

## Western Water and Power Solution Bulletin

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### Powerplant Efficiency Optimization

*Optimization programs increase the overall efficiency of hydroturbine power generation units resulting in millions of dollar savings*

#### What Is The Problem?

A typical hydroelectric powerplant consists of multiple hydroturbine units with varying capacities and characteristics operating over a wide range of generation levels. Under normal powerplant conditions (e.g., no flood control situations), operators attempt to maximize the overall efficiency (optimization) to generate the maximum amount of power with the least amount of water possible. However, it is difficult to achieve powerplant efficiency optimization when generation units operate at a wide range of generation levels and undergo many start and stop cycles. Also, when units operate under excessive start and stop cycles, damage to mechanical equipment may occur and lead to unnecessary maintenance and repairs.

Traditionally, powerplant operators use professional experience and judgment to attempt to achieve powerplant efficiency optimization. The operator tries to minimize start/stop cycles and adjust generation rates while avoiding operation within each units' rough zone. The rough zone is a generation range where excessive vibration is observed and potential damage to mechanical components may occur. However, under fluctuating power demands and water supply constraints, it is difficult to decide on when to start and stop units and how to set appropriate generation levels to attain the best overall powerplant efficiency. Failure to operate at maximum efficiency results in reduced power revenues and increased operation and maintenance costs.

#### What Is The Solution?

Reclamation and its collaborative partners have developed efficiency optimization computer programs designed to assist hydroelectric powerplant operators in determining the most efficient way to operate a powerplant. These programs provide a real-time analysis for a powerplant operator to decide how much of the total powerplant demand should be generated by each unit (unit load) and when to start or stop a unit (unit commitment) that will achieve efficiency optimization and potentially reduce mechanical damage. Reclamation hydroelectric researchers initially perform a detailed analysis of potential powerplant, river, and power system effects and this information is incorporated into efficiency optimization computer programs. Operators use the program output to set unit loads and make unit commitment decisions to attain the best possible overall powerplant efficiency. Using these programs can result in increased power revenues and potentially reduced maintenance and mechanical equipment repairs since operation within rough zones and start and stop cycles are minimized.

#### Who Can Benefit?

The combined benefits of increased power revenues resulting from higher powerplant efficiencies and repair and maintenance

cost savings justify implementation of efficiency optimization programs at any powerplant. All powerplant managers, power marketing agencies and their customers can benefit from implementing powerplant efficiency optimization programs.

#### Where Have We Applied This Solution?

A study conducted at Grand Coulee Powerplant during 2003-04 identified significant efficiency increases resulting from implementing an efficiency optimization analysis program called WaterView2000<sup>®</sup>. From this study, a potential benefit of 2.24 percent increased efficiency can be attained resulting in \$17 million in increased revenue annually. An optimization program developed by Reclamation has been used at Hoover Powerplant for several years. Efficiency increases at Hoover are more difficult to quantify since power regulation (meeting very dynamic demands) has priority over efficiency at this facility.

Reclamation has also conducted efficiency studies for powerplants in its Great Plains Region and on the Snake River.



Grand Coulee Dam and Powerplant

#### Future Development Plans

Reclamation will continue its efforts to evaluate commercially available products such as WaterView2000<sup>®</sup> and develop in-house efficiency optimization programs. An efficiency optimization analysis program is being developed by Reclamation that is planned for implementation at Yellowtail Powerplant in 2008, and efficiency optimization program development and implementation is also planned for Glen Canyon Powerplant. Efficiency studies are anticipated for many of Reclamation's large powerplants. Further studies will be conducted to determine potential powerplant efficiency increase and to improve our understanding of the relationship between mechanical damage and stressful operating conditions (start and stop cycles and rough zone operation).

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#### Collaborators

Reclamation's Science and Technology Program, Pacific Northwest Region and Great Plains Region and Bonneville Power Administration