Plant B24 Hydroelectric Station
PNNL – Alternative Opportunities for Hydropower Workshop

Oscar Ramos – Head Superintendent – SGVWC
Andrew Benjamin, P.E. – Project Manager – NLine Energy

June 27, 2022
Agenda

• Systems Operations Parameters
• Project Intro
• Executive Summary
• Site Orientation
• Design Considerations
• Challenges/Barriers
• Operations and Performance Monitoring
• Questions, Comments and Discussion
System Operations
Parameters

- Privately owned
- Service Area 45 square miles
- 47,400 Service Connections
- 100% Groundwater
- 31 Wells, 2 Basins
- 9 Entry Points to Distribution System
- 8 Groundwater Treatment Plants
- Environmental Protection Agency Superfund Sites
Summary

- A single Pump-as-Turbine, paired with a 480V induction generation will generate electricity using wasted pressure at the B24 Pressure Reducing station
- SGIP
- Investment Tax Credit
- CEC EPIC Grant
- NEM tariff Switch to TOU 8R is recommended
- Sub 10 year payback

### San Gabriel Valley Water Company - B24 Hydroelectric Project Summary

<table>
<thead>
<tr>
<th>Turbine</th>
<th>Cornell 6TR1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available Flow Range (gpm)</td>
<td>0 - 7,000</td>
</tr>
<tr>
<td>Turbine Flow Range (gpm)</td>
<td>2,240 - 3,720</td>
</tr>
<tr>
<td>Available Net Head Range (ft)</td>
<td>110 - 170</td>
</tr>
<tr>
<td>Turbine Net Head Range (ft)</td>
<td>70-170</td>
</tr>
<tr>
<td>Turbine Capacity (kW)</td>
<td>72</td>
</tr>
<tr>
<td>Generator Capacity (kW)</td>
<td>93</td>
</tr>
<tr>
<td>Turbine/Generator Cost</td>
<td>$93,366</td>
</tr>
<tr>
<td>Project Cost</td>
<td>$1,300,000</td>
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<tr>
<td>CEC EPIC Grant</td>
<td>$500,000</td>
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<td>Self-Generation Incentive Program</td>
<td>$60,000</td>
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<tr>
<td>Investment Tax Credit</td>
<td>$160,000</td>
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<tr>
<td>Annual Generation (kWh)</td>
<td>433,000</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>$3,000</td>
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</table>

<table>
<thead>
<tr>
<th>TARIFF:</th>
<th>TOU 8 CPP</th>
<th>TOU 8 R</th>
<th>TOU PA 3 A</th>
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<tbody>
<tr>
<td>Annual Revenue</td>
<td>$42,000</td>
<td>$56,000</td>
<td>$56,000</td>
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<tr>
<td>Year 1 Net Cash Flow</td>
<td>$43,000</td>
<td>$59,000</td>
<td>$59,000</td>
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<tr>
<td>30 Year Net Earnings</td>
<td>$1,460,000</td>
<td>$2,287,000</td>
<td>$2,326,000</td>
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<tr>
<td>30 Year NPV</td>
<td>$452,000</td>
<td>$864,000</td>
<td>$884,000</td>
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<tr>
<td>Payback (years)</td>
<td>12.1</td>
<td>9.4</td>
<td>9.3</td>
</tr>
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</table>
B24: Site Orientation

- B6 24-inch pipeline delivers potable water to the B24 reservoir (2 x 1.5 MG tanks)
- Pressure dissipated via atmosphere into tank
- Stored water then pumped via 6 x 150 hp booster pumps to supply Hacienda Heights service area
- Pump demands always exceed hydro generation (NEM)

**B6 Supply**
- Range = 0 - 4,900 gpm... Average = 3,360 gpm
- 145 ft to 160 ft net head
B24 Hydro: Design Goals

- **Civil, Mechanical, & Electrical**
  - Safety
  - Water Operations must not be impeded
  - Fit site constraints and maintain ease of site access
  - Multiple technology options
  - Provide ample hydraulic and electric protections
  - Efficient power generation
  - PLC and SCADA Integration
  - Surge Mitigation and Backup Power
  - Sound attenuation
  - Replicable
  - Quality
Project Development Milestones

- **CEC EPIC Grant:**
  - Standardized Design and Specs
- **NSF ANSI 61:**
  - Potable Water Cert
- **Environmental:**
  - CEQA Catex
- **City of Industry Development Plan:**
  - Permitted
- **FERC:**
  - QCF NOI
- **SGIP:**
  - Approved
- **Southern California Edison:**
  - Fast Track Approved
  - Zero Added Facilities Costs
- **Design-Build Team:**
Project Challenges

- Space Constrained
- NSF ANSI 61 Process
- Potable Water Tie-In
- SCE Interconnection – Third Party Relay Testing
- DIR – Prevailing Wage Job

**Non Project Specific**
- Interconnection
- Hydraulics Threshold
- Site Control
- Hydro Experienced Contractors
- Internal Champion
- No ITC for public agencies
B24 Hydro 2020 - 2022
Operations and Performance

Maintenance:
- Turbine
- Generator
- HPU
- TSV
- TSV Actuator
- Butterfly Valves
- DC Battery Charger
- DC Battery Backup
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Alternative Opportunities for Hydropower Workshop

Hydropower Within An Irrigation System

Les Perkins and Zach DeHart
Farmers Irrigation District
Introduction

- Located in Hood River, OR
- Owned and operated by FID, Oregon special district
- Two facilities, 4.4 MW generating capacity
- LIHI certified, OR RPS, CEC
- Contained within an irrigation system, in-conduit FERC exemption
- Installed in 1986/1987
- Direct intertie with PacifiCorp distribution system at district owned switchyard
- Currently in second PPA with PacifiCorp which expires on Dec. 31, 2025
Background/Overview of Project

- Originally conceived as a means to fund system improvements
- Takes advantage of large elevation differential in irrigation system
- Utilizes 100+ year old system of diversions and conveyances
- Plant 3: Pelton turbine with just over 700 feet of head and 1.8 MW capacity
- Plant 2: Turgo impulse turbine with 300 feet of head and 2.6 MW capacity
- Operate year round, with peak production in late winter/early spring
Successes

• Has generated nearly $60 million
• Funded nearly complete modernization of the irrigation system
• Generates about 8% of annual electricity demand in Hood River County
• Revenue is used to service debt for system improvements
• Created a resilient agricultural system
• Cultivated an organization with better technical capacity
• Pushes organization to adopt new technologies as they arise and to create technological solutions to problems
Challenges/Barriers

• Very high sediment glacial system
• High number of ESA species
• Historically poorly maintained local distribution system
• Original turbines at Plant 2 not a good fit for water quality
• Dual purpose system with irrigation as primary
• PURPA and Oregon PUC – access to market
• Climate change
Adaptations and Improvements

• Invented horizontal fish screen
• Connected plants with dedicated fiber
• Replaced Francis units with a single Turgo
• New transformer
• New digital controls at both powerhouses
• New HPU’s at both powerhouses
• New exciters at both powerhouses
• New MUB’s at both powerhouses
• Piped conveyances
• Pressurized delivery of irrigation water
• Expanded and improved SCADA/telemetry
Operational Performance

- Original Francis turbines at Plant 2 performed poorly
- Pelton has been very consistent and low maintenance
- New Turgo has reduced maintenance to very low level with minimal down time
- More consistent power production through entire flow range
- More resilient in the face of climate change and other environmental challenges
- PAC system maintenance and hardening has reduced outages/down time
Future Opportunities

- Microgrid development
- Islanding/black start
- Powering essential services
- Pairing with solar and battery
- Alternative PPA outside of PURPA
- Hydrogen production
- Formation of an electric utility
Alternative Opportunities for Hydropower Workshop

Aquifer Storage: Regenerative and Micro-Turbine Power Production

Tim Smith, Control Systems Manager, and Bob Patterson, Public Works Director

City of Pendleton, Oregon
Introduction

Who we are:
- Recognized municipal leader in Oregon for alternative energy development
  - Solar, hydro, cogeneration, LED lighting upgrades, electrical efficiencies and upgrades, etc.
- Largest municipal drinking water Aquifer Storage & Recovery Program in Oregon
  - Operating 19-years
  - Slow decline of native groundwater levels
  - 2021/22: record season with over 900 million gallons stored
  - To date: over 11 billion gallons stored and recovered

How did we get here:
- 1996: Regulatory finding for drinking water system
- 1999: Discussion of aquifer storage
- 2002: Initial assessment of possible power production during recharge
  - Turbine motor generator w/governor
  - Return on investment: 40-plus years
- 2003: Water Filtration Plant and Aquifer Storage & Recovery Program commenced
- 2008: Revisited hydro production
Background/Overview of Project

Why did we do the project:
- Burning 60 to 80 psi at well head during recharge
- Net metering (credit on power production) became available

Type of technology equipment involved:
- Micro-turbine
- Variable frequency drive (VFD) & regenerative drive
- Use of existing turbine motor and pump bowls

Well 5 – 50 kW Micro-Turbine

Well 14 – 45 kW Regenerative Drive & 100 HP VFD
Successes

How did we see the project:
- Micro-turbine application:
  - Capture energy at well head (60 to 80 psi) / known technology
- VFD / regenerative drive application:
  - Capture energy to native ground water level (160 to 222 psi) / unknown technology
  - No information on efficiency of spinning pumping bowls backwards

Did it turn out the way we thought it would:
- 2011 Pilot Project using VFD and regenerative drive technology
  - Developed wire to water efficiency (about 60%)
  - Applied power formula to other wells for consideration

How does it help us and others:
- Return on investment: no brainer for City Council approval
- Operating at all 5 wells used for Aquifer Storage & Recovery
- Allows use of existing turbine motor and pumping bowls

Pay back:
- Return on investment: 7- to 12-years
- Credit of about 10 to 15% towards power costs to pump water
Challenges/Barriers

Approvals/Entities:
- “Fencing” FERC: Conduit exemption approval: “Dam” inspections
- Oregon Water Resources Department: Certificated surface water rights
- Pacific Power: PUC compliance: Relay
- Madison Farm: 2010 Pilot Test: VFD / regen: showed power production, no flow information
  - First to use new technology
  - Staff involved in discussion of using technology

2010/11 Well 14 Pilot Study:
- Coordinated with Pacific Power requirements: 9 months: conversation to testing verification
- Net-metering agreement
- Conducted in-house with Pacific Power staff on-site
- Full-scale: April 2011
Research Gaps

Consultants & Pump Suppliers: ASR hydro production:
- Struggle with use of existing turbine motor and pump bowls
  - Motor will not allow bowls to spin backwards
  - Lead to shaft unscrewing itself or breaking
- City has operated successfully for 10-years
  - Motor is uncoupled from shaft by removing bearings
  - Shaft has never unscrewed or broken

Pump bowls: Efficiency for water to wire not readily known
- City determined through pilot study for overall water to wire efficiency

Turbine motor / VFD sizing:
- City recommends match VFD to motor HP

Well: specific capacity to take water is different than to produce water
- City determines case-by-case
Operational Performance

Is it working as planned:
- Not much maintenance is needed
- VFD / regenerative drive uses less equipment than micro-turbines
- Overall, yes, both applications for power production are working as planned

What would be a better design:
- VFDs matching motor HP
- Regenerative drive matching power production
- Supervisory Control and Data Acquisition (SCADA) control to start / stop automatically

Note: Production of water for customers is primary purpose of water supply and Aquifer Storage & Recovery Program. Power production is secondary for our operation to help offset power costs to produce water.
Questions?

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Bob Patterson, PE, Public Works Director
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Douglas PUD Hydro to H2
Solving Douglas PUD Problems

• History of Research & Development
• Mechanical Plant
• Seasonal/Variable Fuel Supply
• Demand Response - Reserves (15-20MW)
Wholesale Market

2019 ON-PEAK DAILY

PRICE

$300.00

$250.00

$200.00

$150.00

$100.00

$50.00

$0.00

1/1/2019

2/1/2019

3/1/2019

4/1/2019

5/1/2019

6/1/2019

7/1/2019

8/1/2019

9/1/2019

10/1/2019
Benefits of Hydrogen

• Option – Power to Gas
• Input Cost is >80% Electricity
• Smooth Out or Renewable Hydro Generation
• Grid Services
  – Reserves
  – Frequency Regulation
  – Load Following
Equipment Overview

Example of an Electrolyzer and Tube Trailer Filling Station
Hydrogen Transportation
Transportation Fueling Infrastructure

• Electric (Lithium-ion) vs. Hydrogen