

Electric Production Hydroelectric Facilities Asset Management

August 3, 2022
Board of Public Utilities
Adam Cooper



Contents

- Facilities Overview
- Hydro Plants Operations
- Asset Management
- 10 Year Capital Improvement Plan
- Federal Partners Projects
- Performance Metrics
- Future Concerns
- Questions?

Electric Production

AMT MEMBERS

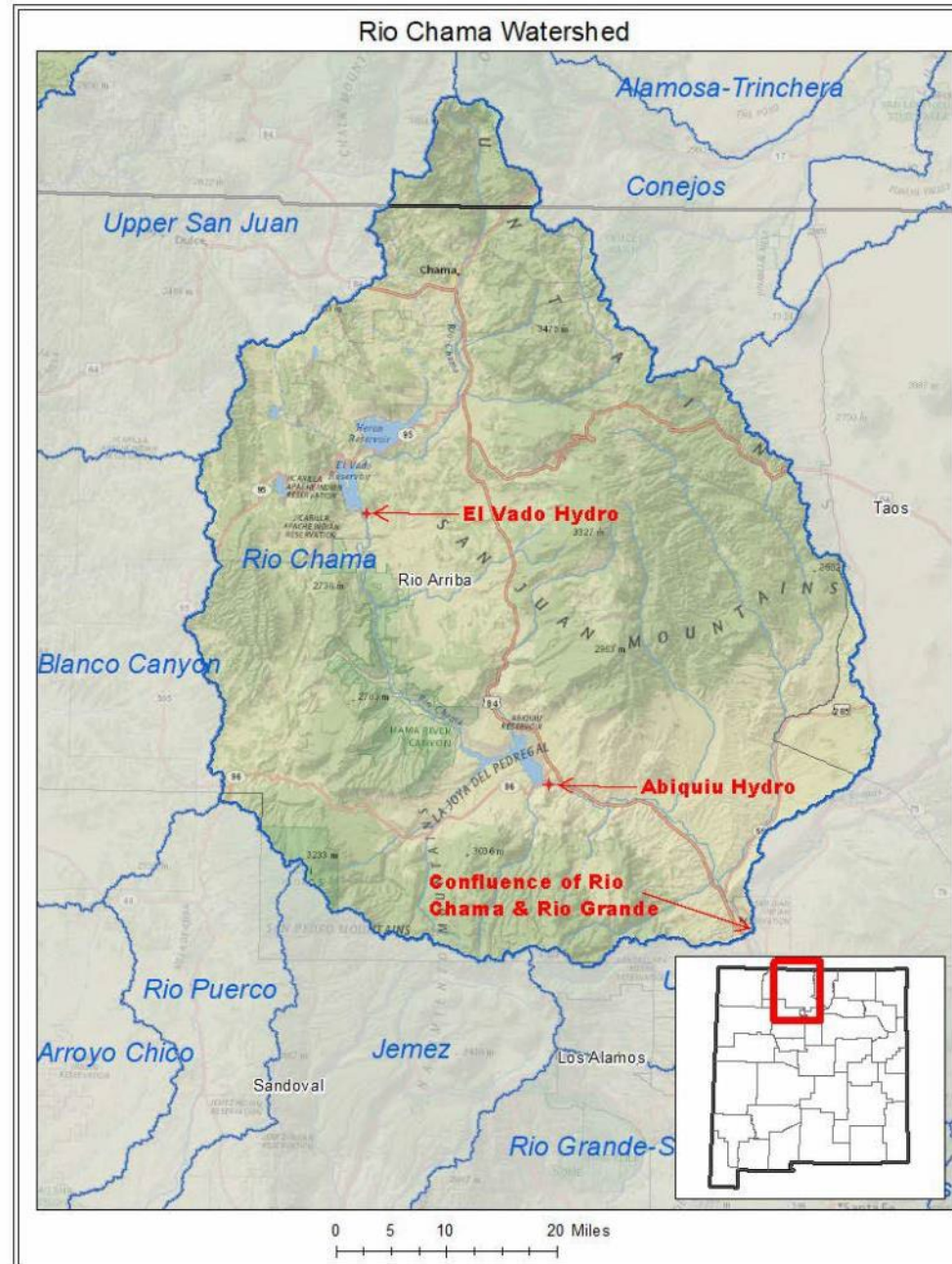
- Jordan Garcia (Deputy Manager – EP)
- James Alarid (Deputy Manager – Engineering)
- Clay Moseley (Engineering)
- Darryl Tabor (SCADA Coordinator)
- Adam Cooper (Hydro Manager)
- Matt Duggan (Hydro Tech)
- Don Wichers (Sr. Hydro Tech)

Hydroelectric Power Plants

- The Incorporated County of Los Alamos Department of Public Utilities (DPU) owns and operates two run-of-the-river hydroelectric power plants, both located on the Rio Chama in Rio Arriba County in northern New Mexico
- The El Vado hydroelectric plant is located approximately 14 miles southwest of Tierra Amarilla, NM on the El Vado Lake Dam, which is owned and operated by the U.S. Bureau of Reclamation
- The Abiquiu hydroelectric plant is located approximately 9 miles northwest of Abiquiu, NM on the Abiquiu Lake Dam, which is owned and operated by the U. S. Army Corps of Engineers

Rio Chama Basin

- The Rio Chama is an approximate 135-mile-long tributary to the larger Rio Grande.
- The Rio Chama Basin (i.e. “watershed”) is 3,157 square miles.
- The El Vado Watershed is very small at only 492 sq. mi.
- The Abiquiu Watershed is much larger at 2,146 sq. mi.
- The San Juan-Chama Project additionally diverts water across the Continental Divide into the Rio Chama System.



Los Alamos County Hydroelectric Generating Stations

Abiquiu – 3 Generating Units –
17 MW combined capacity



El Vado - 1 Generating Unit - 8.9 MW
Capacity



Hydroelectric Plants

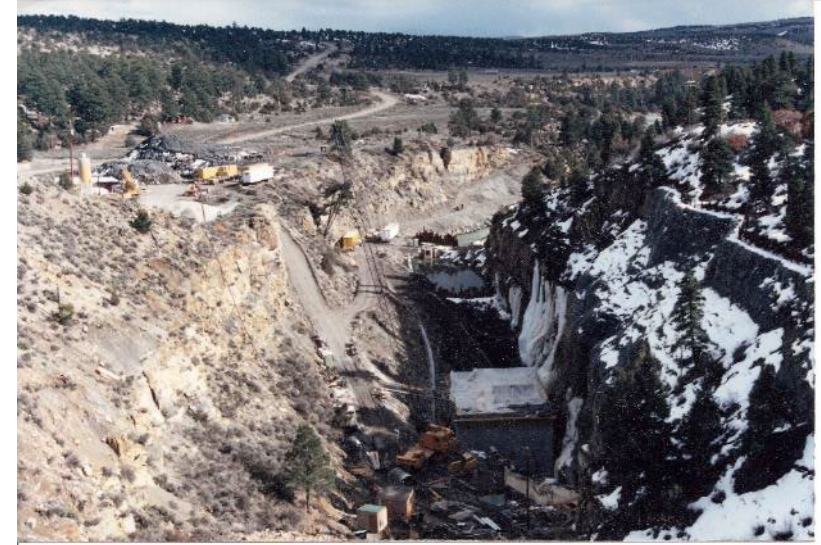
- Los Alamos County operates both plants under the provisions set forth in a Memorandum of Agreement with the dam operator for each plant.
- The Federal Energy Regulatory Commission (FERC) has jurisdiction over both power plants.

El Vado

- The El Vado hydroelectric plant was commissioned in 1987 and began generating in 1988 under FERC Permit No. 5226
- Characteristics of the El Vado hydroelectric plant are provided below

El Vado	Unit 1
Type	Vertical Kaplan
RPM	300
Rated Head	105 Feet
Flow Range	200-1000 CFS
Turbine	Voith (Germany)
Commissioned	1987
Generator	National Industri (Norway)
Rated Power	8.9 MW
Rated Voltage	4160 VAC

El Vado Construction

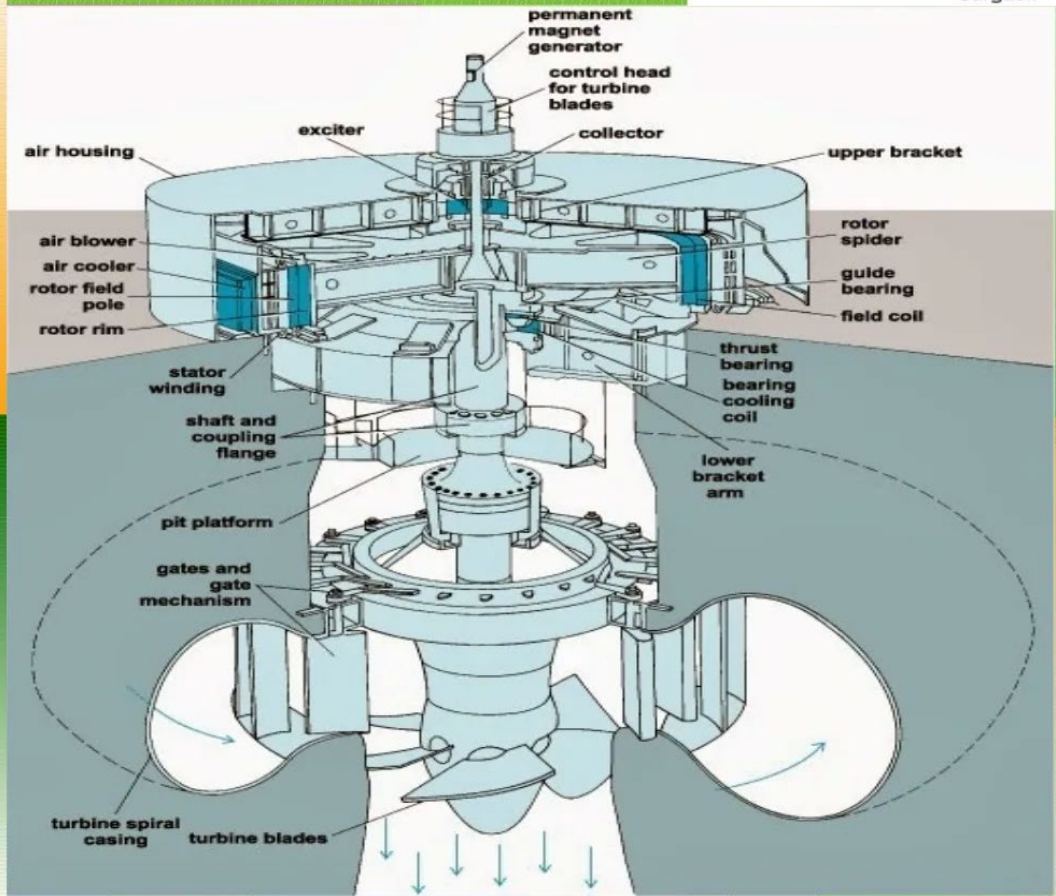


Kaplan Turbines

Typical Vertical Kaplan Unit

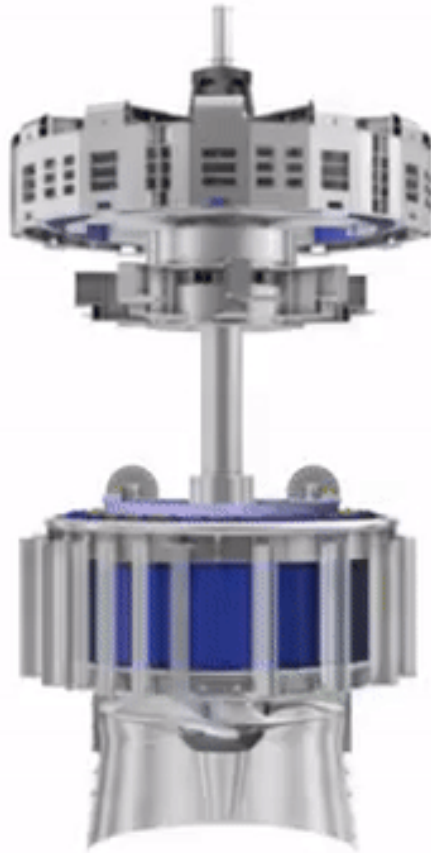
El Vado

ansal
University
Gurgaon



LOS ALAMOS

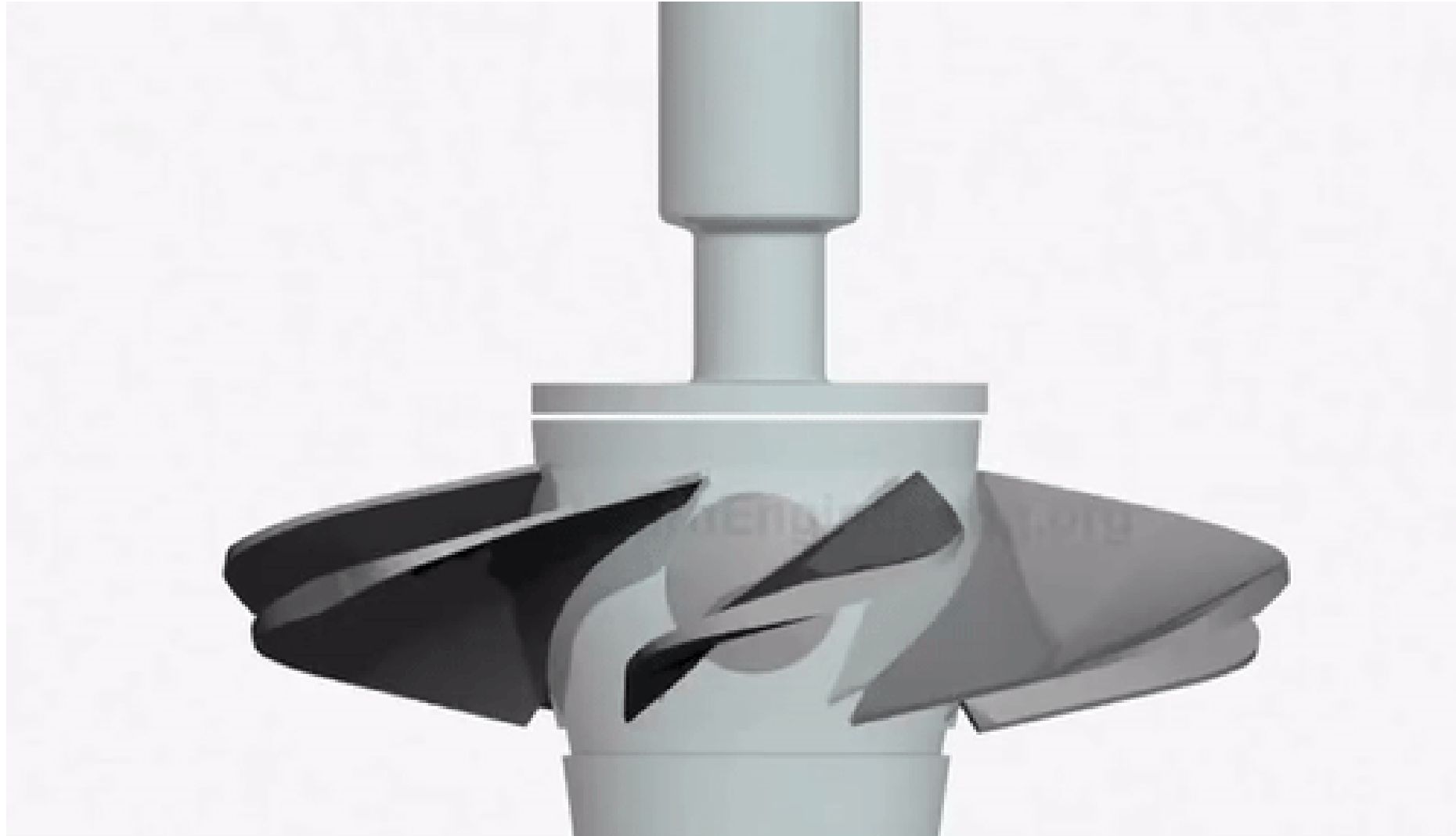
Kaplan Turbine Animation



VOITH

LOS ALAMOS

Kaplan Turbine Animation 2



Abiquiu

- The Abiquiu hydroelectric plant was commissioned in 1989 and began generating in 1990/91. A third low-flow unit was commissioned and brought online in 2011. The Abiquiu project is operated under FERC Permit No. 7396.
- Characteristics of the Abiquiu hydroelectric plant are provided below.

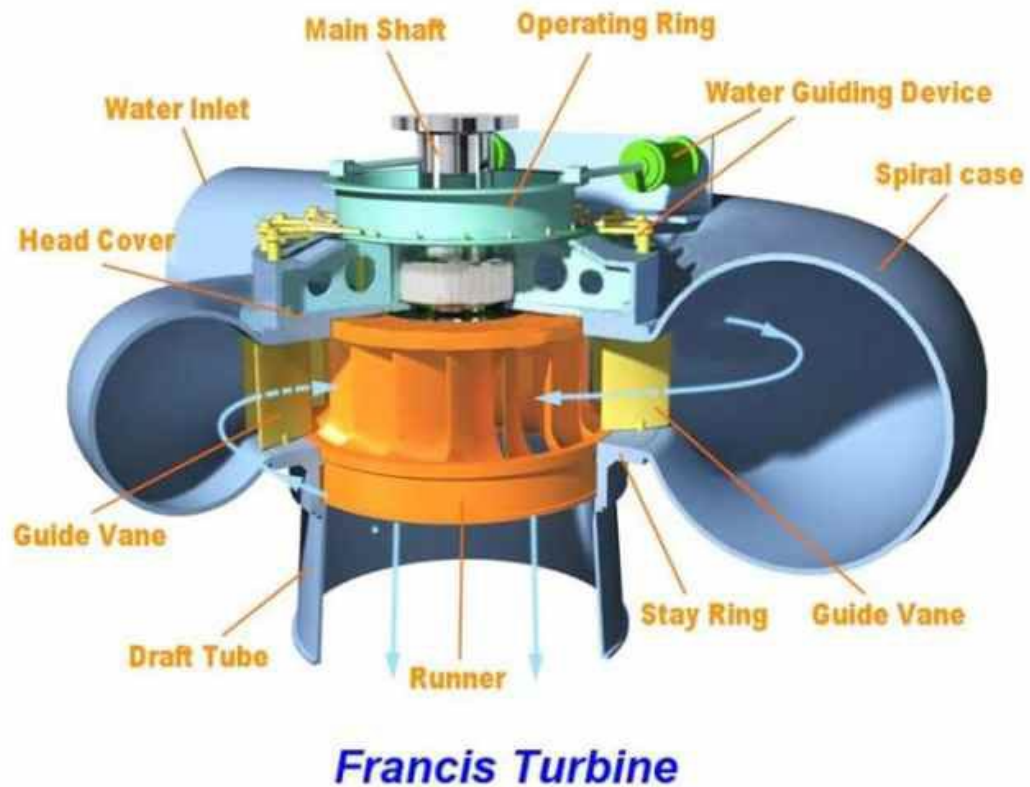
Abiquiu	Unit 1	Unit 2	Unit 3
Type	Vertical Francis	Vertical Francis	Horizontal Francis
RPM	400	400	514
Rated Head	175 Feet	175 Feet	170 Feet
Flow Range	235-550 CFS	235-550 CFS	75-235 CFS
Turbine	Harbin (China)	Harbin (China)	Andritz (Canada)
Commissioned	1989	1989	2011
Generator	Harbin (China)	Harbin (China)	Indar (Spain)
Rated Power	6.9 MW	6.9 MW	3.2 MW
Rated Voltage	4160 VAC	4160 VAC	4160 VAC

Abiquiu Construction



Francis Turbines

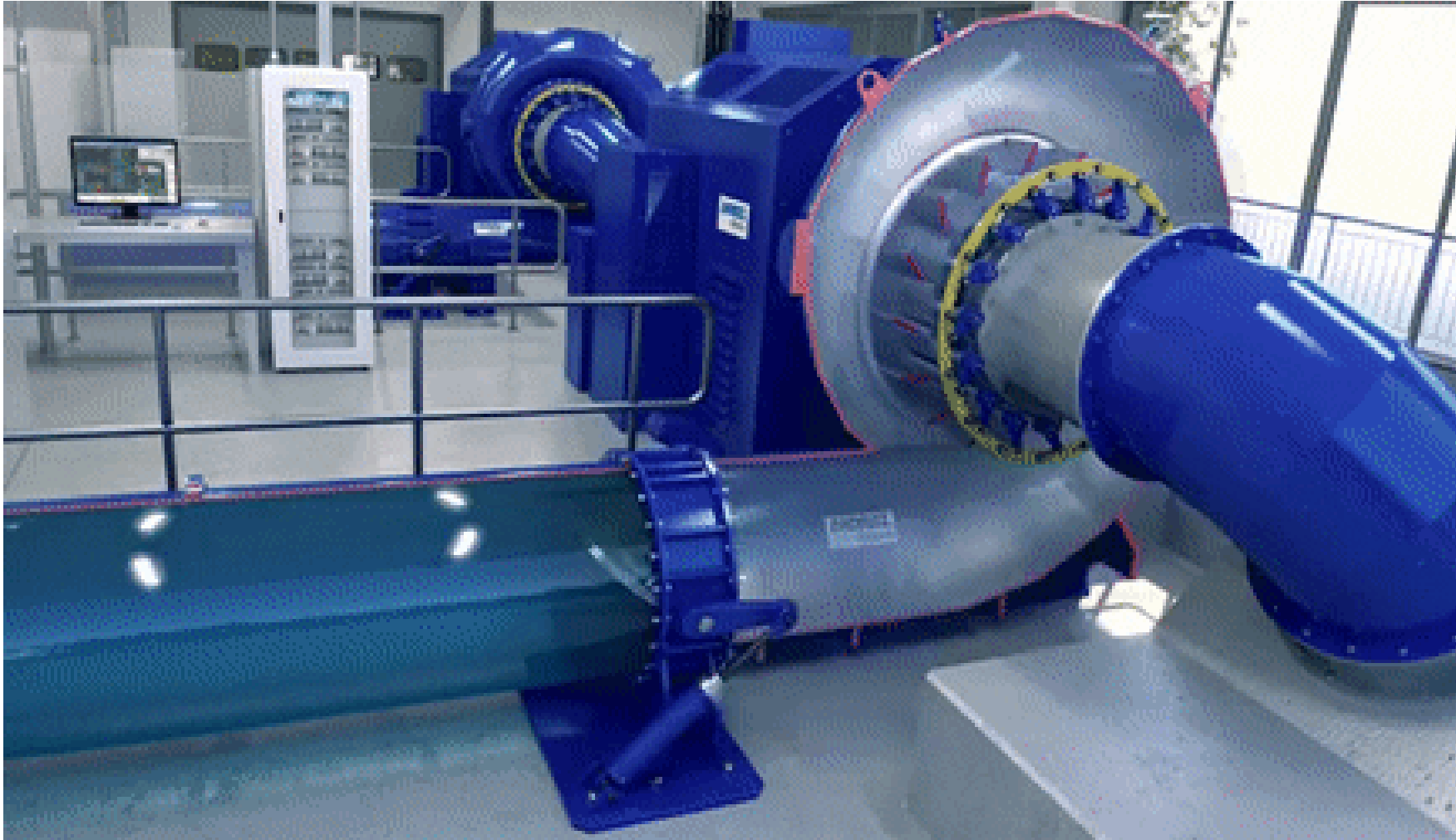
Typical Vertical Francis Unit



Abiquiu Units 1 & 2



Francis Turbine Animation



Hydroelectric Plant Operations

- The two hydroelectric plants are staffed with three full time LAC - DPU employees. They all serve equally as both operators & maintainers.
- All three operators support both plants and work between the two plants as needed. The plants are normally staffed from 7:00 AM to 3:30 PM Monday – Friday, and one plant operator is on-call after hours and on weekends.
- The plants are monitored and operated after hours from the Los Alamos County Power Operations Center (POC) located in Los Alamos, NM. Remote operation and monitoring capabilities exist through a Supervisory Controls And Data Acquisition (SCADA) system.
- The SCADA system has been transferred to DOE-NNSA since the bulk of cybersecurity compliance by the North American Electric Reliability Corporation (NERC) applies to the transmission system which is owned and operated by DOE-NNSA.
- Los Alamos County has responsibility for maintenance and emergency response to the SCADA system for both hydroelectric facilities.

Hydroelectric Plant Asset Management

- The hydroelectric plant operations, maintenance, regulatory compliance, stakeholder coordination and planning are administered through an Asset Management Team (AMT) that consists of the department manager, plant operation staff, a SCADA coordinator and an Engineering Department representative.
- The team meets quarterly to plan, coordinate resources and assess the plants' operational and equipment needs to optimize plant efficiency, prioritize efforts and justify operational and capital budgets annually, including a 10-year capital plan.
- Asset management tools used to schedule and track efforts consists of HydroAMP for assessment of major plant components, MPRO 2000 PLUS software for scheduling & tracking maintenance of equipment, daily walkthrough checklists and facility-specific maintenance schedules.
- Hydropower Asset Management Partnership (HydroAMP) is a structured two-tiered, public domain⁽¹⁾, risk-based condition assessment and economic analysis tool developed and used by the US Bureau of Reclamation, US Army Corps of Engineers, Bonneville Power and Hydro Quebec. The DPU implemented HydroAMP for asset management of the El Vado and Abiquiu hydroelectric plants in 2008. The industry acceptance, systematic approach and database management component aligned well with the DPU's asset management goals.

– **NOTES:**

(1) HydroAMP has since been absorbed (hosted) by CEATI International, Inc., and is now subscription-based. The EP AMT is considering joining for the valuable guides and data contained therein.

El Vado Equipment Condition Index

El Vado – HydroAMP Condition Assessment					
Equipment	Manufacturer	Placed In Service	Condition Index (2008)	Condition Index (2012)	Condition Index (Today)
PLANT					
Main Station Batteries	C&D	2017 Replaced	10.0 / GOOD	-	10.0 / GOOD
Compressed Air System - High Pressure Governor Air	Baur	1987	9.9 / GOOD	-	-
Compressed Air System – Low Pressure Station Service	Champion	1987	9.9 / GOOD	-	-
Crane - 60 Ton Overhead Crane	Gaffey	1998 Bridge 2015 Hoist	10.0 / GOOD	-	10.0 / GOOD
Crane - 5 Ton Jib Crane	Yale	1987	9.67 / GOOD	-	-
Main Transformer	Westinghouse	1987	10.0 / GOOD	6.57 / FAIR	6.57 / FAIR
UNIT					
Main Circuit Breaker (Air)	Siemens	2014 Replaced	10.0 / GOOD	-	10.0 / GOOD
Emergency Closure Valve - TSV Butterfly Valve	Kabota	1987	9.2 / GOOD	-	-
Emergency Closure Valve - PSV Butterfly Valve	Litostroj (Yugoslavia)	1985	8.2 / GOOD	-	-
Emergency Closure Valve - Draft Tube Gates		1987	9.2 / GOOD	-	-
Excitation System	Basler	2007 Digital Upgrade	10.0 / GOOD	-	-
Generator Rotor (Note 1)	National Industri	2015 Cleaned & Tested	Incomplete	4.32 / FAIR (POOR)	10.0 / GOOD
Generator Stator (Note 1)	National Industri	2015 Rewound	Incomplete	7.24 / GOOD (FAIR)	10.0 / GOOD
Governor	Voith	2008 Digital Upgrade	10.0 / GOOD	-	-
Turbine	Voith	2015 Refurbished	8.3 / GOOD	9.42 / GOOD	10.0 / GOOD

Condition Index (CI) LEGEND:

7 ≤ CI ≤ 10: GOOD

3 ≤ CI < 7: FAIR

0 ≤ CI < 3: POOR

Note (2012 K-P Assessment): Although the HydroAMP Condition index indicates that the rotor and stator are in fair to good condition, the extent of the oil/brush dust residue throughout the interior of the generator, and the possible adverse consequences from it, would actually indicate a “poor to fair” condition.

Note (Generator Rotor Assessment): The generator rotor condition changed from “poor/fair” in 2012 to “good” today as a result of the generator rewind project completed in 2017.

Note (Main Transformer Assessment): While the overall assessment is “fair”, CO measurement is very high indicating insulation overheating.

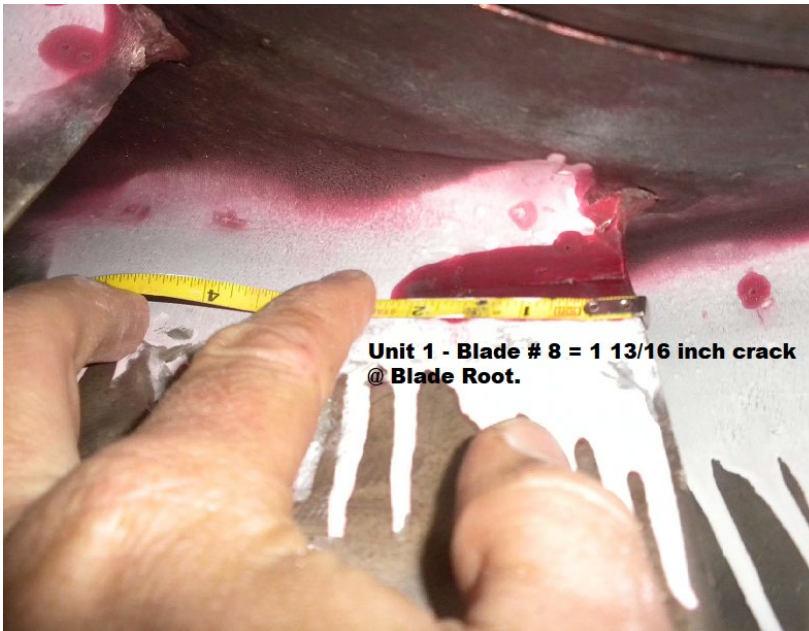
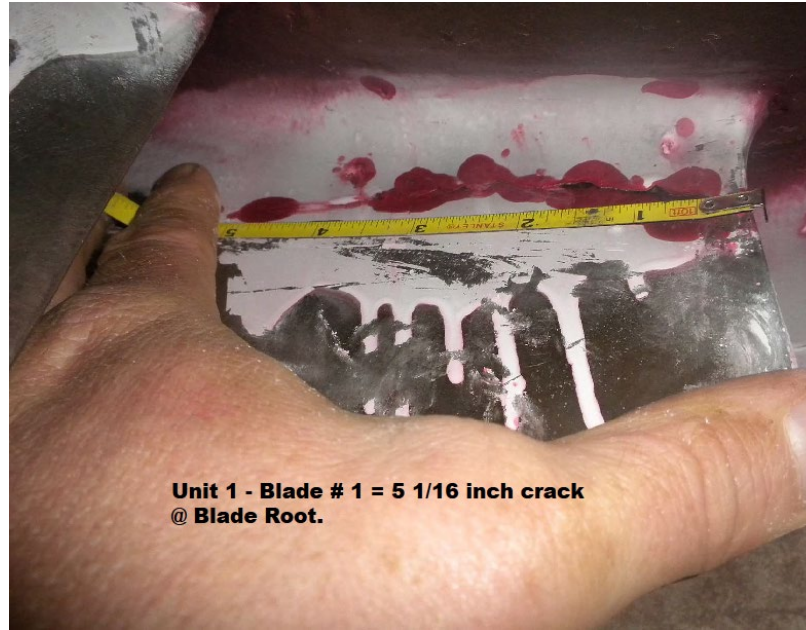
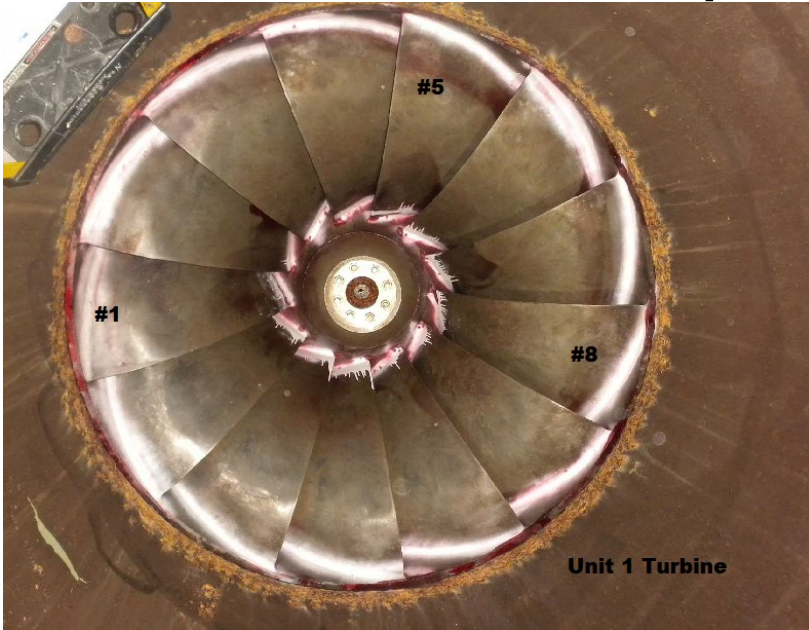
El Vado Main Station Transformer – Needs Replacement



Abiquiu Equipment Condition Index

Abiquiu – HydroAMP Condition Assessment					
Equipment	Manufacturer	Placed In Service	Condition Index (2008)	Condition Index (2012)	Condition Index (Today)
PLANT					
Main Station Batteries	C&D	2017 Replaced	10.0 / GOOD	-	10.0 / GOOD
Compressed Air System - Low Pressure Station Air	Gardner Denver	1989	9.9 / GOOD	-	-
Crane - 60 Ton Overhead	Gaffey	1997	10.0 / GOOD	-	-
Emergency Closure Gate - PRV Bypass Cone Valve #1	Kabota	1989	Pending	-	-
Emergency Closure Gate - PRV Bypass Cone Valve #2	Kabota	1989	Pending	-	-
Emergency Closure Gate - Penstock Tunnel Gate	ZWAG	1989	9.0 / GOOD	-	-
Main Transformer	ASEA Electric	1989	Incomplete	9.91 / GOOD	-
UNIT #1					
Main Circuit Breaker (Air) Unit #1	Siemens	2014 Replaced	7.37 / GOOD	-	10.0 / GOOD
Emergency Closure Valve - TSV Butterfly Valve - Unit #1	Harbin Equipment Package	1989	8.2 / GOOD	-	-
Emergency Closure Gate - Draft Tube Gate Unit #1	Telluride Iron Works	1989	8.5 / GOOD	-	-
Excitation System Unit #1	Basler	2005 Digital Upgrade	10.0 / GOOD	-	-
Generator Rotor Unit #1	Harbin	1989	Incomplete	9.02 / GOOD	-
Generator Stator Unit #1	Harbin	1989	Incomplete	8.42 / GOOD	-
Governor Unit #1	HPS	2003 Digital Upgrade	10.0 / GOOD	-	-
Turbine Unit #1	Harbin	1989	7.8 / FAIR	4.75 / FAIR	4.75 / FAIR
UNIT #2					
Circuit Breaker (Air) Unit #2	Siemens	2014 Replaced	7.37 / GOOD	-	10.0 / GOOD
Emergency Closure Valve - TSV Butterfly Valve - Unit #2	Harbin Equipment Package	1989	8.2 / GOOD	-	-
Emergency Closure Gate - Draft Tube Gate Unit #2	Telluride Iron Works	1989	8.5 / GOOD	-	-
Excitation System Unit #2	Basler	2005 Digital Upgrade	10.0 / GOOD	-	-
Generator Rotor Unit #2	Harbin	1989	Incomplete	9.02 / GOOD	-
Generator Stator Unit #2	Harbin	1989	Incomplete	8.42 / GOOD	-
Governor Unit #2	HPS	2003 Digital Upgrade	10.0 / GOOD	-	-
Turbine Unit #2	Harbin	1989	8.8 / GOOD	8.75 / GOOD	-
Condition Index (CI) LEGEND:					
7 <= CI <= 10: GOOD					

Abiquiu Unit 1 Turbine Blades Cracks



Maintenance, Testing and Capital Projects

- The DPU has completed several major maintenance, testing and capital improvements over the years as either planned reliability improvements or due to equipment failure.
- Consideration of these improvements in assessing the condition of each plant, plant reliability and economic planning of future budgets is critical.
- The table below summarizes the major maintenance and capital improvements that have taken place at the Abiquiu Plant and the El Vado Plant.

Past 10-Year CIP & O&M

Facility	Year	Cost	Description
Abiquiu	2012		New Plant Main Control Battery(ies) Chargers
Abiquiu	2012		Rebuild Unit #1 Wicket Gate Hydraulic Cylinder (1 of 2)
Abiquiu	2013		Rebuild Unit #1 Wicket Gate Hydraulic Cylinder (2 of 2)
Abiquiu	2013	\$15,252.00	Clean & Dispose of Plant Sumps' Sludge
Both	2013	\$55,220.00	CO2 Fire Protection Systems Evaluations
Both	2013	\$163,935.00	Hydro Power Plant(s) Condition Assessment(s)
Abiquiu	2014	\$20,562.00	Replace/Upgrade Plant RTU (SCADA)
El Vado	2014	\$20,562.00	Replace/Upgrade Plant RTU (SCADA)
Abiquiu	2015	\$194,077.00	Upgrade Mechanical Relays With Solid State Devices
El Vado	2015	\$192,949.00	60 Ton Hoist for Existing Bridge Crane
El Vado	2015	\$194,077.00	Upgrade Mechanical Relays With Solid State Devices
Both	2015	\$89,157.00	River Gauging Stations VHF Radio Telemetry Upgrades
El Vado	2015	\$8,989.00	Road Widening and Stabilization for Unit Transport/Refurbishment
Abiquiu	2017	\$65,625.00	New 125 kW Propane Emergency Back-up Generator
El Vado	2017	\$65,625.00	New 80 kW Diesel Emergency Back-up Generator
El Vado	2017	\$4,587,174.00	Main Generator Rewind & Turbine Refurbishment Project
Abiquiu	2018	\$336,979.00	Plant PLC & Digital Controls Upgrade
Abiquiu	2018	\$36,299.00	Main Plant Control Batteries Replacement
Abiquiu	2018	\$450,316.00	Main Dam Penstock Vent Shafts - Shutoff Valves Installation
El Vado	2018	\$36,299.00	Main Plant Control Batteries Replacement
Both	2018	\$31,519.00	POC SCADA Room Uninterruptable Power Supply (SCADA)
Both	2018	\$31,964.00	POC SCADA Room HVAC Replacement (SCADA)
Abiquiu	2020	\$107,757.00	PRV Chamber Gates 3-Ton Jib Crane Installation
El Vado	2021	\$31,000.00	12 Miles 69kV Transmission Line Pole Inspections
El Vado	2021	\$432,587.00	Purchase New Main Station Transformer
Both	2021	\$369,541.00	Paint Hydro Decks, Floors, Railings, Cranes, Hatches etc.
Both	2021	\$8,419.00	Dispose of Abandoned CO2 Bottles

Current 10-Year CIP

Facility	Year	Cost (1)	Description
Abiquiu	2022	\$100,000	Main Station Transformer Replacement - Drafting RFP - Target Advertise Aug 2022
El Vado	2022	\$375,000	Install 12 Miles of New Fiber Optic Line from El Vado to Spills Sub - Target Advertise Aug 2022
Both	2022	\$90,000	Hydro Yards Perimeter Security Fencing Upgrades - Target SPA Award Aug 2022
Both	2022	\$250,000	SCADA Hardware/Software Upgrades - Target Design-Build Award Sep 2022
El Vado	2022	\$85,000	Replace 1,000 gal. Diesel UST and Piping (REGULATORY) - Target Award Oct 2022
Abiquiu	2022	\$150,000	Construct New Office Building (SAFETY) - Target Award Oct 2022
El Vado	2022	\$150,000	Main Station Transformer Replacement - Awaiting Build 26-28 Weeks - Target Advertise Nov 2022
Abiquiu	2023	\$60,000	New Concrete Slab in Loading Area - Target Award Feb 2023
Abiquiu	2023	\$300,000	USACE Main Penstock Tunnel Liner Repair
Abiquiu	2023	\$400,000	Unit #1 Runner Repair or Replacement (TENTATIVE)
El Vado	2023	\$90,000	Install Ultrasonic Flow Meter
El Vado	2024	\$440,000	Plant PLC & Digital Controls Upgrade
Abiquiu	2024	\$1,500,000	Main Dam Penstock Vent Shafts Repairs
Abiquiu	2026	\$250,000	Rewind study (Condition Assessment)
NOTES:	(1)	The majority of these items were budgeted Pre-COVID. Many of these figures will go over existing budget figures.	

USBR & USACE Projects

- USBR has just begun a 5-year project to perform extensive repairs on El Vado Dam 2022–2026.
 - LAC will see lost revenues and shared costs.
- USACE has identified repair projects to their existing steel penstock liner and air vent shafts.
 - USACE is performing ongoing inspections in preparation for engineered solutions.
 - LAC will see lost revenues and shared costs.

El Vado Dam Repairs

USBR has successfully begun significant repairs to El Vado Dam under their federal Safety of Dams (SOD) Program.

- The program appropriates Congressional funding for repairing Dams flagged as unsafe. The 1935 Dam has settled significantly, warping the steel membrane and inducing additional seepage pathways around, under and through the Dam.

2 Phase Project:

- Phase 1 (2022–2023): Drain Lake to minimum pool (15 feet deep at Dam). Grout behind existing steel membrane & affix new geomembrane liner on top of steel membrane. New Cathodic Protection. Extensive Sub-terranean Grout Curtain.
 - El Vado Hydro cannot generate during this 2-year period – lake levels below minimum operating head.
- Phase 2 (2024-2026): Lake Level Restriction raised to 1/3 capacity. Remove existing steel spillway, road & bridge and spillway gate. Lower Dam by 4 feet. Construct new concrete spillway, new radial gate, rebuild road and bridge, straighten road, add concrete wave deflectors to regain original capacity.
 - Water operations will go back to normal (with the caveat of the lower head restriction), and El Vado Hydro can handle all water releases as before. Vehicular access across the road on NM112 will be unavailable for 3 years.

El Vado Dam & Spillway Construction 1933-35

NO. 902 PLATE *XIV*



NO. 902 PLATE *VIII*



NO. 902 PLATE *XI*



NO. 902 PLATE *IX*



NO. 902 PLATE *XIV*



NO. 902 PLATE *XII*



NO. 902 PLATE *XX*



NO. 902 PLATE *XXII*



NO. 902 PLATE XV



NO. 902 PLATE XVIII



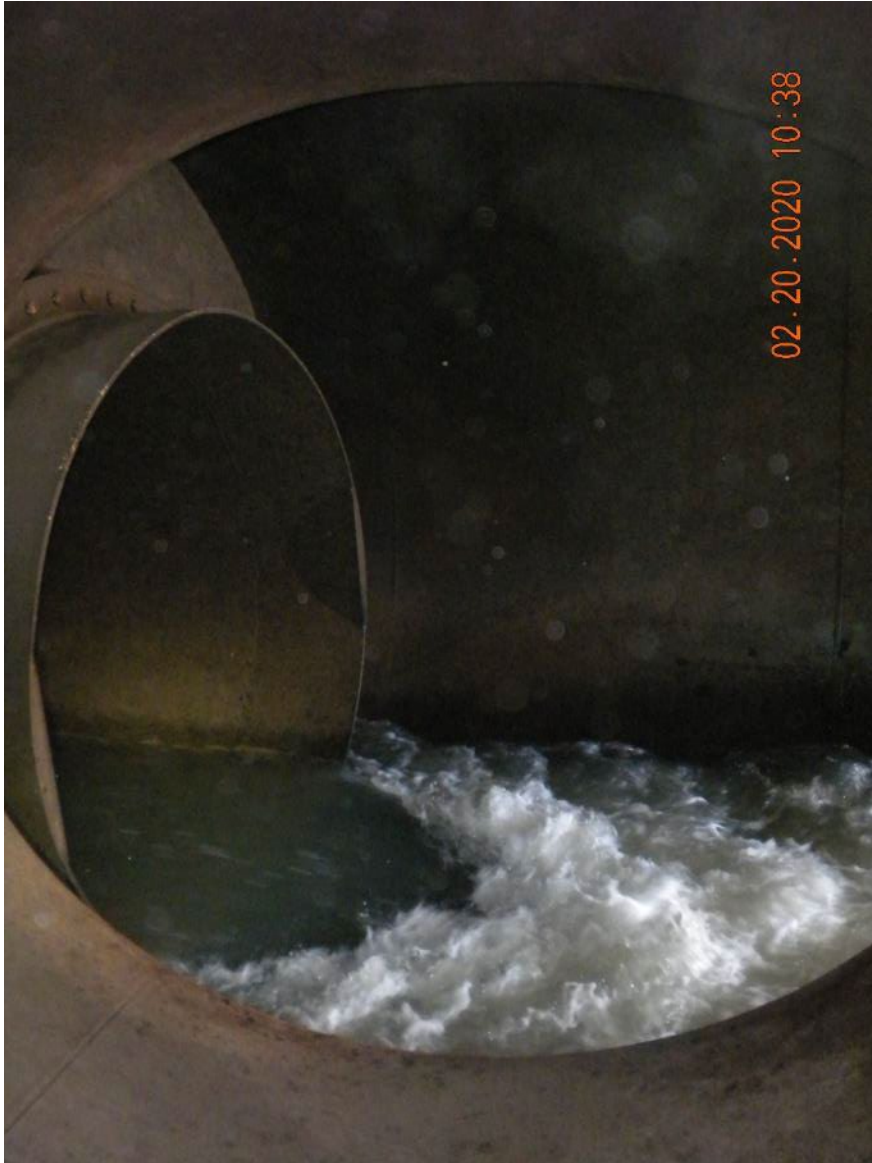
Abiquiu Tunnel Liner

- USACE Main Discharge Gates & Penstock Tunnel from lake to river is in need of repair.
- USACE has put LAC on notice that we will incur a portion of the cost.
- Project currently budgeted for 2022/2023
- LAC share is estimated at \$300k
- DPU will include in FY2023 Budget request
- Outage Duration currently unknown

USACE Regulating Gates



USACE Penstock Outlet Works



USACE Tunnel Corrosion



Abiquiu Vent Shaft Repairs

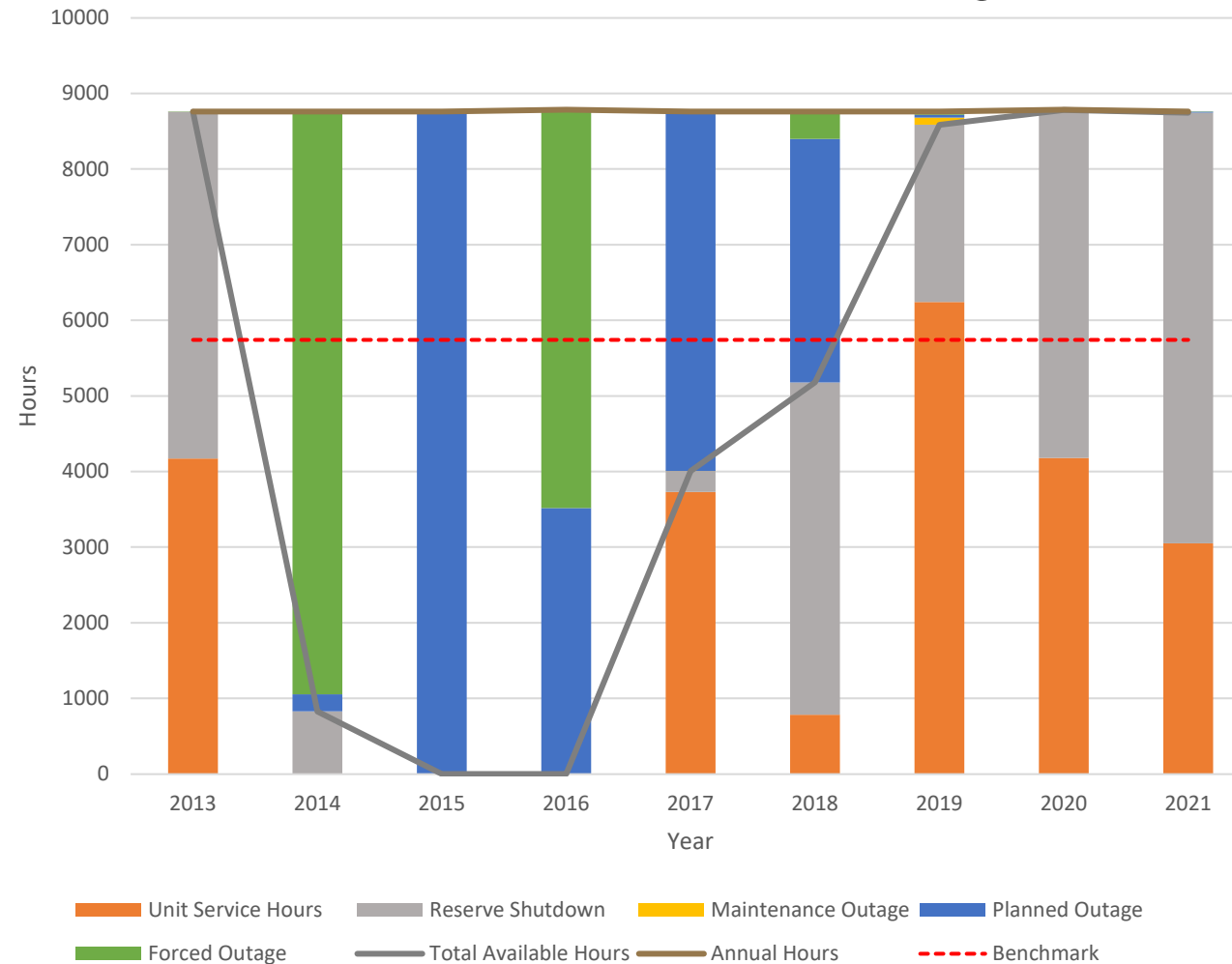
- USACE has also identified corrosion in the air vent shafts on the main penstock.
- USACE has put LAC on notice that we will incur a portion of the cost to repair.
- Vent Shaft replacement currently estimated at \$3 million. Lower cost alternatives being considered.
- USACE looking at Current Administrations Infrastructure Bill for potential cost sharing.
- LAC portion of repairs currently unknown. Plan to negotiate.
- Outage Duration currently unknown

USACE Vent Shafts Exterior Corrosion



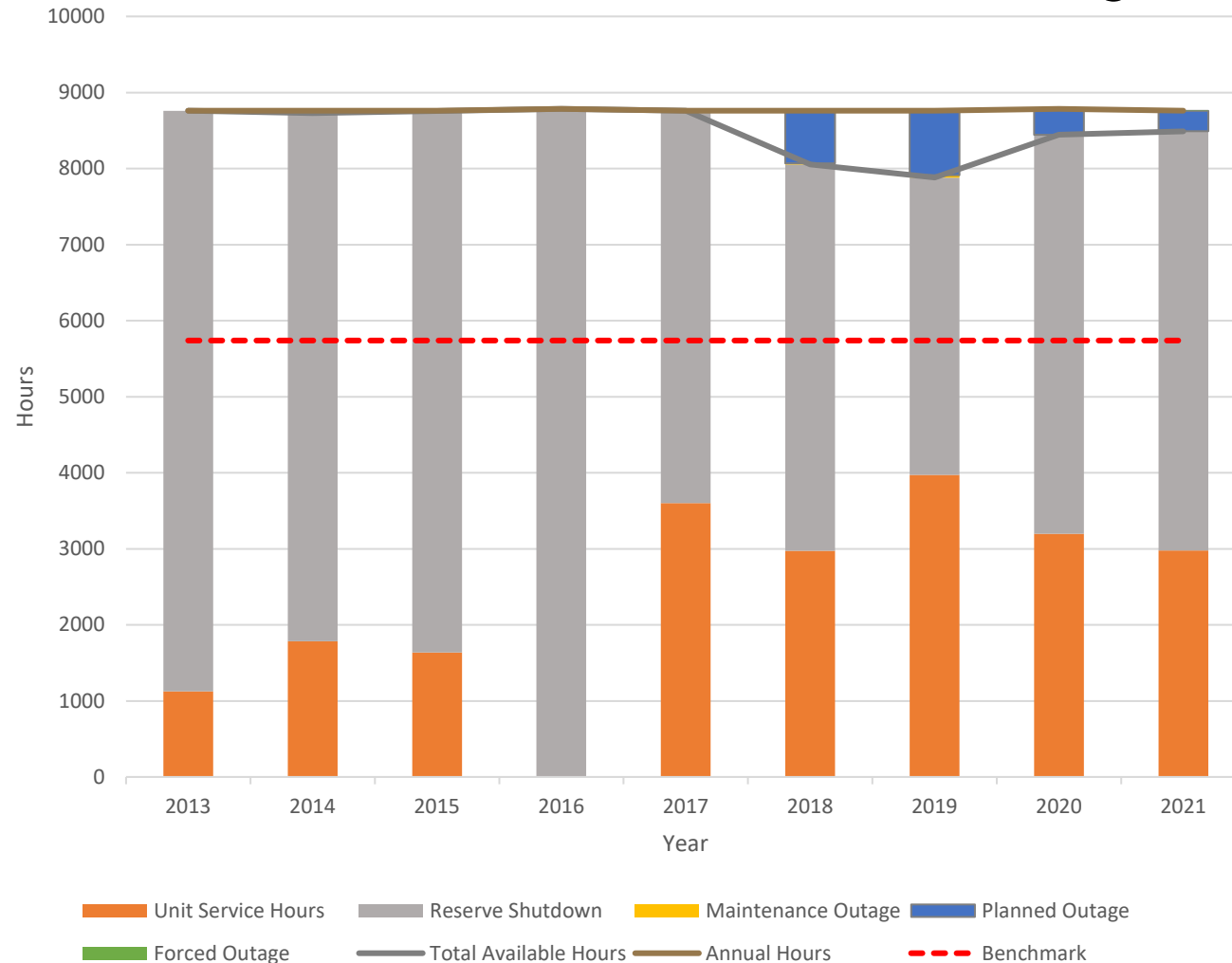
Performance Metrics

El Vado Availability Factor



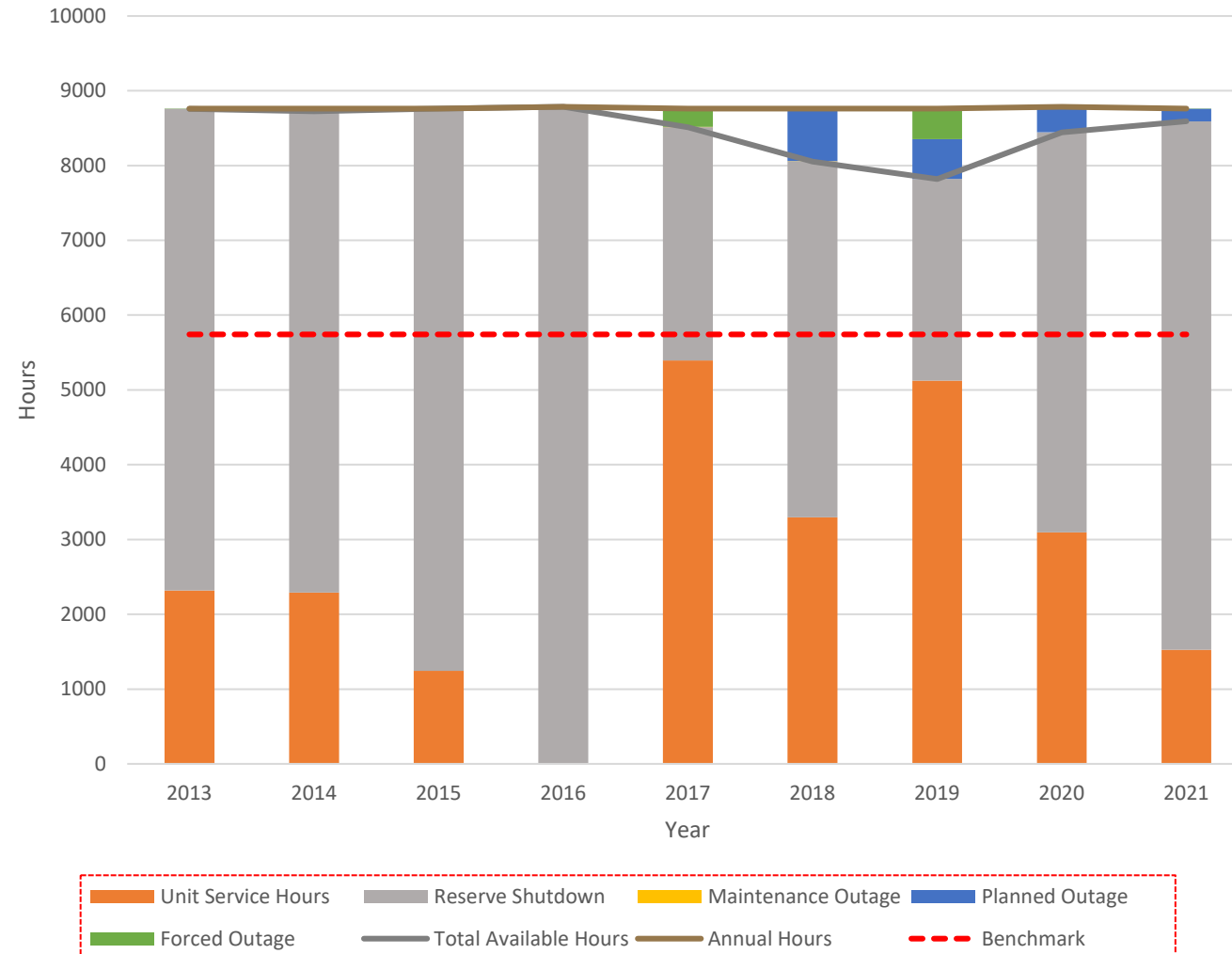
Performance Metrics

Abiquiu Unit 1 Availability Factor



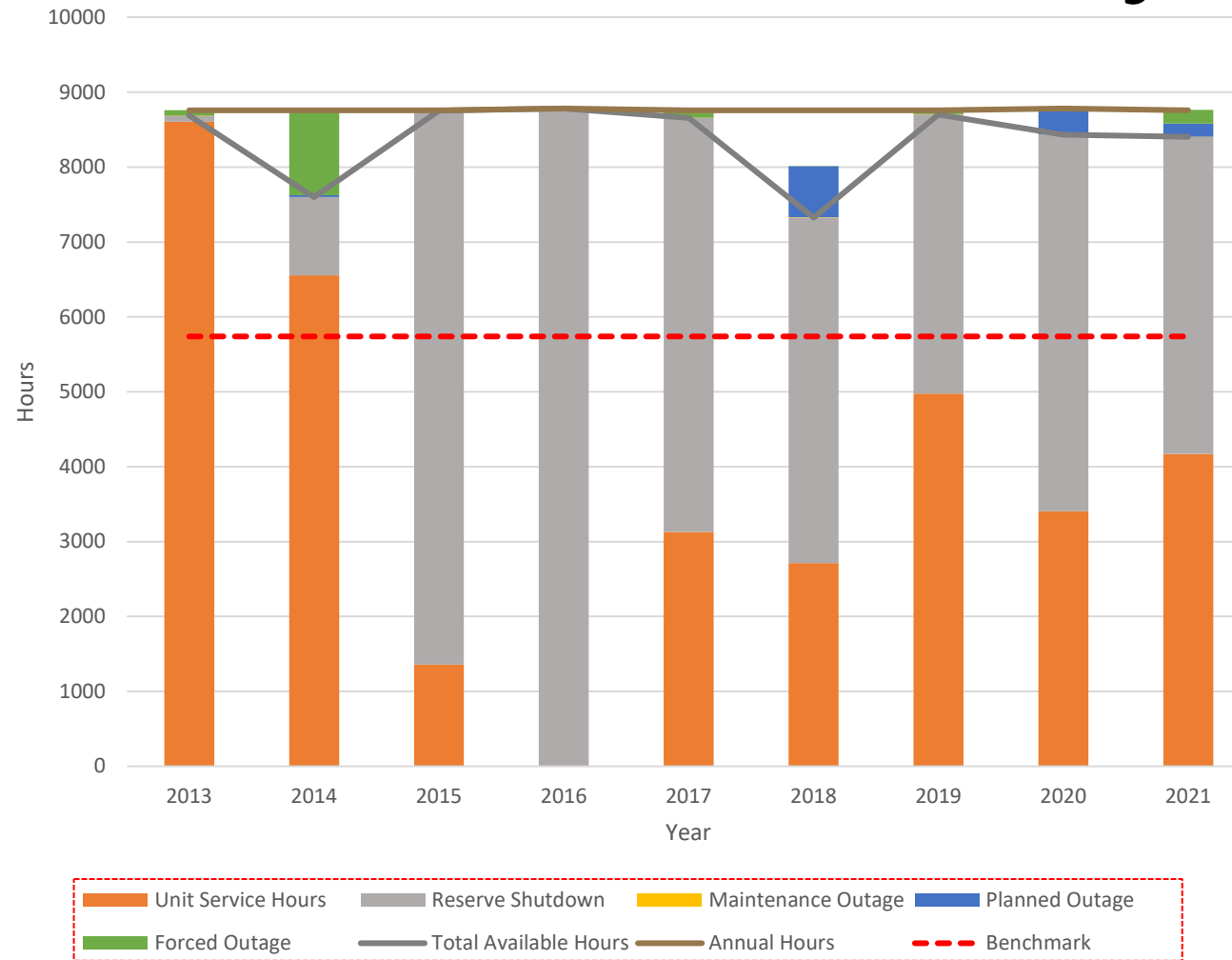
Performance Metrics

Abiquiu Unit 2 Availability Factor



Performance Metrics

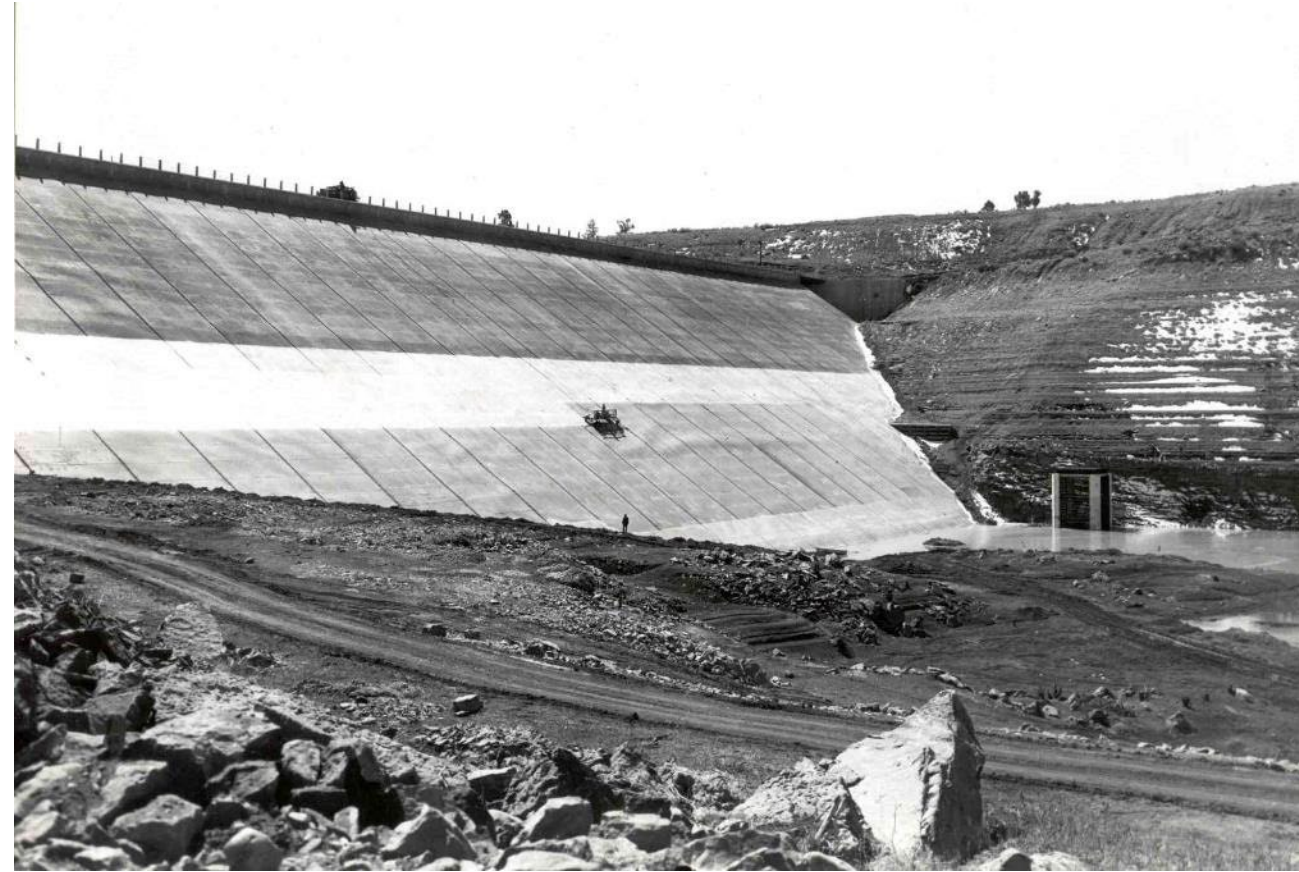
Abiquiu Unit 3 Availability Factor



Future Hydro Concerns – Sediment & Debris

- It is widely agreed upon that both El Vado and Abiquiu Dams are experiencing sedimentation issues at their intake structures.
- El Vado Hydro's intake utilizes the original 1935 outlet tunnel. The intake structure was modified in 1953 and again during plant construction in the late 1980's to address sedimentation.
- Abiquiu Hydro's Intake is common to the only penstock associated with the dam from the 1960's. Its horizontal orientation has always been prone to passing sediment.
- Both power plants have been passing sediment from the lake into the river channels for years.
- Abiquiu Hydro is experiencing an increase in larger debris entering the plant's water conduits. Large rocks are becoming lodged in the spiral cases and/or turbines.

El Vado Intake Structure Upgrade 1953



El Vado Sediment Passage (Typical)



Abiquiu Intake Structure



Relative Size Van in Front of Trash Rack



Relative Size Man in Front of Trash Rack

Abiquiu Sediment Passage July 2021



Abiquiu Unit #3 May 2017



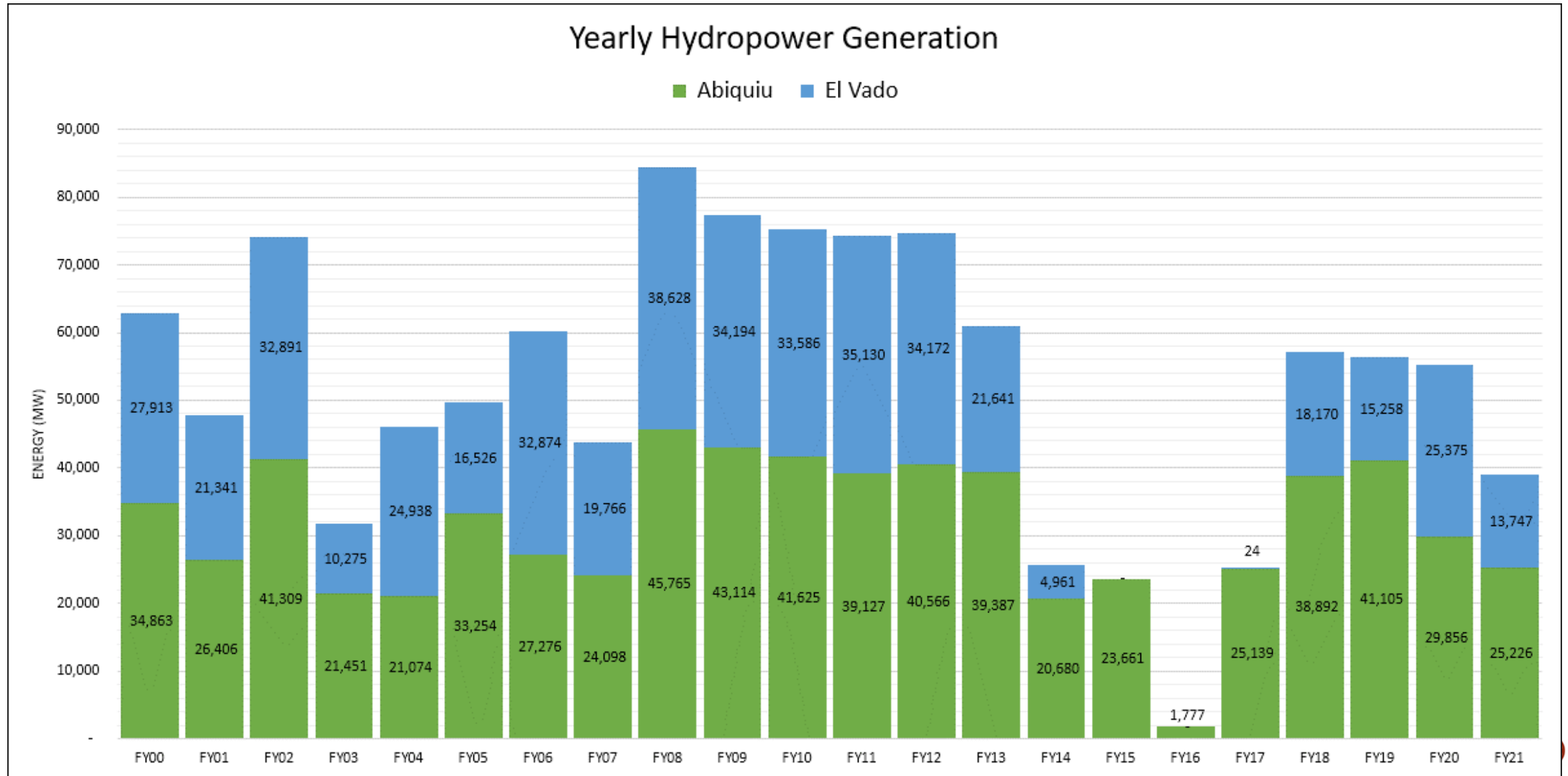
Abiquiu Unit #1 August 2017



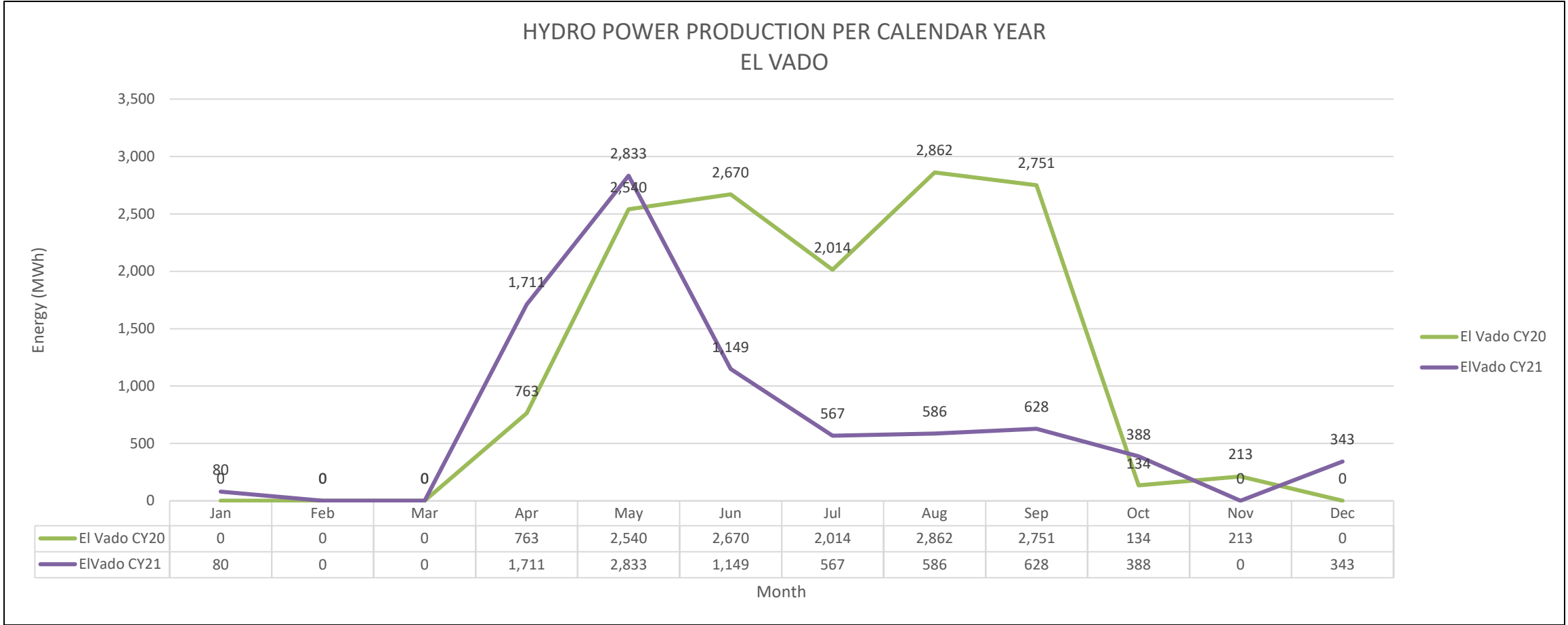
Abiquiu Unit #3 February 2020



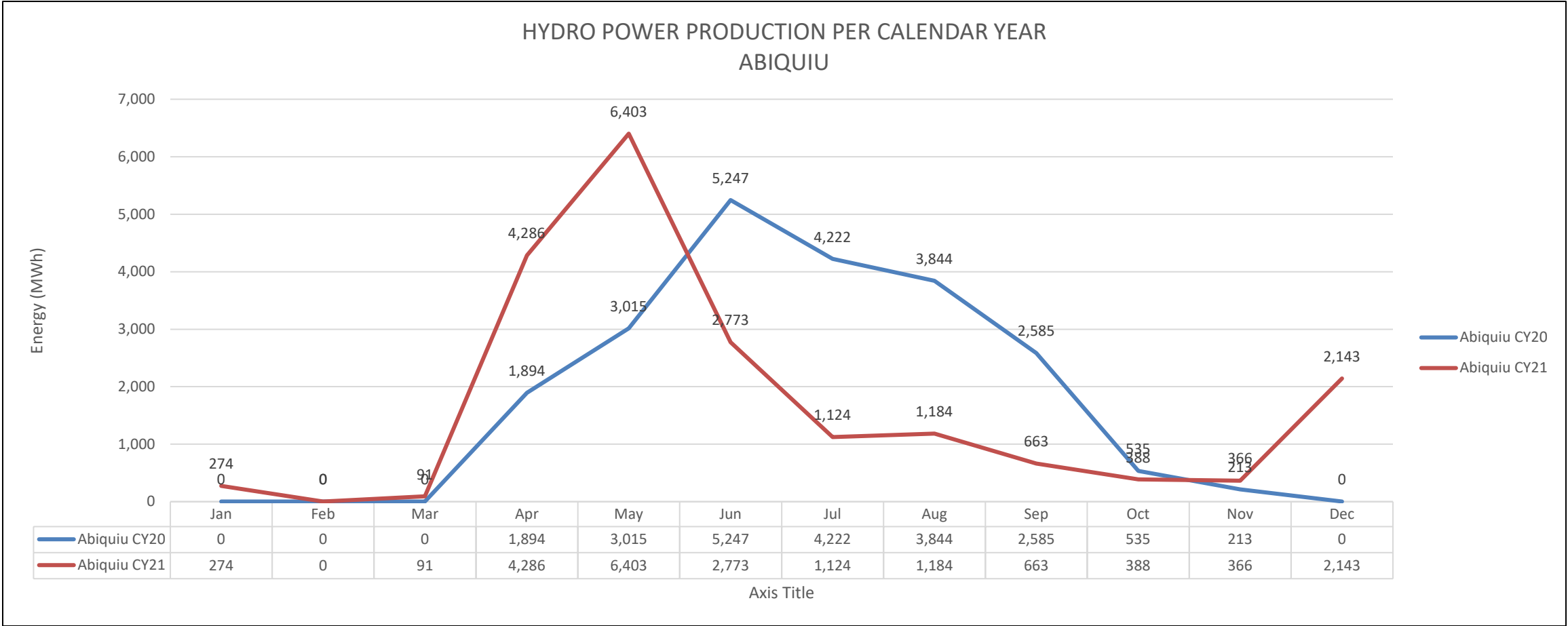
Annual Hydro Generation



El Vado 2 Yr. Monthly Generation



Abiquiu 2 Yr. Monthly Generation



Questions

