

RiverWare Optimization at the Tennessee Valley Authority

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Tennessee River System



Valley Rainfall and Runoff



ΙVΑ

Reservoir System Benefits

Recreation

Restricted summer drawdown to provide higher summer lake levels

Releases to support trout fishing, whitewater rafting, and drift boating

Special flows and elevations to support community events

Water Quality

Dissolved oxygen & temperature monitoring

Injection of gaseous oxygen into reservoirs

Hydrothermal often dictates operation during dry periods

Water Supply

700 water intakes (industry; thermalelectric cooling; irrigation; municipal)

Drinking water for nearly 5 million people



Reservoir System Benefits

Flood Control

Use reservoir storage to reduce flood crest and release at non-flood discharge rate after crest

Average annual flood damages averted \$240 million

Power

~10% of TVA's energy portfolio (~3500MW)

Water temperature support for thermal generating plants

Rapid dispatch and flexibility

Low O&M Costs

Navigation

652 miles of navigable waterways

~\$1B per year in shipper savings



Goal of Optimization

To work within reservoir system constraints while utilizing the flexibility of the reservoir system to

Balance system benefits

Minimize total cost of generation/Maximize hydro "Net Avoided Cost"

(net avoided cost = maximum avoided operating cost + cumulative value of storage)



Optimization Process at TVA





Operating Policy (Constraints)

Current Day Operating Schedule

Eliminate/Minimize Spill

Minimum Flow Requirements

Meet water quality, hydrothermal, and navigation needs

System Minimum Operating Guide

Balancing for Tributary Storage Reservoirs

Ensure equitable drawdown

Special Operations (Specific Flows, Reservoir Elevations, Generation)

For thermal compliance, recreation, river cleanups, etc.

Operating Policy (Constraints)

Unit Outages

Limit how much water a plant can pass without spilling

Kentucky/Barkley Operations

Meet requirements for canal flow, minimum discharge, and navigation

Coordinate with USACE during Ohio River floods

Ramp Rates

For downstream safety, due to plant limitations, etc.

Flood Guide

Protect flood storage availability

Top and Bottom of Daily Operating Zone on Run-of-river Reservoirs





Future Value of Water

Value of Project Storage

Based on current storage, estimated inflows, a target elevation or storage, and hourly market price power forecast

Hourly Market Price Power Forecast

What TVA thinks future market rate will be to us. Incorporates planned unit outages, long-term weather forecasts



POSE DATA

Hourly Hydropower Value

Hour-by-hour variations due to changes in demand and unit availability

System Load Forecast

Block Cost (all plants except hydro)



5000

BLOCK COSTS

file last updated: Jan 0607:15

Mon Tue

S11 and below

\$11 - \$15 \$15 - \$20 \$20 - \$25

\$25 - \$30 S30 - S35

\$35 - \$40 \$40 - \$50

\$50 - \$60 \$60 - \$70

S70 - S80

\$80 - \$90

S90 - S100 \$100 - \$200 \$200 and up

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 Adjustment 		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total local	3.08	2.89	2.75	2.82	2.50	2.39	2.28	2.18	2.08	1.99	1.90	1.82	1.74	1.64	
Total inflow		2.89	2.75	2.82	2.50	2.39	2.28	2.18	2.08	1.99	1.90	1.82	1.74	1.64	
► Storage	266.29	261.31	259.07	259.56	254.20	247.76	243.63	235.23	232.03	221.26	215.89	206.02	200.53	201.49	
Elevation	963.28	962.72	962.46	962.52	961.91	961.16	960.67	959.67	959.28	957.95	957.27	956.00	955.27	955.40	
▼ Energy		1,204	765	364	1,185	1,331	961	1,519	782	1,752	1,023	1,523	1,002	98	
6:00		131	15	15	15	334	15	329	15	235	15	14	14	42	
12:00		464	338	167	500	333	331	538	172	525	470	507	309	14	
18:00		377	337	15	336	332	234	326	271	475	70	503	223	28	
24:00		232	74	167	335	332	381	325	324	517	468	499	455	14	
 Power factor 	164	154	155	157	153	151	151	145	149	139	144	135	141	144	
 Turbine discharge 	8.15	7.87	4.98	2.34	7.86	8.82	6.41	10.58	5.28	12.76	7.27	11.68	7.23	0.68	
 Sluice discharge 		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Regulated spill		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
 Total outflow 	8.15	7.87	4.98	2.34	7.86	8.82	6.41	10.58	5.28	12.76	7.27	11.68	7.23	0.68	
► CHATUGE															
► Adjustment		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
► Total local	0.17	0.16	0.15	0.14	0.13	0.12	0.12	0.11	0.10	0.10	0.09	0.09	0.08	0.08	
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IVA







Enhancements in Progress

Implementation of a DELFT-FEWS hydrological forecast and warning system, which requires additional RiverWare functionality

Improvements to how we model Special Operations

Creation of model adapters that allows FEWS and RiverWare to communicate



Summary

TVA Uses RiverWare Optimization Models to

Meet TVA's operating policies

Balance river benefits

Optimize releases over the intermediate-term (next 2 weeks)

Optimize generation over the short-term (next 2 days)

Maximize the value of hydro generation to TVA



