Agenda
- IRP process review
- Load forecast
- Streamflow forecast
- Hydro production forecast
- Hydro climate change modeling results
- PURPA forecast and assumptions
- Natural gas price
Important Notice

Some of the information discussed during today’s meeting may be confidential (for business or securities law reasons) or competitive (for anti-trust law reasons). Thus, please treat as confidential and sensitive the information provided by Idaho Power during this meeting, unless and until Idaho Power itself discloses the information publicly.

If you are uncertain whether information is either confidential or competitive, or whether any particular information has been publicly disclosed, please ask. Adhering to this practice helps protect both you and Idaho Power.
How is Reliability Assessed?

1. Energy
2. Peaking capacity
3. Flexible capacity
Energy (Monthly)

1,800 MW annual avg
15.8 million MWh

1,400 MW April avg
1.0 million MWh

2,550 MW July avg
1.9 million MWh
Flexible Capacity

MW customer load
Duck Curve
March 26–30, 2018
Add Wind to the Net Load

- Load net Solar
- Load net Solar and Wind
Reliability Today
Idaho Power Generation Mix
(2017 Data)

Idaho Power Company

- Hydroelectric: 49.54%
- Natural Gas: 8.37%
- Long-Term Purchases: 18.71%
- Coal: 18.28%
- Other Purchases: 5.10%

National Average

- Natural Gas: 31.7%
- Nuclear: 20.0%
- Coal: 30.1%
- Hydroelectric: 7.5%
- Other: 0.5%
- Non-Hydro Renewables: 9.6%
- Fuel Oil: 0.5%

Data Source: U.S. Energy Information Administration
July 7, 2017
Boise Temperature 102°F

3,422 MW
July 7, 2017
Resource Stacking
January 6, 2017
Boise Temperature -11°

[Graph showing energy production sources and statistics]
IRP Steps

Forecast the needs of Idaho Power’s system (energy, peaking capacity, and flexible capacity).

Examine current supply- and demand-side resources.

Determine whether Idaho Power’s current resources will meet forecasted system needs.

If not, determine what resources Idaho Power can use to make up shortfalls.

Determine which combination of existing and new resources is best to serve future system needs, based on the goals.
Idaho Power’s Integrated Resource Plan (IRP) examines the demand for energy over the next 20 years and the best ways to meet that demand for our customers. The plan is updated every two years and includes a series of public meetings that help guide our planning process. The 2017 IRP was submitted to the Idaho Public Utilities Commission and the Public Utility Commission of Oregon in June 2017.
2019 IRP Sales and Load Forecast

October 11, 2018
Idaho Power System Overview

2017 Billed Sales: 14,634 GWh

All-Time Summer System Peak: 3,422 MW (07/07/17)

All-Time Winter System Peak: 2,527 MW (01/06/17)

2017 Customers: 545,067
Agenda

• Executive Summary
  – 2019 Forecast
  – Summary Growth Rates
  – System Sales/Peak Graphics

• Economic Outlook

• Class Sales Forecasts

• Peak Forecast

• Risk Assessments
Executive Summary

- **Sales forecast** nears 17,850 GWh by 2038, **1.0% CAGR**
- Annual **peak forecast** above 4,500 MW by 2038, **1.2% CAGR**
- Sales **growth consistent** with 2017 IRP
- **Long-term customer growth at 1.7%**, nearly 775,000 customers by 2038
## Composite Executive Summary

### Composition of Operational and Financial Change Statistics from 2017 IRP

<table>
<thead>
<tr>
<th></th>
<th>OPERATIONAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Peak Impact by 2038 (MW)</td>
</tr>
<tr>
<td>(1) Residential</td>
<td></td>
</tr>
<tr>
<td>(2) C/I Sales</td>
<td></td>
</tr>
<tr>
<td>(3) Irrigation</td>
<td></td>
</tr>
<tr>
<td>(4) Special Contracts</td>
<td></td>
</tr>
<tr>
<td>TOTAL OF CHANGES</td>
<td>(205) MW</td>
</tr>
</tbody>
</table>

¹ Twenty year growth represents 2019-2038
## Summary Sale Growth Rates

### Historic and Forecasted Billed Sales Growth Rates by Year

<table>
<thead>
<tr>
<th></th>
<th>History (weather adjusted)</th>
<th>2019 IRP Forecast</th>
<th>5-yr Growth</th>
<th>20-yr Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System Sales</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(x Irr/Spec)</td>
<td>(1.1)%</td>
<td>1.2%</td>
<td>0.8%</td>
<td>1.3%</td>
</tr>
<tr>
<td><strong>System Sales</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(x Irr/Spec)</td>
<td>(0.2)%</td>
<td>0.8%</td>
<td>1.7%</td>
<td>0.7%</td>
</tr>
</tbody>
</table>

*Includes 8 months of actuals and 4 months of forecast.
Peer and Western Utility Growth Rates

Historic System Sales 5-year CAGR (2012-2016)

Source: FERC Form 1 filings through 2016
System Customer Forecast

System Customer Growth (12-month change)
Macroeconomic Drivers
Economic Headlines

Headline Statistical Economic Considerations

• **Strongest immigration rate in country** (big impact)

• **Housing permits over 9k/yr** in service territory, slight ebbing

• Idaho **labor market** remains robust compared to U.S. average at **3.2% job growth**.

• Idaho economy ranks **2nd in the nation** in year-over-year personal income growth.
Net Migration at the Wheel

State Rankings of Net Migration Rates

Note: 2017 top 10 not pictured South Carolina (3), Florida (8), and North Carolina (10)
Housing Continues Strong Showing

12 Month Rolling Single- and Multi-Family Housing Permits

Source: Ada County, Adams County, Bannock County, Bingham County, Blaine County, Boise County, Canyon County, Cassia County, Elmore County, Gem County, Gooding County, Jerome County, Oneida County, Payette County, Twin Falls County, and Valley County reported permit data through 07/31/2018
Labor Market Update

Idaho and National Employment Growth

Labor Sectoral Contributions

Idaho Private Employment Growth Sectoral Contributions Relative to National

<table>
<thead>
<tr>
<th>Industry</th>
<th>Idaho Growth Rate</th>
<th>US Growth Rate</th>
<th>Trend (Q117-Q118) (ID vs US)</th>
<th>US Avg Hr Wage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial Activities</td>
<td>4.5%</td>
<td>1.7%</td>
<td></td>
<td>34.67</td>
</tr>
<tr>
<td>Leisure and Hospitality</td>
<td>3.9%</td>
<td>2.0%</td>
<td></td>
<td>15.49</td>
</tr>
<tr>
<td>Education and Health Care</td>
<td>3.9%</td>
<td>2.1%</td>
<td></td>
<td>26.91</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>3.7%</td>
<td>1.9%</td>
<td></td>
<td>28.26</td>
</tr>
<tr>
<td>Construction</td>
<td>3.5%</td>
<td>3.4%</td>
<td></td>
<td>29.69</td>
</tr>
<tr>
<td>Professional/Business Serv.</td>
<td>3.2%</td>
<td>2.3%</td>
<td></td>
<td>32.29</td>
</tr>
<tr>
<td>Transportation/Utilities</td>
<td>2.5%</td>
<td>2.9%</td>
<td></td>
<td>24.33</td>
</tr>
<tr>
<td>Wholesale</td>
<td>2.3%</td>
<td>1.1%</td>
<td></td>
<td>30.36</td>
</tr>
<tr>
<td>Retail</td>
<td>0.7%</td>
<td>0.3%</td>
<td></td>
<td>18.68</td>
</tr>
<tr>
<td>Information Services</td>
<td>(0.5)%</td>
<td>(1.0)%</td>
<td></td>
<td>39.31</td>
</tr>
</tbody>
</table>

## Overall Regional/Idaho Personal Income

### Percent Change in Personal Income – Top 10 States (percent change from 17Q1 to 18Q1)

<table>
<thead>
<tr>
<th>RANK</th>
<th>STATE</th>
<th>CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Washington</td>
<td>6.0%</td>
</tr>
<tr>
<td>2</td>
<td>Idaho</td>
<td>5.0%</td>
</tr>
<tr>
<td>3</td>
<td>Utah</td>
<td>4.9%</td>
</tr>
<tr>
<td>4</td>
<td>Oregon</td>
<td>4.6%</td>
</tr>
<tr>
<td>5</td>
<td>New York</td>
<td>4.5%</td>
</tr>
<tr>
<td>6</td>
<td>California</td>
<td>4.5%</td>
</tr>
<tr>
<td>7</td>
<td>Colorado</td>
<td>4.4%</td>
</tr>
<tr>
<td>8</td>
<td>Arizona</td>
<td>4.3%</td>
</tr>
<tr>
<td>9</td>
<td>Nevada</td>
<td>4.1%</td>
</tr>
<tr>
<td>10</td>
<td>Florida</td>
<td>3.8%</td>
</tr>
</tbody>
</table>

### Percent Change in Personal Income – Bottom 10 States (percent change from 17Q1 to 18Q1)

<table>
<thead>
<tr>
<th>RANK</th>
<th>STATE</th>
<th>CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>New Hampshire</td>
<td>2.4%</td>
</tr>
<tr>
<td>42</td>
<td>Nebraska</td>
<td>2.2%</td>
</tr>
<tr>
<td>43</td>
<td>Kansas</td>
<td>2.2%</td>
</tr>
<tr>
<td>44</td>
<td>Vermont</td>
<td>2.2%</td>
</tr>
<tr>
<td>45</td>
<td>Arkansas</td>
<td>2.0%</td>
</tr>
<tr>
<td>46</td>
<td>New Mexico</td>
<td>2.0%</td>
</tr>
<tr>
<td>47</td>
<td>Iowa</td>
<td>2.0%</td>
</tr>
<tr>
<td>48</td>
<td>Louisiana</td>
<td>1.9%</td>
</tr>
<tr>
<td>49</td>
<td>Mississippi</td>
<td>1.9%</td>
</tr>
<tr>
<td>50</td>
<td>South Dakota</td>
<td>1.8%</td>
</tr>
</tbody>
</table>

Source: U.S. Bureau of Economic Analysis (BEA). Data Table SQ4: Personal Income by Major Component. Actual data through Q118. US Q171 to Q118 growth 3.6%. 
Class Forecasts
Residential Overview

Residential Sales (000's MWh)

- 2019 IRP
- 2017 IRP
- Weather Adjusted

Key Trends:
- 2004-08: 3.1%
- 2009-11: (0.7)%
- 2012-18: 0.3%
- 2019-38: 1.2%
- 2019-38: 1.1%
Residential Modeling

- **Residential Customer Model**
- **Residential Customer Forecast**
- **Residential Use Per Customer Model**
- **Residential Use Per Customer Forecast**

**Data Inputs:**
- Economic Data
- Utility Data
- Appliance/Usage Data (EIA)
- Weather Data

**Forecast:**
- Residential Sales Forecast

**Architecture:** SAE Framework
- Training Start = 2008
- Dependent Variable = Monthly Sales
Residential Usage Drivers End-Use Modeling

Use Per Customer Forecast

Sources of Increases
- Larger Home Size
- AC Saturation
- Plug-ins
- Household Income

Sources of Decreases
- Lighting
- App Efficiency/Bldg Codes
- Single/Multi-family Shares
- Gas/Electric Share
- EE/Rooftop Solar
Residential Use Per Customer

Use Per Customer Forecast (weather-adjusted kWh per customer)

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2013</td>
<td>2017</td>
</tr>
<tr>
<td>MWh/yr</td>
<td>12.0</td>
<td>11.5</td>
</tr>
</tbody>
</table>

- Homes built after 2000 used, on average, 5%-10% less electricity than homes built before 2000.
- Replacement cycle of old appliances plays out in UPC forecast. No major code change beyond lighting.
- Potential for increased impact from customer generation under current rate design.
Commercial and Industrial Sales

Commercial and Industrial Sales (000’s MWh)

2004-08: 1.8%
2009-11: 0.2%
2012-18: 1.1%
2019-38: 0.9%
2019-38: 0.7%
C/I Modeling Process

**IPC Industrial Sales Forecast**

**IPC Aggregate C/I Sales Forecast**

**IPC Commercial and Industrial**

**Industrial Mfg. Model**
**Industrial Services Model**
**Irregular Industrial Models**
**Comm. Mfg. Model**
**Comm. Services Model**
**Comm., Large Mfg. Model**
**Comm. Large Services Model**

**Utility Data**
**Economic Data**
**Weather Data**

Architecture = Econometric
Training Start = early 1990’s
Dependent Variable = Annual Sales

Architecture = Econometric
Training Start = early 2000’s
Dependent Variable = Annual Sales
C/I Sales by Category – Manufacturing

Segment Growth Rates in Mfg.-Based Industries

- Historic
- Future

Segment Contributions to Sales

1. Historic represents the actual average annual growth rate from 2014-2018
2. Future represents the forecasted average annual growth rate from 2019-2023
3. Does NOT include impacts of DSM programs
C/I Sales by Category – Services

Segment Growth Rates in Service-Based Industries

- Historic
- Future

<table>
<thead>
<tr>
<th>Industry</th>
<th>Historic</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office/Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Segment Contributions to Sales

- 2017:
  - Education: 20%
  - Health: 21%
  - Retail: 15%
  - Office/Other: 44%

- 2023:
  - Education: 19%
  - Health: 24%
  - Retail: 15%
  - Office/Other: 43%

1. Historic represents the actual average annual growth rate from 2014-2018
2. Future represents the forecasted average annual growth rate from 2019-2023
3. Does NOT include impacts of DSM programs.
Recent Commercial EE Headlines

City of Fruitland Earns More than $200,000 for Energy Efficiency
July 23, 2018
FRUITLAND, Idaho — This week designing and installing a new wastewater treatment plant, the City of Fruitland has received a Idaho Power energy efficiency incentive check for $208,620.30. The Fruitland City Council will accept the check during its next meeting.

Fruitland's new wastewater treatment plant is an innovation in itself. It replaced two outdated lagoon systems. The new facility is more efficient as well as more economical. In addition, the city is using a new technology called VPER, which stands for Variable Pressure Effluent Reuse System. This technology helps to reduce the amount of wastewater that needs to be treated.

The upgrades save the City of Fruitland energy and money by reducing the amount of wastewater that needs to be treated. This is a significant achievement for the city, and it is a clear example of how energy efficiency can help communities save money and reduce their environmental impact.

Ash Grove Cement Earns Energy Efficiency Incentive
September 11, 2017
Idaho Power presented Ash Grove Cement with an incentive check for $132,797.75 for its commitment to energy efficiency. Ash Grove Cement has been a long-time energy efficiency leader and received an additional $75,415.00 in incentives from Idaho Power’s Commercial and Industrial Efficiency Program.

Ash Grove replaced approximately 1,300 light fixtures with more energy-efficient LED fixtures. The improved lighting not only reduces energy use and maintenance costs but also improves the overall lighting environment. These upgrades also provided major benefits for the facility and the people working there.

Idaho Power’s energy efficiency incentives program is designed to help businesses save energy and money by making energy-efficient upgrades. Idaho Power has invested more than $86 billion on energy—more than $1.6 billion annually. The company has completed more than 1,300 projects encompassing everything from lighting upgrades to process changes. In total, the district has saved 13.6 million kWh, which is equivalent to a savings of more than $550,000 in energy costs and a reduction in CO2 emissions of more than 85 million pounds.
C/I Sales - Historical Impact of EE

Historical Energy Efficiency Acquisition in Commercial and Industrial

- Reconstitution of direct impact from company sponsored EE to C/I sales only.
  Does not include other considerations such as expansions from additional capital investment at plant or impacts of federal rulemakings etc.
- Portion of Small Commercial (R.107) carries minimal impact (<5%) on total C/I sales
Special Contracts Sales Forecast

**Forecast Notes**

- Expectations of future growth and/or energy consumption **telegraphed by customers** as per qualification for categorization.

- Special contracts forecast (Micron, Simplot, and INL) below realized energy past several years. **IPC adjusted customer submitted forecast downward** to accommodate.

- Site load forecasts configured as per communications with customer engineers/managers.
Irrigation Sales Forecast

Probability band suggests 10% chance sales will be higher or lower by 225 GWh due to weather.

Main drivers for potential variance include temperatures and \textit{precipitation, crop prices, agricultural output, and crop cycle water intensity} (alfalfa and corn).

Slightly below 16-year trend, but weather-normalized 2018 actuals launch off of new point.
Customer Generation and EV Forecasts

Customer Generation (Net Metering)

<table>
<thead>
<tr>
<th>Customer Gen. Forecast</th>
<th>2019</th>
<th>2023</th>
<th>2028</th>
<th>2038</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>5,017</td>
<td>17,134</td>
<td>28,286</td>
<td>49,858</td>
</tr>
<tr>
<td>Commercial</td>
<td>176</td>
<td>335</td>
<td>624</td>
<td>1,504</td>
</tr>
<tr>
<td>Energy Reduction – in aMW</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>-0.8</td>
<td>-11.0</td>
<td>-19.5</td>
<td>-37.9</td>
</tr>
<tr>
<td>Commercial</td>
<td>-0.0</td>
<td>-0.4</td>
<td>-1.2</td>
<td>-3.5</td>
</tr>
</tbody>
</table>

- Rate of change nonlinear regression model used for customer count independent variable
- Modeled the impact of rooftop solar (NM) on the sales forecast, **avg reduction in summer billing demand ~8%**
- Customer count as of Jun 2018 for residential: over 2,100

IPC Battery Electric Vehicle (BEV) Forecast

- Forecast utilizes population/migration model for flows into Ada county from neighboring states.
- 2023 has over 1,100 vehicles impact system load ... **not significant in near term at 3,375 kWh/yr/car**
- Forecast represents BEV only (historic forecast adjusted to reflect BEV only).
Peak Forecast
System Peak Forecast Contributions

Customer Class Compositional Analysis of System Coincident Peak (MW) at 90th

- 2019:
  - Resi: 42%
  - Com: 23%
  - Ind: 11%
  - Irr: 20%
  - Oth: 4%
- 2038:
  - Resi: 44%
  - Com: 24%
  - Ind: 10%
  - Irr: 19%
  - Oth: 4%

Customer Class System Coincident Peak 20-year (2019-2038) Growth Rates

- Total
- Resi
- Com
- Ind
- Irr
- Oth
System Peak Forecast Design

Training Period = 25 years
Historic/Forecasted Energy Sales
Peak Day Temperature
Peak Day Precipitation
30-yr Trended Temperature

Neural Network
Legacy Load Shapes
Customer Class

Linear Node
Heating Node (Sigmoid)
Cooling Node (Sigmoid)

Forecasted Monthly Peaks
Hourly Sales Forecast LT
Historic Monthly System Peaks

Monthly system peaks sorted by era and average daily temperature

System monthly peaks organized by era and season

Dominate summer peaking utility currently whereas, growth and level consistent 1980’s to 1990’s between summer and winter seasons

Since 2000, growth in summer peak more aggressive
Historic System Load Factors

Time Series of Monthly Load Factors sorted by season

Load Factor = MWh / (MW * hrs in month)

As depicted in previous slide, Idaho Power is a summer-peak utility

On top of analytics on use per customer by month, month load factor of system develops similar picture.

Lower LF translates to “peaker” system, faster peak growth
Uncertainties
## Trade and Tariffs Impact in Idaho

### Select Export Products from Idaho

<table>
<thead>
<tr>
<th>Product</th>
<th>Export Value</th>
<th>Export Region</th>
<th>Original Tariff</th>
<th>New Tariff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kidney Beans</td>
<td>$8.1M</td>
<td>EU</td>
<td>0%</td>
<td>25%</td>
</tr>
<tr>
<td>Whey</td>
<td>$33.6M</td>
<td>China</td>
<td>2%</td>
<td>25%</td>
</tr>
<tr>
<td>Milk</td>
<td>$2.2M</td>
<td>China</td>
<td>20%</td>
<td>25%</td>
</tr>
<tr>
<td>Peas</td>
<td>$3.8M</td>
<td>China</td>
<td>0%</td>
<td>25%</td>
</tr>
<tr>
<td>Plywood, Veneer</td>
<td>$17.5M</td>
<td>Canada</td>
<td>0%</td>
<td>10%</td>
</tr>
<tr>
<td>Fungicides</td>
<td>$15.7M</td>
<td>Canada</td>
<td>0%</td>
<td>10%</td>
</tr>
<tr>
<td>Rooms Deodorizing</td>
<td>$19.1M</td>
<td>Canada</td>
<td>0%</td>
<td>10%</td>
</tr>
<tr>
<td>Bread, Pastry, Cakes</td>
<td>$8.6M</td>
<td>Canada</td>
<td>0%</td>
<td>10%</td>
</tr>
<tr>
<td>Sugar</td>
<td>$4.4M</td>
<td>Canada</td>
<td>0%</td>
<td>10%</td>
</tr>
<tr>
<td>Polymer Bags</td>
<td>$7.9M</td>
<td>Canada</td>
<td>0%</td>
<td>10%</td>
</tr>
<tr>
<td>Cheese</td>
<td>$14.3M</td>
<td>Mexico</td>
<td>0%</td>
<td>25%</td>
</tr>
<tr>
<td>Potatoes</td>
<td>$15.4M</td>
<td>Mexico</td>
<td>0%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Source: Idaho Department of Commerce, Idaho State Department of Agriculture
**Irrigation Considerations**

**Eastern Snake Plain Aquifer groundwater agreement**

Identified groundwater **wells affected by agreement** (approximately 3,000 sites) in Idaho Power’s service territory.

No adjustments made to **current forecast**, can identify sites, wait and see if materializes.

ESPA groundwater agreement built on several concepts: **Increase predictability**, manage overall demand, maximize recharge/withdrawal cycle.

Map Credit: Idaho Resource Water Board (ESPA)
Recap

• On balance, Idaho growth cycle continues
  – 20-year growth Sales: 1.0%, Peak:1.2%

• Strong Idaho economics
  – Population growth
  – Great mobility, Idaho labor, and balance sheets

• Residential use-per-customer decline perpetuated .... erodes ~(1-2)% per year
  – Residential UPC building off current year
  – Current lighting legislation has largest impact

• Commercial and industrial sales growth
  – Commercial class telegraphed by lagged growth pattern from residential
  – Watch large load expansions in 2020+, cannibalization, DSM, renewables

• Uncertainties
  – Tariffs and trade of dairy products in Idaho
  – Eastern Snake River Plain
  – Dynamic macroeconomic playing field
Overview

• Planning Flows
  – Model Development
  – Results

• Hydro Generation
  – Results

• Climate Change Risk Analysis
  – Federal Long-Term Planning Study Review
  – Idaho Power Modeling Results
Operations Hydrology (OH) Team

Power Supply, Tess Park

Power Supply Planning and Operations, Tom Harvey

Resource Planning and Operations, Mitch Colburn

Kresta Davis-Batts
Water Policy & Operations Hydrometeorology Specialist
CHQ - Sixth floor

David L. Blew
Hydrologist II
CHQ - Sixth floor

Frank Gariglio
Senior Engineer
CHQ - Sixth floor

Janak Timilsena
Engineer II
CHQ - Sixth floor

John Hildreth
Engineer II
CHQ - Sixth floor

Tim Brewer
Principal Engineer
CHQ - Sixth floor
Idaho Power Generating System

Hydroelectric Facilities and Nameplate Capacities
1. Hells Canyon 391.5 MW
2. Oxbow 190.0 MW
3. Brownlee 585.4 MW
4. Cascade 12.4 MW
5. Swan Falls 27.2 MW
6. C. J. Strike 82.8 MW
7. Bliss 75.0 MW
8. Lower Malad 13.5 MW
9. Upper Malad 8.3 MW
10. Lower Salmon 60.0 MW
11. Upper Salmon 34.5 MW
12. Thousand Springs 8.8 MW
13. Clear Lake 2.5 MW
14. Shoshone Falls 12.5 MW
15. Twin Falls 52.9 MW
16. Milner 59.4 MW
17. American Falls 92.3 MW
Total 1,709.0 MW

Thermal Facilities And Capacities
Coal
- Jim Bridger 770.5 MW*
- North Valmy 283.5 MW*
- Boardman 64.2 MW*
Total 1,118.2 MW

Natural Gas
- Bennett Mountain 172.8 MW
- Danskin 270.9 MW
- Langley Gulch 318.5 MW
Total 762.2 MW

Diesel
- Salmon Diesel 5.0 MW
Total 1,885.4 MW

*Note: Idaho Power share
Planning Flows Development

Objective:
To model exceedance probabilities of hydro generation for the next 20 years
Key Term

- Reach Gain

Reach Gain = 200 CFS – 100 CFS = 100 CFS
Three Primary Models

- Snake River Planning Model (SRPM) (Flow Depletion)
- Enhanced Snake Plain Aquifer Model 2.1 (ESPAM) (Groundwater)
- PDR580 (Hydro Generation)

Assumptions
- Spring discharge trends will continue, if no groundwater management occurred.
- Natural flow conditions from 1928-2009 are representative of future conditions.
- Diversion patterns have not changed significantly since 2009.
- Current reservoir management will continue into the future.
Snake River Planning Model

Figure 5. Schematic of Snake River system modeled by the SRPM.
2009 Conditioning SRPM

- IDWR completed an update of the model in 2012.
- Model uses reconstructed reach gains from 1928-2009.
- Reach gains are adjusted to 2009 levels for:
  - Irrigation Return Flows
  - Spring Discharges
- Diversion adjustments
  - Observed used for 1995-2009
  - Average of 1995-2009 diversions used from 1928-1994
Future Assumptions Influencing Water Supply

• Expected water management activities
  – Managed Recharge
    • IWRB
    • Private
  – Groundwater Pumping Reductions
  – System Conversions (groundwater supply converted to surface water supply)

• Weather Modification

• Reach Declines
  – Based on trend analysis (1988-2017)
Modeled Management Activities

EASTERN SNAKE PLAIN AQUIFER SEES LARGEST ANNUAL INCREASE IN WATER VOLUME IN MORE THAN 80 YEARS

NEWS RELEASE - FOR IMMEDIATE RELEASE JEROME, Idaho - (July 13, 2018) – The Eastern Snake Plain Aquifer (ESPA) experienced the single largest increase in water volume in more than 80 years – 1.7 million acre-feet – as a result of the Idaho Water Resource Board’s managed aquifer recharge program, farmers reducing water use, private aquifer-recharge efforts, increased tributary flows, and natural seepage from two back-to-back robust winter runoff years.
ESPA Modeling
ESPA Modeling

New Reach Gains

Diversions for Recharge

Milner Dam
2016 Settlement Agreement

Sentinel Well Locations: SWC - IGWA Settlement Agreement
System Conversions

Adopted from the Interim Mitigation Agreement between SWID-SWC

b. **Conversions:** SWID will provide surface water to convert, in total or in part, approximately 30,000 ground water irrigated acres within SWID’s boundary. Subject to water availability and delivery capability, SWID will attempt to accomplish not less than the following amounts of surface water conversion (identified by delivery system):

<table>
<thead>
<tr>
<th>District</th>
<th>Amount (acre-feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burley Irrigation District</td>
<td>23,100</td>
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<tr>
<td>Milner Irrigation District</td>
<td>12,630</td>
</tr>
<tr>
<td>Twin Falls Canal Company</td>
<td>6,500</td>
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<tr>
<td>West Cassia Pipeline</td>
<td>12,120</td>
</tr>
<tr>
<td>Total</td>
<td>54,350</td>
</tr>
</tbody>
</table>

Courtesy of Idaho Department of Water Resources.
Managed Recharge
Weather Modification
Weather Modification

- 2019 IRP assumptions:
  - Current level of weather modification in Payette
  - Expansion in the Upper Snake and Henrys Fork
  - Development and expansion in Boise and Wood River Basins
  - Full Build out reached in WY2024

<table>
<thead>
<tr>
<th>Water Year</th>
<th>Upper Snake</th>
<th>Henrys Fork</th>
<th>Wood River</th>
<th>Boise</th>
<th>Payette</th>
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</thead>
<tbody>
<tr>
<td>2019</td>
<td>280</td>
<td>145</td>
<td>113</td>
<td>229</td>
<td>212</td>
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<tr>
<td>2024</td>
<td>424</td>
<td>191</td>
<td>162</td>
<td>280</td>
<td>212</td>
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</table>
## Trend Analysis

<table>
<thead>
<tr>
<th>Reach Gain Location</th>
<th>Trend (cfs/year)</th>
<th>P-Value Less than 0.01</th>
<th>TFPW RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackfoot to Neely (Reach 57)</td>
<td>-21.1</td>
<td>TRUE</td>
<td>(-) TREND</td>
</tr>
<tr>
<td>Lower Salmon Falls To Bliss (Reach 67)</td>
<td>-17.0</td>
<td>TRUE</td>
<td>(-) TREND</td>
</tr>
</tbody>
</table>
Trend Analysis

Blackfoot to Neeley (Reach 57)

R² = 0.5866

Graph showing the flow rates in cubic feet per second (CFS) from 1986 to 2019, with a downward trend indicated by a linear regression line.
Trend Analysis

Lower Salmon Falls to Bliss (Reach 67)

R² = 0.3739
Water Management

Water Management Gains

- Reach Gains from SWC 2019
- Reach Gains from SWC 2017

Graph showing the trends of water management gains from 2018 to 2038.
Management Gain distribution
Weather Modification

![Graph showing weather modification data over time with 2019 and 2017 data points.](image-url)
Reach Gain Declines

The graph illustrates the decline in reach over the years from 2018 to 2038. The green line represents the decline in 2019, and the dashed green line represents the decline in 2017. The MAF (Measurable Audience Field) decreases steadily over the years, indicating a decline in reach.
Development of Exceedances

Snake River near Murphy, ID
Swan Falls May 2013

2013 Exceedance = \frac{\text{Years equal to or exceeding}}{\text{Total years}}

22 \text{ years} / 38 \text{ years} = 58\% \text{ Exceedance Probability}
Swan Falls July 2013

2013 Exceedance = (Years equal to or exceeding) / (Total years)

36 years / 38 years = 95% Exceedance Probability
Milner Results

Snake River at Milner
Water Year Exceedance Volumes
2017 IRP and 2019 IRP

Historical
2019 IRP 50%
2019 IRP 70%
2019 IRP 90%
2017 IRP 50%
2017 IRP 70%
2017 IRP 90%

Million Acre-Feet

Swan Falls Results

Snake River Near Murphy
Water Year Exceedance Volume
2017 IRP and 2019 IRP

Million Acre-Feet

Brownlee Results

Brownlee Inflow
Water Year Exceedance Volumes
2017 IRP and 2019 IRP

Million Acre-Feet

Monthly Results for 2024

Comparison of Monthly Exceedances
Year 2024 Brownlee Inflow

- IRP2019 50%
- IRP2019 70%
- IRP2019 90%
- IRP2017 50%
- IRP2017 70%
- IRP2017 90%
Planning Generation Results
Hydro in the IRP

Load
Energy Efficiency
Demand Response

Hydro

Thermal
Gas
Coal
Purchased Power
CSPP
PPA
Market Purchases
Surplus or (Deficiency)
New Resource Portfolio
Balanced System

Energy
70% Exceedance

Capacity
90% Exceedance
Annual Generation Results

Total Annual Hydropower Generation

- Historical
- 2019 IRP 50%
- 2019 IRP 70%
- 2019 IRP 90%
- 2017 IRP 50%
- 2017 IRP 70%
- 2017 IRP 90%
50% Hydropower Results

Total Annual Hydropower Generation, 2017 and 2019 IRP, 50% Exceedance

- 2017 IRP
- 2019 IRP
- MWH Increase

Generation (MWh)

Generation Increase (MWh)
70% Hydropower Results

Total Annual Hydropower Generation, 2017 and 2019 IRP, 70% Exceedance

- 2017 IRP
- 2019 IRP
- MWH Increase
90% Hydropower Results

Total Annual Hydropower Generation, 2017 and 2019 IRP, 90% Exceedance

- 2017 IRP
- 2019 IRP
- MWH Increase

Generation (MWH)

2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038
Monthly Hydropower Results
Climate change is a significant policy issue that will have major implications for Idaho Power and may transform the energy industry.

Policy and societal decisions made about climate change policy will significantly affect our customers and the future prices they pay for energy.

Idaho Power's nearly 100-year history is based on using clean, renewable generation resources like our hydroelectric plants that have little if any greenhouse gas emissions.

Although our generation portfolio does include fossil fuel generation, our carbon emissions are some of the lowest in the utility industry.
Federal Long-Term Planning Study

Climate and Hydrology Datasets for Use in the River Management Joint Operating Committee (RMJOC) Agencies’ Longer-Term Planning Studies

Part IV – Summary

Columbia River Forecast Group

Climate and Hydrology Datasets for RMJOC Long-Term Planning Studies: Second Edition (RMJOC-II)

Part I: Hydroclimate Projections and Analyses

June 2018

River Management Joint Operating Committee (RMJOC):
Bonneville Power Administration, United States Army Corps of Engineers,
United States Bureau of Reclamation

September 2011
Figure 15: Hydroclimate modeling process flowchart.

[Diagram showing the process flow from Global Climate Models to Hydraulic Modeling/Hydroregulation with a note: Not Covered in RMJOC-II Part 1]
Global Climate Models (GCM)
Adopted from Figure 17, relative error of 31 GCM’s for overall historical performance over the Pacific Northwest. The select 10 GCM’s to be used in study highlighted in Blue and Green.
Snake Basin GCM Results

Adopted from Figure 39, Modeled temperature and precipitation changes of 10 GCM’s for Snake River Basin above Lower Granite
Multivariate Adaptive Constructed Analogs Downscaling

Figure 15: Hydroclimate modeling process flowchart.

- Physical Processes in a Model
- Horizontal Grid (Latitude-Longitude)
- Vertical Grid (Height or Pressure)
- Statistical downscaling
- Physically based downscaling
- MACA - CMIP5 Future Climate Dataset

Precipitation, Annual
Higher Emissions (RCP 8.5), 2010-2030 mean
Downscaled Climate Projections

University of Idaho
VIC Hydrologic Modeling

Variable Infiltration Capacity (VIC) Macroscale Hydrologic Model

Grid Cell Vegetation Coverage

Cell Energy and Moisture Fluxes

Canopy
Layer 0
Layer 1
Layer 2

Variable Infiltration Curve

$\text{Infiltration Capacity} = \frac{Q}{w_f}$

$\text{Fractional Area} = \frac{w_f}{w_l + w_f + w_g}$

Baseflow Curve

$\text{Baseflow, } B \propto \frac{D_s}{D_t}$

$\text{Layer 2 Soil Moisture, } w_2$

RVIC Streamflow Routing Model

Development of Impulse Response Functions
1. Flow is routed to the edge of each grid cell using a point hydrograph
2. Each grid cell is represented as a node in the channel network
3. Flow from each grid cell in the basin is routed through network using velocity and diffusion parameters
4. Upscaling impulse response functions
5. Impulse response functions are developed on a high resolution grid
6. Impulse response functions are remapped to VIC grid (6x6 km)
7. Flow routing is performed on VIC grid
8. Flow is routed to the edge of each outlet
9. Convolution of IFF and runoff for all source points upstream of each outlet point produces a timeseries of streamflow at the outlet

Hydrologic Modeling (type, calibration)

Global Climate Models (temperature and precipitation)

Flow from the land surface model is combined.
Annual Natural Flow Results

Adopted from Figure 60 and 61, 10 RCP8.5 GCM annual volume change in natural streamflow Historic (1976-2005) to Future (2020-2049)
Adopted from Figure 64, 10 RCP8.5 GCM volume change by season in natural streamflow Historic (1976-2005) to Future (2020-2049)
Brownlee Natural Flow Results

Adopted from Figure 64, daily range of natural exceedance flows at Brownlee for RCP8.5 Historic (1976-2005) and Future 2030s (2020-2049)
IPC Regulated Streamflow Analysis

**Question:** How does projected future climate impact *regulated* streamflows for the Snake River basin above Brownlee?

**Model Criteria**
- Keep management practices the same in all model runs.
  - Isolate the effects from projected future climate (2020-2039).
- Use 2009 management practices as currently modeled in SRPM.
- Look at surface water component only.
  - Groundwater impacts are excluded (Not running ESPAM 2.1).
- Looking at the average impacts due to future climate.
  - Only averages are used in this analysis.
Natural Flow Dataset

- Selected 20 Locations in Snake Basin that contribute significant runoff
-Computed each reach gain from the natural flow dataset
Dataset Development
Dataset Development
Volume Change

Annual Volume increase of 20KAF
Timing Change

Monthly Percent = Monthly Volume / Annual Volume
SRPM Reach Gain Development

- Ignore future projections in the Malad, Owyhee, and Eastern Oregon basins.
- Modified the 1950-2009 SRPM reach gain file
  - Added the volume change to each year 1950-2009
  - Applied the timing change to each year 1950-2009
  - Applied these changes to each of the 20 reach gain locations
    - All other locations held at 1950-2009 calibrated reach gains
- Model runs
  - Run base case with no changes to the SRPM reach gain file.
  - Run 10 climate change scenarios for each RCP.
RCP4.5 Results

Brownlee Reservoir Average Monthly Inflow

- RCP45 10 Model Ensemble (2020-2039)
- RCP45 Monthly Max (2020-2039)
- RCP45 Monthly Min (2020-2039)
- Historic (1950-2009)
RCP4.5 Results

Brownlee Reservoir Average Monthly Inflow

- RCP4S 10 Model Ensemble (2020-2039)
- RCP4S Monthly Max (2020-2039)
- RCP4S Monthly Min (2020-2039)
- Historic (1950-2009)
RCP8.5 Results

Brownlee Reservoir Average Monthly Inflow

- RCP8.5 10 Model Ensemble (2020-2039)
- RCP8.5 Monthly Max (2020-2039)
- RCP8.5 Monthly Min (2020-2039)
- Historic (1950-2009)
RCP8.5 Results

Brownlee Reservoir Average Monthly Inflow

- RCP85 10 Model Ensemble (2020-2039)
- RCP85 Monthly Max (2020-2039)
- RCP85 Monthly Min (2020-2039)
- Historic (1950-2009)
Combined Results

Brownlee Reservoir Average Monthly Inflow

- **RCP8.5 10 Model Ensemble (2020-2039)**
- **RCP8.5 Monthly Max (2020-2039)**
- **RCP8.5 Monthly Min (2020-2039)**
- **RCP4.5 10 Model Ensemble (2020-2039)**
- **RCP4.5 Monthly Max (2020-2039)**
- **RCP4.5 Monthly Min (2020-2039)**
- **Historic (1950-2009)**

**Flow (cfs)**

- 45,000
- 40,000
- 35,000
- 30,000
- 25,000
- 20,000
- 15,000
- 10,000

**Dates:**
- 1-Oct
- 1-Nov
- 1-Dec
- 1-Jan
- 1-Feb
- 1-Mar
- 1-Apr
- 1-May
- 1-Jun
- 1-Jul
- 1-Aug
- 1-Sep
Future Climate Conclusions

• Reservoir regulation significantly dampens the effects from the shift in timing of runoff in the Snake River.

• Approximately six months of streamflow are relatively unaffected by future climate.
  – State minimum flow requirements, flood control rule curves, and state water right allocations really drive regulated flows in the Mid-Snake.

• The six months of streamflow affected by future climate show more water in the Mid-Snake in almost all models.
Questions?
Renewable Energy and Cogeneration and Small Power Production (CSPP) Forecasts

- Idaho Power PURPA Qualifying Facility Energy Sales Agreements (ESA)
  - PURPA ESAs
- Idaho Power Renewable Power Purchase Agreements (PPA)
  - Utility PPAs
PURPA

Public Utility Regulatory Policies Act

Act passed by Congress in 1978 creating a mandatory requirement that utilities such as Idaho Power must purchase the energy from any cogeneration or small power production (CSPP) facility that meets the definition of a qualifying facility (QF) and can deliver its energy to the utility.

Congress created the mandate, implemented by:

- Federal Energy Regulatory Commission (FERC)
- State Commissions
  - Idaho Public Utilities Commission
  - Public Utility Commission of Oregon
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<td>Hydro</td>
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<td>70</td>
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<td>461</td>
<td>17</td>
<td>298</td>
<td>19</td>
<td>316</td>
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<tr>
<td>Wind</td>
<td>22</td>
<td>447</td>
<td>27</td>
<td>577</td>
<td>32</td>
<td>627</td>
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<td><strong>101</strong></td>
<td><strong>682</strong></td>
<td><strong>109</strong></td>
<td><strong>831</strong></td>
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<td><strong>1,302</strong></td>
<td><strong>133</strong></td>
<td><strong>1,136</strong></td>
<td><strong>134</strong></td>
<td><strong>1,149</strong></td>
</tr>
</tbody>
</table>
PURPA Projects Under Contract as of October 01, 2018: 1,149 MW

- Solar Under Contract
  - OR: 76 MW
  - ID: 240 MW

- Wind Under Contract
  - OR: 53 MW
  - ID: 574 MW

- Cogen/Thermal Under Contract
  - OR: 21 MW
  - ID: 135 MW

- Hydro Under Contract
  - OR: 14 MW
  - ID: 33 MW

- Biomass Under Contract
  - OR: 3 MW
  - ID: 33 MW

PURPA Projects Under Contract and Operational as of October 01, 2018: 1,120 MW
PURPA projects under contract and associated nameplate rating (MW)

2017 IRP 1,136 MW

- Wind, 627
- Solar, 298
- Hydro, 155
- Biomass, 35
- Cogen, 21

2019 IRP 1,149 MW

- Wind, 627
- Solar, 316
- Hydro, 149
- Biomass, 36
- Cogen, 21
Forecasting of PURPA electricity production is very challenging

- Hourly forecasting and certainty
- New projects
  - Idaho Power has no control over PURPA project development, therefore Idaho Power does not include any assumptions as to what new PURPA projects may or may not materialize.
### Current Forecast – Annual Average MW Production

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual Average MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>104</td>
</tr>
<tr>
<td>2011</td>
<td>171</td>
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<tr>
<td>2012</td>
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<td>2037</td>
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<tr>
<td>2038</td>
<td>338</td>
</tr>
</tbody>
</table>
Renewable Energy PPAs

In addition to the 1,149 MW of PURPA projects, Idaho Power has utility PPAs with three other renewable energy projects.

- Elkhorn Valley Wind Project 101 MW
- Raft River Geothermal Project 13 MW
- Neal Hot Springs Geothermal Project 22 MW

These resources were identified in prior year IRP processes, RFPs were issued, and these were the successful projects.
# Renewable Energy PPAs

## Current Forecast – Annual Average MW Production

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual Average MW</th>
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</thead>
<tbody>
<tr>
<td>2010</td>
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<tr>
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<tr>
<td>2038</td>
<td>64</td>
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</tbody>
</table>

The graph shows the historical data and forecast data for annual average MW production. Historical data is shown in blue, and forecast data is shown in green.
Renewable Energy and Cogeneration and Small Power Production (CSPP)

Questions and Comments

Idaho Power Energy Contracts Team
– Michael Darrington
– Jerry Jardine
– Toby Wilson
– energycontracts@idahopower.com
Natural Gas Price

IRP Advisory Council Meeting
October 11, 2018
Natural Gas Price Forecasts $/MMBtu

- EIA-2018 REF
- EIA-2018 HOG
- EIA-2018 LOG
- 17 IRP (2016 EIA HOG)
- 2018 Market
- EIA-2016 REF
- EIA 2016 REF
- EIA 2018 REF
- EIA 2018 LOG
- EIA 2018 HOG
- 2018 Market

Year: 2019, 2021, 2023, 2025, 2027, 2029, 2031, 2033, 2035, 2037

Price Level: $2.00, $4.00, $6.00, $8.00, $10.00, $12.00
Slide omitted due to confidentiality requirements.
Email irp@idahopower.com with questions.