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off the shelf hardware and software, and employs a lifecycle strategy of predicatively replacing equipment before it is obsolete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

<table>
<thead>
<tr>
<th>Plant (type)</th>
<th>Average Annual Generation(^1) (MW-hr)</th>
<th>Annual Value of 2% increase in Generation(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barkley (K)</td>
<td>680,025</td>
<td>$689,274</td>
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<tr>
<td>Cheatham (K)</td>
<td>179,457</td>
<td>$181,189</td>
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<td>Cordell Hull (K)</td>
<td>338,262</td>
<td>$342,862</td>
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<td>Old Hickory (K)</td>
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<td>$460,360</td>
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<td>Center Hill (F)</td>
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<td>Dale Hollow (F)</td>
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<td>$103,876</td>
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<td>Wolf Creek (F)</td>
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<td>$745,048</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$2,844,304</strong></td>
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</tr>
</tbody>
</table>

\(^1\) 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?