Idaho Power Uses PI System Products to Optimize Water Utilization Along the Snake River

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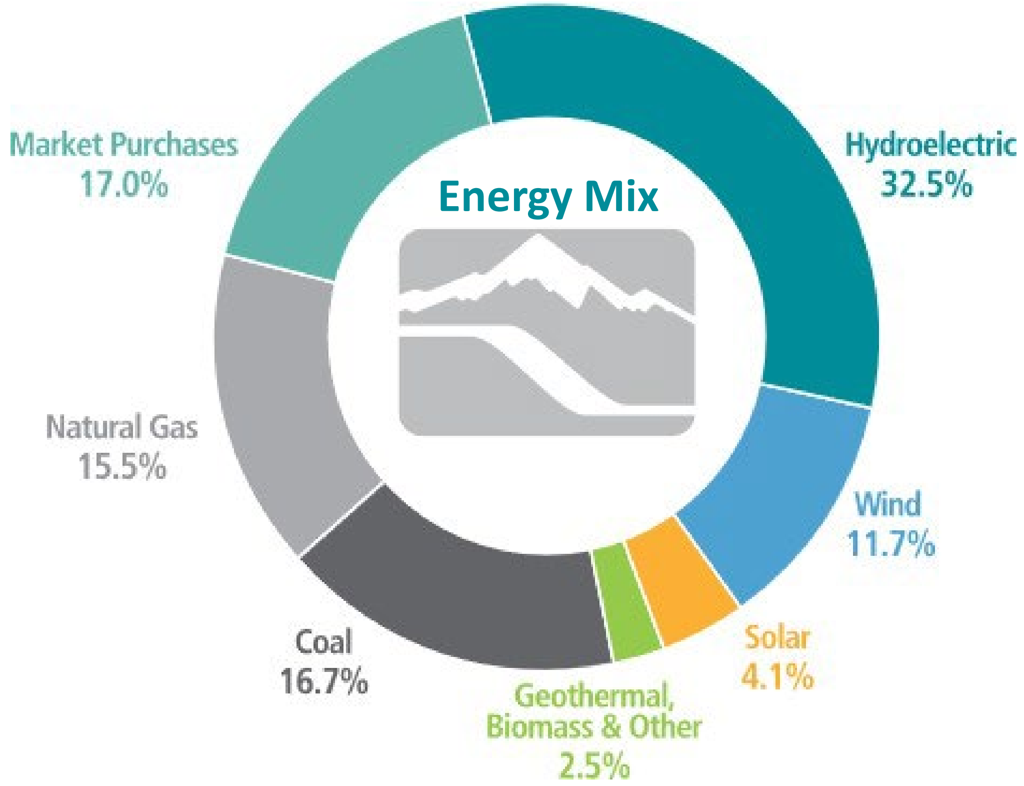
Idaho Power

- Serving more than 610,000 customers
- 3,486 MW generating capacity from owned sources
- 100% clean energy by 2045



The Snake River and Idaho Power's Hydroelectric System

Total Hydroelectric Capacity – 1,798.9 MW

Water availability for power generation depends on:

- Environmental protection restrictions
- Mountain snowpack levels
- Reservoir storage
- Water leases and rights
- Weather conditions

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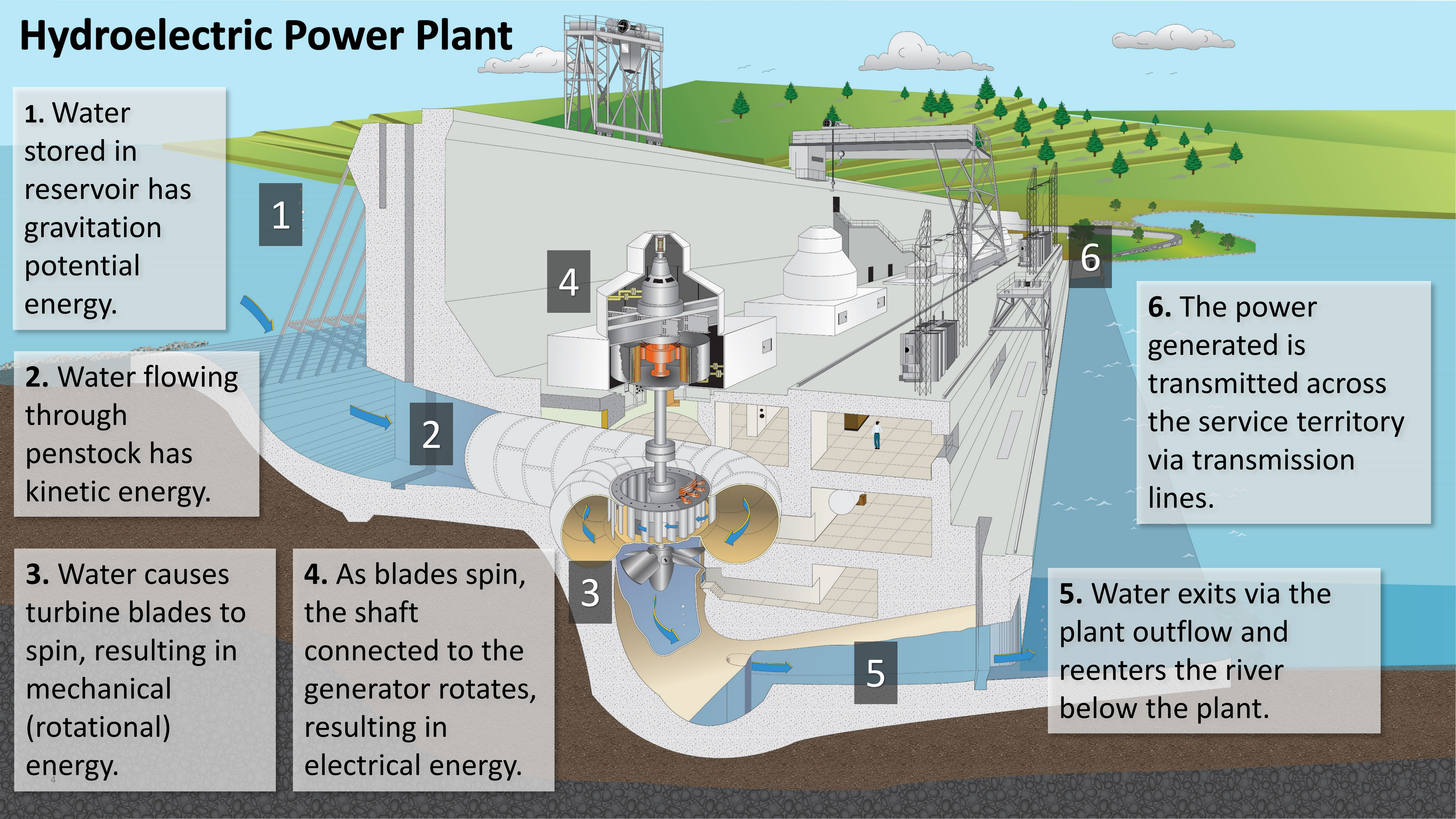
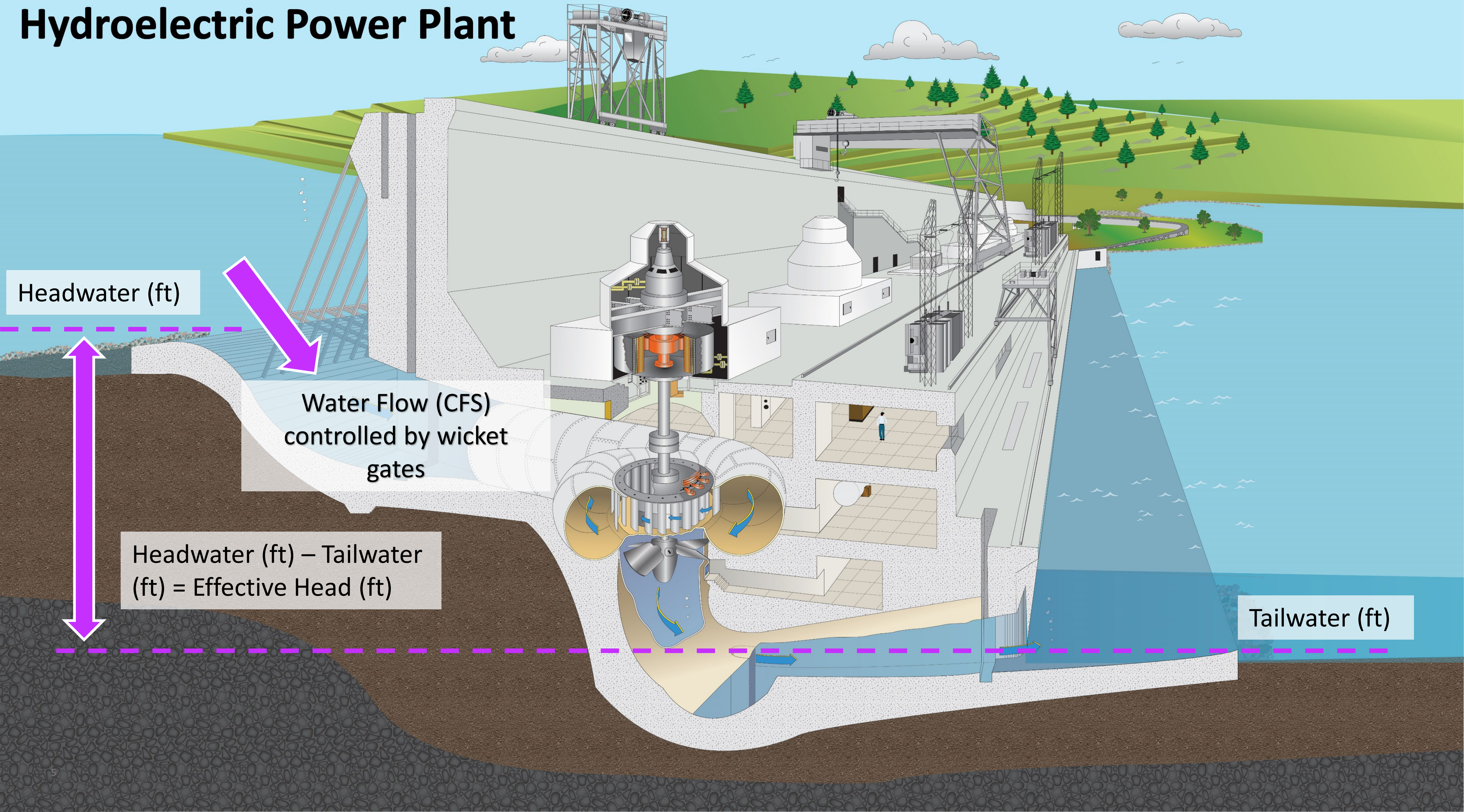
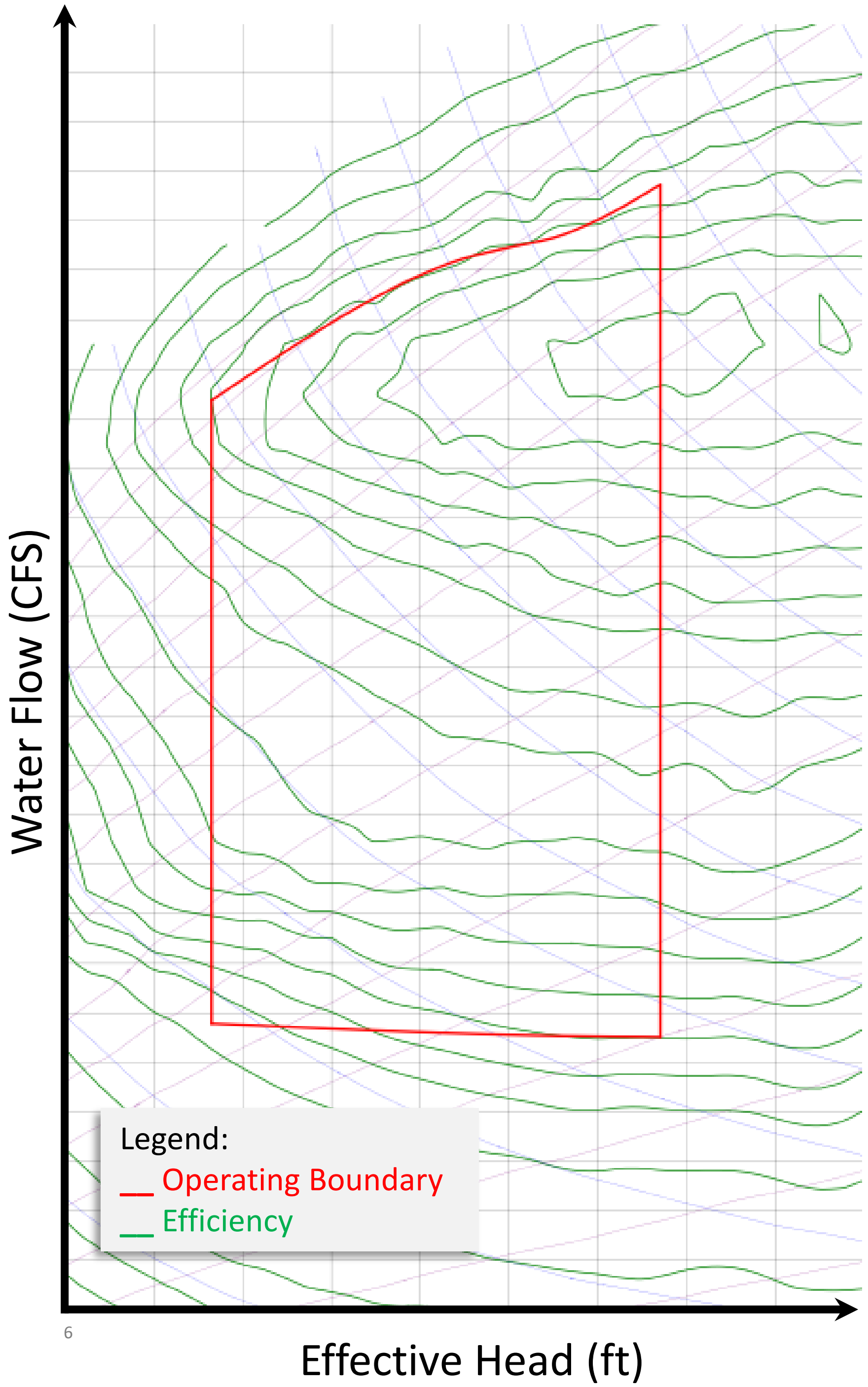
Hydroelectric Power Plant



Hydroelectric Power Plant





Power Generation is Determined Using Hill Charts

Hill Charts:

- Illustrate unique turbine performance
- Manufacturer-provided
- Non-formulaic and derived from empirical data
- Cumbersome to use for real-time operations

Three Relevant Variables

1. *Effective Head* – based primarily on river conditions
2. *Water Flow* – operator controllable
3. *Efficiency* – dependent on variables 1 and 2

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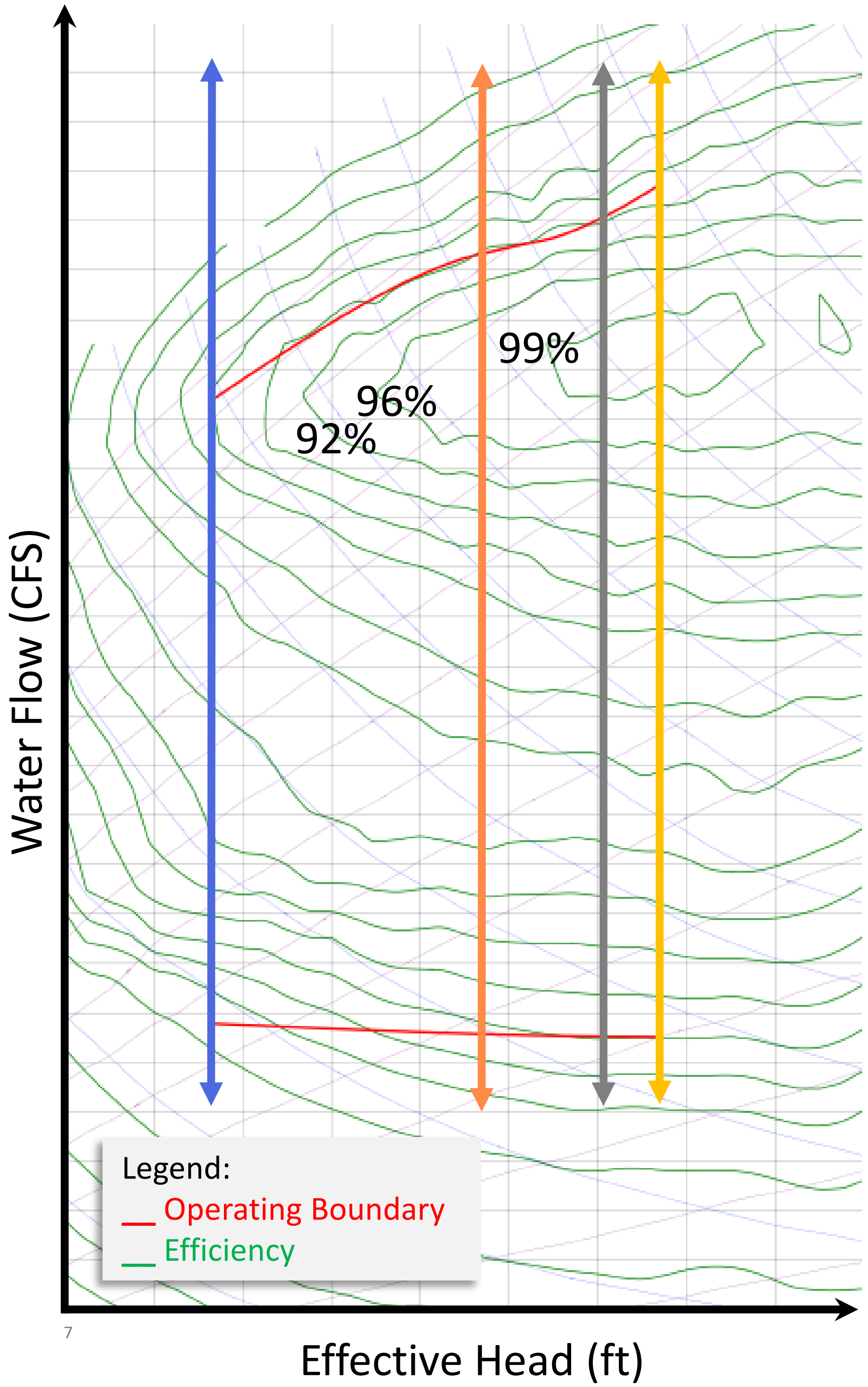
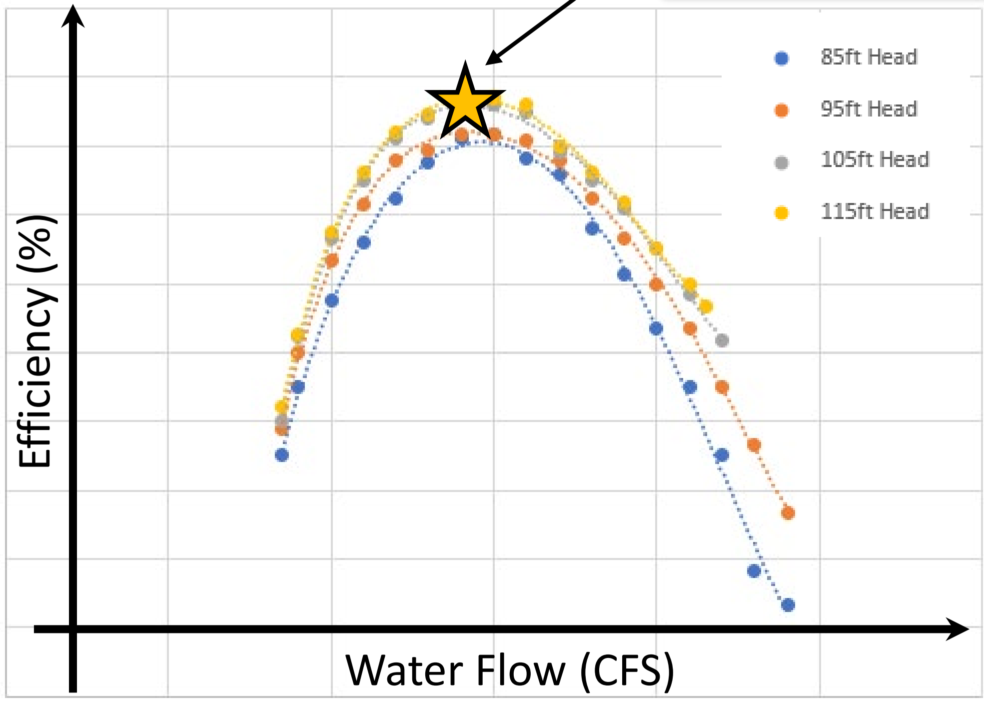
Greatest Efficiency Realizes Best Water Utilization



- Efficiency is non-linear
- Single best efficiency point for given head value
- Different turbine styles have different curve shapes

Same data presented differently

Point of greatest efficiency for given effective head



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The Business Challenge

Idaho Power operators need real-time tools to optimize water utilization along the Snake River.

Current State

- Real-time plant data with no efficiency information
- Cumbersome Hill charts

Transformation Tools

- PI Historian
- PI Asset Framework
- PI System Explorer

Future State

- Plant and unit efficiencies calculated in real-time
- Real-time PI Vision display communicating:
  - Efficiency projections
  - Historical information
  - Previous hour snapshot

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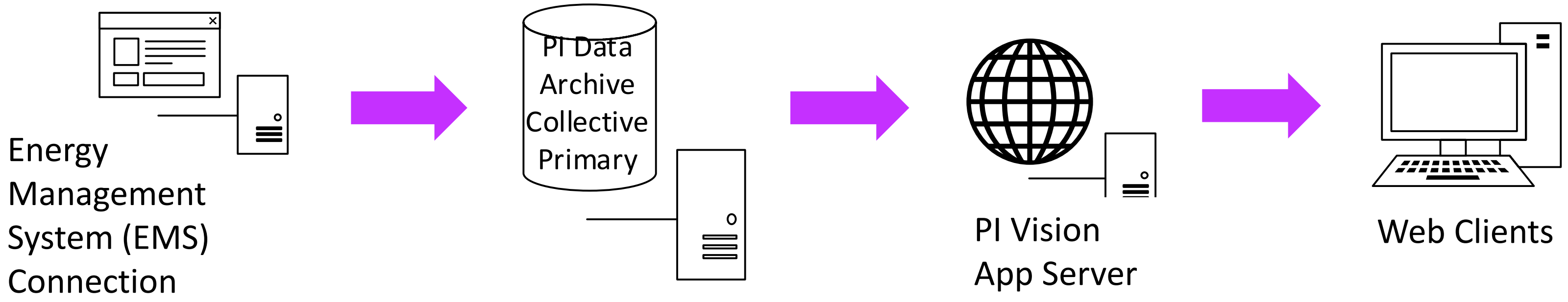
Step 1: Collect Real-Time Plant Data with PI Tags

Create PI tags for real-time water flow and effective head data and use these tags as inputs into the efficiency calculation.

Water flow and effective head data is collected with sensors and brought into Idaho Power's Energy Management System (EMS). PI tags are created to keep historical record of this data and therefore can be used as inputs for efficiency calculation.



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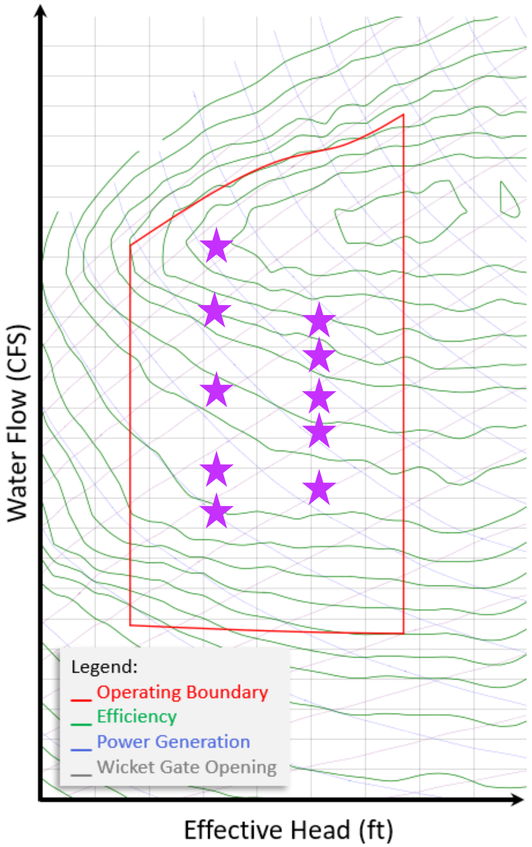
Step 2: Convert Hill Charts into PI Asset Framework Tables

Converting the Hill Chart to electronic tabular format provides PI with the foundation to perform lookup calculations in real-time on behalf of the operator.



Gather a collection of points (corresponding flow, head, and efficiency values) and summarize in tabular format

Known **Inputs**   Desired **Outputs**

Plant Efficiency Curves

General | Table | Define Table | Version

Plant Efficiency Curves

Filter

Unit	CFS	Head	Efficiency	Time
Unit Name	2000	90	22.68	6/22/2022 12:00:00 AM
Unit Name	2100	90	33.76	6/22/2022 12:00:01 AM
Unit Name	2200	90	42.7	6/22/2022 12:00:02 AM
Unit Name	2300	90	49.92	6/22/2022 12:00:03 AM
Unit Name	2400	90	55.78	6/22/2022 12:00:04 AM
Unit Name	2500	90	60.6	6/22/2022 12:00:05 AM
Unit Name	2600	90	64.63	6/22/2022 12:00:06 AM
Unit Name	2700	90	68.08	6/22/2022 12:00:07 AM
Unit Name	2800	90	71.12	6/22/2022 12:00:08 AM
Unit Name	2900	90	73.87	6/22/2022 12:00:09 AM
Unit Name	3000	90	76.41	6/22/2022 12:00:10 AM
Unit Name	3100	90	78.8	6/22/2022 12:00:11 AM
Unit Name	3200	90	81.07	6/22/2022 12:00:12 AM
Unit Name	3300	90	83.21	6/22/2022 12:00:13 AM
Unit Name	3400	90	85.2	6/22/2022 12:00:14 AM
Unit Name	3500	90	87	6/22/2022 12:00:15 AM

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Step 3: Perform PI Bilinear Interpolation

Because the PI Asset Framework Table is not continuous (it has a finite number of data points), bilinear interpolation must be used to interpolate between values in the table.

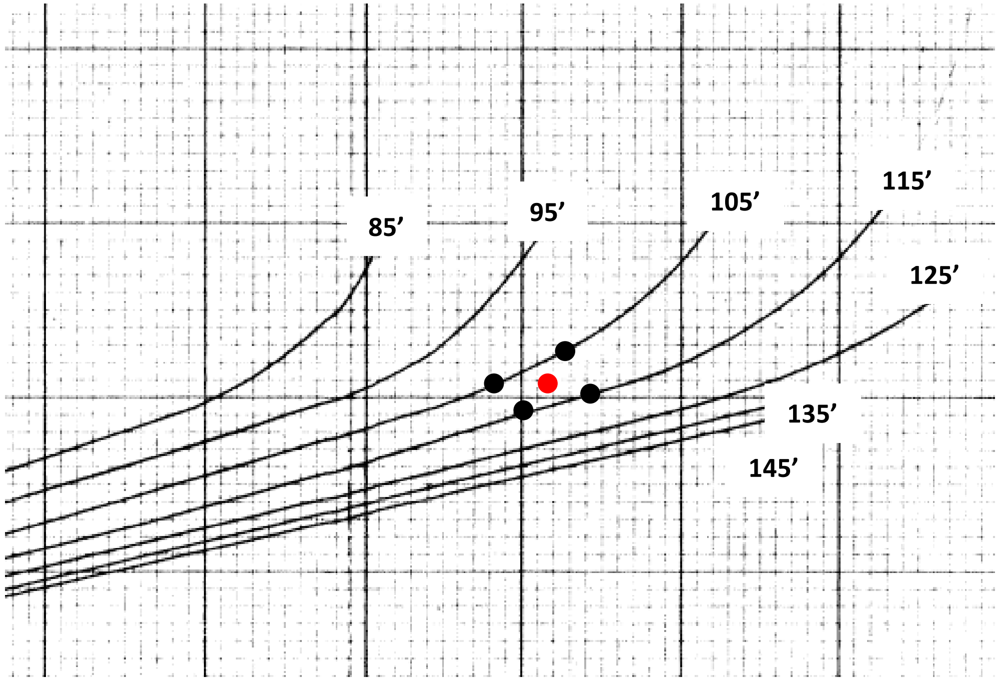
Bilinear interpolation – Distance weighted average of four closest data points to desired point of operation

Function Format:

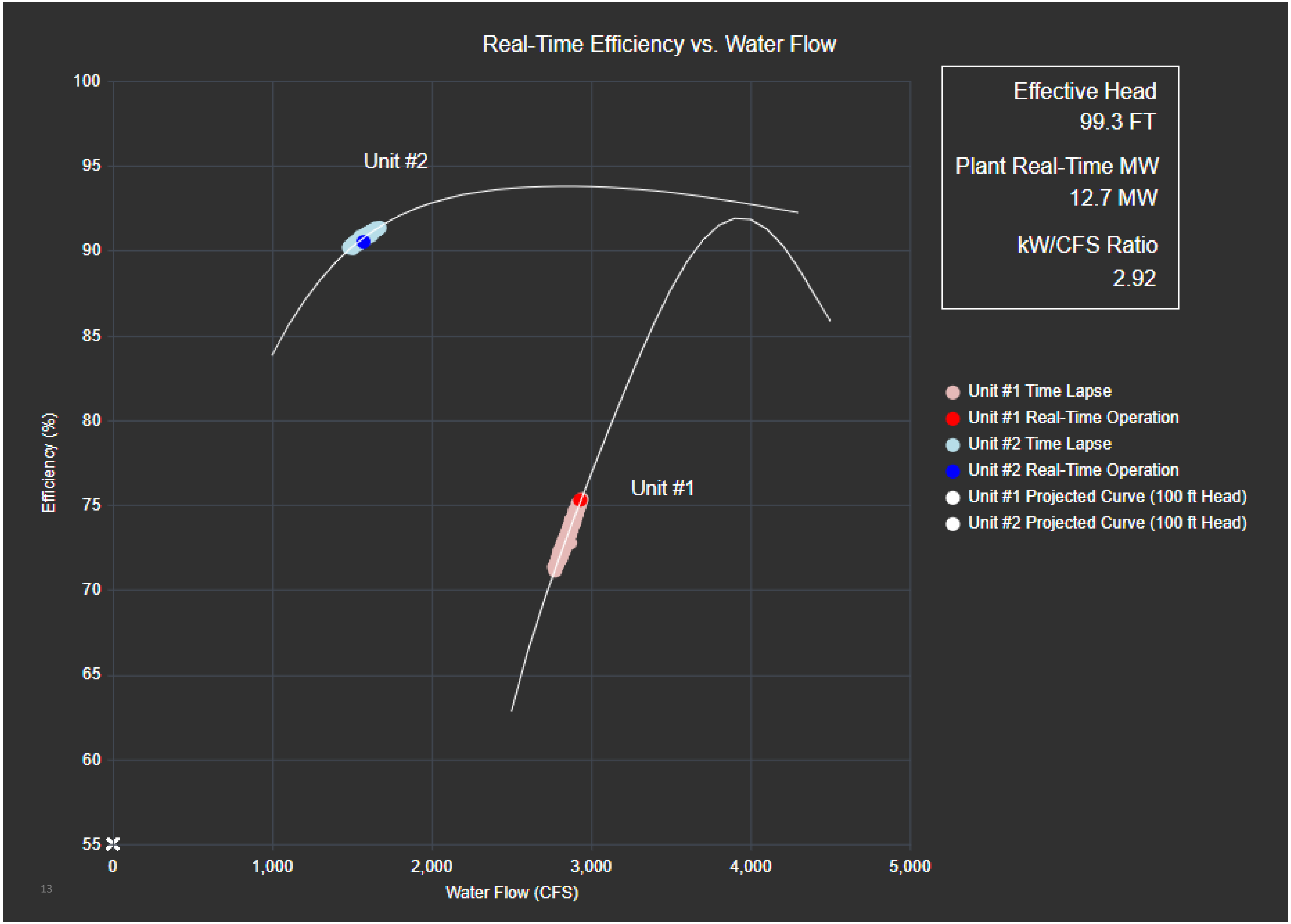
SELECT Efficiency FROM Table1 WHERE INTERPOLATE(CFS, @RT_CFS) AND INTERPOLATE(Head, @RT_HEAD)

Interpretation:

"Given corresponding real-time inputs (head and water flow) not found in the table, interpolate the dependent variable (efficiency) using the closest data found in the table."



Step 4: Summarize the Data in a PI Vision Display



PI Vision display shows real-time distribution of water between two turbine units.

Operators may determine that distributing the water differently results in more efficient water utilization.

kW/CFS ratio provides a benchmark for current utilization (greater the ratio, greater the efficiency).

PI Vision display shows historical reference for plant and individual turbine efficiency.

Display provides operators with perspective, indicating how the efficiency of one turbine may impact overall plant efficiency.

Historical data can serve as training tool across shifts depicting best practices for best water utilization.

Impact and Project Expansion

AVEVA PI System Products make it possible for Idaho Power operators to use water most efficiently.

Impacts:

- Operators now receive real-time plant and turbine efficiency information
- Operators can now make better operating decisions

Future Project Expansion:

- Automated decision making for water utilization
- Maintenance tracking based on historical data
- Apply concept to other forms of renewable energy

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