

Integration of Real-Time Data Management Systems and Runoff Models in Reservoir Operations

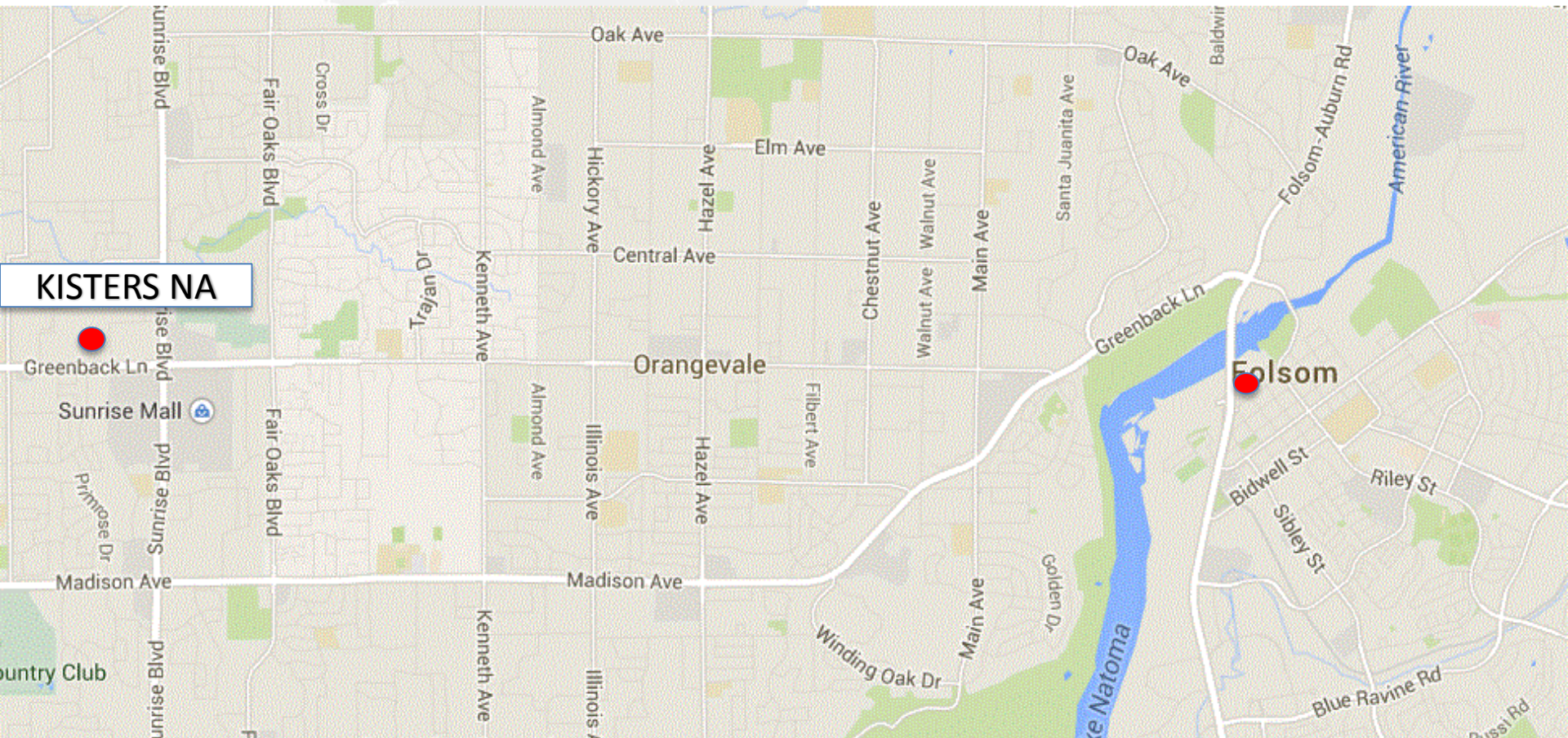
- World leader of time series data management product with 30 years of experience headquartered in Germany
- KISTERS' software are deployed in all over the world in various industries
 - Operational Management
 - Optimization
 - Data Analysis
 - Monitoring

KISTERS' World Wide Locations



KISTERS North America

KISTERS North America



TransAlta

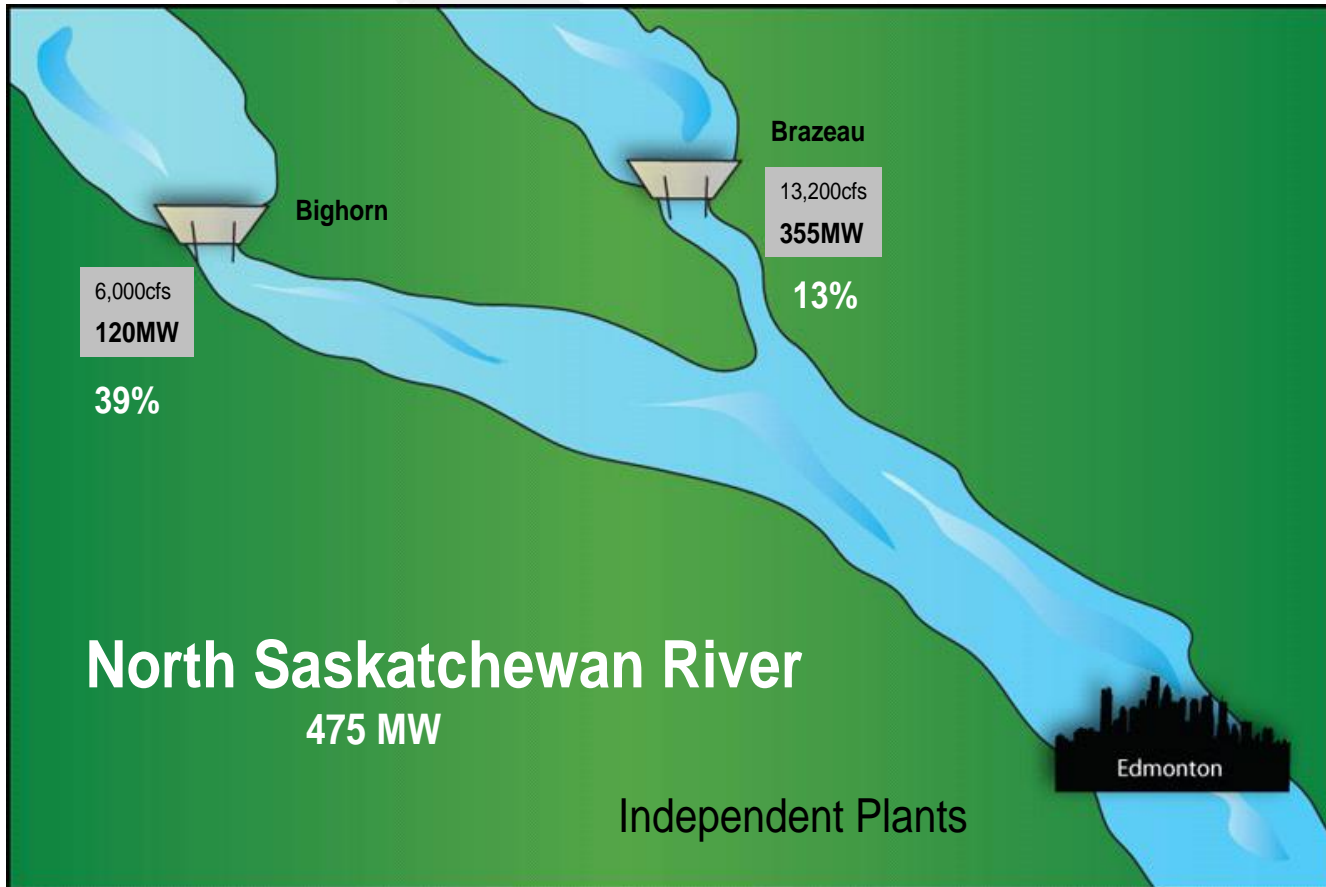
- TransAlta is one of the largest electricity power generators and wholesale marketing company.
- Operates geothermal, wind, hydro, natural gas and coal power generation facilities.
- TransAlta is a leading hydroelectric energy company currently implementing KISTERS' WISKI and ResOpt solutions.

TransAlta

Map of Operations



TransAlta

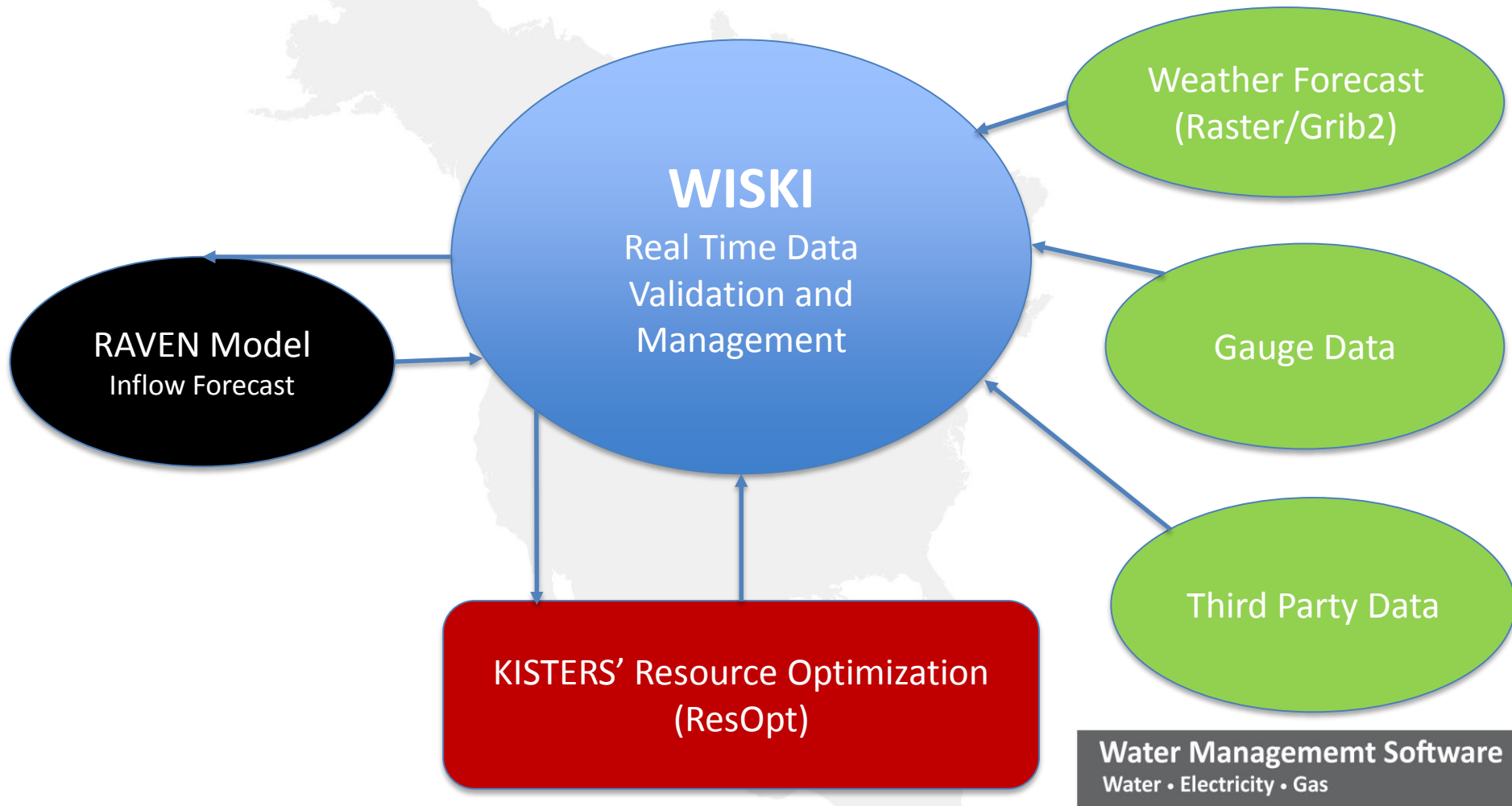


TransAlta
Hydro Fleet in
Alberta, CA –
801 MW

Project Objective

- Integrate real-time data, forecast data, model results, and resource optimization to operate hydroelectric system
 - Hydro Unit Commitment
 - Determine optimal operational plan for reservoirs from daily to yearly operations
 - Satisfies all the constraints simultaneously i.e. operational, seasonal, budget and regulatory constraints

Data Integration



What is WISKI?

- WISKI (**W**ater **I**nformation **S**ystem **K**ISTERS) is a water data management software.
- Collects, stores, cleanses, validates, analyzes and reports real-time data.
- Data integration and can be easily Interfaced with other software
- Used in all areas of environmental data management (Meteorology, Water Quality, Dam safety Monitoring, urban hydrology, groundwater, waste water, drinking water, dam operations, etc..)

What is WISKI?

WISKI - [Wiski Explorer]

File Edit View Tools Windows Help

Sites Washington State / WS-DEMO-001 Map [Washington State / WS-DEMO-001] (0 / 2747) from 2003-11-13 until 2006-12-07

Sites

- Customer Y / CYID
- Dam Safety Demo / DSD01
- deleteME / deleteME
- DEMO / USGS
- DEMO SITE / DS01
- GRCA / GRCA01
- Groundwater Demo / GWD01
- kiwis.kisters.de / KiWIS
- Lorne Park WTF / 7434-210001317
- Mississippi_Demo / MissD01
- PTEST / pt01
- Reservoir Demo / ResD01
- RiverDemo / RD01
- SSA Pump Structure / SSA
- stationCopy / SC01
- StormSewerDemo / SSD01
- Training / Train001
- Upper Pump Building / UPS01
- USFWS / USFWS01
- Video Training / VT01
- WADI Test Site 003 / WADI_Test_Site_003
- Washington State / WS-DEMO-001

Details

Reports

Documents

- Map [Washington State / WS-DEMO-001] (0 / (BIG) TWIN LAKE NR WINTHROP / 12448610
- 148TH AV STORM SWR BLW LK HILLS BLVD BE
- 148TH AVE DOWNSTREAM MANOMETER AT B
- 148TH AVE UPSTREAM MANOMETER AT BELLE
- ABERNATHY CR NR LONGVIEW, WASH. / 142
- AENEAS LAKE NEAR TONASKET, WASH. / 124
- AGENCY CREEK NEAR FORT SIMCOE, WA / 1:
- AHTANUM CR AT GOODMAN RD AT UNION GA
- AHTANUM CR AT THE NARROWS NR TAMPICO
- AHTANUM CR NR TAMPICO, WA / 12501990
- AHTANUM CREEK AT UNION GAP, WASH. / 1:
- AL LAKE NEAR SKYKOMISH, WASH. / 12129361
- ALDER CR AT ALDERDALE, WASH. / 14034359
- ALDER CREEK AT MOUTH NR FORKS, WASH.
- ALDER CREEK NEAR BICKLETON, WASH. / 14
- ALDER CREEK NR HAMILTON, WASH. / 12196
- ALDER RESV AT ALDER WASH / 12085000
- ALICE LAKE NR DREXTON / 12145400

Graph 1

Climate Site / Pasture Peter / Precip / 1

Time t

Days

Zoom active Zoom factor (x/y): 46.58% / 98.29% 12-11-1994 13:09:21 : -97.84

Date	Time	Precipitation [mm]	Quality ..
18-03-2004	03:15:00	0.0254	(Unknllir
18-03-2004	03:30:00	0.0254	(Unknllir
18-03-2004	03:45:00	0.0254	(Unknllir
18-03-2004	04:00:00	0.0254	(Unknllir
18-03-2004	04:15:00	0.0254	(Unknllir
18-03-2004	04:30:00	0.0254	(Unknllir
18-03-2004	04:45:00	0.0254	(Unknllir
18-03-2004	05:00:00	0.0254	(Unknllir
18-03-2004	05:15:00	0.0254	(Unknllir
18-03-2004	05:30:00	0.0254	(Unknllir
18-03-2004	05:45:00	0.0254	(Unknllir
18-03-2004	06:00:00	0.0254	(Unknllir
18-03-2004	06:15:00	0.0254	(Unknllir
18-03-2004	06:30:00	0.0254	(Unknllir
18-03-2004	06:45:00	0.0254	(Unknllir
18-03-2004	07:00:00	0.0254	(Unknllir
18-03-2004	07:15:00	0.0254	(Unknllir
18-03-2004	07:30:00	0.0254	(Unknllir
18-03-2004	07:45:00	0.0254	(Unknllir
18-03-2004	08:00:00	0.0254	(Unknllir
18-03-2004	08:15:00	0.0254	(Unknllir
18-03-2004	08:30:00	0.0254	(Unknllir
18-03-2004	08:45:00	0.0254	(Unknllir
18-03-2004	09:00:00	0.0254	(Unknllir
18-03-2004	09:15:00	0.0254	(Unknllir
18-03-2004	09:30:00	0.0254	(Unknllir
18-03-2004	09:45:00	0.0254	(Unknllir
18-03-2004	10:00:00	0.0254	(Unknllir
18-03-2004	10:15:00	0.0254	(Unknllir
18-03-2004	10:30:00	1.2254	(Unknllir
18-03-2004	10:45:00	1.1254	(Unknllir
18-03-2004	11:00:00	41.9254	(Unknllir
18-03-2004	11:15:00	3.0254	(Unknllir
18-03-2004	11:30:00	0.0254	(Unknllir
18-03-2004	11:45:00	1.2254	(Unknllir
18-03-2004	12:00:00	0.0254	(Unknllir
18-03-2004	12:15:00	0.0254	(Unknllir
18-03-2004	12:30:00	0.0254	(Unknllir
18-03-2004	12:45:00	0.0254	(Unknllir
18-03-2004	13:00:00	0.0254	(Unknllir
18-03-2004	13:15:00	0.0254	(Unknllir
18-03-2004	13:30:00	0.0254	(Unknllir
18-03-2004	13:45:00	0.0254	(Unknllir
18-03-2004	14:00:00	0.0254	(Unknllir
18-03-2004	14:15:00	0.0254	(Unknllir

376365 18-03-2004

wiskiadm on W7DEMO@localhost (MsSql) - User: Admin | KITSM

Ready

Raven

- TransAlta uses Raven model which produces surface/snow runoff forecast



- Raven is a software package for watershed modeling
- Raven is integrated and can be launched using WISKI launch pad

ResOpt

- KISTERS **Resource Optimization** software (ResOpt)
- Uses powerful mathematical programming technique (Mixed Integer Linear Programming)
- Numerous Applications
 - Unit Commitment, Water Quality Management, Water Distribution System Network, Irrigation Management, Transportation Network, Work Force Management, Inventory Optimization, General Portfolio Management

WISKI Integration

Manage Forecasts in WISKI

Wiski-Explorer [List of time series]

Sites ▾ EC Grib2 / EC ▾ Banff / BanffGrib2 ▾ Precip ▾ List of time series from 2014/05/01 until 2014/07/01

Sites


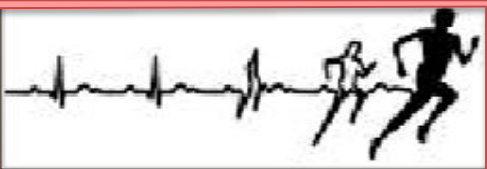
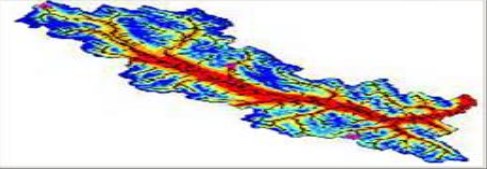
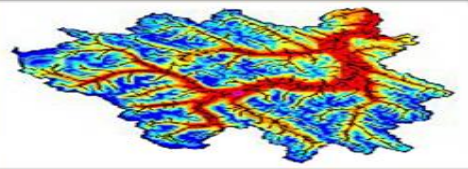
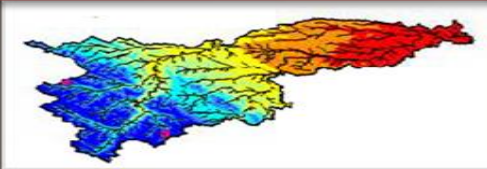
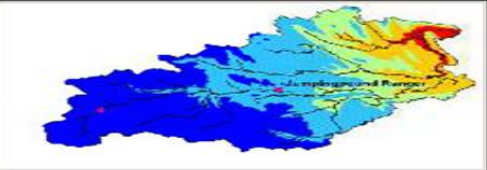
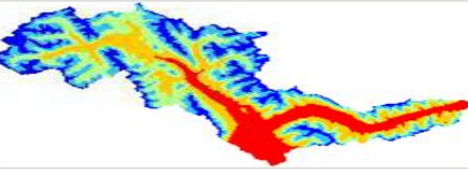
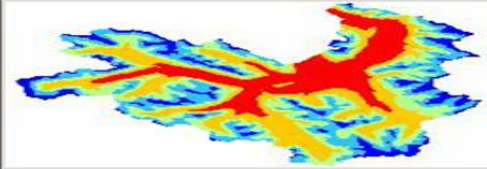
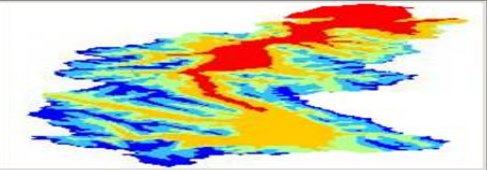
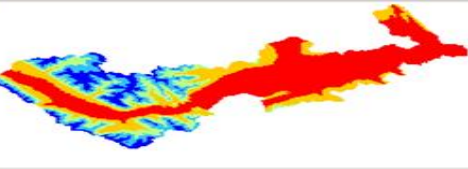

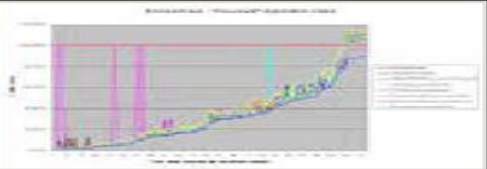
- / 0
- Alberta Environment / AEnv
- Barrier / 0290-A00
- Bearspaw / 0290-B00
- Bighorn / 0290-C00
- Bow Summary / BOW1
- Brazeau / 0290-D00
- Cascade / 0290-E00
- Control Dam / 0290-E01
- EC Grib2 / EC
 - Details
 - Reports
 - Documents of site
 - Banff / BanffGrib2
 - Details
 - Reports
 - Documents
 - Standard graph groups
 - Station time series
 - Comparison stations
 - Groups
 - AT
 - Precip**
 - Banfftest / BanfftestGrib2
 - Bighorn / BighornGrib2
 - Brazeau / BrazeauGrib2
 - Cascade / CascadeGrib2
 - Jumpingpound / JumpingpoundGrib2
 - KananaskisRiver / KananaskisRiverGrib2
 - SprayLake / SprayLakeGrib2
 - Upperbow / UpperbowGrib2
- Ghost / 0290-F00
- Horseshoe / 0290-G00
- Interlakes / 0290-H00
- Kananaskis / 0290-G01
- Outlet Works / 0290-D01
- Pocaterra / 0290-K00
- Rundle / 0290-L00
- site 1 / 13
- Spray / 0290-M00
- TAU Water Management / TAU-WM001

Name	Data from	Data until	Short name	Type	Time zone
CAPA.Band1.O	2014/02/14 17:00:00	2014/07/01 11:00:00	Cmd.CAPA.B1.O	cmd	US/Mou...
CAPA.Band2.O	2014/02/14 17:00:00	2014/07/01 11:00:00	Cmd.CAPA.B2.O	cmd	US/Mou...
CAPA.Band3.O	2014/02/14 17:00:00	2014/07/01 11:00:00	Cmd.CAPA.B3.O	cmd	US/Mou...
CAPA.Band4.O	2014/02/14 17:00:00	2014/07/01 11:00:00	Cmd.CAPA.B4.O	cmd	US/Mou...
CAPA.Band5.O	2014/02/14 17:00:00	2014/07/01 11:00:00	Cmd.CAPA.B5.O	cmd	US/Mou...
CAPA.Band6.O	2014/02/14 17:00:00	2014/07/01 11:00:00	Cmd.CAPA.B6.O	cmd	US/Mou...
CAPA.DayTotal.Band1	2014/02/14 00:00:00	2014/07/01 00:00:00	Day.Total.B1	aggtotal	US/Mou...
CAPA.DayTotal.Band2	2014/02/14 00:00:00	2014/07/01 00:00:00	Day.Total.B2	aggtotal	US/Mou...
CAPA.DayTotal.Band3	2014/02/14 00:00:00	2014/07/01 00:00:00	Day.Total.B3	aggtotal	US/Mou...
CAPA.DayTotal.Band4	2014/02/14 00:00:00	2014/07/01 00:00:00	Day.Total.B4	aggtotal	US/Mou...
CAPA.DayTotal.Band5	2014/02/14 00:00:00	2014/07/01 00:00:00	Day.Total.B5	aggtotal	US/Mou...
CAPA.DayTotal.Band6	2014/02/14 00:00:00	2014/07/01 00:00:00	Day.Total.B6	aggtotal	US/Mou...
GDP5.Band1.O	2014/03/24 23:00:00	2014/07/11 05:00:00	Cmd.GDP5.B1.O	cmd	US/Mou...
GDP5.Band2.O	2014/03/24 23:00:00	2014/07/11 05:00:00	Cmd.GDP5.B2.O	cmd	US/Mou...
GDP5.Band3.O	2014/03/24 23:00:00	2014/07/11 05:00:00	Cmd.GDP5.B3.O	cmd	US/Mou...
GDP5.Band4.O	2014/03/24 23:00:00	2014/07/11 05:00:00	Cmd.GDP5.B4.O	cmd	US/Mou...
GDP5.Band5.O	2014/03/24 23:00:00	2014/07/11 05:00:00	Cmd.GDP5.B5.O	cmd	US/Mou...
GDP5.Band6.O	2014/03/24 23:00:00	2014/07/11 05:00:00	Cmd.GDP5.B6.O	cmd	US/Mou...
GDP5.DayTotal.Band1	2014/03/24 00:00:00	2014/07/11 00:00:00	Day.Total.GDP5.B1	aggtotal	US/Mou...
GDP5.DayTotal.Band2	2014/03/24 00:00:00	2014/07/11 00:00:00	Day.Total.GDP5.B2	aggtotal	US/Mou...
GDP5.DayTotal.Band3	2014/03/24 00:00:00	2014/07/11 00:00:00	Day.Total.GDP5.B3	aggtotal	US/Mou...
GDP5.DayTotal.Band4	2014/03/24 00:00:00	2014/07/11 00:00:00	Day.Total.GDP5.B4	aggtotal	US/Mou...
GDP5.DayTotal.Band5	2014/03/24 00:00:00	2014/07/11 00:00:00	Day.Total.GDP5.B5	aggtotal	US/Mou...
GDP5.DayTotal.Band6	2014/03/24 00:00:00	2014/07/11 00:00:00	Day.Total.GDP5.B6	aggtotal	US/Mou...
RDPS.Band1.O	2014/03/20 20:00:00	2014/07/03 17:00:00	Cmd.RDPS.B1.O	cmd	US/Mou...
RDPS.Band2.O	2014/03/20 20:00:00	2014/07/03 17:00:00	Cmd.RDPS.B2.O	cmd	US/Mou...
RDPS.Band3.O	2014/03/20 20:00:00	2014/07/03 17:00:00	Cmd.RDPS.B3.O	cmd	US/Mou...
RDPS.Band4.O	2014/03/20 20:00:00	2014/07/03 17:00:00	Cmd.RDPS.B4.O	cmd	US/Mou...
RDPS.Band5.O	2014/03/20 20:00:00	2014/07/03 17:00:00	Cmd.RDPS.B5.O	cmd	US/Mou...
RDPS.Band6.O	2014/03/20 20:00:00	2014/07/03 17:00:00	Cmd.RDPS.B6.O	cmd	US/Mou...
RDPS.DayTotal.Band1	2014/03/20 00:00:00	2014/07/03 00:00:00	Day.Total.RDPS.B1	aggtotal	US/Mou...
RDPS.DayTotal.Band2	2014/03/20 00:00:00	2014/07/03 00:00:00	Day.Total.RDPS.B2	aggtotal	US/Mou...
RDPS.DayTotal.Band3	2014/03/20 00:00:00	2014/07/03 00:00:00	Day.Total.RDPS.B3	aggtotal	US/Mou...
RDPS.DayTotal.Band4	2014/03/20 00:00:00	2014/07/03 00:00:00	Day.Total.RDPS.B4	aggtotal	US/Mou...
RDPS.DayTotal.Band5	2014/03/20 00:00:00	2014/07/03 00:00:00	Day.Total.RDPS.B5	aggtotal	US/Mou...
RDPS.DayTotal.Band6	2014/03/20 00:00:00	2014/07/03 00:00:00	Day.Total.RDPS.B6	aggtotal	US/Mou...

Wiski7 on wiski7@cgysqlt10\cgysqlt10;dbname=wiski7 (MsSql) - User: Admin | KiTSM: MaiDomain / cgyht01 / 7430 36 Records

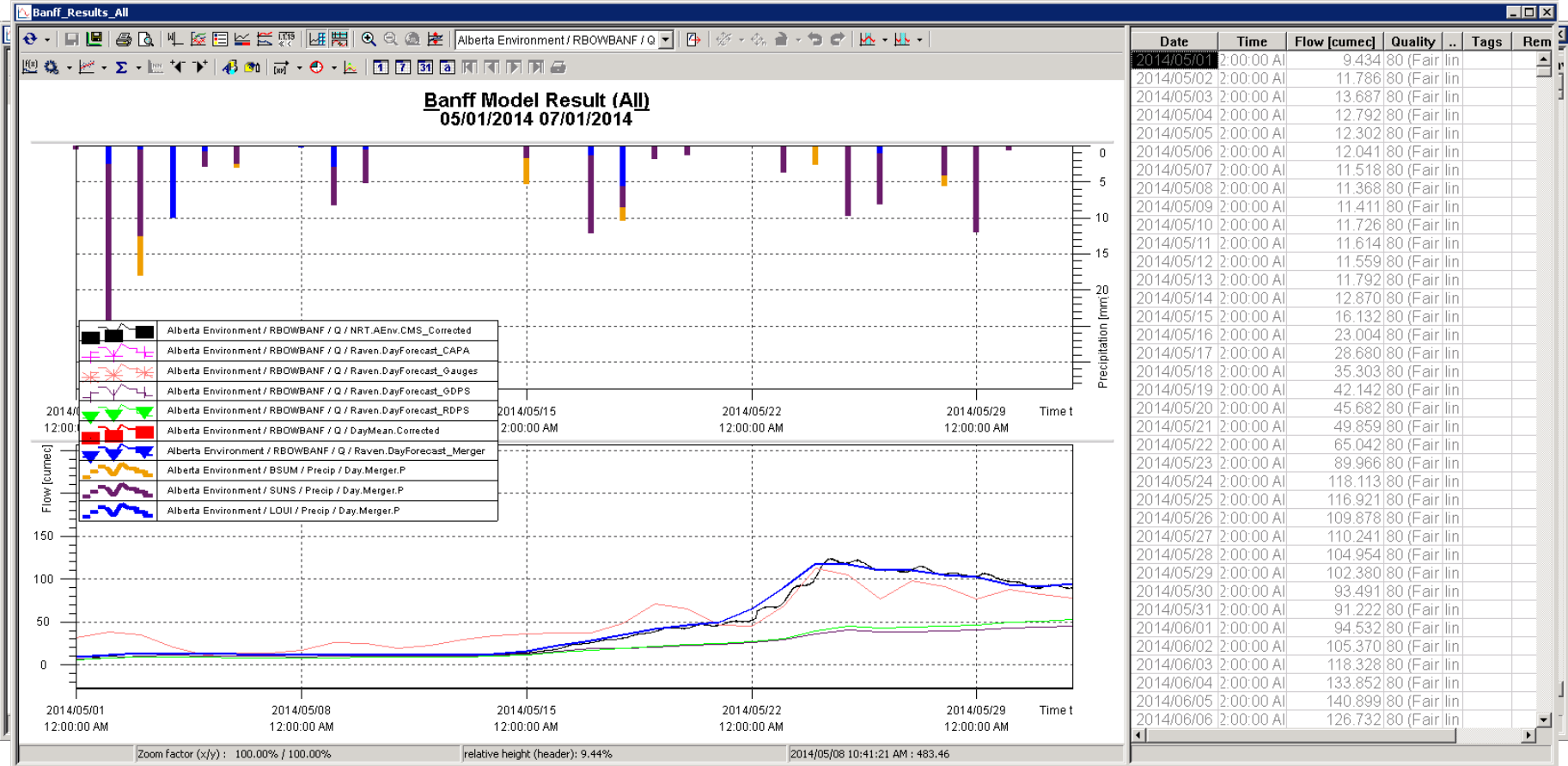
TransAlta Model Launchpad

The screenshot shows a software window titled "InflowForecastModel-Main" with a grid of 12 buttons. The buttons are arranged in a 4x3 grid. The second button in the first row, "Run All Models B", is highlighted with a red border. The other buttons are: "RunAllModels_G", "Banff Basin", "Bighorn Basin", "Brazeau Basin", "Jumpingpound Basin", "Cascade Basin", "Spray Lake Basin", "Kananaskis River Basin", "Upper Bow Basin", "Reports System", and "Graphs System".

 RunAllModels_G	 Run All Models B	 Banff Basin
 Bighorn Basin	 Brazeau Basin	 Jumpingpound Basin
 Cascade Basin	 Spray Lake Basin	 Kananaskis River Basin
 Upper Bow Basin	 Reports System	 Graphs System

Run All Models From WISKI Launchpad

TransAlta Model Launchpad

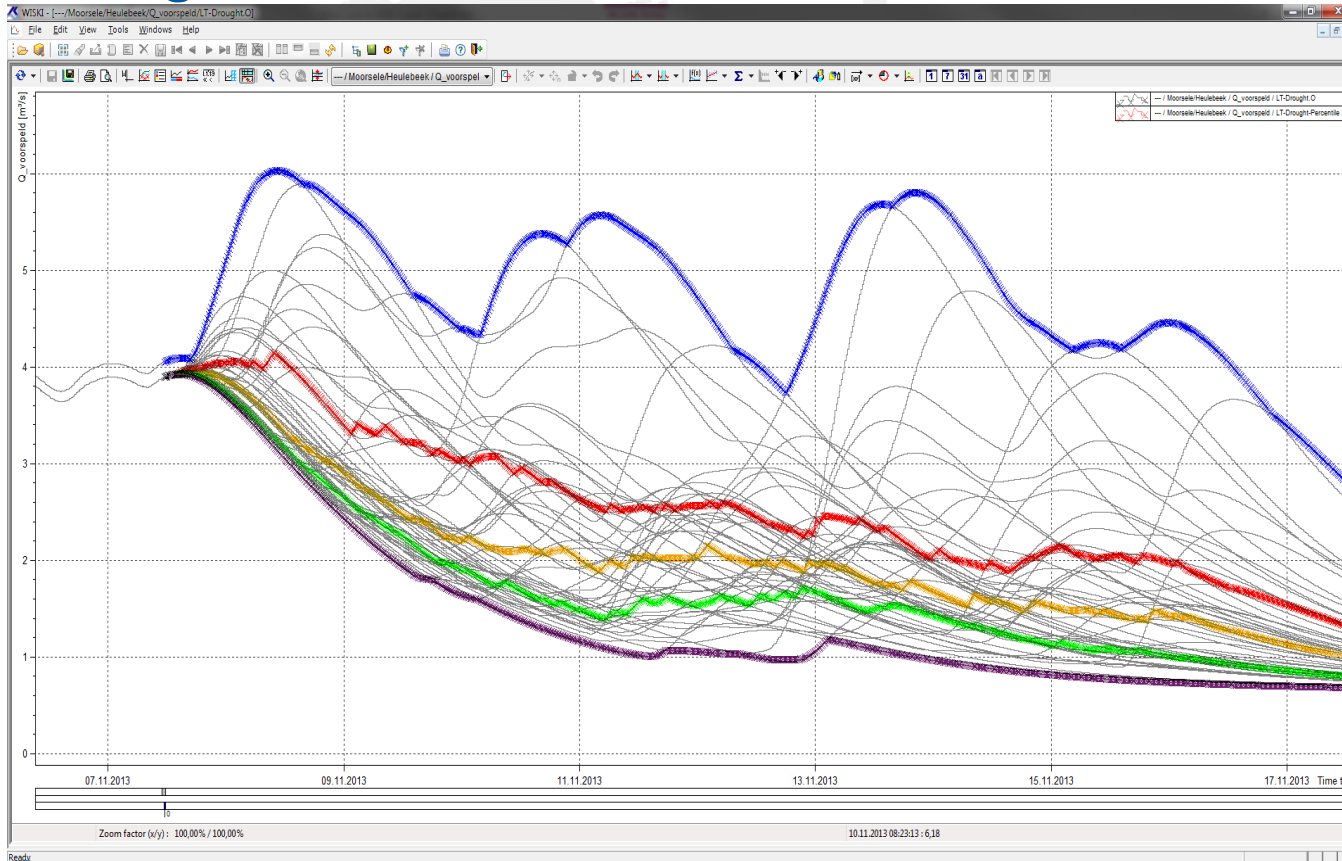


SolutionRVC_B	Results_All	Result_Gauges	Result_RDPS	Result_GDPS
Result_CAPA	Reports System	Graphs System	StatisticResult	BackToMain

Water Management Software
Water • Electricity • Gas

WISKI Statistics and Analysis Tools

Storage of Ensembles



Use case

- When was which forecast available?
- How did it look like?
- How accurate are my forecasts over time?
- What is the 90%ile of all forecast?
- What is the 10%ile of all forecasts?
- What is the 50%tile of all forecasts?

ResOpt

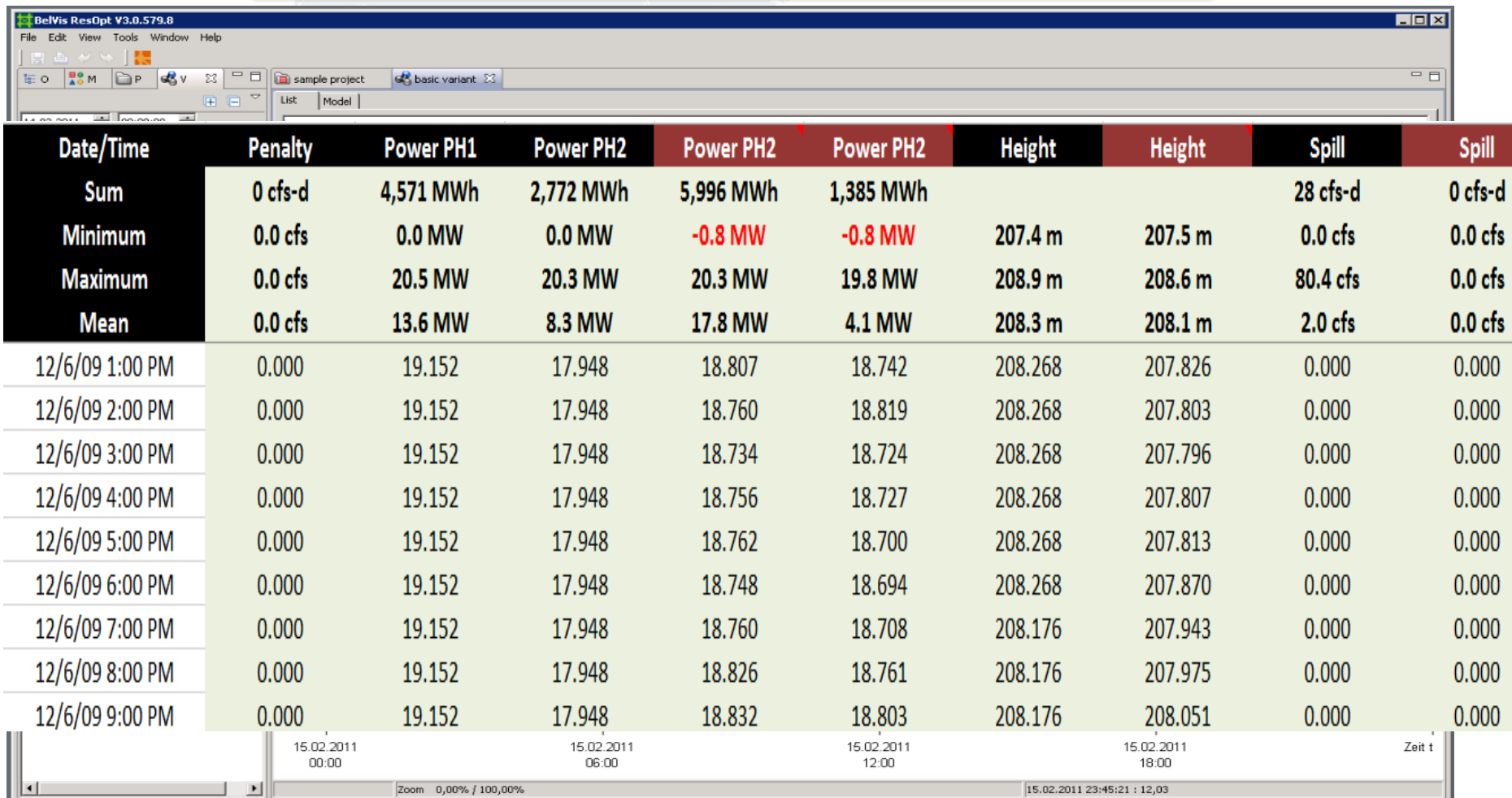
The screenshot displays the BelVis ResOpt V3.1.938.5 software interface. The main workspace shows a complex power system simulation model with the following components and connections:

- Inflows:** BRR_inflow, BHR_inflow, CSR_inflow, BOW_inflow, and SPR_inflow.
- Central Region:** North.Saskatchewan.
- Markets:** BOW_SPK_market, BOW_SR_market, BOW_RR_market, and BOW_SUP_market.
- Nodes:** CN_SPK, CN_SR, CN_RR, CN_SUP, and CN_BASE.
- System:** BOW.System.

The interface includes a file explorer on the left showing a tree structure of components like BHR_inflow, BOW.System, BA_delay, CAS_System, CS1, CS2, CSR, CS_loss, CS_delay, Calgary_restricted, Irrigation_Calgary, Kananaski_System, Load_Calgary, Lower_BOW_System, BS, BSR, BSR_dummy, BSR_inflow, and GH_Base_BOV. A 'ToolBox' on the left contains various contract and cost models such as S_Supply_contract, S_Trading_Power, S_Reference_simple, S_Supply_simple, S_Converter_Costs, and Contract_reserve. A 'Variant Model Expl...' window shows a tree structure for 'root (Hydro_DSS_VM)' with sub-nodes STO_1, STO_4, STO_5, STO_3, and STO_2. A 'Workspace Log' at the bottom shows a message: 'Loaded "C:/Kisters/ResOpt3/BelVisResOptClient/external/kisters.resopt.rps.port...' dated 4/26/13 12:38 PM. The Windows taskbar at the bottom shows the Start button, system tray icons, and the user 'gmojica' with the session name 'BELVISEDIM' and the date '2013/04/26'.

ResOpt

Operation Schedule



Date/Time	Penalty	Power PH1	Power PH2	Power PH2	Power PH2	Height	Height	Spill	Spill
Sum	0 cfs-d	4,571 MWh	2,772 MWh	5,996 MWh	1,385 MWh			28 cfs-d	0 cfs-d
Minimum	0.0 cfs	0.0 MW	0.0 MW	-0.8 MW	-0.8 MW	207.4 m	207.5 m	0.0 cfs	0.0 cfs
Maximum	0.0 cfs	20.5 MW	20.3 MW	20.3 MW	19.8 MW	208.9 m	208.6 m	80.4 cfs	0.0 cfs
Mean	0.0 cfs	13.6 MW	8.3 MW	17.8 MW	4.1 MW	208.3 m	208.1 m	2.0 cfs	0.0 cfs
12/6/09 1:00 PM	0.000	19.152	17.948	18.807	18.742	208.268	207.826	0.000	0.000
12/6/09 2:00 PM	0.000	19.152	17.948	18.760	18.819	208.268	207.803	0.000	0.000
12/6/09 3:00 PM	0.000	19.152	17.948	18.734	18.724	208.268	207.796	0.000	0.000
12/6/09 4:00 PM	0.000	19.152	17.948	18.756	18.727	208.268	207.807	0.000	0.000
12/6/09 5:00 PM	0.000	19.152	17.948	18.762	18.700	208.268	207.813	0.000	0.000
12/6/09 6:00 PM	0.000	19.152	17.948	18.748	18.694	208.268	207.870	0.000	0.000
12/6/09 7:00 PM	0.000	19.152	17.948	18.760	18.708	208.176	207.943	0.000	0.000
12/6/09 8:00 PM	0.000	19.152	17.948	18.826	18.761	208.176	207.975	0.000	0.000
12/6/09 9:00 PM	0.000	19.152	17.948	18.832	18.803	208.176	208.051	0.000	0.000

15.02.2011 00:00 15.02.2011 06:00 15.02.2011 12:00 15.02.2011 18:00 Zeit t

Zoom 0,00% / 100,00%

15.02.2011 23:45:21 : 12,03

Conclusion

Benefits

- Ensure the highest quality data
- Maximize the revenue from hydro system operations.
- Minimize the operational cost.
- Minimize flooding by more efficiently managing the reservoir system through optimization.
- All information in one integrated system provides accountability