

+ Implementing Smart Digital Solutions For Power and Water Management



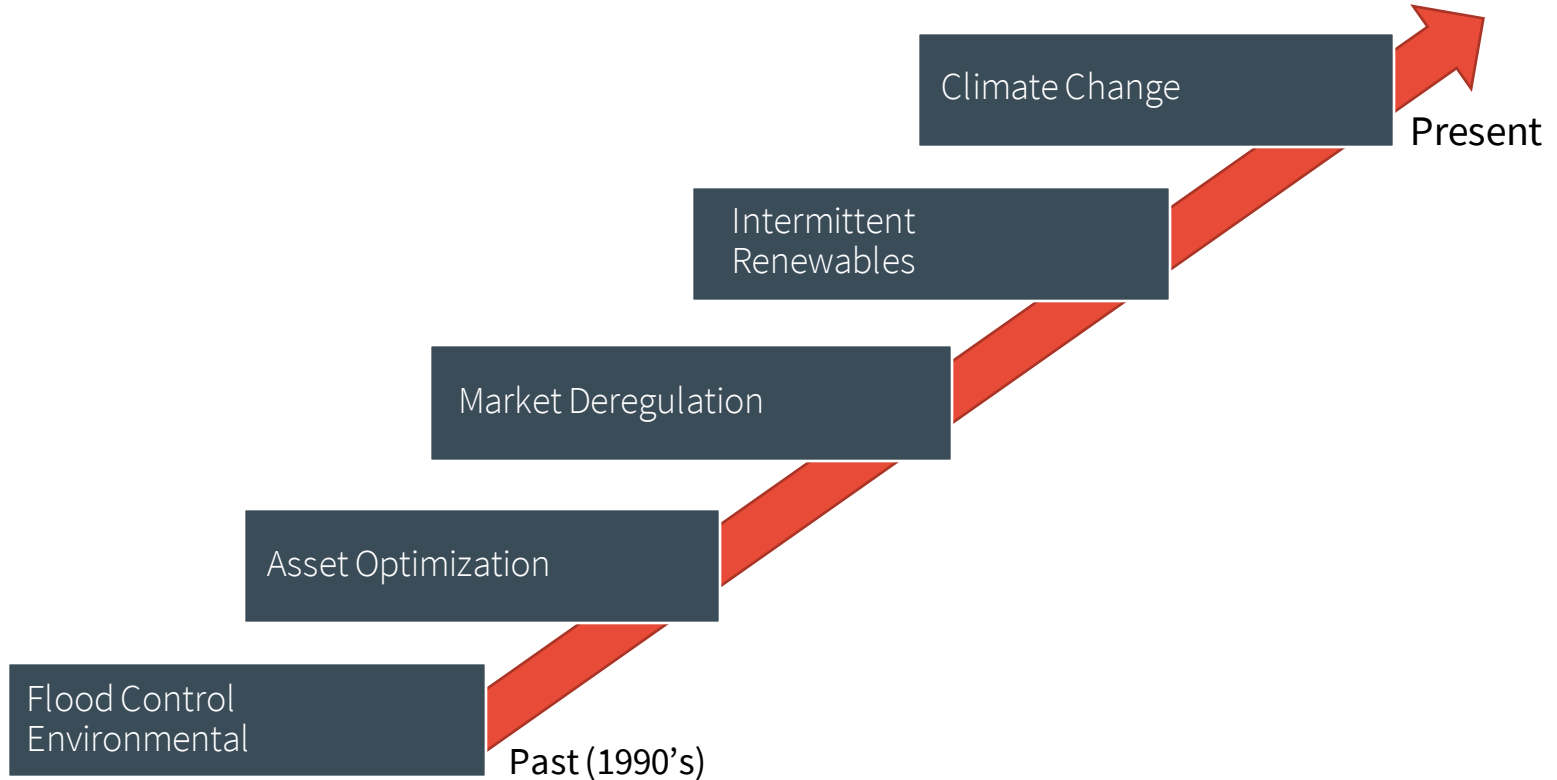
May 26, 2021

HATCH

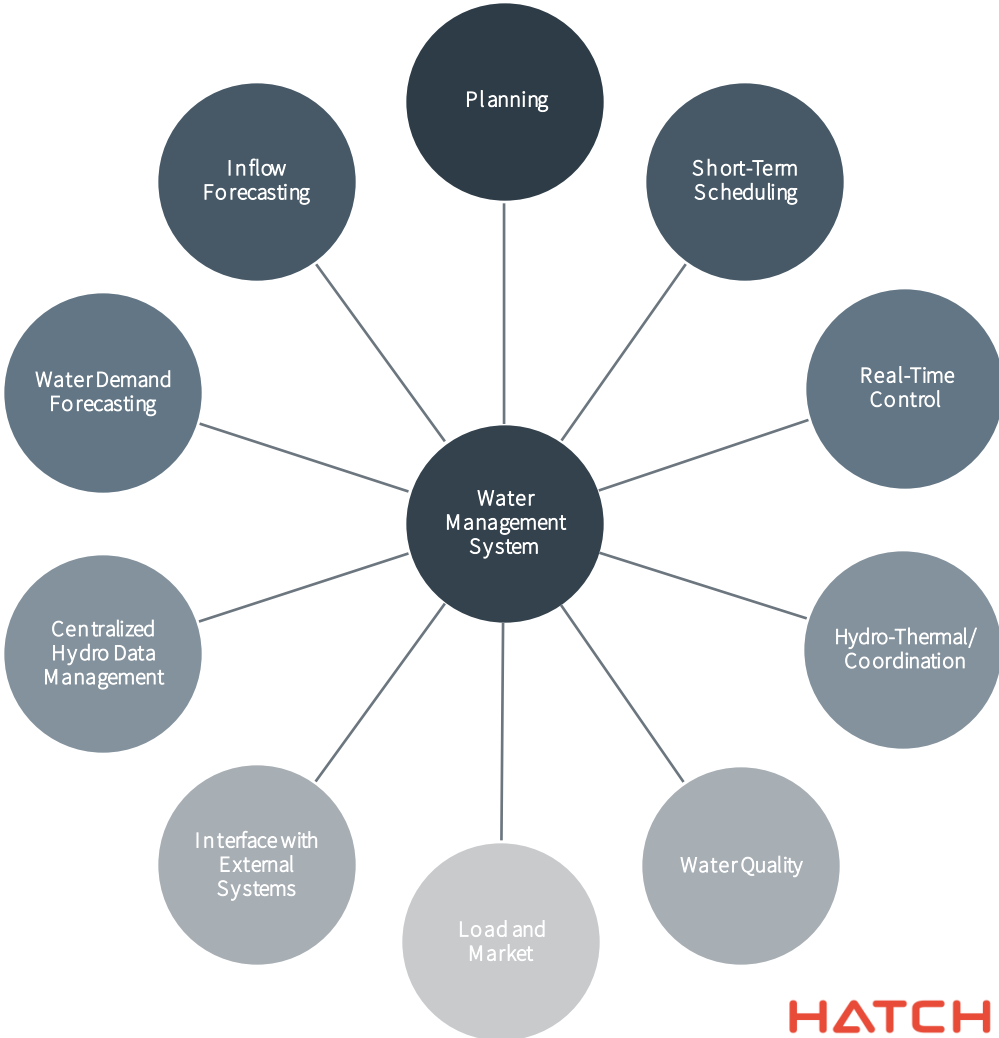
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Introduction

Need for Smart Digital Solutions in Hydro Operation

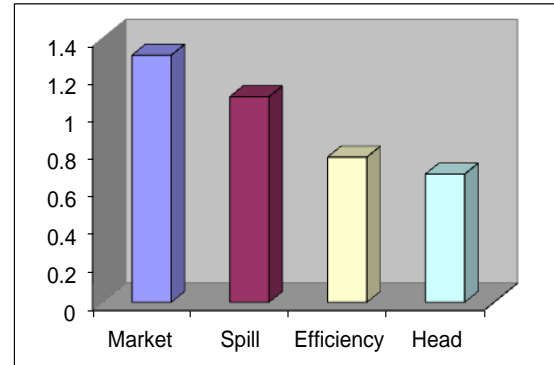


Smart Digital Solutions: Scope



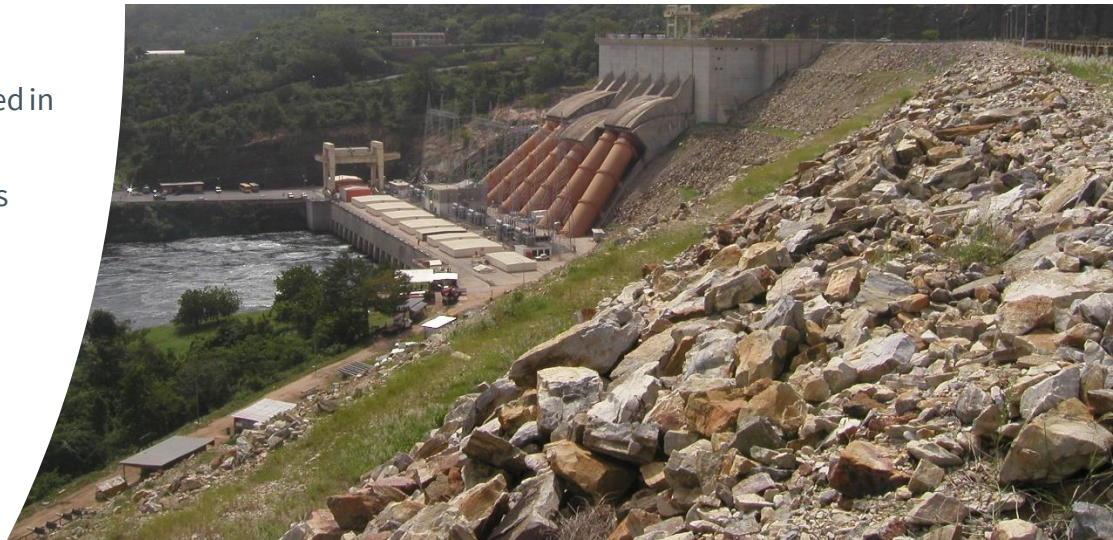
Benefits of Digital Solutions for Operations

- Optimization and Economic Benefits: Potentially of the order of 1% to 5%
- Assist planners, schedulers and operators in investigating alternate scenarios
- Training of new staff
- Greater automation



Hatch Power and Water Resource Modelling

- Hatch (formerly Acres) has a long history of world-class simulation and optimization of power and water resource systems
- 1970s developed and applied Acres Reservoir Simulation Package (ARSP)
- ARSP implementations over 30+ years
- Vista Decision Support System (Vista DSS™) developed in 1990s through present time
- Diverse implementations of Vista DSS and continuous evolution





Vista DSS™ Solution Overview

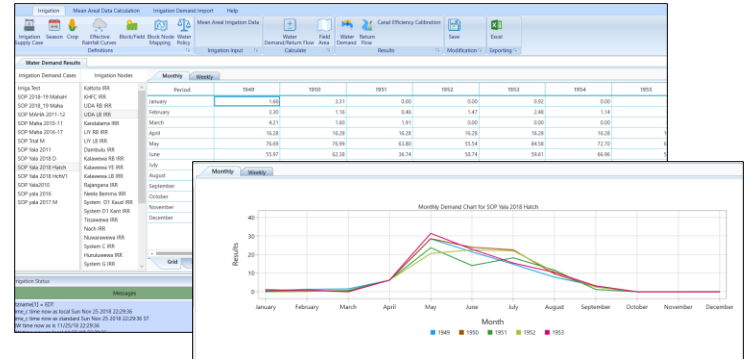
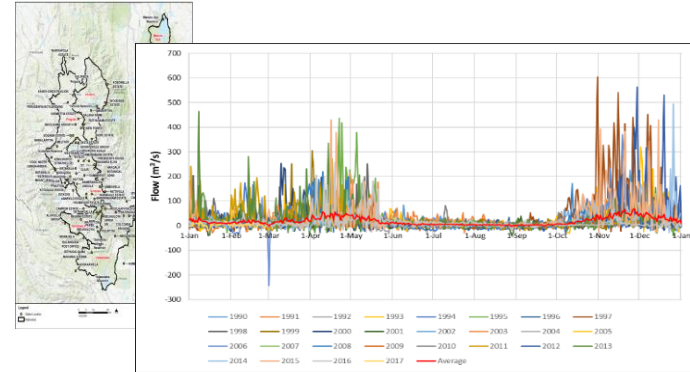


Vista DSS™ Planning + Scheduling Software for Hydroelectric Operations



Forecasting

- Inflow Forecasting
 - Met Data representation
 - Rainfall-runoff model
 - Watershed model calibration
 - Long term forecast
 - Short term forecast
 - Automatic adjustment for actual flows
- Irrigation Water Demand Forecasting
 - Met data representation
 - Evapotranspiration calculation
 - Water Demand model
 - Long Term seasonal forecast



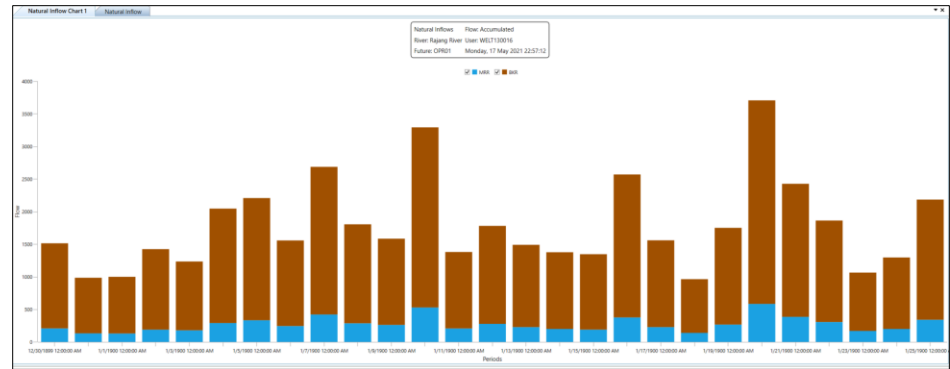
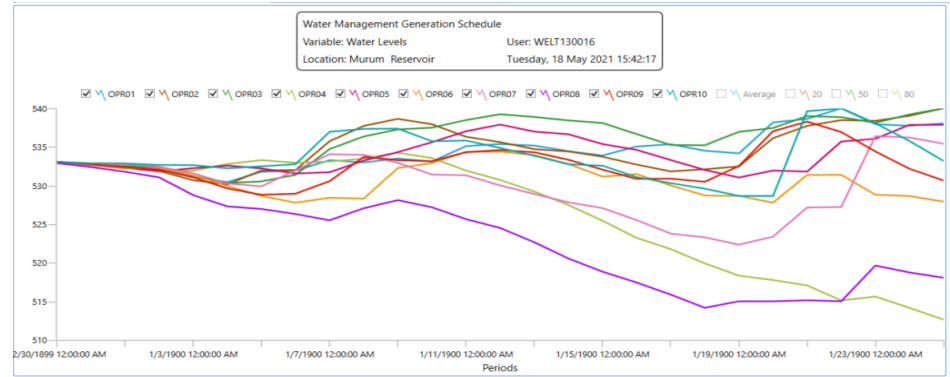
Planning and Scheduling

– Long Term Planning

- Stochastic optimization
- Seasonal reservoir trajectories
- Long term generation and transactions
- Value of water in storage

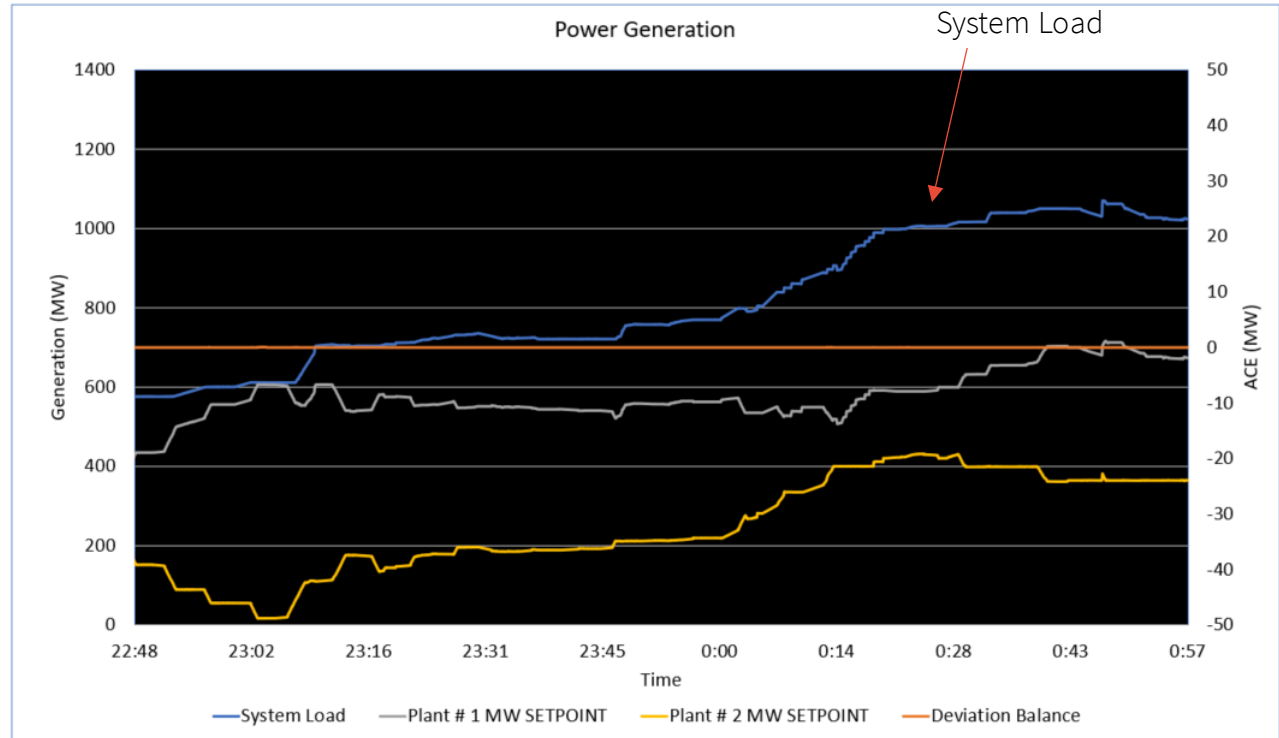
– Short Term Scheduling

- Optimal water allocation
- Plant and unit dispatch
- Short term transactions
- Bid curves
- Hydro-Thermal coordination

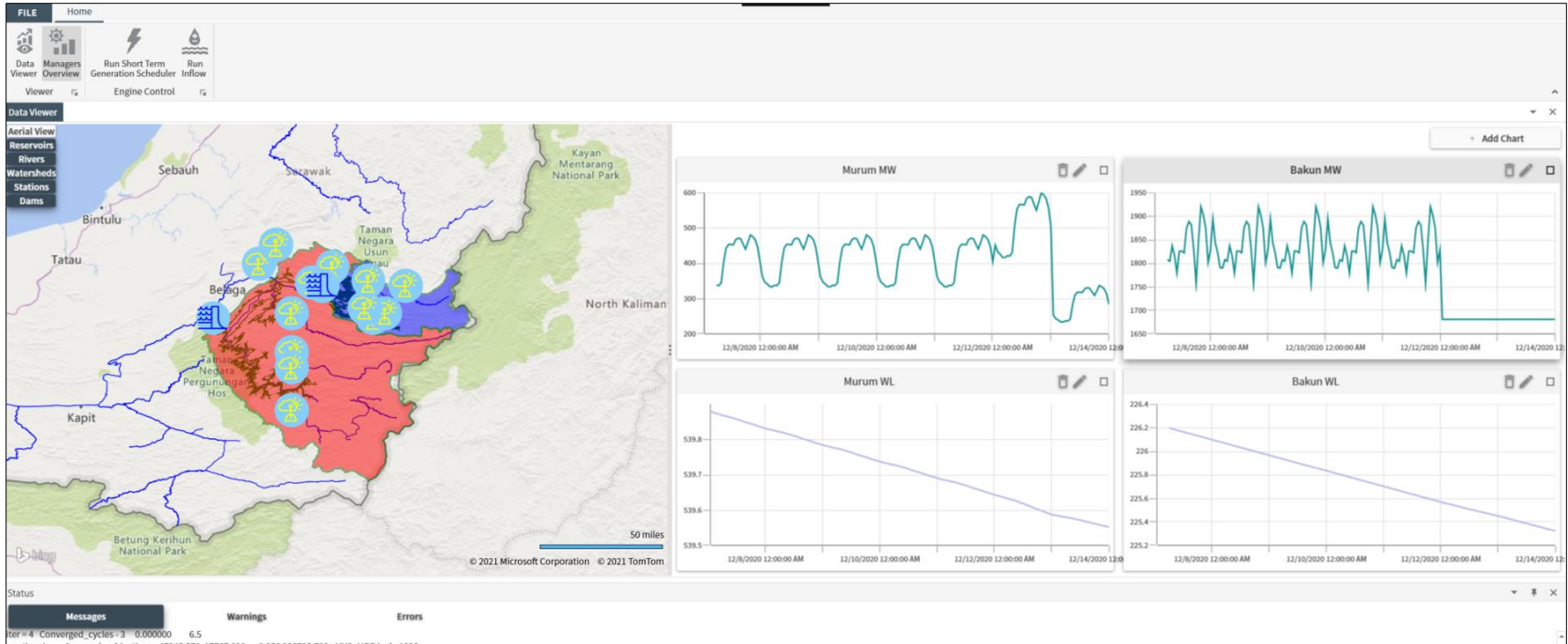


Simulate Real-Time Operation

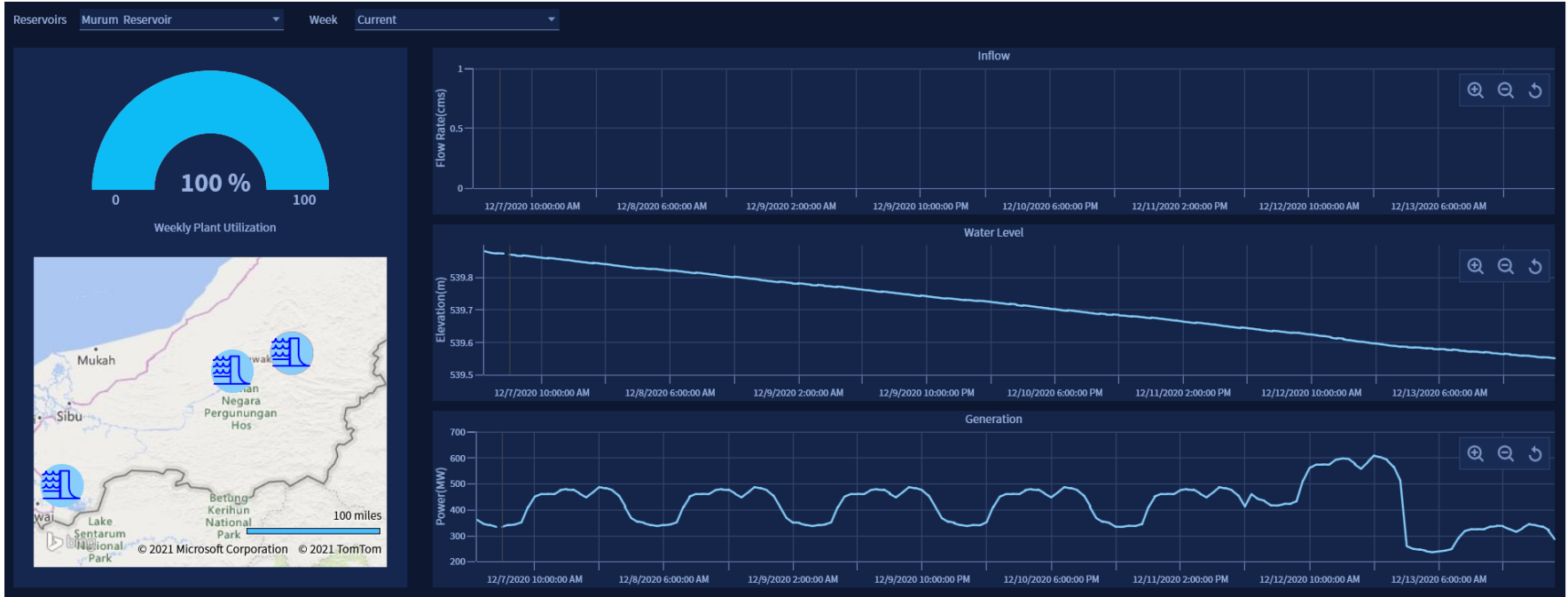
- Plant dispatch
- Unit Dispatch
- Water levels
- Constraint monitoring



Operator's View

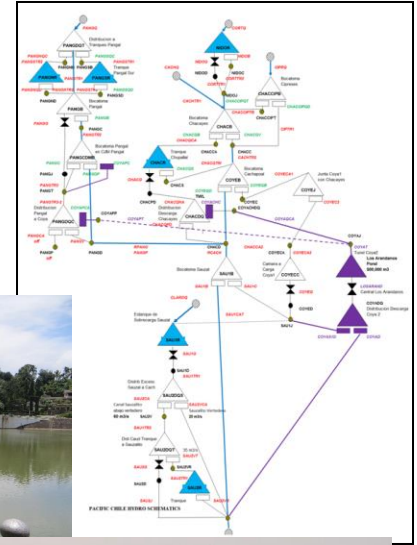


Manager's View



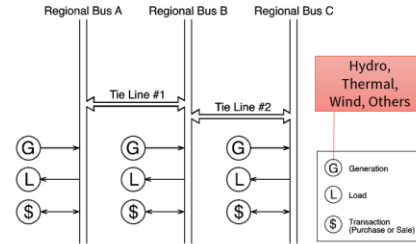
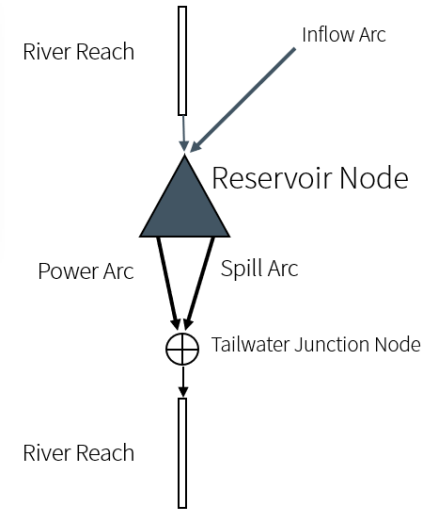
Study Applications

- Upgrade and rehabilitation studies
 - Unit upgrade
 - Additional storage
- Redevelopment studies
- Relicensing
- Integrated resource planning
 - Wind integration
 - New facilities



Flexible Models

- Large and small hydro plants
- Storage
- Hydro-Thermal generation
- Exchange of energy with neighboring countries
- Other renewables
- Model both hydraulic and transmission networks
- Energy and Ancillary services



History of Deployment



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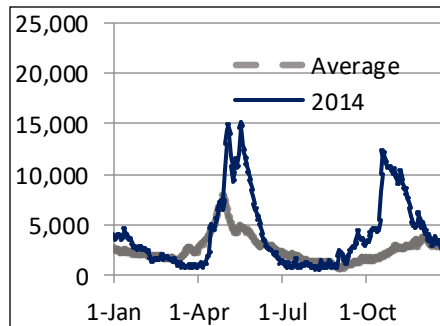
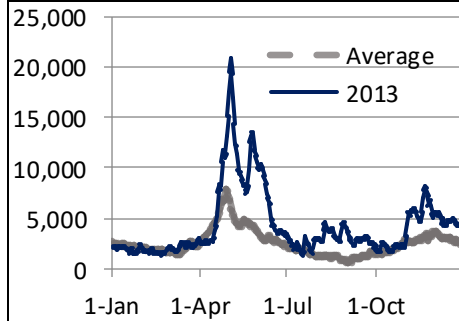
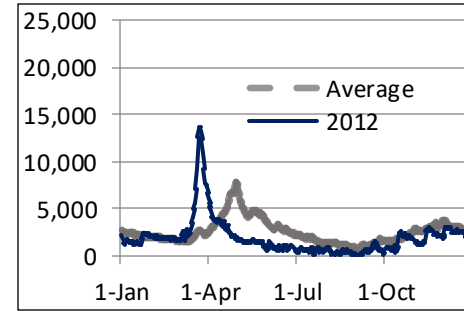
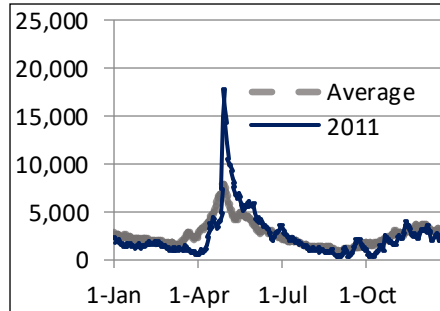
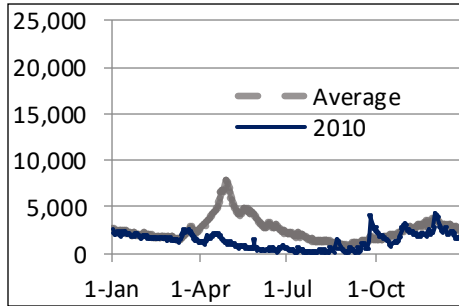
Experience in Applying Decision
Support Systems

Climate Change – Reservoir Management

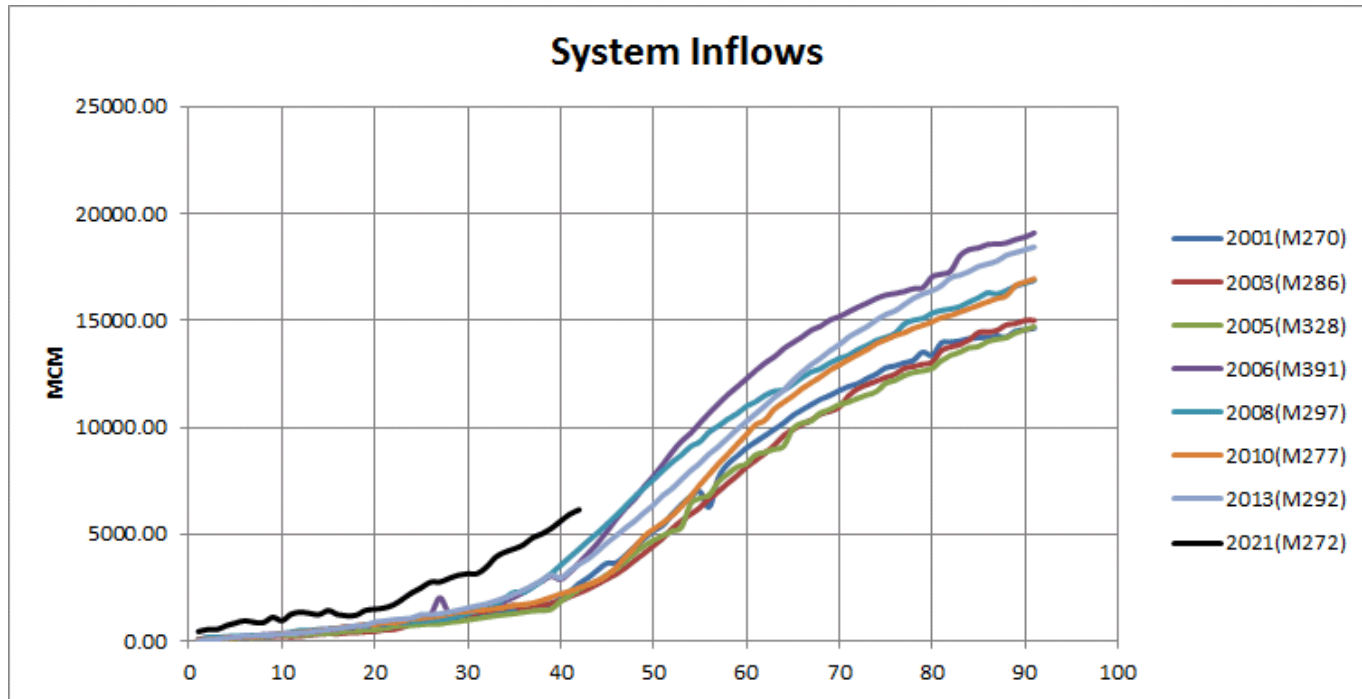
- Major Canadian utilities using the Vista DSS. Hatch has worked closely with them for decades.
- Some evidence of increased climate variability evident in recent decade(s)
 - Extremes dry/wet
 - Timing of spring runoff
 - Makes reservoir management more challenging



Northern Ontario



Eastern Canada



Reservoir Management: Adaptive Decision Support Systems vs. Guide Curves

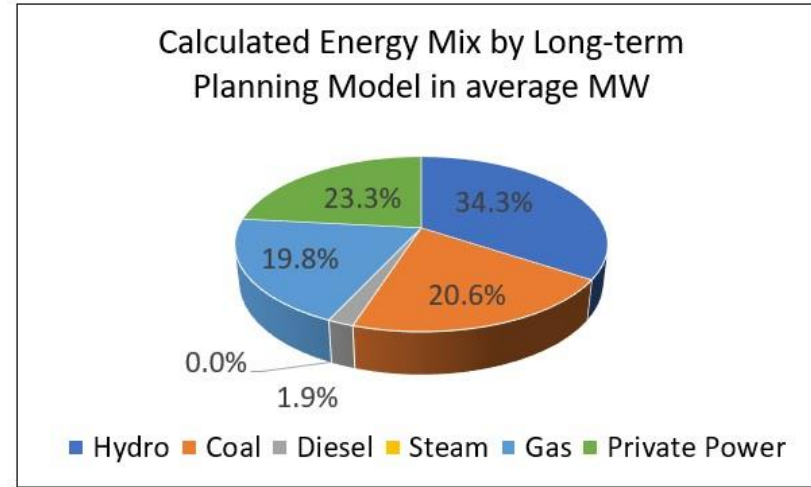
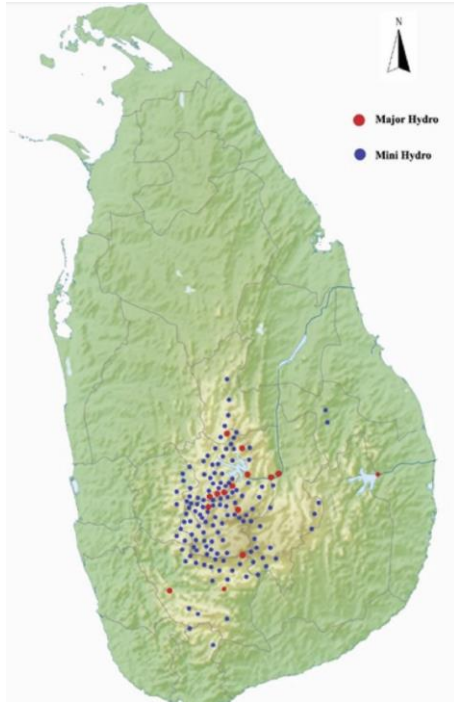
- Guide Curves (GC) are still commonly used to manage reservoir
- GC are static and usually derived from historic water levels
- Reflect operations under “average” conditions
- Adaptive Decision Support Systems
 - Dynamic, no pre-determined plan
 - Respond to inflow forecasts, price, load uncertainty
 - Analysis revisited every week

Multi-Use Reservoir Management in Asia

- Hydropower is an important but not primary objective in reservoir use
- Multiple stakeholders
- Changing conditions due to:
 - Economic development
 - Climate change



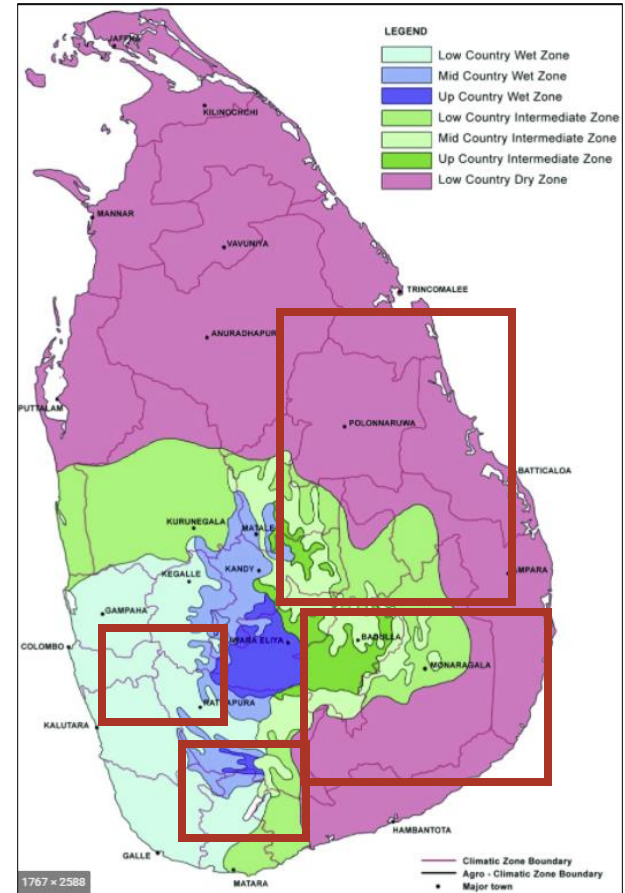
Multi-Objective Operation: Hydro Generation



- Significant contribution: 30-50%
- Peaking capability

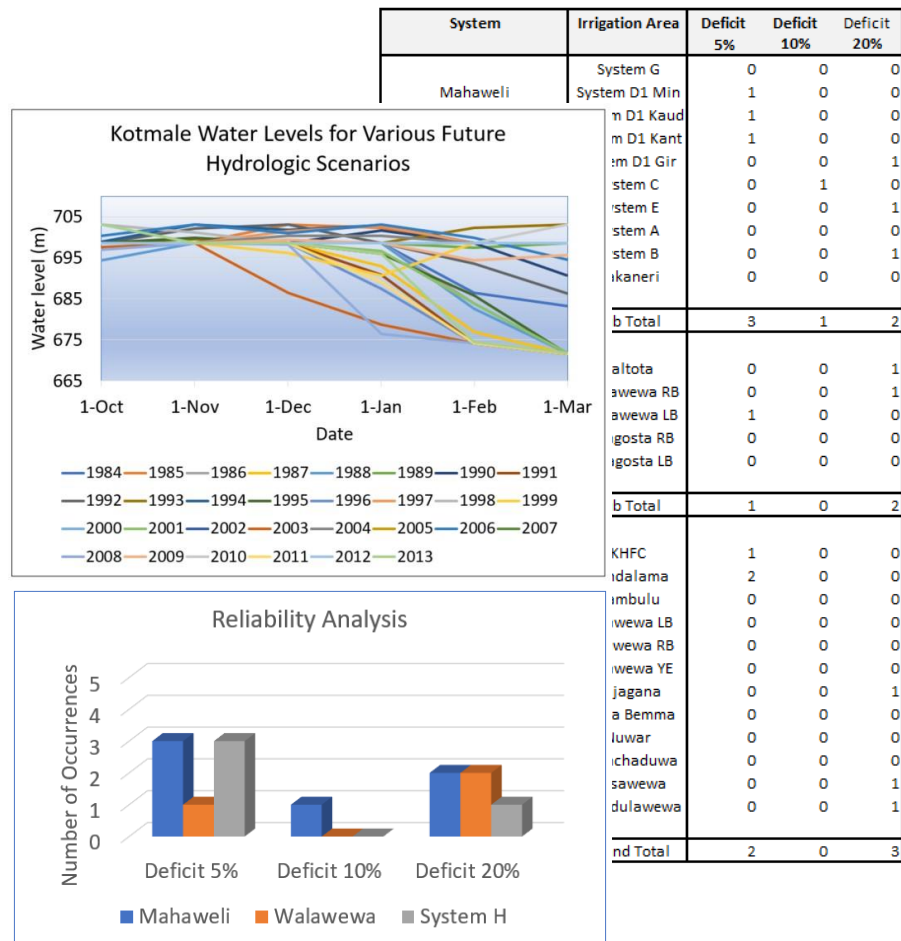
Multi-Objective Operation: Irrigation

- Irrigation as a primary objective
- Rice paddies (40% of all crops)
- Non-paddy crops
- Distribution to diverse areas
- Management of water shortages

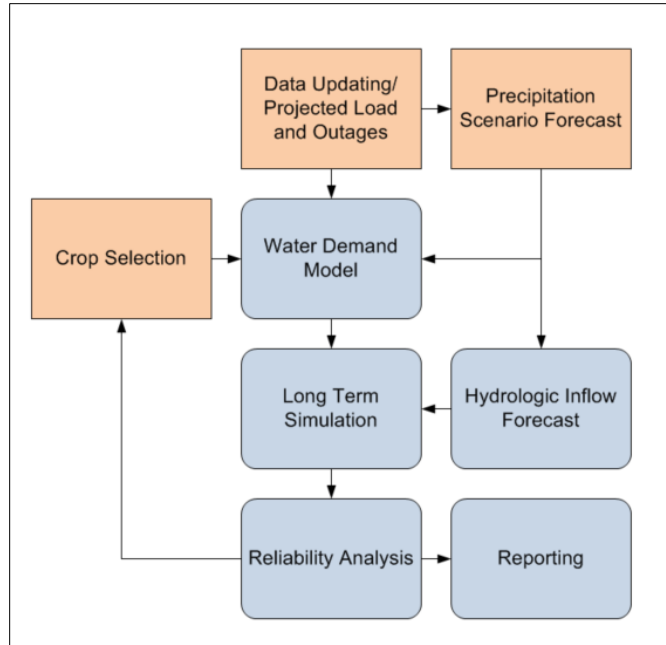


Water Availability/ Shortage Analysis

- Time series analysis
- Reliability criteria
- Interactive use for crop selection

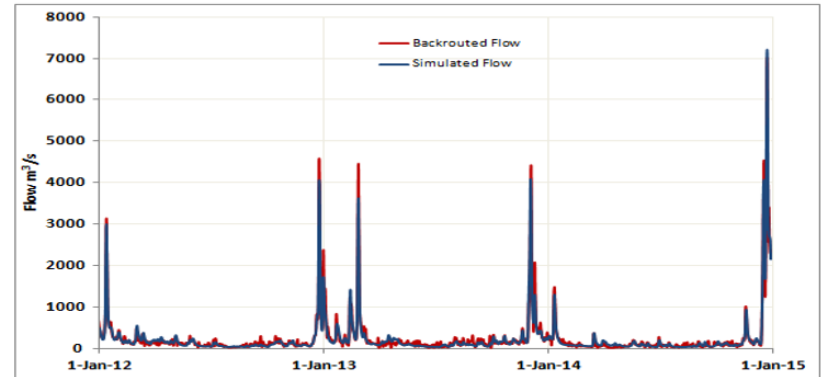
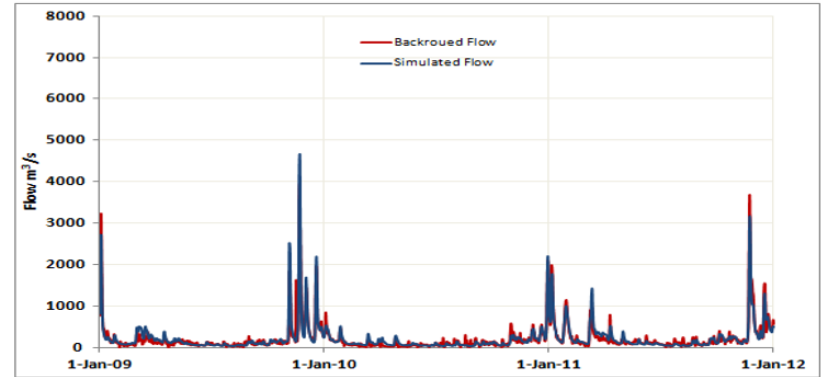


Use of Water Management System for Decision Making



Flood and Spill management in South-East Asia

- Intense Rain Events
- Need for accurate forecasting
- Minimize spill
- Dam safety consideration



Sarawak Energy, Malaysia Inflow Forecast and Dynamic Dispatch



Bakun Dam, 2,400MW

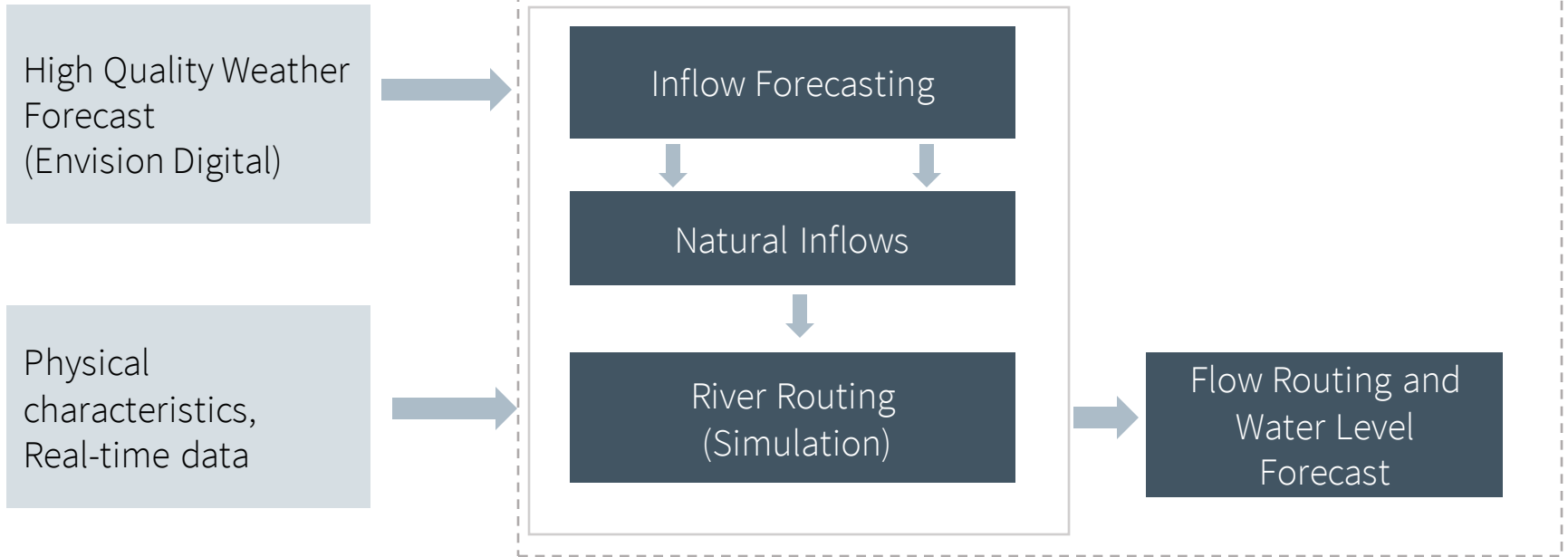


Murum Dam, 944MW



Flow and Flood Forecasting

Vista DSS



High Quality Weather Forecast



EnWeather™ – WEATHER FORECASTING

High-resolution micro-climate weather forecasts are crucial to ensuring safety and operational excellence across the hydro-power, air traffic control, and renewable energy generation sectors.

EnWeather provides up to **0.5km x 0.5km** Temperature, Wind, Humidity, Rain, Lightning and Solar Irradiance at **15-minute resolution** up to **72 hours** in advance, at over 90% forecast accuracy.

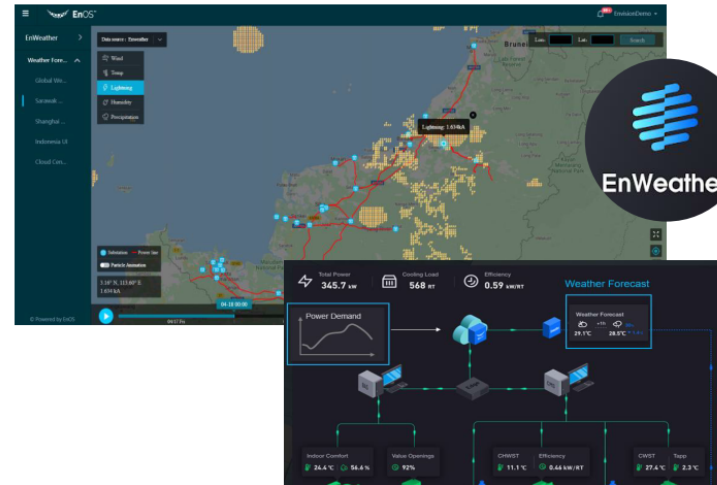
Capabilities

EnWeather offers the world's first high-definition AI weather forecast. Coverage includes:

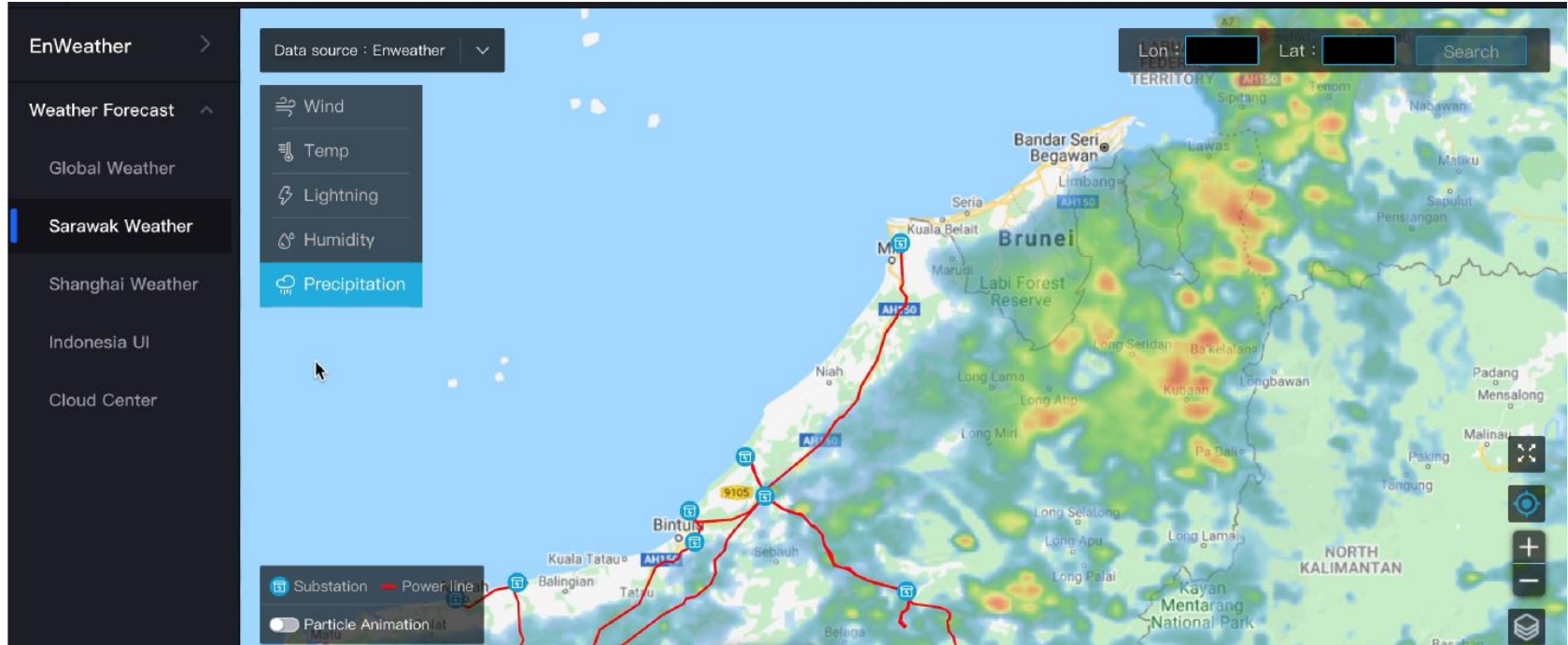
- Irradiance
- Temperature
- Humidity
- Wind speed and direction
- Rainfall
- Lightning



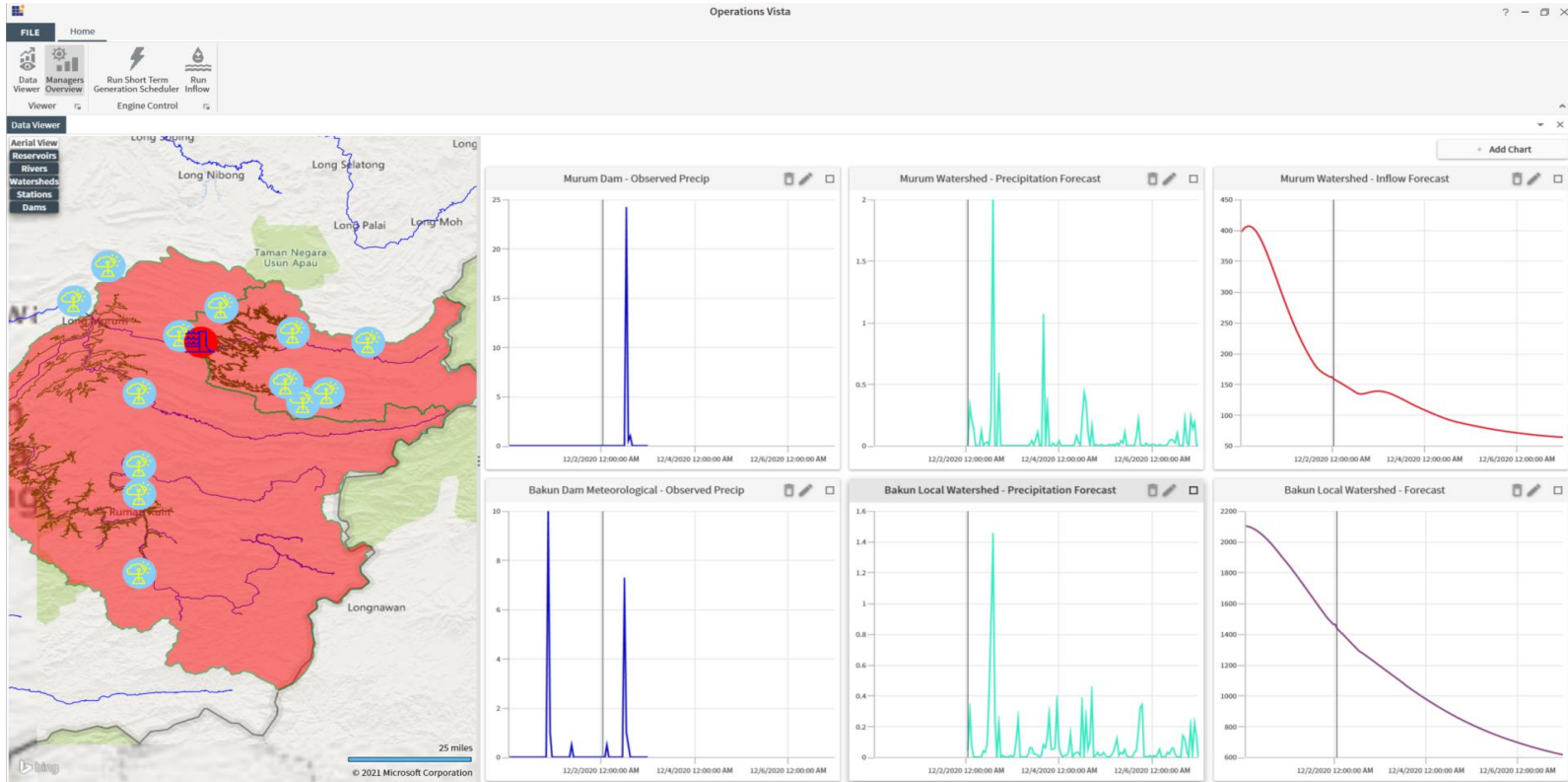
Technologies
& Services



Precipitation Forecast



Inflow Forecast

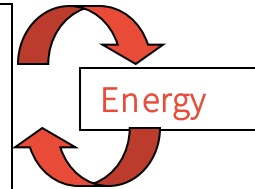


Market Deregulation

- Many regions have markets for
 - Energy
 - Ancillary Services (Reg-up, Reg-down, spin and non-spin)
- Hydro generation usually an energy limited resource and hydro is ideally suited for A/S
- Trade-off between offering energy or A/S into market
- Joint optimization is needed



- Spin
- Non-Spin
- Regulation Up
- Regulation Down

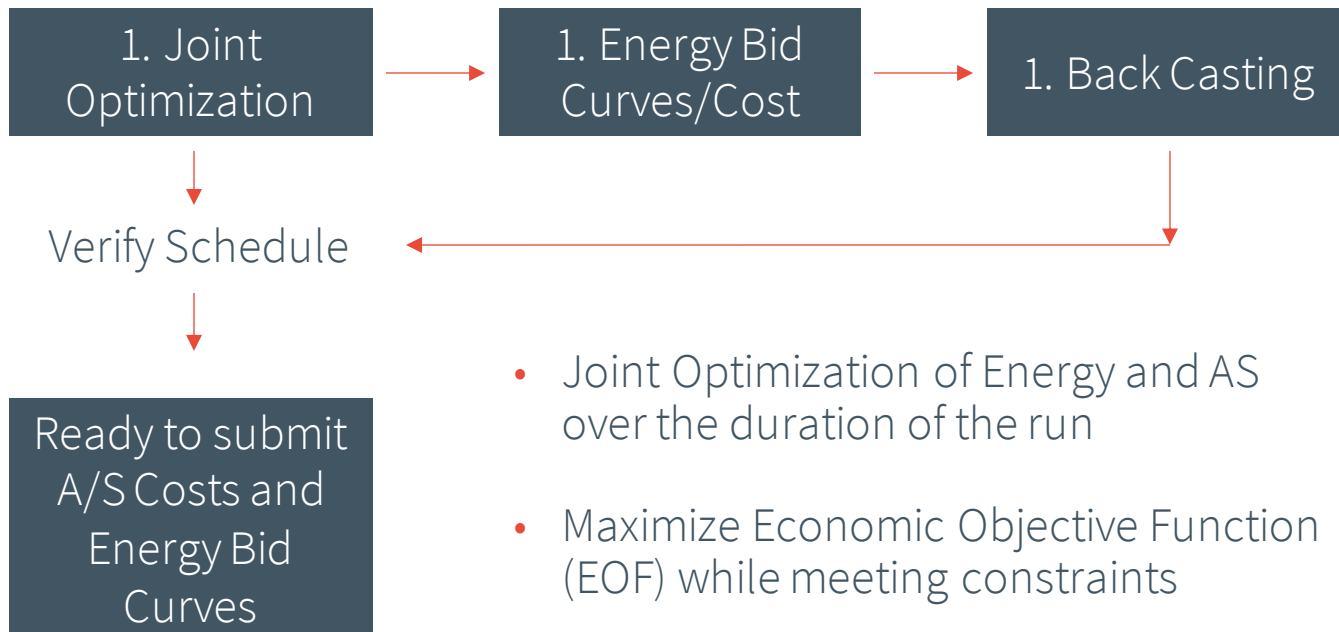


Short Term Scheduling and Market Bids (CA, USA)

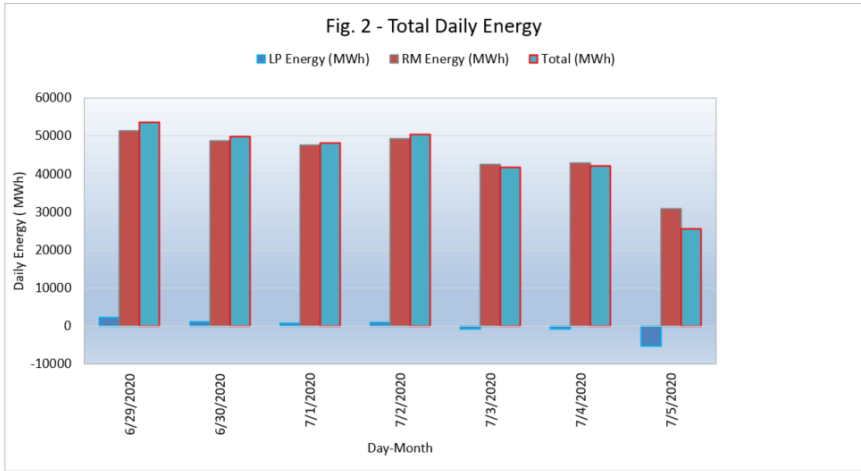
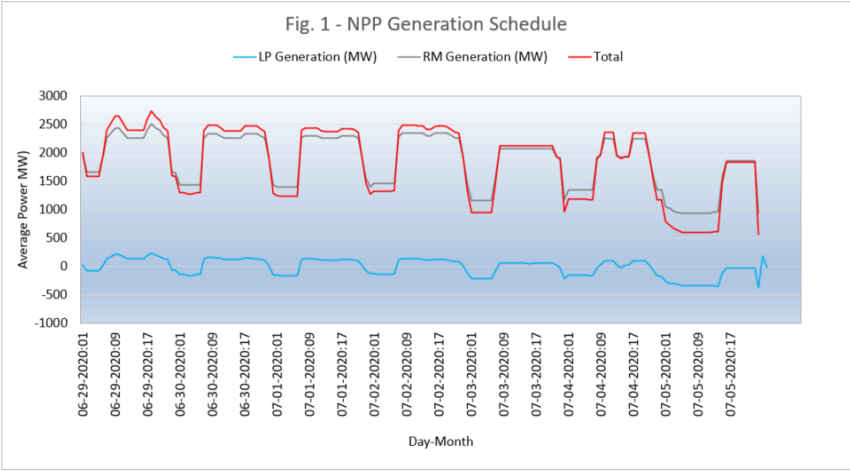
- Two River System
- Ten powerhouses
- 1,000 MW
- Seven Major Dams
- Generation and A/S bid into CAISO market



ST – Joint Optimization and Bid Creation Process

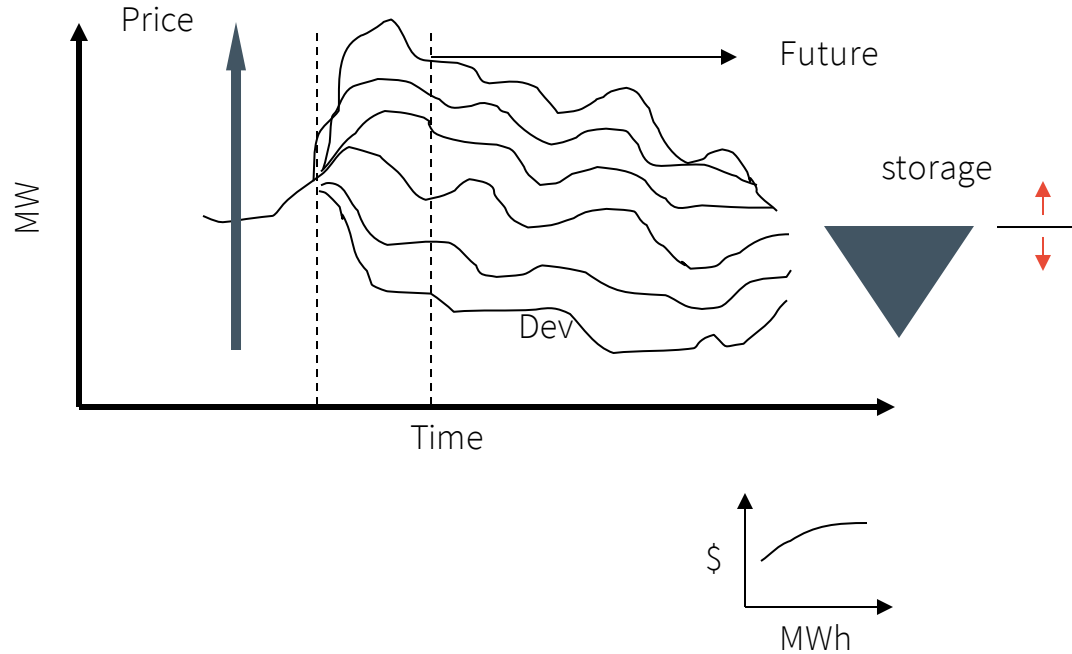


Step 1: Optimization of Energy and A/S

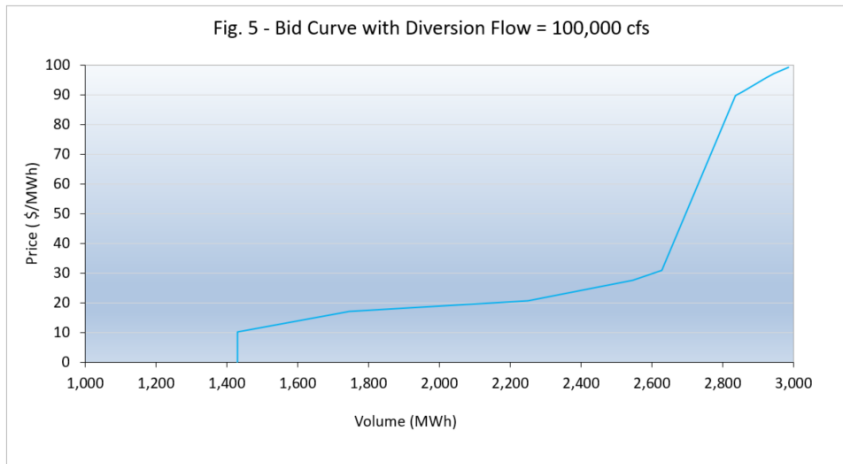
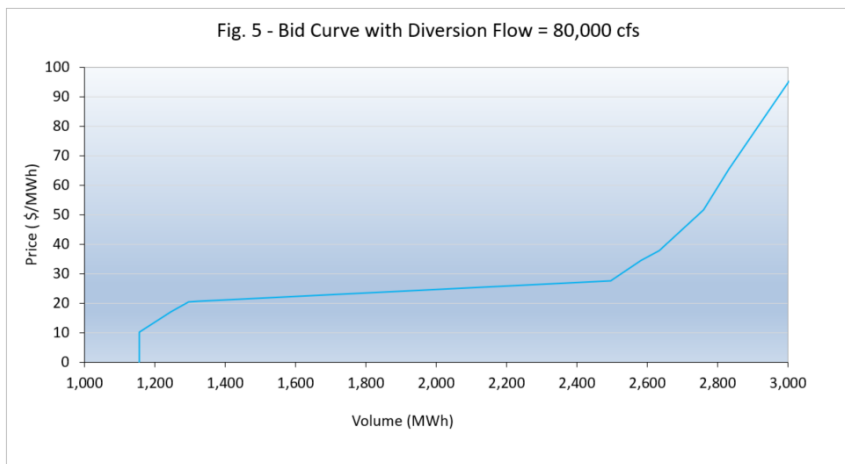


Step 2: Bid Costs Analysis

- Price sensitivity analysis
- Get optimal energy for each price



Step 2: Results Energy Bid Curves

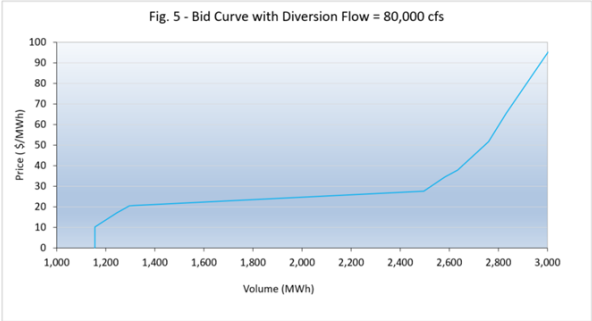


- Price Volume curves based on price-volume sensitivity analysis
- Direct output of the ST short term model – Bid analysis

Step 3: Backcasting

All Hours

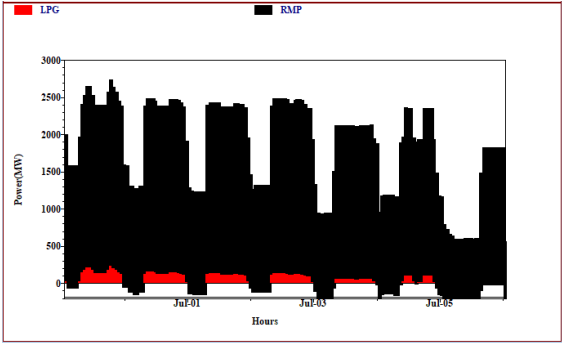
Price Forecast



MW



Compare vs. schedule in Step 1



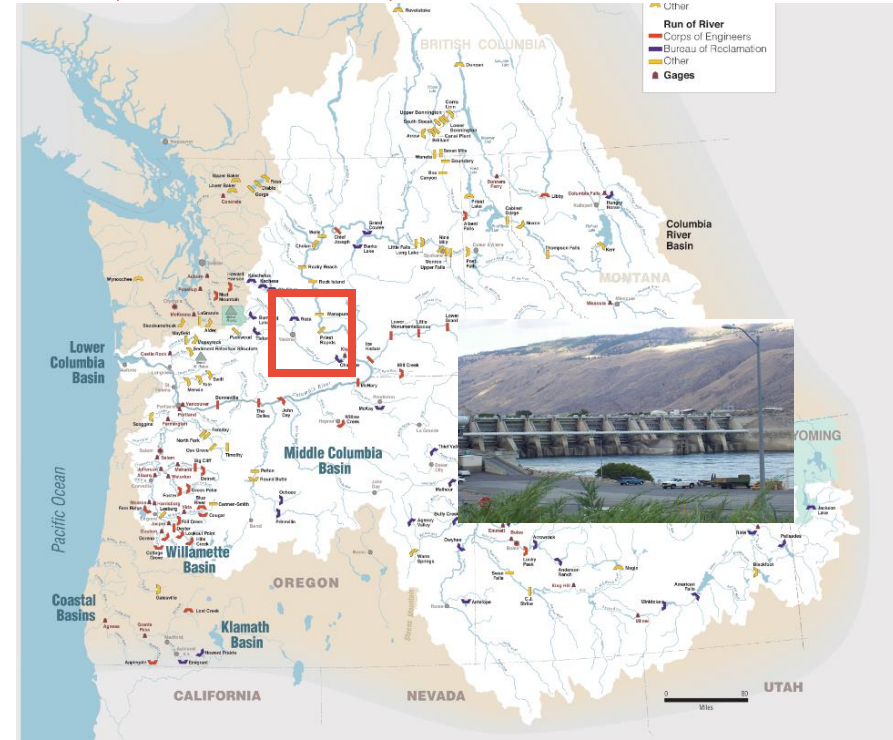
Real-Time Operation in Western US

- Coordination between cascading hydro plants
- Load balance requirements
- Automated generation control while handling water management



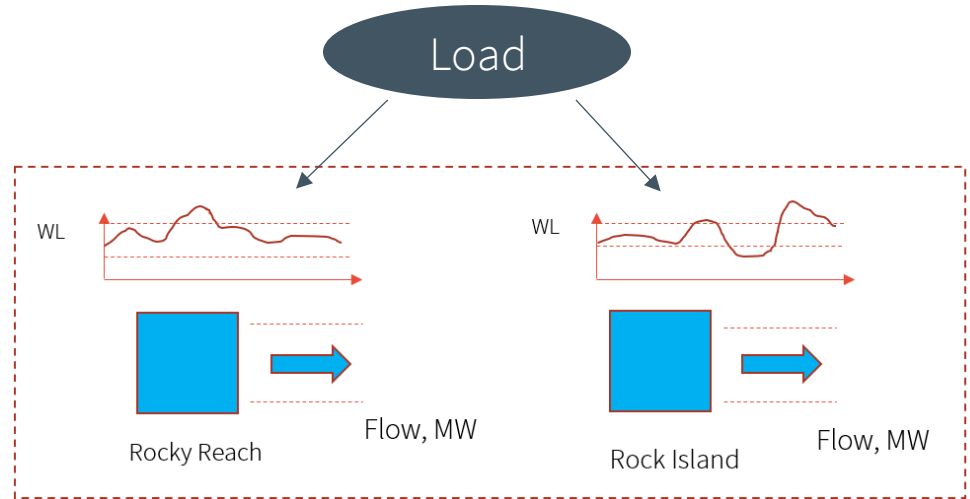
Chelan County PUD Efficient Dispatch with RT *Vista* (WA, USA)

- Two plants in cascade:
 - Rocky Reach: 1000 MW
 - Rock Island: 650 MW
- 5-minute load/ inflow forecast
- 4 second load signal
- RT Vista used on-line in
 - Planning mode --5 min resolution
 - Instantaneous mode – 4 sec updates
- Over 1000 tags communicated with SCADA via OPC at every cycle



Scope: Automated Optimal Control in Real Time

- Meet Load
- Meet license requirements
- Optimal water management (Smart AGC)

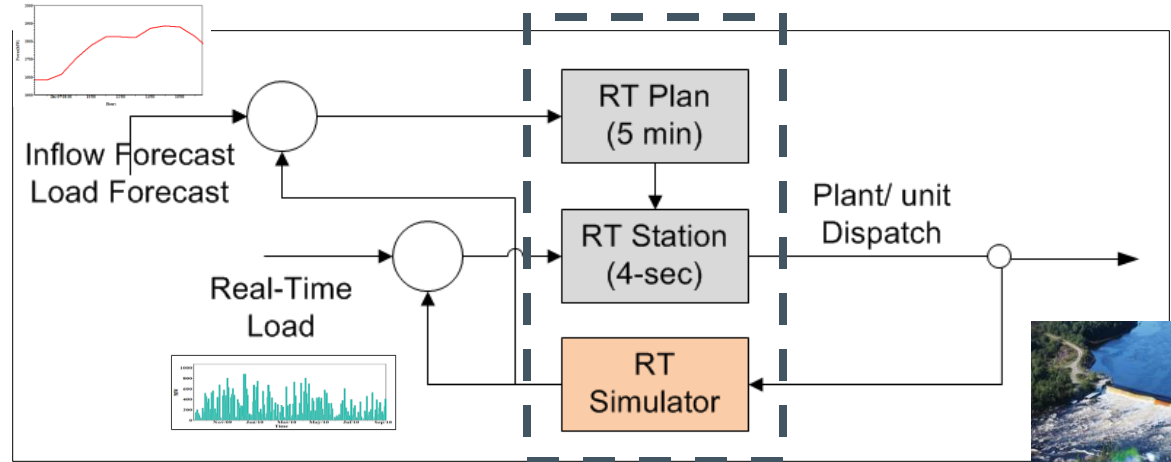


Objective = Flow Usage + Constraint penalty

- Minimize Flow (water usage) for given load
- Minimize constraint penalty
- Minimize over total River/ Time horizon

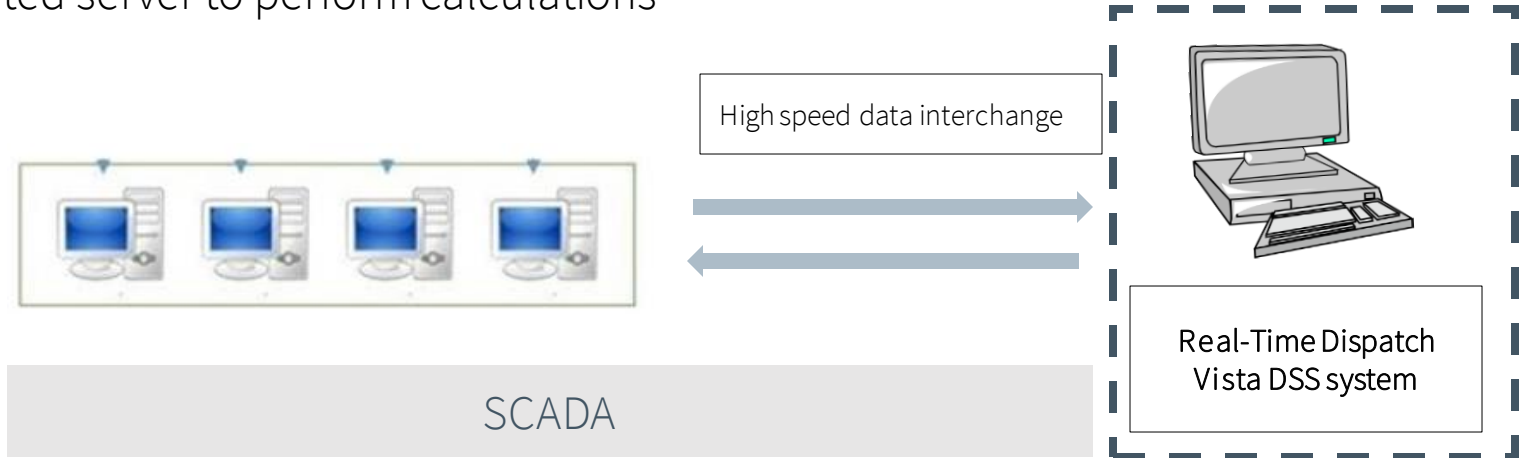
Solution Strategy

- Two-stage strategy
- Optimization based
- Performance driven
- Built-in simulator



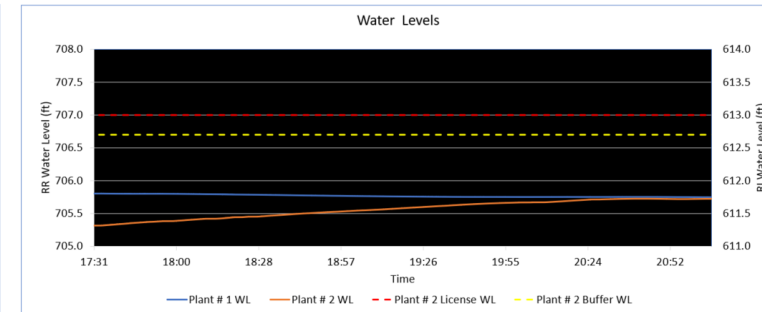
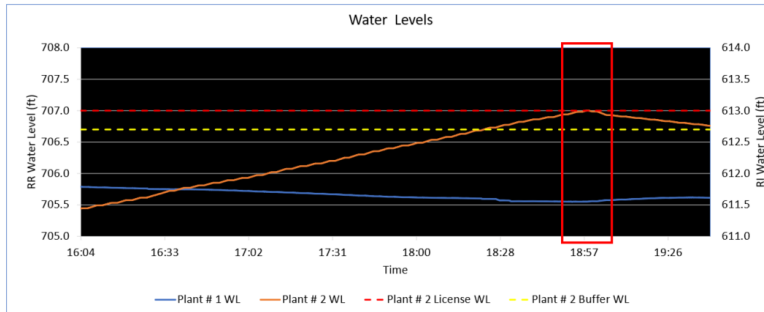
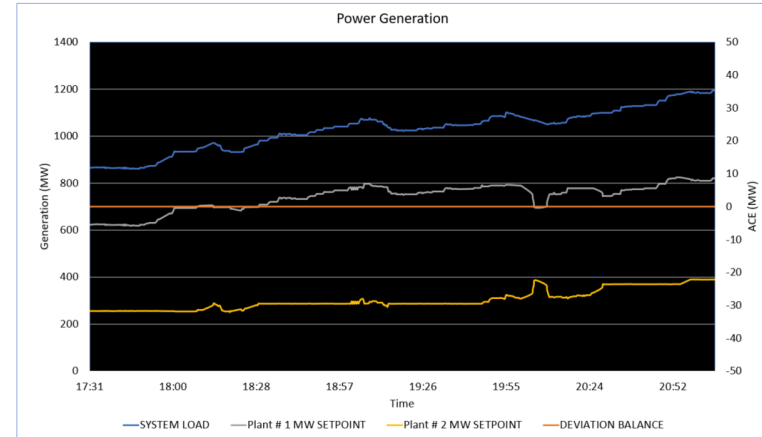
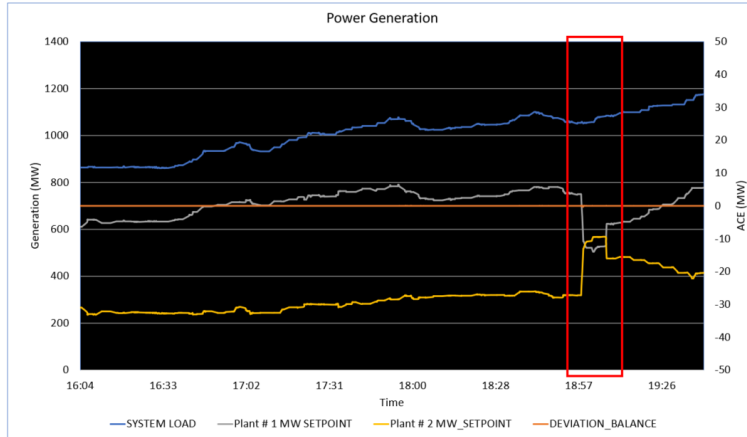
Real-Time Implementation

Dedicated server to perform calculations



Simulated Performance and Stability

- Response
- Anticipation
- Preferred options



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Concluding Remarks

Future Directions

- Further advances in optimization technologies / machine learning
- Greater use of distributed inflow forecasting
- Further system integration
- Greater automation
- Expanded visualization/ Cloud computing and access

Vista DSS: international and across Canada experience, yet a made in Ontario solution



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Thank you.

For more information,
please visit www.hatch.com

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