TEAM CUMBERLAND

Hydropower Optimization

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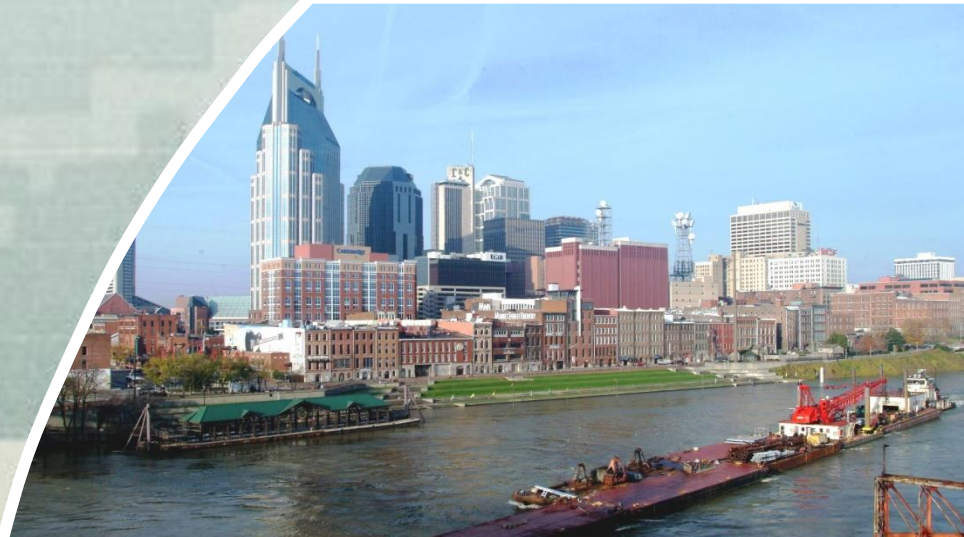

US Army Corps of Engineers

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Hydropower Optimization

- Nashville District has embarked on a Hydropower Optimization Program for the Cumberland River System

- What is Hydropower Optimization ?

  Maximizing the amount of energy produced for a given amount of water discharged by operating individual units and power plants at optimal efficiencies

- **THE PURPOSE** of Hydropower Optimization is to gain maximum benefit from available water and most efficiently operate the individual units and plants as a system.

The Problem

- Aging equipment – Existing SCADA nearing end of design life
- Technology and operational models built in the 1940’s-1970’s
- Insufficient digital instrumentation prevents operators from running units and plants at peak efficiency
- A mix of analog and digital instrumentation inhibits proactive maintenance and extends outages

The Solution

- Establish Nashville District Hydropower Optimization Team (HOT)
- Work in collaboration with Hydroelectric Design Center (HDC)
- Address efficiency of the equipment, operational systems and models
- Implement optimization in phases
- HDC’s total cost estimates is **$13,820,000**

Optimization Phases

- Phase 1 – SCADA
  - Immediate need – replace/upgrade current SCADA system
  - Ever increasing cyber security requirements demands more advanced and secure system
- Phase 2 – Individual Units Optimization
  - Installation of digital governors on Kaplan units
  - Unit performance test (index test) Kaplan and Francis
  - Telemetry instrumentation installation for head measurement
  - Gate and blade position instrumentation
- Phase 3 - Optimize Plants
  - Optimize all units within a plant using computerized algorithm leveraging real time data
  - Run unit that is most efficient for river conditions
  - Strategic scheduling of outages
- Phase 4 – Optimize River System
  - Dr. Lebeuf (Vanderbilt University) study on managing river flows

Benefits

- 2% to 5% in increased unit efficiency
- Increased energy production using less water for same or more power production
- New SCADA will have Sequence of Events functionality to allow for root cause analysis and forensics in case of a powerhouse incident resulting in reduced down time
- New SCADA will use commercial off the shelf hardware and software, and employs a lifecycle strategy of predicatively replacing equipment before it is obsolete
- Increased cyber security and ability to adapt to new threats

Benefits

Plant (type)	Average Annual Generation[1] (MW-hr)	Annual Value of 2% increase in Generation[2]
Barkley(K)	680,025	$689,274
Cheatham (K)	179,457	$181,898
Cordell Hull (K)	338,262	$342,862
Old Hickory (K)	454,183	$460,360
Center Hill (F)	316,680	$320,986
Dale Hollow (F)	102,481	$103,876
Wolf Creek(F)	735,052	$745,048
	TOTAL	**$2,844,304**

[1] Based on 2000-2009 generation
[2] Based on $50.68/MW-hr

Way Forward

- Develop HDC's recommendations into clearly defined subprojects
- Commit remaining unallocated Legacy MOA funds to system optimization subprojects through the ballot process
- Nashville District aggressively pursue FY17 Federal Appropriations to target specific subprojects

QUESTIONS?