Grant PUD Renewable Energy

A Study of Wind Integration by a Small Public Utility District

Presented by

Kevin Conway

Grant County
PUBLIC UTILITY DISTRICT
Innovation & Excellence...Yesterday, Today and Tomorrow

Overview

- Grant PUD Resources
- Generation Characteristics
- Statistical Analysis
- Shaping Services
- System Constraints
- What’s Next

Who Is Grant County PUD?

- **Own & Operate the Priest Rapids Project**
  - 2 approx 1,000 MW each Hydro Developments
  - GCPD Capacity 966 MW
- **Project is in the FERC relicensing process**
- **Approx 42,000 customers**
  - 579 MW summer peak
  - 520 MW winter peak
- **15.9 MWs Small Hydro**
- **32 MWs Diesel Generation**

Nine Canyon Wind Project

49 Turbines

- 1.3 MW each Turbine
- 63.7 MW Generating Capacity

Located near Kennewick, WA

10 Project Participants

- Benton County PUD, Chelan County PUD, Douglas County PUD, Grant County PUD, Grays Harbor County PUD, Lewis County PUD, Mason County PUD #3, Okanogan County PUD, Cowlitz County PUD, Columbia Generating Station

First Electricity Produced: 6/02

Commercial Operation: 9/02

Grant Share: 18.88% (12MWs)

Other Renewable Opportunities Grant PUD is exploring

- Incremental Hydro Improvements
- Low impact Hydro
- Biomass and Digesters
- Wind Development
- Solar Projects

Characteristics of Thermal and Hydro Generation

- Positive Attributes
  - High Predictability
  - Dispatchable
  - Can be scheduled to meet firm load
  - Provides Ancillary Power Support
  - Ramping Ability
- Negative Attributes
  - Start Up Costs
  - Fuel Costs

Characteristics Wind and Solar Generation

- Positive Attributes
  - Some Predictability
  - No fuel costs
  - Low start up costs, but new information indicates that they may be more significant
- Negative Attributes
  - Not Dispatchable
  - Can't be scheduled to meet firm load
  - Uncontrolled Ramping
  - Provides Little Ancillary Power Support

Interests of Utilities and Wind Plants

- Utility / Load Serving Entity
  - Serves load
  - Match load requirements with generation
  - Reliable operation
  - Minimize costs to rate payer OR Maximize return to investor
- Wind Plant Owner
  - Economic objective: sell energy to system
  - Clean, affordable energy
  - Long-term price stability

Wind as Negative Load

- Wind and Load share many similar characteristics
  - Hourly Predictability
  - Ramping
  - Reactive Power
  - Dispatchability
  - Non-conformity to market structure

Needs for a Control Area to Integrate Wind

- Good interconnection agreement that provides for:
  - Reserves
  - Regulation
  - Voltage support
  - Accurate wind forecasting and data
  - Scheduling and Energy Imbalance
  - Cost Recovery

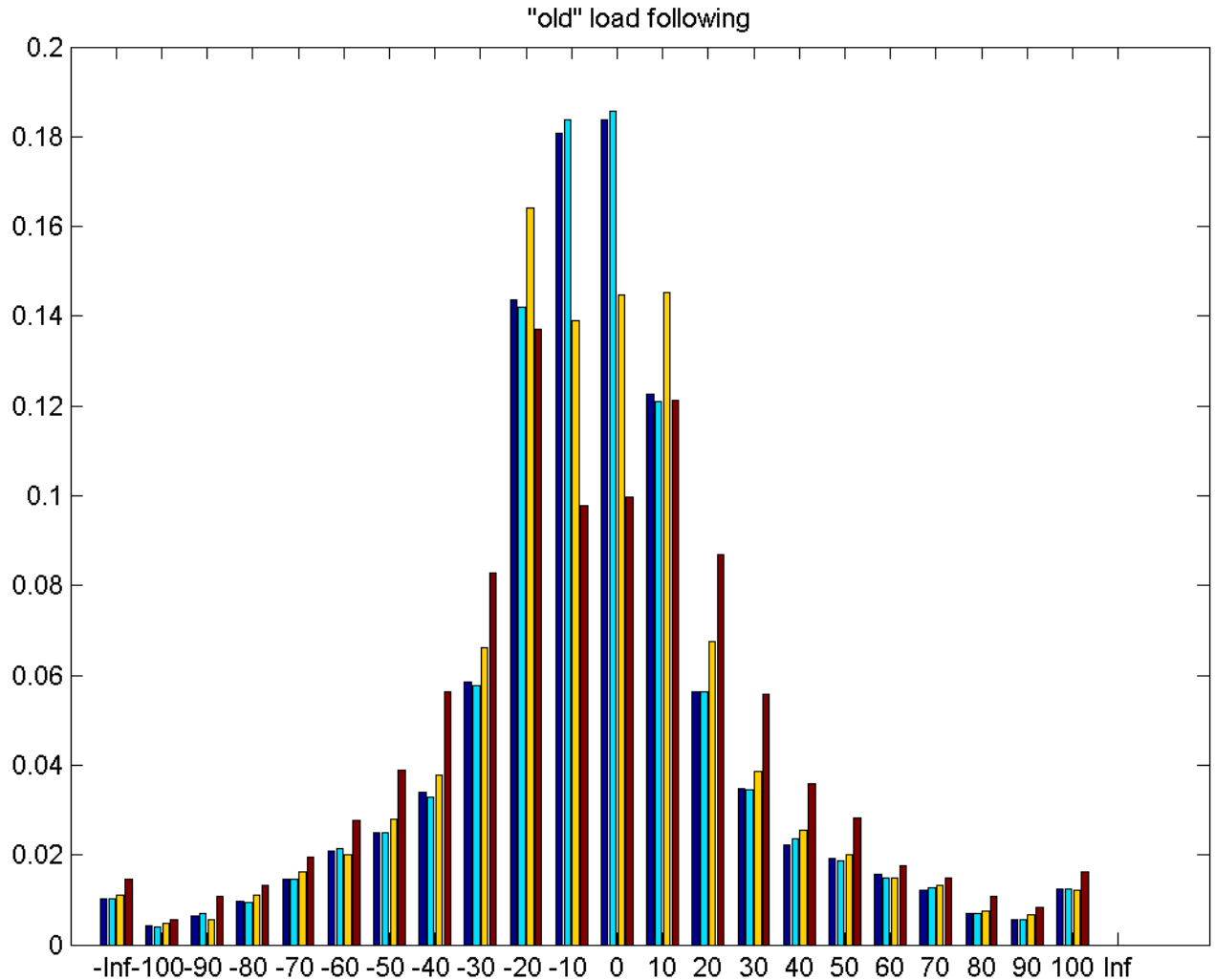
Wind Regulation Concerns

- Load Following Vs. Regulation
  - Small project –
    - Volatility of generation is high impact
    - Ramping from 0 to 100% is low impact
    - Regulation is difficult
  - Large project –
    - Diversity across project seems to reduce volatility to generation output
    - Ramping from 0 to 100% is high impact
    - Load Following is difficult

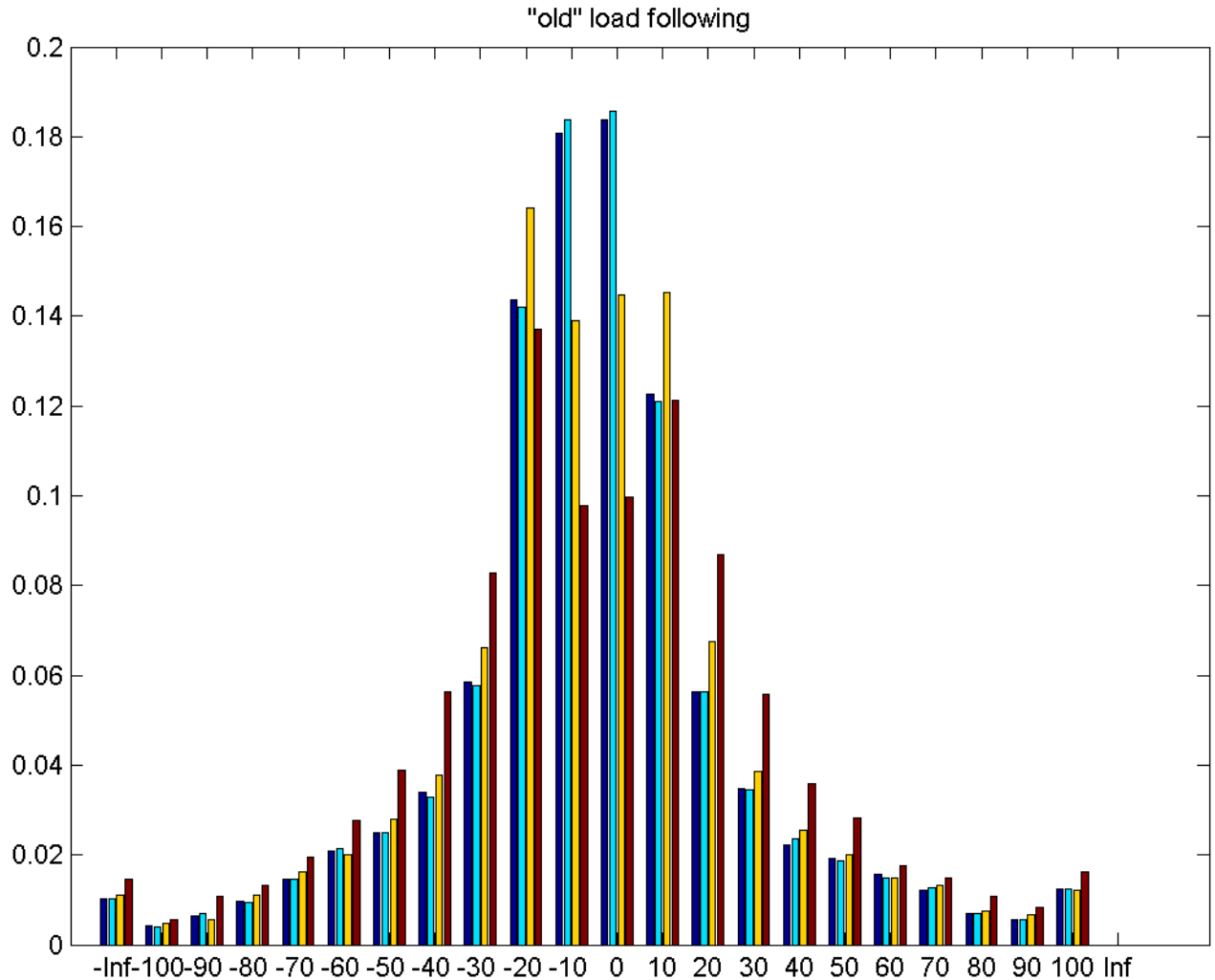
Looking at the Statistics

- Historic statistical evaluation is a good tool when looking at wind integration
- Statistical evaluation doesn’t tell the whole story.

Statistical Dispersion

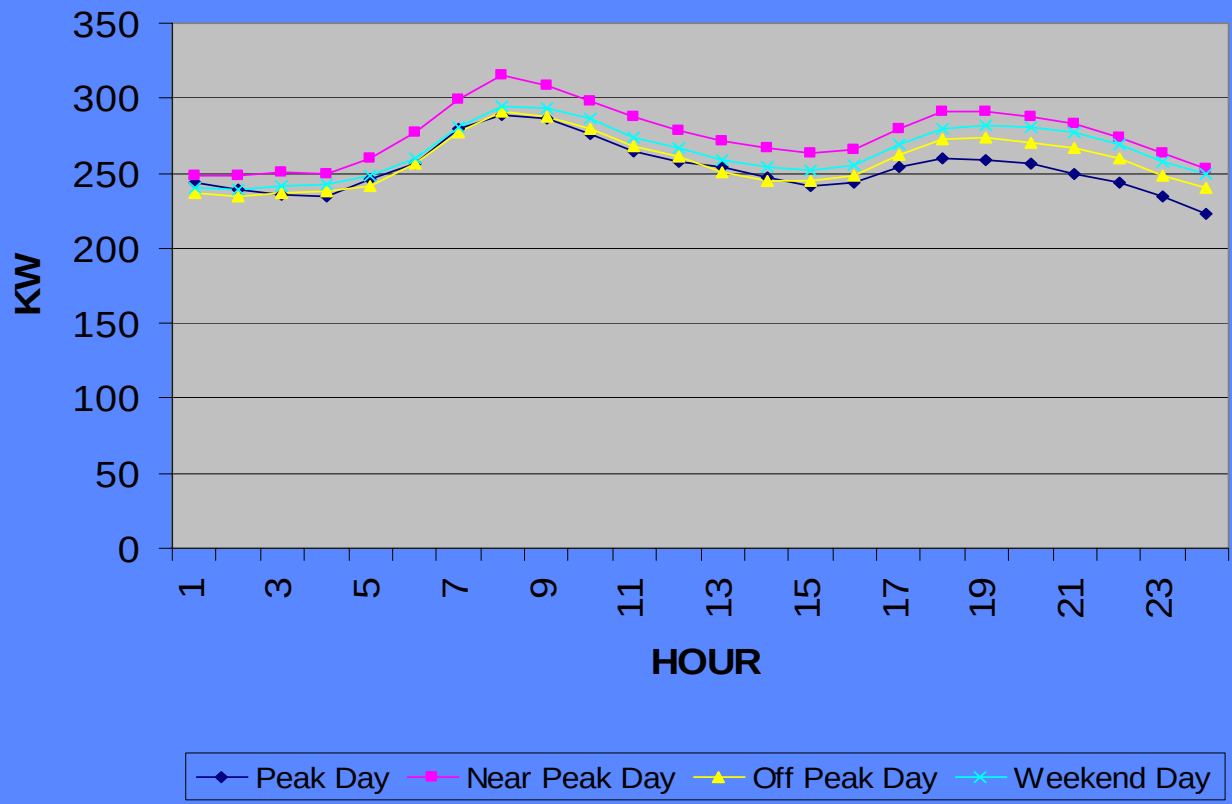

"old" load following
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
-Inf -100 -90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 Inf

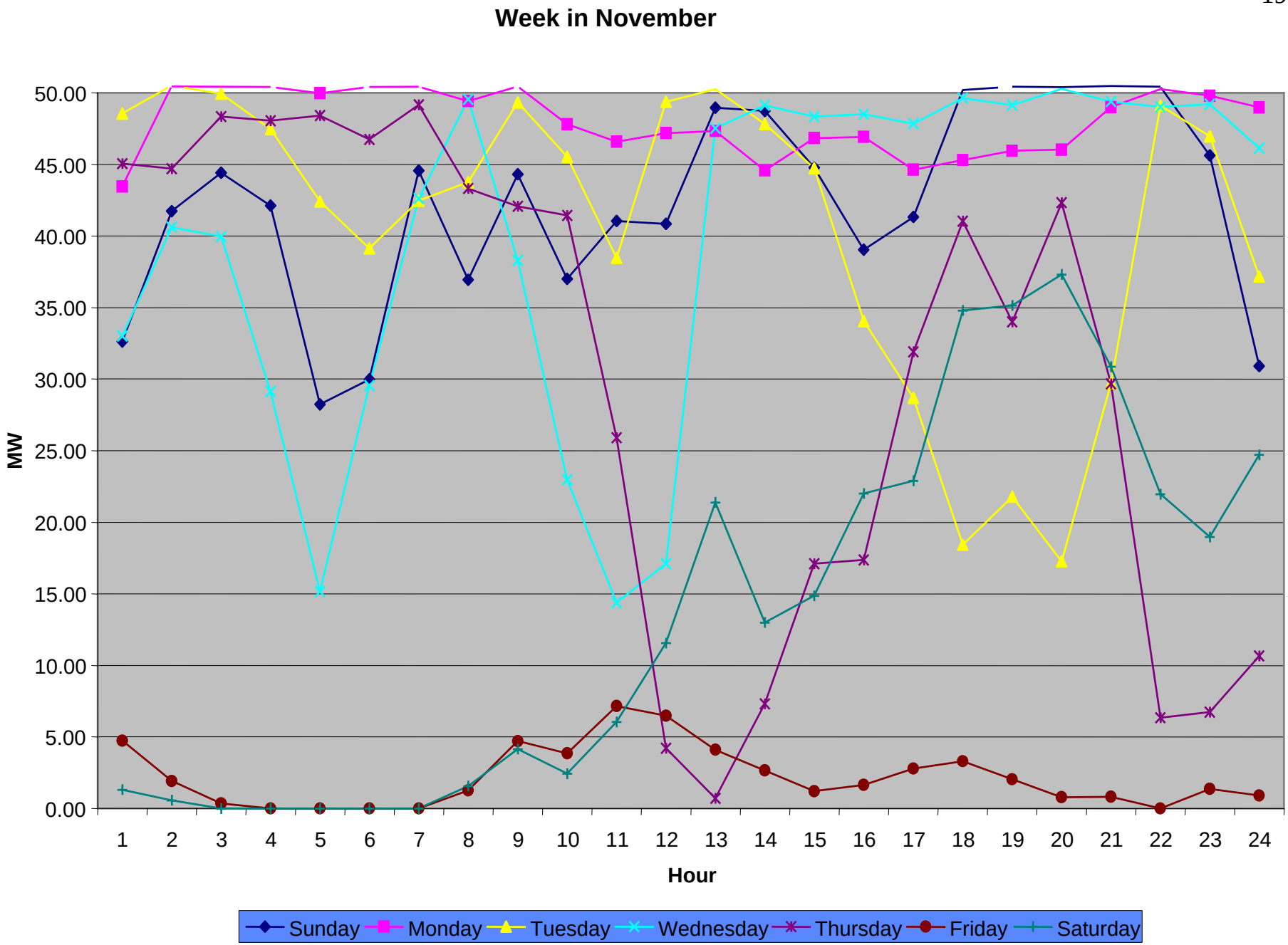
Statistical Dispersion with Purpose


"old" load following
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
-Inf -100 -90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 Inf

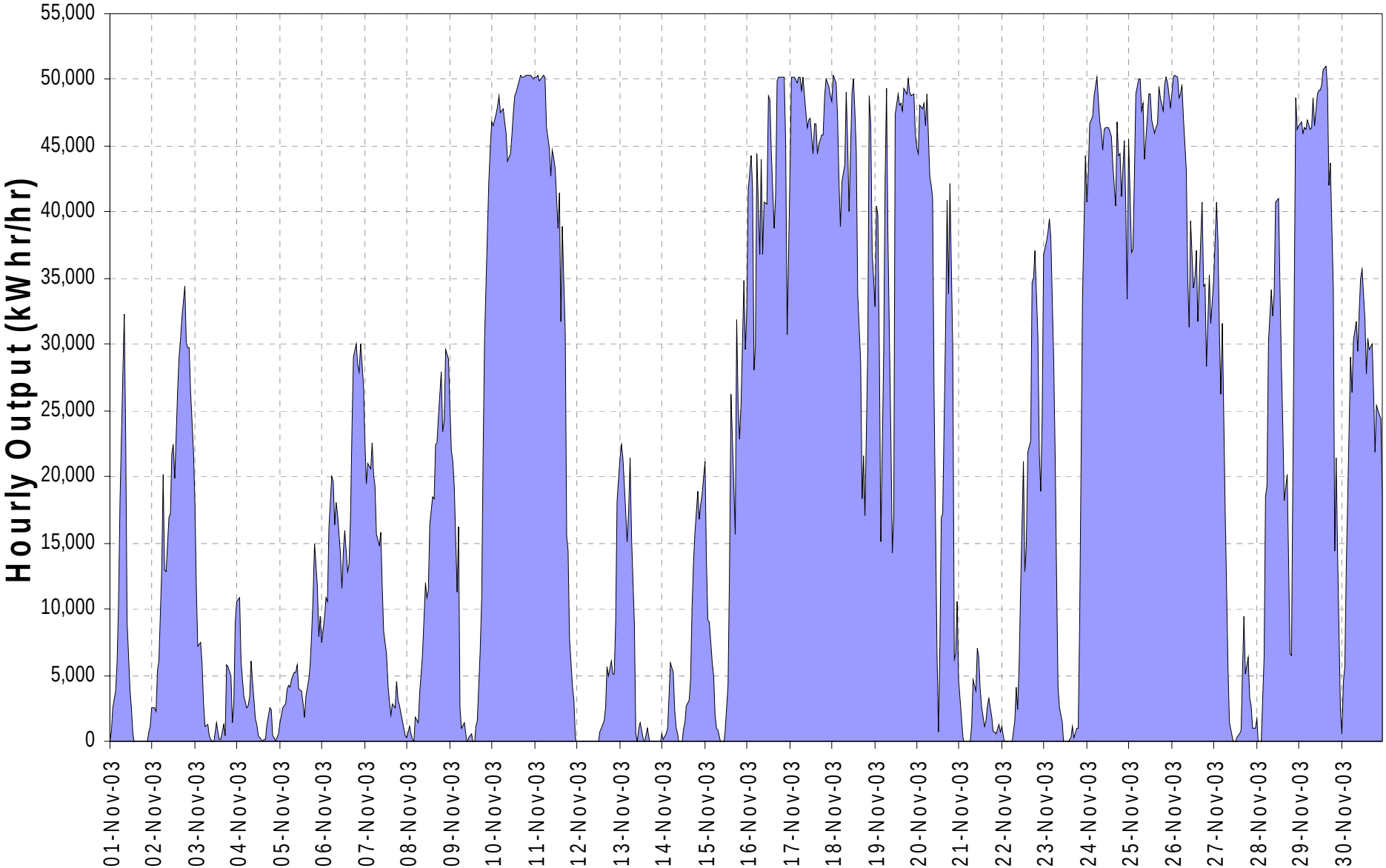
What's The Difference?

TYPICAL DAY HOURLY LOAD SHAPES, November




Week in November
MW
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday

Nine Canyon Output



Transmission and Scheduling Concerns

- Market allows for 1 hour transmission requests
- Schedules are based on clock hours
- Power sales are based on HLH and LLH, and structured products
- Wind ramps outside of established 1 hour blocks
- Transmission penalties exist for the unauthorized use of transmission

The Need for Shaping Services

2001to 2004

- The Nine Canyon project needed subscribers for the project to move forward
- Grant developed a shaping service at the request of three smaller purchasers
- Grant Integrated 18 MWs of Nine Canyon Output
- BPA offered the a similar service in 2004

What Was Learned

- Grant was able to successfully integrate 18 MW
- 18 MW to Grant's system is equivalent to approximately 660 MW in the Northwest Federal System
- Grant was able to do this even though one of Grant's two major hydro projects faces severe constraints

NREL

NORTHERN ARIZONA UNIVERSITY
FLAGSTAFF

Grant County PUBLIC UTILITY DISTRICT
Innovation & Excellence...Yesterday, Today and Tomorrow

Constraints on Providing Services

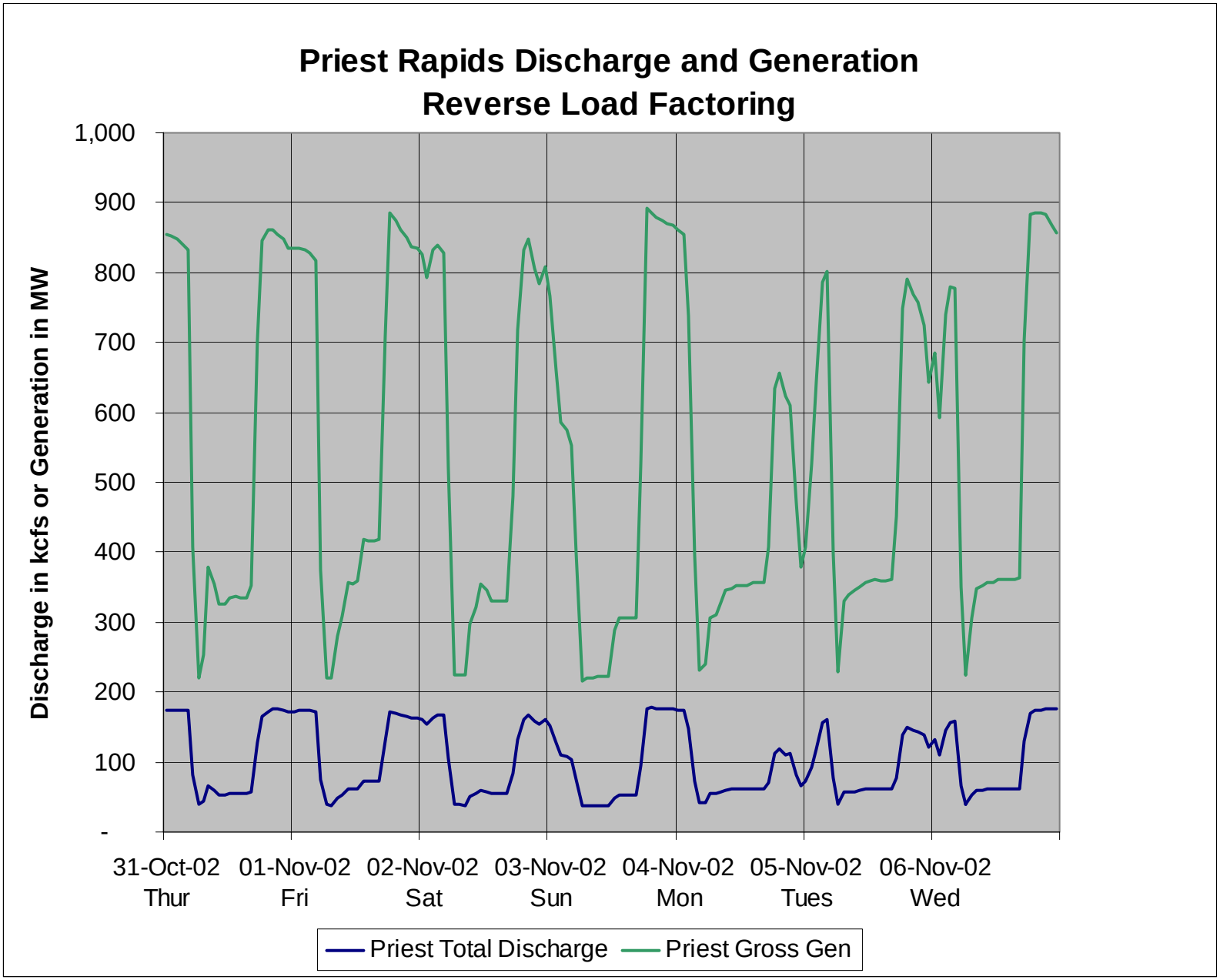
- Non Power Requirements can substantially reduce a hydro project's ability to supply shaping and storage services
- Priest Rapids Dam has a rated capacity of 955 MW, and yet this hydro project often has little to no ability to offer shaping services.

Major Hydro Constraints

- Reverse Load Factoring
- Protection Level Flows
- Rearing Period Operations
- Total Dissolved Gas (TDG)
- Recreation
- Flood Control

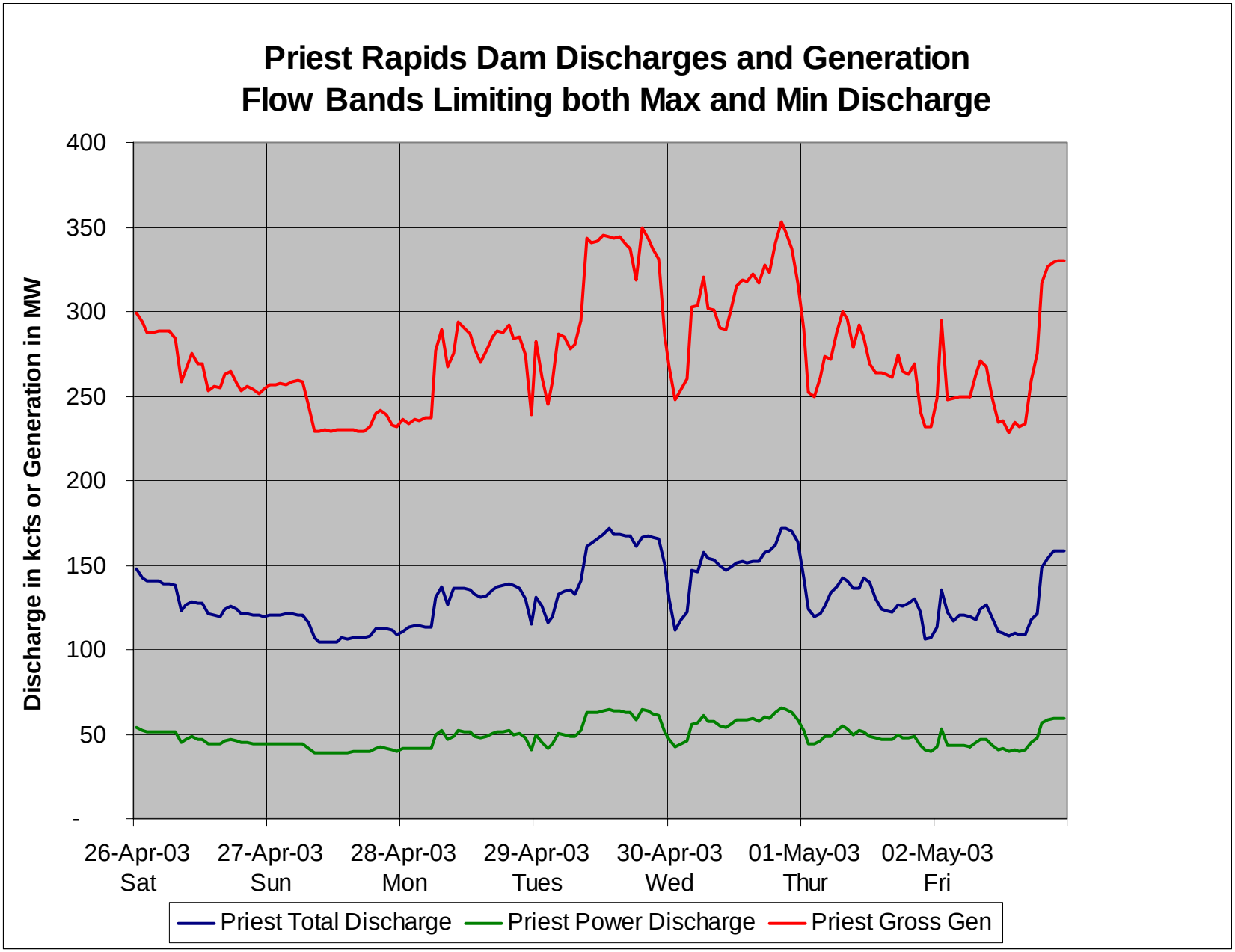
Reverse Load Factoring

- Flows are highly limited during daylight hours
- This is done to encourage Salmon to spawn at lower elevations
- Mid October to Late November


Priest Rapids Discharge and Generation
Reverse Load Factoring
Discharge in kcfs or Generation in MW
1,000
900
800
700
600
500
400
300
200
100
-
31-Oct-02
Thur
01-Nov-02
Fri
02-Nov-02
Sat
03-Nov-02
Sun
04-Nov-02
Mon
05-Nov-02
Tues
06-Nov-02
Wed
Priest Total Discharge
Priest Gross Gen

Protection Level Flows

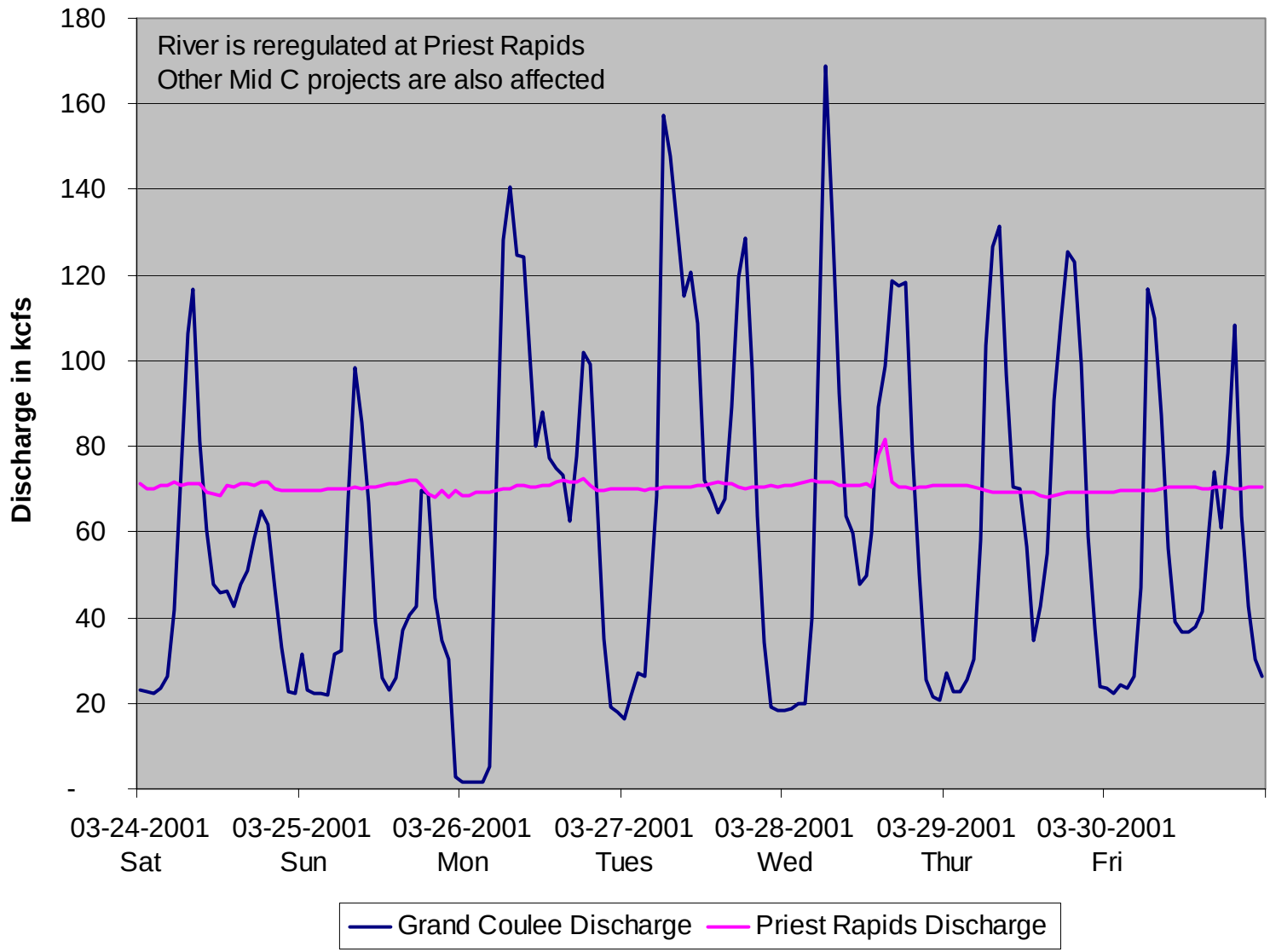
- High minimum discharge must be maintained
- The minimum flow is equal to the weekly average flow and limits the projects ability to vary output
- Generally November to mid April


Priest Rapids Dam Discharges and Generation
Flow Bands Limiting both Max and Min Discharge
Discharge in kcfs or Generation in MW
400
350
300
250
200
150
100
50
-
26-Apr-03 Sat
27-Apr-03 Sun
28-Apr-03 Mon
29-Apr-03 Tues
30-Apr-03 Wed
01-May-03 Thur
02-May-03 Fri
Priest Total Discharge
Priest Power Discharge
Priest Gross Gen

Rearing Period

- Flow fluctuations are limited to avoid stranding
- Priest Rapids may only be able to vary the output by 50 MW per day though rated capacity is 955 MW
- Generally mid March to June

Grand Coulee and Priest Rapids Total Discharge
Minimum Protection Flow of 70 kcfs at Priest Rapids



What Is Next?

- NREL and Grant PUD are completing a study of how best to integrate wind power
- Grant PUD believes renewable energy is viable and supports its continued development
- No one type of renewable energy is the answer, a mixed portfolio of generation is best
- Additional focus needs to be placed on renewable energy that adds predictability and dispatchable capacity to the system
- Grant is proud to have pioneered the way in developing and supplying wind storage and shaping services in the Northwest

Thank You