U.S. DEPARTMENT OF **ENERGY** | Energy Efficiency & Renewable Energy

R&D to Support Modernization, Upgrades, and Security for Existing Hydropower Fleet

Hydropower Program

Thursday, October 10, 2019

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Water Power Technologies Office

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Hydropower Program Strategic Priorities

Environmental R&D and Hydrologic Systems Science

Big-Data Access and Management
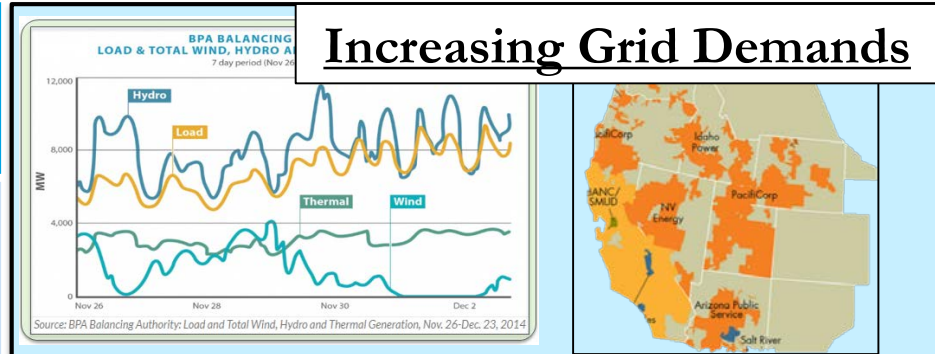
Technology R&D for Low-Impact Hydropower Growth

R&D to Support Modernization, Upgrades and Security for Existing Hydropower Fleet

Understand, Enable, and Improve Hydropower's Contributions to Grid Reliability, Resilience, and Integration
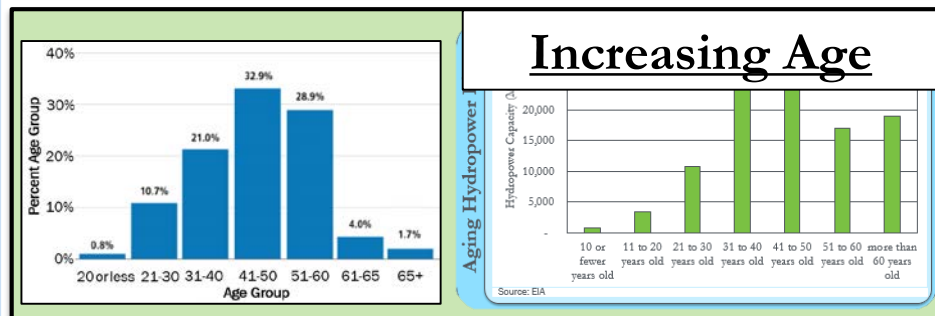
Program Strategy and Objectives

R&D to Support Modernization, Upgrades, and Security for Existing Hydropower Fleet

- Introduction of new technologies and upgrades of the existing fleet occur over long time periods given longevity of assets
- Hydropower facilities are extremely different from one another, with wide ranges of operational and physical characteristics and limited information availability
- Hydropower and PSH plants are increasingly connected to information technology systems which heighten cybersecurity risks
- Effective application of digitization requires a heretofore unestablished "right sized" focus on information and analytics
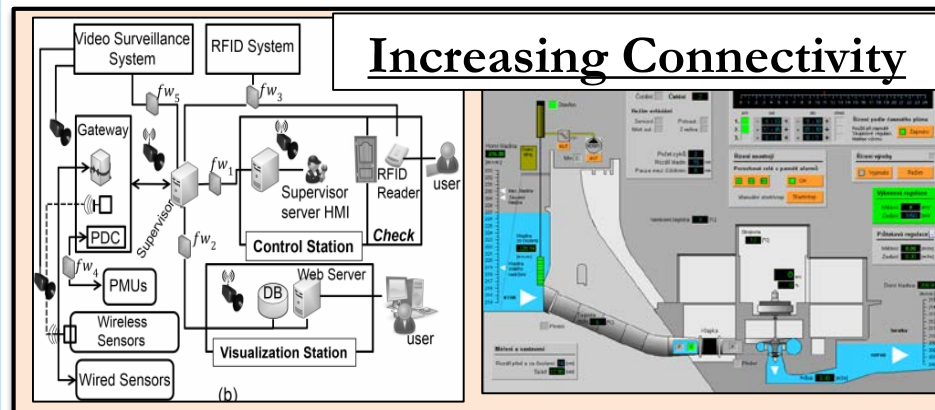

Increasing Grid Demands

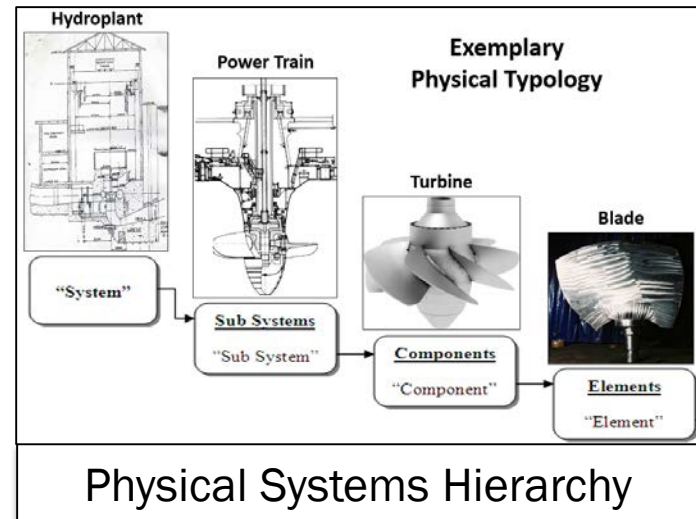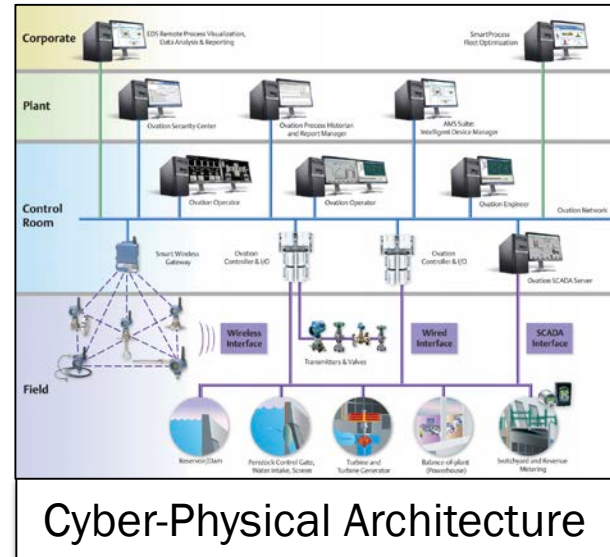Source: BPA Balancing Authority: Load and Total Wind, Hydro and Thermal Generation, Nov. 26–Dec. 23, 2014

Increasing Age

Source: EIA

Increasing Connectivity

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R&D to Support Modernization, Upgrades, and Security for Existing Hydropower Fleet

- Create mechanisms to classify diverse hydropower plants by mechanical and cyber-physical systems, providing better characterization of the fleet and allowing identification of exemplary facilities / practices
- Advanced instrumentation and data evaluation to improve equipment longevity and condition based repair
- Creation of cybersecurity tools and studies which help enhance the security of critical dam infrastructure by articulating the cybersecurity target, risk and recovery landscape
- Develop cross-cutting digitalization systems and advanced sensor suites to empower data driven decisions on O&M and asset management

Cyber-Physical Architecture

Physical Systems Hierarchy

Program Strategy and Objectives

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Novel Sensors

Hydro Fleet Intelligence

R&D to Support Modernization, Upgrades, and Security for Existing Hydropower Fleet

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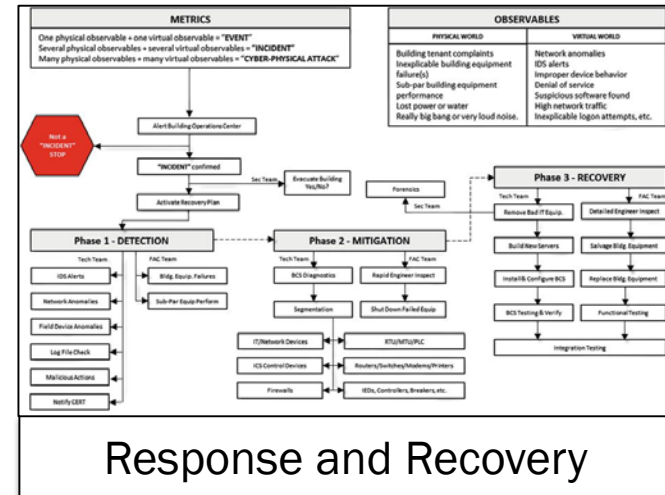

Response and Recovery

Cyber Surrogate

Program Strategy and Objectives

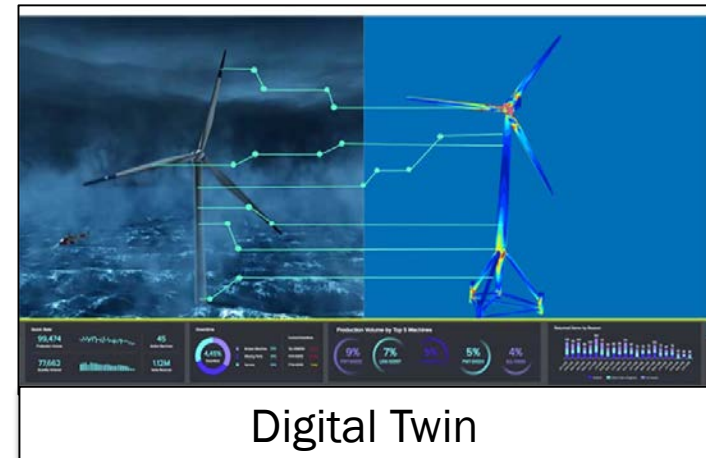## R&D to Support Modernization, Upgrades, and Security for Existing Hydropower Fleet
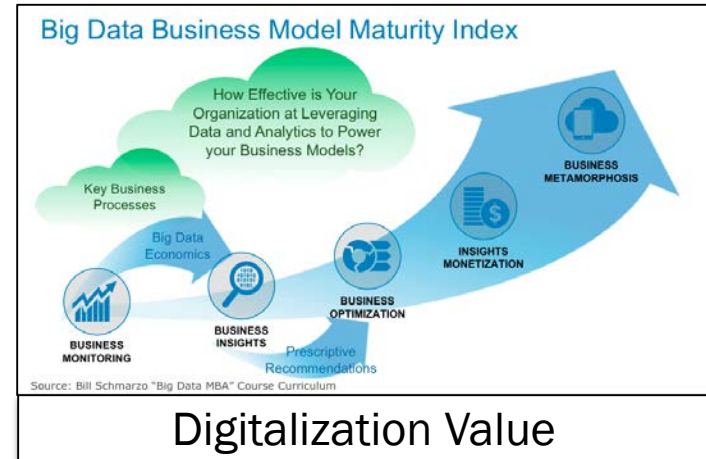
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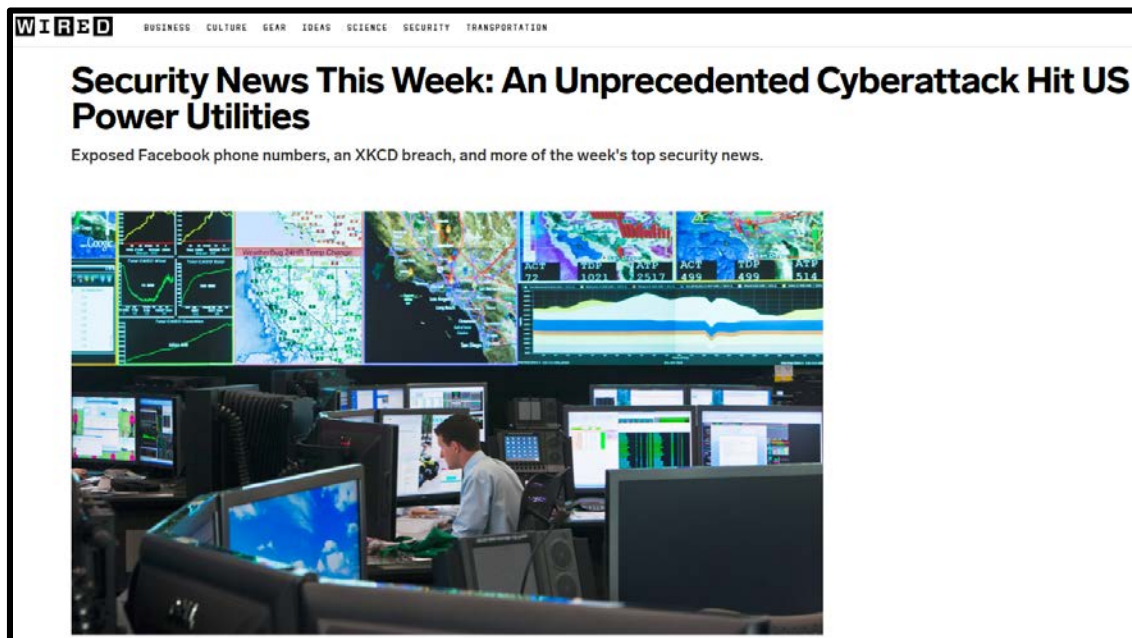

Digitalization Value

Digital Twin

Track 1: Thursday, October 10th

Start	End	Agenda Session	Presenter	Affiliation	Track	Room
1:15 PM	1:35 PM	Overview of R&D to Support Modernization, Upgrades and Security for Existing Hydropower Fleet	Mark Christian	WPTO	New Tech+Mod	Washington /Jefferson
1:35 PM	2:05 PM	Hydro Fleet Database Development and Analyses (Hydro Source)	Brennan Smith	ORNL	New Tech+Mod	Washington /Jefferson
2:05 PM	2:35 PM	Low-Head, Short-Intake Flow Measurement Research	Sam Harding	PNNL	New Tech+Mod	Washington /Jefferson
2:35 PM	3:05 PM	Hydropower Fleet Intelligence	Stephen Signore	ORNL	New Tech+Mod	Washington /Jefferson
3:05 PM	3:15 PM	End-of-Session Networking Activity	All recent presenters	All recent presenters	New Tech+Mod	Washington /Jefferson
3:15 PM	3:35 PM	WPTO's Closing Words from the New Tech+Mod Panel	Marisol Bonnet	WPTO	New Tech+Mod	Washington /Jefferson
3:35 PM	3:45 PM	Coffee Break and Transition				
3:45 PM	5:30 PM	Town Hall	Multiple	Multiple	Plenary	Grand Ballroom
5:30 PM	6:00 PM	Peer Reviewer Only Meetings (all hydro reviewers)				Madison

Program Portfolio

Cybersecurity:

- Congressional Appropriation requiring EERE submit a "<u>multi-year program plan</u>" to "<u>bring cybersecurity into early stage R&D</u>"
- Focus on articulating the State of the fleet

WIRED   BUSINESS   CULTURE   GEAR   IDEAS   SCIENCE   SECURITY   TRANSPORTATION

Security News This Week: An Unprecedented Cyberattack Hit US Power Utilities

Exposed Facebook phone numbers, an XKCD breach, and more of the week's top security news.

Key Takeaways:
- The cybersecurity landscape is non-uniform and changing more rapidly than hydro fleet assets.
- Hydroplants have unique operational attributes, legacy characteristics and failure mechanisms.
- Effective and "Right-Sized" guidance is key for effective cybersecurity implementation by industry

Program Portfolio

Digitalization:

- Digital transformation can provide hydro plants with the information and actionable capabilities necessary to operate in the modern electrical and water system.
- <u>Value sensitivity and articulation is critical to effort success</u>

CLOUD CONNECTIVITY/EDGE

KPI

OUTPUT

TECHNOLOGY ENABLERS

Courtesy : GE Renewable Energy

Key Takeaways:
- Understanding the current state of the art/fleet is critical to effective focus of research efforts.
- Hydroplants have unique operational attributes, legacy characteristics and system requirements that digital technologies can help empower but must be efficiently tailored to ensure an economic and valuable role.

Maintenance:

- Process to ensure asset performance, reliability and safety.
- Maintenance operations are a combination of site specific requirements as well as risk mitigation efforts.
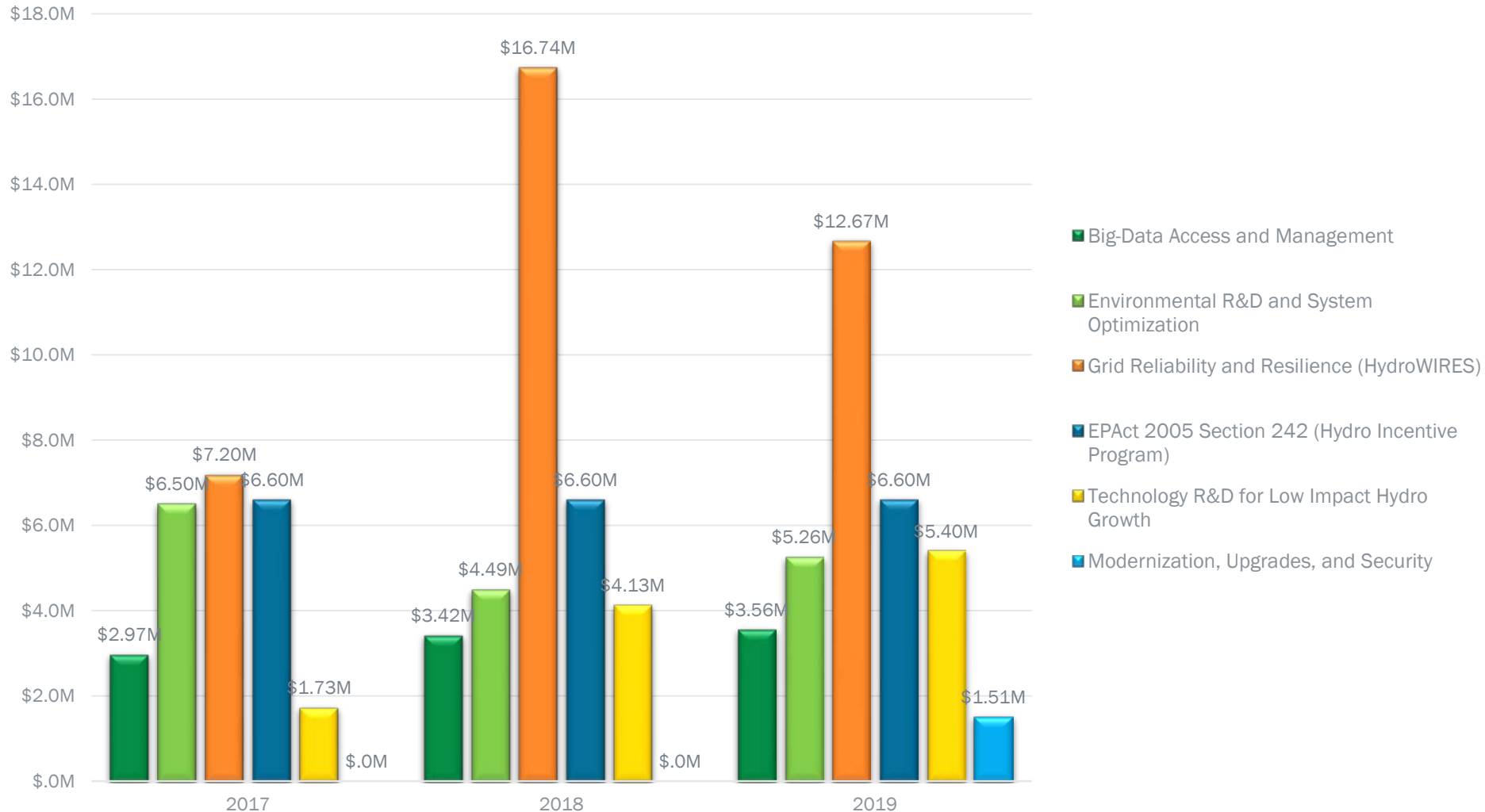- Significant history of industry activity
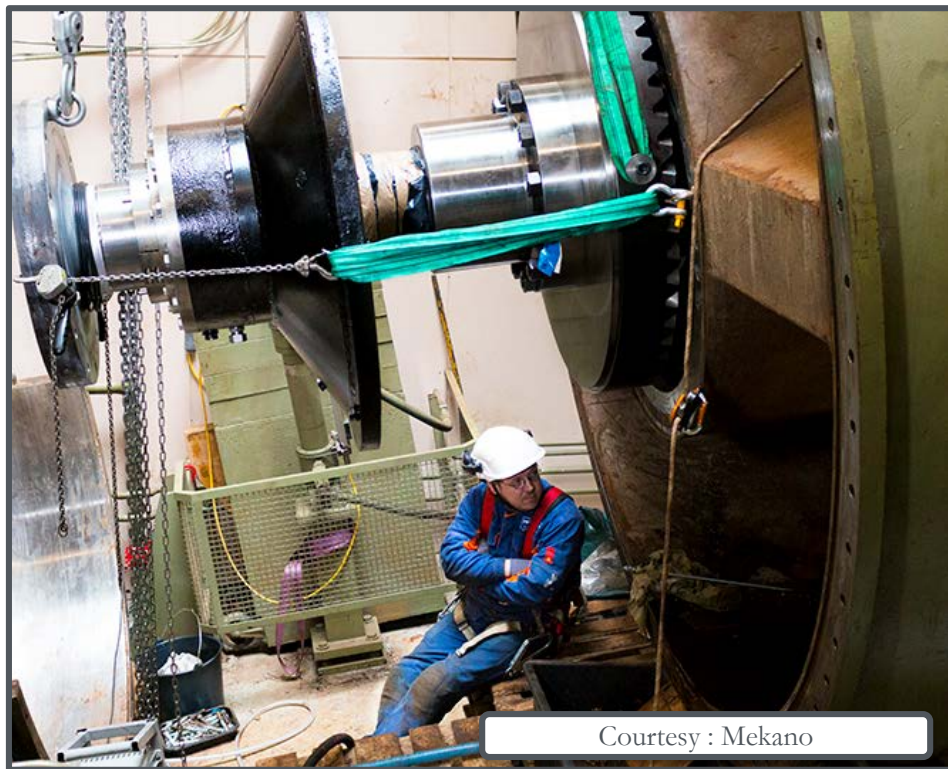
Courtesy : Mekano

Key Takeaways:
- Hydroplants are performing unlike they have in the past, and there are potentially significant maintenance and cost implications that are not explored.
- Quality data is foundational to making effective decisions – but it is not enough! Standardized processes must be put in place to make sure the data is used properly.

Legend:
- Big-Data Access and Management
- Environmental R&D and System Optimization
- Grid Reliability and Resilience (HydroWIRES)
- EPAct 2005 Section 242 (Hydro Incentive Program)
- Technology R&D for Low Impact Hydro Growth
- Modernization, Upgrades, and Security

2017:
- $2.97M
- $6.50M
- $7.20M
- $6.60M
- $1.73M
- $.0M

2018:
- $3.42M
- $4.49M
- $16.74M
- $6.60M
- $4.13M
- $.0M

2019:
- $3.56M
- $5.26M
- $12.67M
- $6.60M
- $5.40M
- $1.51M

Program Management Approach

Hydro Fleet Intelligence:

- HydroAMP Data Assessment: Q3 FY18

- Engagement with PG&E: Q3 FY19

- Flexible Impacts Data Analysis: Q4 FY19

Flow Measurement:

- ADCP Flume Testing: Q1 of FY19

- Flow Meter Field Testing: Q4 of FY19

Cybersecurity:

- Response & Recovery Funded: Q4 of FY19

- Cyber-Physical Topologies Funded: Q4 of FY19

Stakeholder Engagement, Outreach, and Dissemination

Stakeholder Input Incorporated:

- Industry Working Groups: EUCG, HydroAMP, IPSIG, HPLIG

- Standards Committees: ASME PTC-18

- Owner Operators: USACE, USBR, PG&E

- Other Agencies: NERC, DHS, NIST, USACE, USBR

Dissemination of Information:

- Project Development (Two Way Communication!)

- Industry Workshops and Forums

- Conferences

Key Partnerships:

- PG&E: Hydropower Fleet Intelligence

- US Armey Corps of Engineers: Field Testing of Flow Measurement Devices

Future Work

Digitalization

- Advanced Analytics
- Digitalization Valuation

Cybersecurity

- Cyber Risk Matrix/SOTF
- Cybersecurity Valuation

Maintenance

- HFI Cost / Condition / Reliability

Digital Twin

- Advanced Sensors
- Secure Coms/ Data Transfer

Cyber Surrogate

Condition Based Repair