

# HYDRO GENERATION OPTIMIZATION ADDS VALUE TO POWER SALES AND EMISSION CREDITS (CDM)

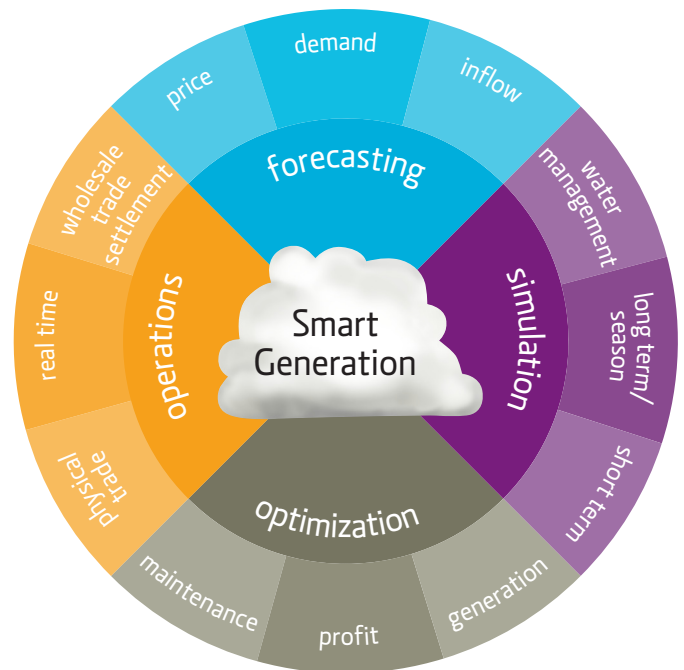
**P**owel Smart Generation software suite enables hydropower generation companies to create maximum output of generation from their available water resources. The optimization software is designed to help improve daily operational planning processes and long-term planning of hydropower resources and can increase generation of by 1-5% in most cases. This provides hydropower producers not only with surplus energy sales, but also emission credit revenue through CDM projects.

Energy production efficiency can be significantly improved by optimizing the generation schedules for a hydropower system taking into account varying demand, precipitation forecasts, water inflow, restrictions and energy prices. The Powel Smart Generation software provides tools for this entire forecasting and planning process. Long-term market analysis and seasonal planning of water usage and optimization of short-term plant schedules are supported.

Power producers using Powel's Smart Generation software suite report that optimization of their production assets typically results in 1-5% increased energy output from their plants. In CDM approved projects, the producer can benefit twice from these efficiencies: as a result of additional power sales, plus through obtained CDM credit sales. With the current market price of emission credits, this will result in a significant win-win situation regarding energy efficiency and emission reductions. By using Powel optimization software, power producers will have a better overview of the operation, extended hydropower generation operation and the ability to improve internal work processes and operational routines.

The potential efficiency gains depends greatly on the characteristics of water courses, reservoirs, restrictions and trade contracts. In most cases the largest efficiency gains are achieved with most complex generation systems.

The Powel Smart Generation software suite provides tools for the entire forecasting and planning process. For short-term planning, the system simulates and optimizes each hydropower system 1-4 weeks ahead in time, based on input like contract prices, inflow forecast, generation availability and long-term pricing of hydropower resources.



Powel Smart Generation software accurately models all water courses including reservoirs and generation units and performs simulation testing before being implemented in daily planning and operational optimization routines.

For all units, the models are configured to include efficiency curves, discharge and reservoir capacity curves, restrictions and availability for all hydropower generators.

The result is an optimal generation plan for each generating unit with hourly or 15 minutes resolution. Compared to historical data, the generator can quantify for CDM credits based on the efficiencies realized.

## Processes in optimization of power generation

### Modeling

- Watercourses
- Reservoirs
- Plant and generators
- Restrictions

### Verification

- Statistics
- Test and calibration
- Evaluation of adequacy

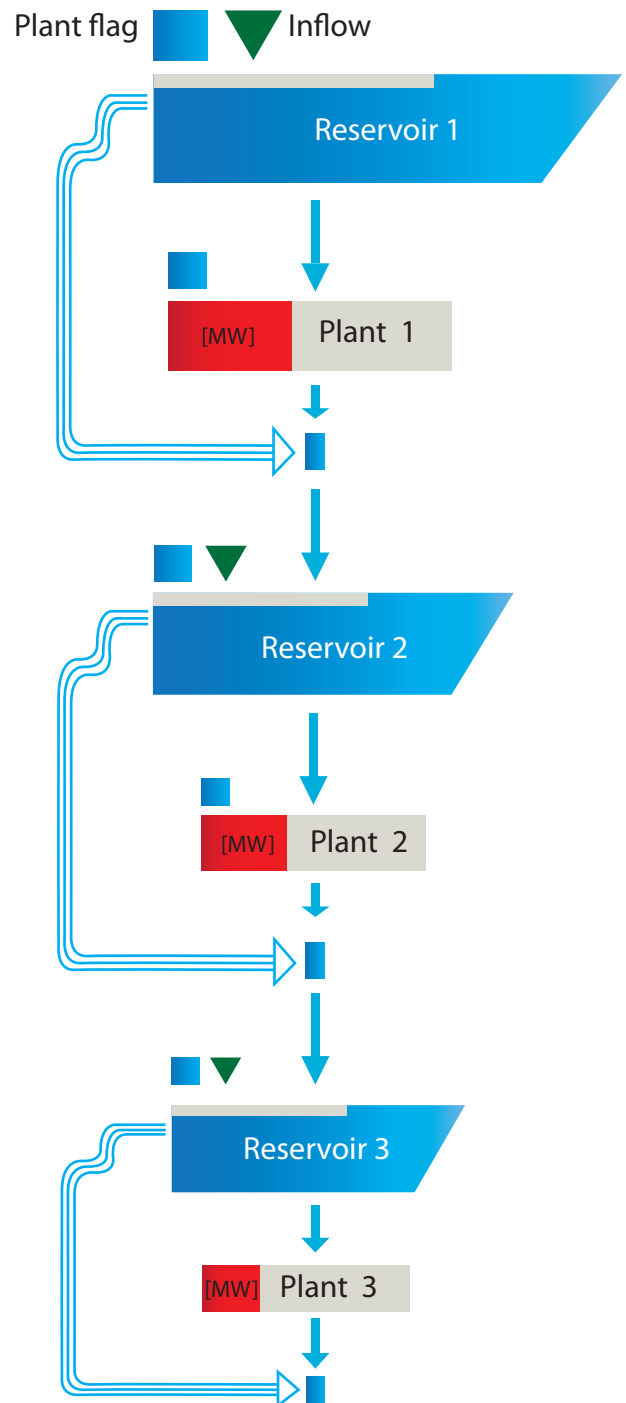
### Operation

- Real-time data import from SCADA
- Optimization of generation
- Plant operation!

Power Smart Generation systems are used for both single river plant systems, multiple reservoir systems and as a master for planning several independent plant systems. Example of output reports.

- Generation cost
- Marginal cost
- Simulated generation [MW]
- Priorities for generation plan
- Start cost
- Cost of water in watercourses
- Water head information
- Maximum available water flow [m<sup>3</sup>/s]
- Maximum variation of water courses [m<sup>3</sup>/s]/h
- Inflow [m<sup>3</sup>/s]
- Water restrictions [m<sup>3</sup>/s]
- Available ancillary services [MW]
- Slow reserves [MW]
- Rotating reserves [MW]
- Power efficiency
- Availability
- Historical data

## User interface for modeling watercourse - utilizing 3 reservoirs and 3 power plants



*In thirteen years, Powel has developed from being a part of academic community at SINTEF/NTNU in Norway to being a world-leading software supplier with more than 240 employees serving the energy sector. Powel is committed to creating and implementing systems that provide rapid profit improvement, cost management, operating efficiency and customer service for all stakeholders.*

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