Information Current as of May 2019

Except as expressly noted, the information in this presentation is current as of May, 2019 —and should not be relied upon as being current as of any subsequent date. PGE undertakes no duty to update the presentation, except as may be required by law.

Forward-Looking Statements

Statements in this news release that relate to future plans, objectives, expectations, performance, events and the like may constitute “forward-looking statements” within the meaning of the Private Securities Litigation Reform Act of 1995, Section 27A of the Securities Act of 1933, as amended, and Section 21E of the Securities Exchange Act of 1934, as amended. Forward-looking statements include statements regarding earnings guidance; statements regarding the expected capital costs for the Carty Generating Station and the recovery of those costs; statements regarding future load, hydro conditions and operating and maintenance costs; statements concerning implementation of the company’s integrated resource plan; statements concerning future compliance with regulations limiting emissions from generation facilities and the costs to achieve such compliance; as well as other statements containing words such as “anticipates,” “believes,” “intends,” “estimates,” “promises,” “expects,” “should,” “conditioned upon,” and similar expressions. Investors are cautioned that any such forward-looking statements are subject to risks and uncertainties, including reductions in demand for electricity; the sale of excess energy during periods of low demand or low wholesale market prices; operational risks relating to the company’s generation facilities, including hydro conditions, wind conditions, disruption of fuel supply, and unscheduled plant outages, which may result in unanticipated operating, maintenance and repair costs, as well as replacement power costs; failure to complete capital projects on schedule or within budget, or the abandonment of capital projects, which could result in the company’s inability to recover project costs; the costs of compliance with environmental laws and regulations, including those that govern emissions from thermal power plants; changes in weather, hydroelectric and energy markets conditions, which could affect the availability and cost of purchased power and fuel; changes in capital market conditions, which could affect the availability and cost of capital and result in delay or cancellation of capital projects; the outcome of various legal and regulatory proceedings; and general economic and financial market conditions. As a result, actual results may differ materially from those projected in the forward-looking statements. All forward-looking statements included in this news release are based on information available to the company on the date hereof and such statements speak only as of the date hereof. The company assumes no obligation to update any such forward-looking statement. Prospective investors should also review the risks and uncertainties listed in the company’s most recent annual report on form 10-K and the company’s reports on forms 8-K and 10-Q filed with the United States Securities and Exchange Commission, including management’s discussion and analysis of financial condition and results of operations and the risks described therein from time to time.
PGE at a Glance

Quick Facts:

- Vertically integrated electric company encompassing generation, transmission and distribution
- 51 Oregon incorporated cities serving ~885,000 customers\(^{(1)}\)
- 46% of Oregonians
- 75% of Oregon’s commercial and industrial activity

Financial Snapshot\(^{(2)}\):

Revenue: $2.0 billion

Earnings per share: $2.37

Net Utility Plant Assets: $6.9 billion

(1) As of 12/31/2018
(2) As of 12/31/2018
100% regulated utility

High-growth service area

Investing in a reliable and clean energy future

Focusing on operational effectiveness and efficiency

Delivering exceptional customer experience

Building a smarter and more resilient grid
Smart Grid
A vertically integrated grid in operation for last 125 years
What is Smart Grid?

- A modern power generation and distribution infrastructure which can automate and manage the increasing complexity and needs of electricity in the 21st century
  - Support and Integrate renewable energy sources
  - Empower Customer with real-time information about their energy consumption
  - Assist utilities to reduce outages

- Traditional generation is very much needed, but augmented by distributed generation in the form of wind, solar, EV and other customer owned generation sources which can also be sold back to the utility
Drivers for Smart Grid

- **Grid reliability**
  - Aging assets, heightened load

- **Environment**
  - Global climate concerns
  - State mandates for green power

- **Energy Security**
  - Homeland security
  - Dependence on foreign oil

- **Customer Choices**
  - Growing needs and expectations
  - Desire for greater flexibility and options
Energy Transformation is Accelerating

Disruption is a prevailing and un-compromising threat to our industry.

Multiple megatrends underpin utility industry transition:

1. Greater customer choice and demand for more (sustainable) energy options
2. Increased policies and regulations to reduce carbon emissions
3. Shifting power-generating sources
4. Search for shareholder value: new ventures and increased M&A
5. Regionalization of energy
6. Merging of mega industries around growth opportunities
7. Replacement of old infrastructure and transition toward an increasingly clean, decentralized and intelligent grid architecture:

Source: Navigant Research
A Smart Grid influenced Utility

- Energy storage devices
- Local power generation
- Digital sensors and controls
- Real-time data
- Real-time price signals
- Broadband communications

A electrical network influenced by digital intelligence

- Smart Homes
- Smart Buildings
- Electric transportation
Why do we need it?

- Make renewable power feasible
  - Policies, Affordability

- Equip the grid to meet increasing energy demands

- Decrease the likelihood of burnouts, blackouts and surges
  - Overhaul aging equipment
  - Capacity of equipment to handle distributed generation

- Reduce the cost of energy consumption and production
  - Less dependency on fossil fuels, nuclear
  - Increase dependency on renewable generation such as PV, Wind

- Give consumers near real-time information and control over their energy bills

- Adoption of Electrification for building and transportation

- Societal Awareness and Regulations
  - Decarbonization, Zero Net Energy Homes, GHG Reduction
Smart Grid Benefits

**Environmental**
- Lower emissions (carbon footprint)
- Reduce need for peaking plants
- Optimize existing assets
- Easier integration of renewables
- Speed acceptance of alternative transportation

**Consumer**
- Increased energy efficiency/conservation options
- More reliable service
- Heightened satisfaction
- Cost savings

**Employee**
- Better ways to get the job done through technology
- More attractive workplace
- Better data for operations and decision making
- Improved plant safety/security

**Investor**
- Additional opportunities for revenue and return
- Deferral of capital spending
- Shared risk model for funding
- Reputation as innovative, environmental company
Smart Grid – Domain Areas

Source: NIST Smart Grid Framework 1.0 Sept 2009
Goal: Merge Communication and Energy Networks
Enabling an Integrated and Flexible Distribution Grid
Primary focus areas

- **Foundational**
  - Network Communications
  - Cyber Security
  - Grid Management Systems
  - Geographical Information System
  - Grid Analytics
  - Planning & Engineering Tools

- **Distribution Automation**
  - Intelligent and Self Learning
  - Automated Devices

- **Generation**
  - PV, Microgrids, Energy Storage

- **Electric Transportation**
  - Building Electrification
  - Transportation Electrification

- **Customer Focused**
  - Grid Interconnection
  - Energy Efficiency Offerings
  - Demand Response Programs
Technology Trends – Network Comms

**NOW**
- Wide Area Network
  - Typically a 2-wire copper
  - Connected to modems
  - Ethernet based or fixed lines

- Field Area Network
  - Usually microwave radio or cell net

- Neighborhood Area Network
  - Nearly non existent

**GOING FORWARD**
- Wide Area Network
  - MPLS
  - Fiber based network
  - Low Latency

- Field Area Network
  - Unlicensed Spectrum
  - Private Network
  - FirstNet
  - 4G/5G Network

- Neighborhood area network
  - Zigbee,
  - 802.15.4
  - 2030.5 for direct devices
Technology Trends – Grid Management Systems

**NOW**
- Stand alone Energy Management, Distribution Management and Outage Management Systems
- Leveraged hardwired devices
- Heavily dependent on human interface and intelligence

**GOING FORWARD**
- Integrated Advanced Distribution Management Systems supporting Distribution Management functions and Outage Management functions
- A new module or solution to operate Distributed Energy Resources called “DERMS”
- Cloud based DERMS solutions such as enbala, Autogrid et al.
- A variety of data sources from cloud providers such as weather data, demographics data, economic data will be integrated
- Complex modeling software solutions that heavy lift forecasting and modeling functions
- Will utilize field devices to predict and localize outages
For the Grid to operate reliably, an accurate and accessible geographical information system based electric network model is important.

**NOW**
Traditionally, mappers update the data in a system and maps are produced in schematic forms which are imported into EMS, DMS.

**GOING FORWARD**
An up-to-date model of geographic network representation of the circuits and all attributes includes sizes of conductors, impedance, and all network components are modeled.

Integrated with micro-climates, traffic, fire, telematics, weather and geological information are imperative to operate distributed grid.
Due to the large implementation on “Internet Protocol” based devices and equipment’s on the electrical network, the network is vulnerable to the “man in the middle”

Extensive cyber security solutions are in play to secure the grid

- Malware Management
- Vulnerability Management
- Access Control
- Data Protection
Distribution Automation

Distribution Automation enables a safe, reliable, state of the art, and cost effective distribution automation system to reduce customer minutes of interruption, enhance system operations, and improve system reliability.

Examples are

- Remote Control Switches / Remote Intelligent Switches
- Remote Automatic Reclosers
- Remote Transmission Switches
- Programmable Capacitor Controls replacing Distribution Capacitor Banks
- Remote Fault Indicators
Customer Focused Programs

- **Energy Efficiency programs**
  - Work with Cities and Municipalities to offer innovative programs to promote renewables
  - Cities are self-certifying as “Renewable and carbon free” cities to attract new generation residents
  - Utilities to be Inter-linked with Alexa, NEST & Google Home to offer energy efficiency services
  - Intelligent Devices interact each other to coordinate EE programs

- **Demand Response Programs**
  - Demand Response as a Service; Utilities work with aggregators to offer DR programs
  - Packaged and Time of Use Rate based DR programs
  - Heat Pumps, Pool Management, A/C Management, Voltage Management
Storage and Electrification

- **Storage**
  - Batteries are getting cheaper
  - Grid Scale Storage
  - Leverage Residential Storage to offset immediate need
  - Utility scale storage near substations to balance frequency

- **Electrification**
  - Cities move towards cleaner energy transportation
  - Logistics companies are making the change
  - New Building codes demand more energy efficient programs and offerings
Value Shift – To Distribution and Behind the Meter

- Less asset-based, central power generation
- Increased investment in grid modernization and intelligence
- Energy Cloud platforms with energy & non-energy services

Disruptors are cash-heavy, with a keen focus on innovation & customer relationships.

Source: Navigant Research
Future Trends

- **Energy as a subscription service**
  - Buy blocks of preferred energy
  - Use when you need to want
  - Buy Renewable Credits

- **Leverage Block chain to**
  - Track renewables from generation to usage
  - NY residents use Block Chain to transact solar energy (pilots)
  - Authenticate billing for EV charging stations
  - Easily implementable in Microgrids for transactions and settlement
  - Central capability for a Transactive Energy Market

- **Utilities need to transform/act as a “Technology Company”**

- **Vehicle to Grid (V2G), Building to Grid (B2G), Internet of Energy (central distribution) are a reality, not a myth**
A great place, and time to be in utilities industry; remember Telcomm went through this in early 90s.

It won’t happen all at once:
- Smart Grid will be an evolution with long-term implications

Start up costs are high; but savings expected in the long run

Solid focus will remain on customer choice

New non traditional energy players will emerge and consolidate

Prepare to change;
- Don’t resist; instead absorb and accommodate
Portland’s public mass transit agency TRIMET and PGE just launched an all-electric bus powered by wind energy.
Questions & Contact

- Contact

Ananth Sundaram  
Chief Architect – Integrated Grid  
Portland General Electric  
[Ananth.Sundaram@pgn.com](mailto:Ananth.Sundaram@pgn.com)  
626-483-4856
- BACKUP Slides
A different Customer

- Added green power sources
- Plug-in hybrid electric cars
- Real-time and green pricing Signals
- Smart thermostats, appliances and in-home control devices
- Customer interaction with utility
- High-speed, networked connections
Changing the Face of the Grid

Real-time Simulation

Wide-Area Reliability

Network Optimization

Customer Participation

Participation in Energy Markets

Source: EPRI IntelliGrid