying TEP’s Resource Portfolio

Energy Mix

- Coal
- Natural Gas & Purch. Power
- Renewables

<table>
<thead>
<tr>
<th>Year</th>
<th>Coal</th>
<th>Natural Gas &amp; Purch. Power</th>
<th>Renewables</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>20%</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>2017</td>
<td>30%</td>
<td>16%</td>
<td>34%</td>
</tr>
<tr>
<td>2023</td>
<td>36%</td>
<td>16%</td>
<td>30%</td>
</tr>
<tr>
<td>2032</td>
<td>36%</td>
<td>34%</td>
<td>30%</td>
</tr>
</tbody>
</table>
Operator Challenges From Intermittancy
As of EOY 2016 TEP had ≈5% of the grid-scale energy storage capacity in U.S.

Provide frequency and voltage support for local distribution grid

1. NextEra Energy Resources
   - 10MW lithium nickel-manganese-cobalt battery, 15 minute duration (2.5 MWh)
   - DeMoss-Petrie Substation

2. E.On Climate & Renewables
   - 10MW lithium Titanate oxide battery, 15 minute duration (2.5 MWh)
   - Combined with 2 MW Solar PV
   - U of A Science and Tech Park
EPRI – Project RAIN

- **Resource Aggregation and Integration Network**
  - Will complement work done in APS’ Solar Partner Program
  - Requested by Arizona Corporation Commission
    - Study effects of DERs with phasor-based measurements on distribution grid
    - Study how a DERMS could help successful deployment of DERs
  - Battery Storage
  - Inverter Firmware
  - Water Heaters
  - Thermostats
  - Electric Vehicle Chargers

- **Will be tested in EPRI labs with multiple vendors**
  - Scorecard

- **No integration to utility networks**
  - Setup strictly as a research project
  - Currently deploying an Advanced Distribution Management System (ADMS)
TEP’s Roller Coaster

- 30% Target
- 2030 Winter/Spring Day
- Existing Solar (8% of 2030 Target)
- 15% of 2030 Target

- Reduced Thermal Unit Minimums
- Thermal Unit Ramp Up
- Thermal Unit Ramp Down
- TEP Coal minimum (reduced with retirements)
- No Peak Contribution
Flexible Generation Resources

- **Natural Gas Combined Cycle Generation**
  - Backstop for coal plant retirements
  - Low cost, efficient, fast-ramping resources
  - $300/kW purchase price

- **Natural Gas Reciprocating Internal Combustion Engines (RICE)**
  - Fast-ramping resource for renewable integration (starts in 2 minutes, full load in 5 minutes)
  - Low water consumption
  - 200 MW online in 2019
Future...

- **100 MW Wind – COD 2020**
  - NextEra Energy Resources
  - New Mexico wind
  - Existing Transmission Capacity

- **100 MW Solar + 30 MW Energy Storage – COD 2020**
  - NextEra Energy Resources
  - Sub-$30 per MWh for solar energy
  - 4-hour duration storage

- **Wind RFP**
  - 100-150 MW
  - Closed, Currently reviewing bids
  - 7 respondents
Future...

- **Energy Storage Task Force**
  - Identifying use cases for future storage up to 70 MW
  - Solutions looking for problems
  - Batteries can do a lot of things, but only 1 or 2 really well

- **Arizona Energy Modernization Plan**
  - 80% Clean Resources by 2050
  - 3,000 MW of storage
    - Batteries, pumped, compressed air, etc.
    - 2,000 pumped-storage hydro in development – Big Chino
  - Biomass
    - 50,000 acres per year ~80 MW per year
  - Electric Vehicles
  - Revamped Energy Efficiency

- **NextGen Ballot Initiative**
  - 50% by 2030
  - 10% Distributed Generation carve-out
Thank you!

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