Macro Invertebrate Flow Experiment
Financial Impact on Hydropower: Process and Methods

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Western Area
Power Administration

"Request that WAPA provide additional information regarding purchase power cost estimates, including assumptions and uncertainty, such that effects to hydropower are minimized if Bug Flows are implemented in the future."

Goal: Provide a general understanding of how CRSP hydropower financial impacts are estimated.

- Hydropower model overview
- Modelling process
- Bug Flow modelling
- Previous Estimates
- Looking forward
- Questions

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GTMax SuperLite

- Modified version of original GTMax Model and customized for the SLCA/IP system
- Models flow of electricity, water, and money
- Maximizes economic or financial value of electrical power generation while adhering to user-defined inputs and restrictions
- Produces “optimal” hourly generation patterns for 1 week each month
- Two formulations
  - Flaming Gorge
  - Other CRSP units
- Can optimize “bug flows”

GTMax SL

Goal: Provide a general understanding of how CRSP hydropower financial impacts are estimated.

- Hydropower model overview
- Modelling process
  - Inputs and assumptions
  - Model outputs
  - Model accuracy
- Bug Flow modelling
- Previous Estimates
- Looking forward
- Questions

Power System Physical Properties

- Unit efficiency
- Max release
- Plant capacity
- Losses (8%)
- Outages
- Ancillary services

Operating Criteria

- Water laws
- Ops plans
- Environmental laws

Endangered Species Act

Hydrology Forecasts

- 24-month study
- CRSS
- Monthly volumes
- Reservoir elevations

BUREAU OF RECLAMATION

Energy Prices

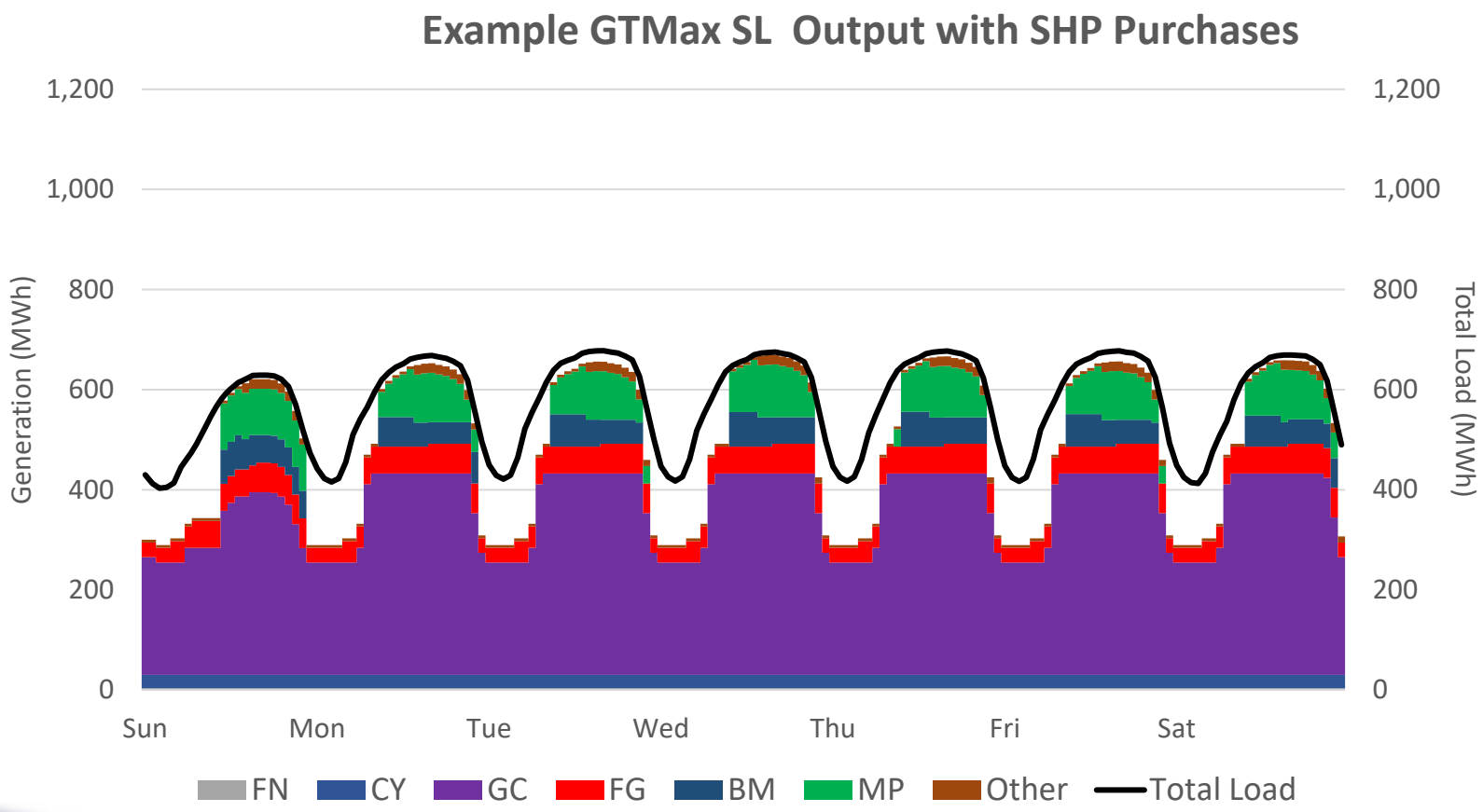
- Palo Verde Hub
- Monthly on and off peak
- Convert to hourly prices

Electric Demand

- Hourly average customer schedule 2006-2018
- Project use

GTMax SL

Example: GTMax SL Output



GTMax SL Accuracy

- Used observed hydrologic data for WYs 2009 – 2016
- Compared model predicted generation to observed generation (PO&M 59)
- Actual generation was less than modelled in all but one year

Water Year	Modelled Generation (MWh)	Observed Generation (MWh)	% Difference
2009	4,799,959	4,711,766	1.9%
2010	4,655,393	4,575,425	1.7%
2011	6,925,842	6,855,827	1.0%
2012	5,345,123	5,219,578	2.4%
2013	4,109,416	4,003,033	2.7%
2014	3,923,947	3,873,198	1.3%
2016	4,996,324	5,011,928	-0.3%
Total	34,756,005	34,250,756	1.5%

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  - 2021 Example
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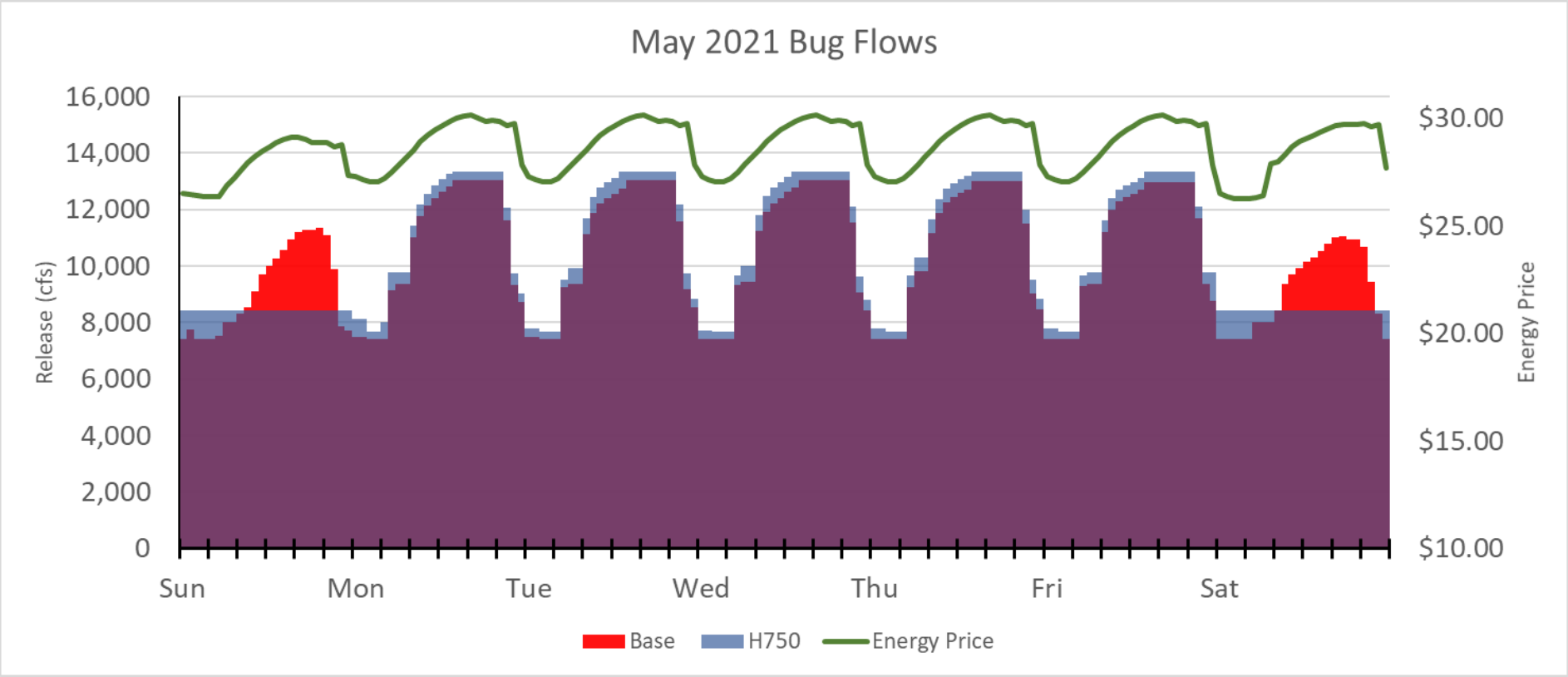
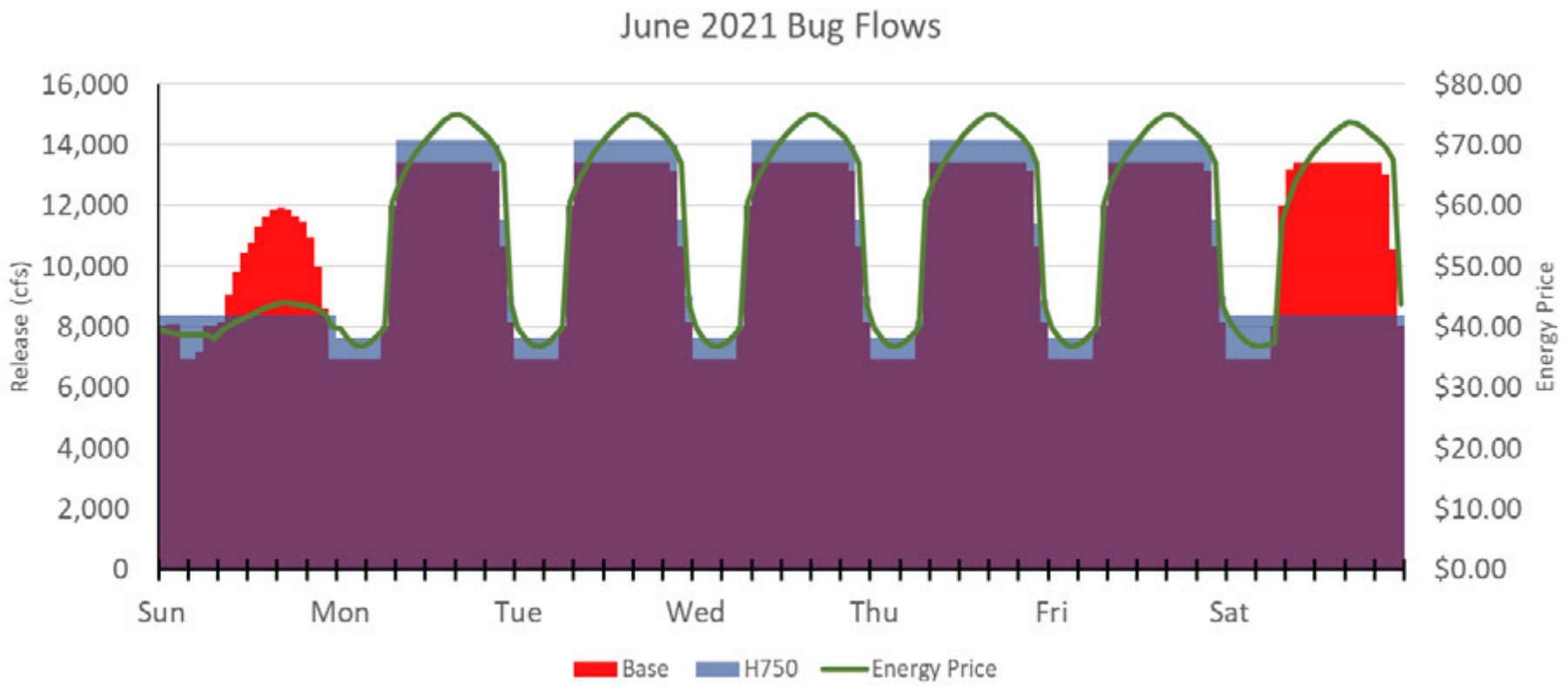
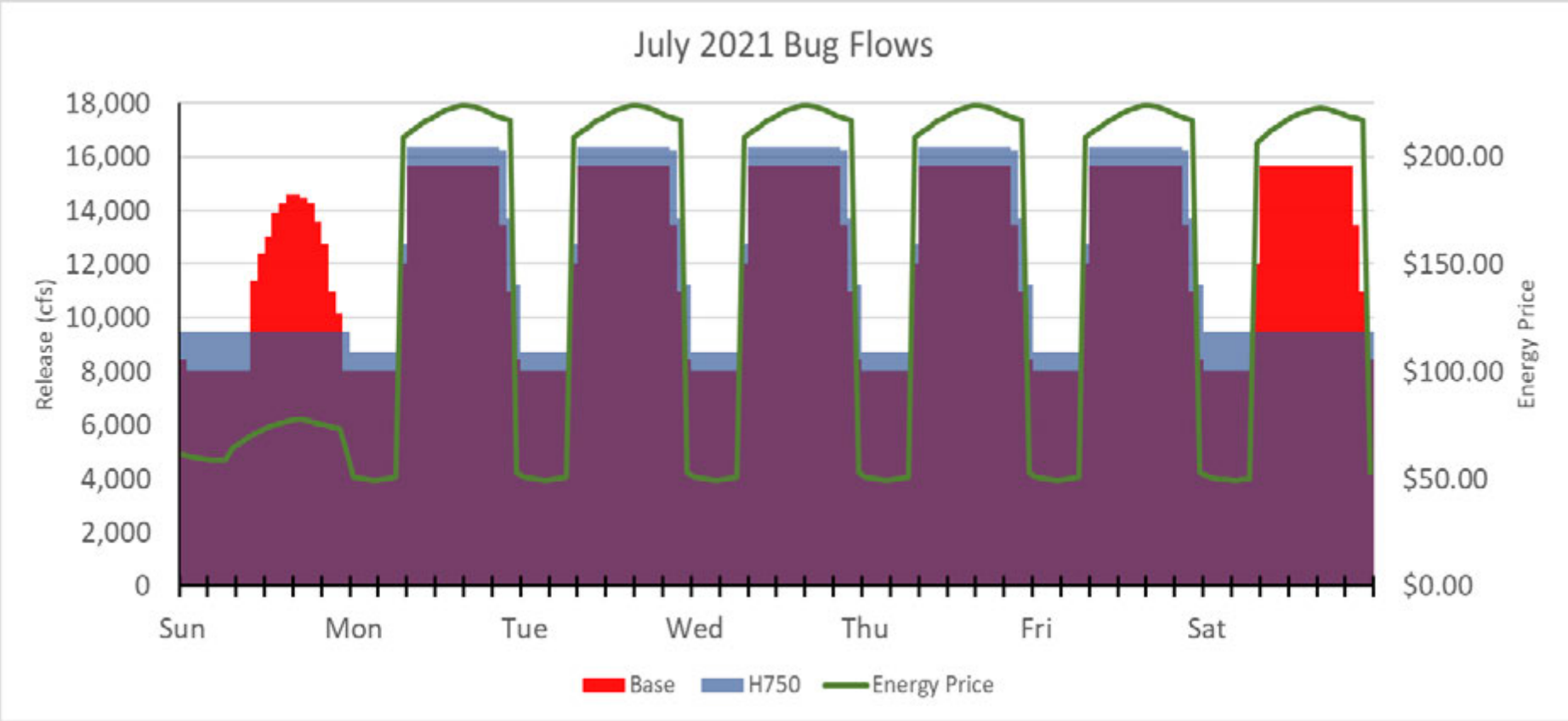
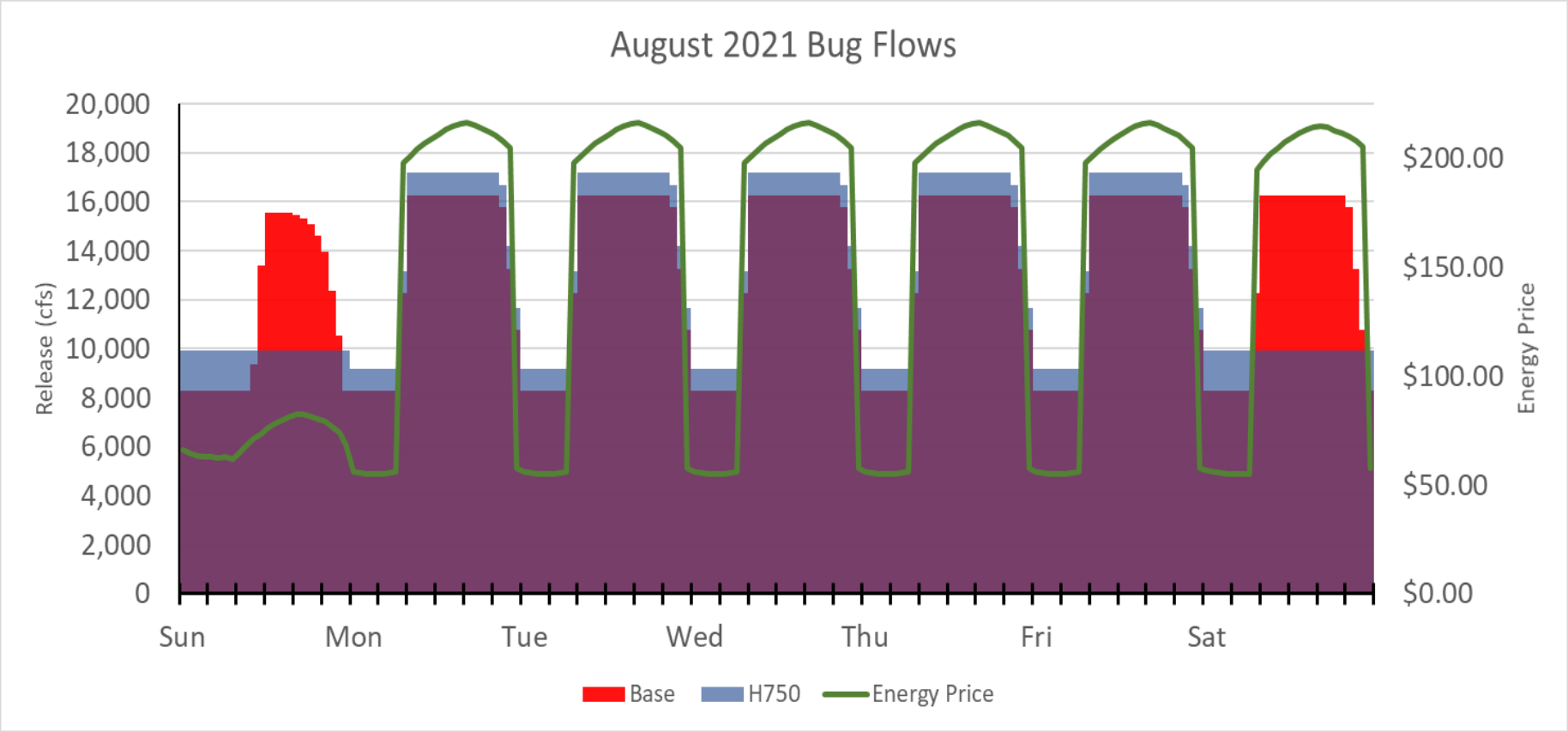
- Questions

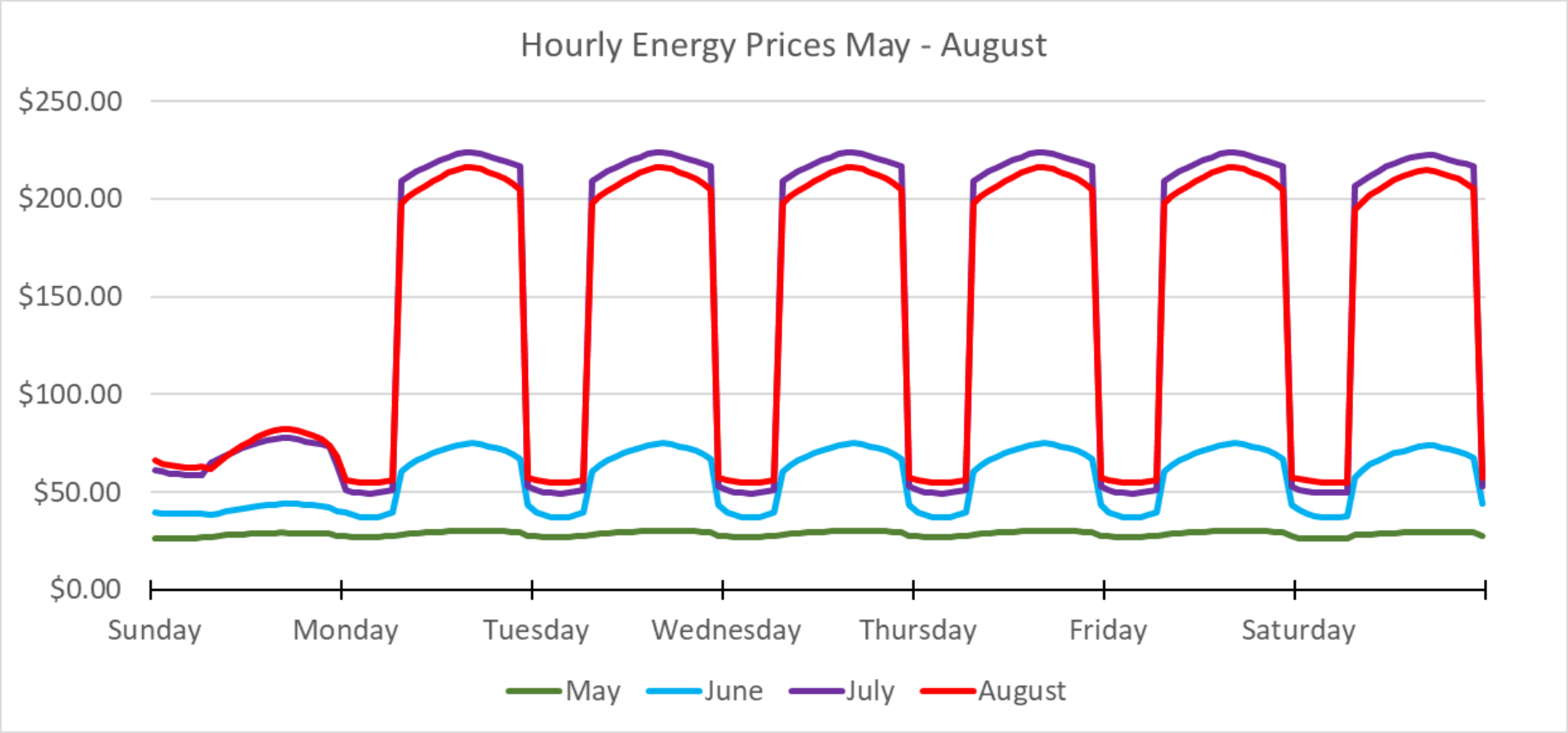

May 2021 Bug Flows
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Release (cfs)
$30.00
$25.00
$20.00
$15.00
$10.00
Energy Price
Sun
Mon
Tue
Wed
Thu
Fri
Sat
Base
H750
Energy Price


June 2021 Bug Flows
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Release (cfs)
$80.00
$70.00
$60.00
$50.00
$40.00
$30.00
$20.00
$10.00
$0.00
Energy Price
Sun
Mon
Tue
Wed
Thu
Fri
Sat
Base
H750
Energy Price


July 2021 Bug Flows
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Release (cfs)
$200.00
$150.00
$100.00
$50.00
$0.00
Energy Price
Sun
Mon
Tue
Wed
Thu
Fri
Sat
Base
H750
Energy Price


August 2021 Bug Flows
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Release (cfs)
$200.00
$150.00
$100.00
$50.00
$0.00
Energy Price
Sun
Mon
Tue
Wed
Thu
Fri
Sat
Base
H750
Energy Price

Key Points


Hourly Energy Prices May - August
$250.00
$200.00
$150.00
$100.00
$50.00
$0.00
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
May
June
July
August

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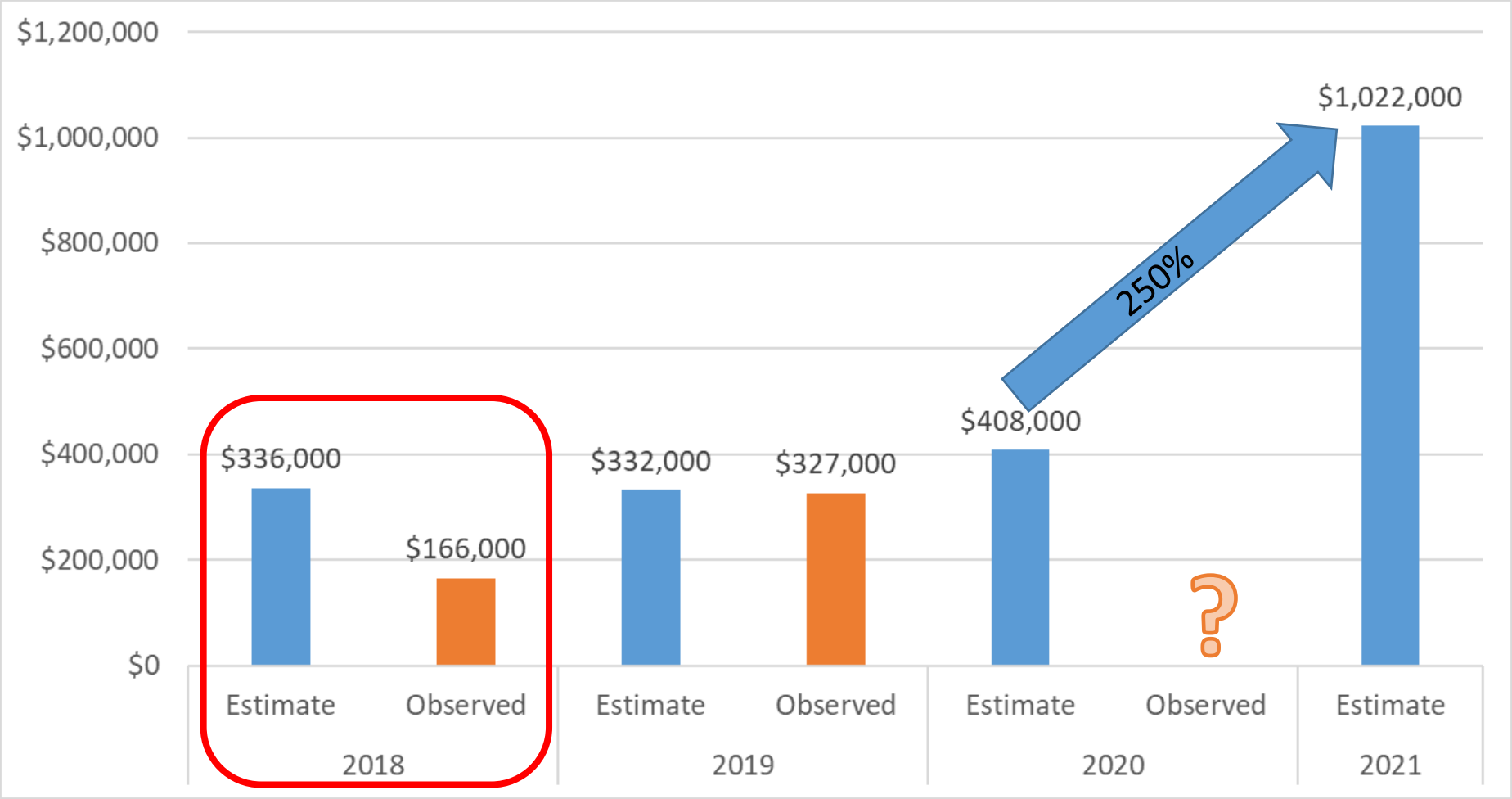
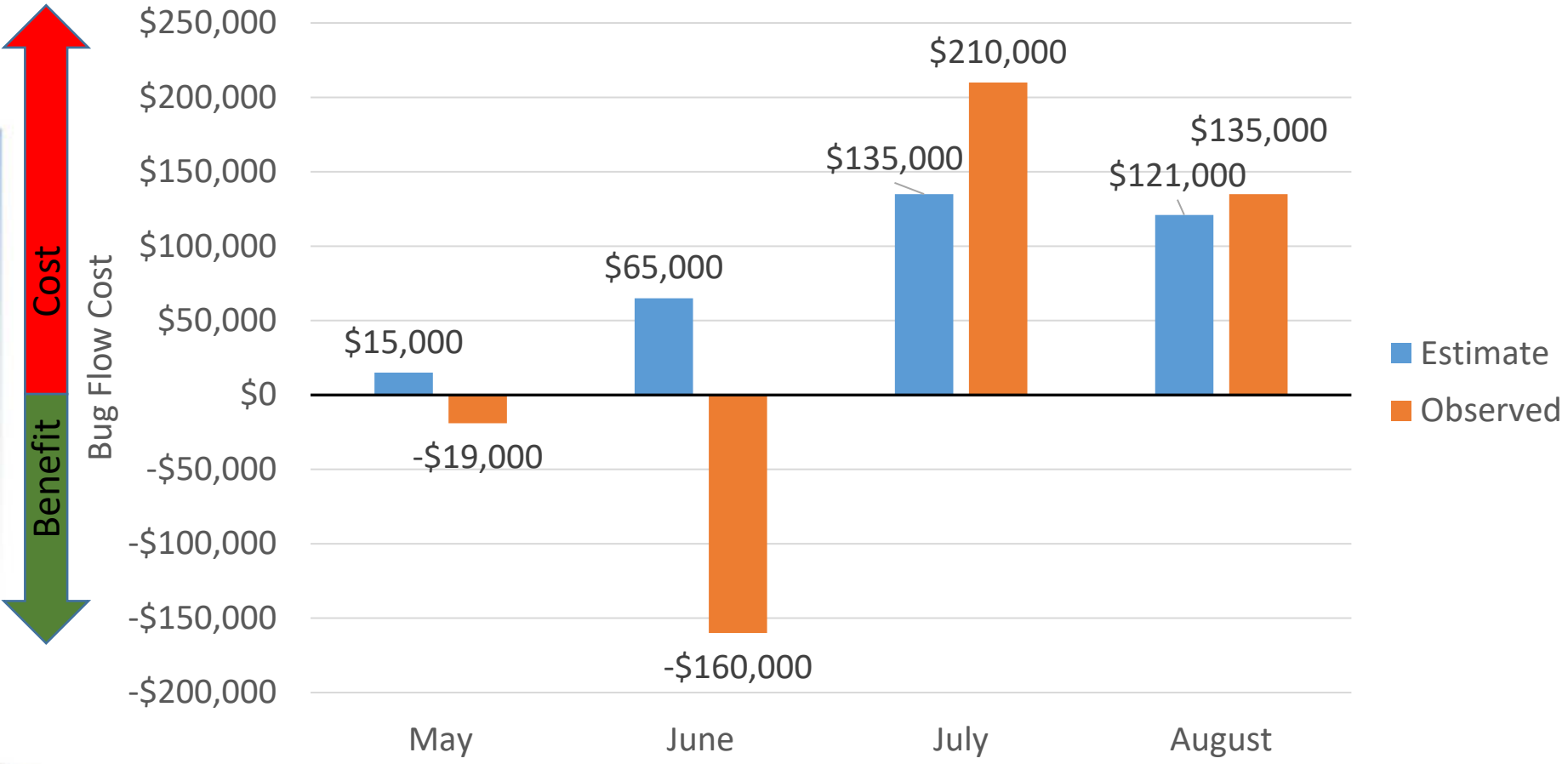
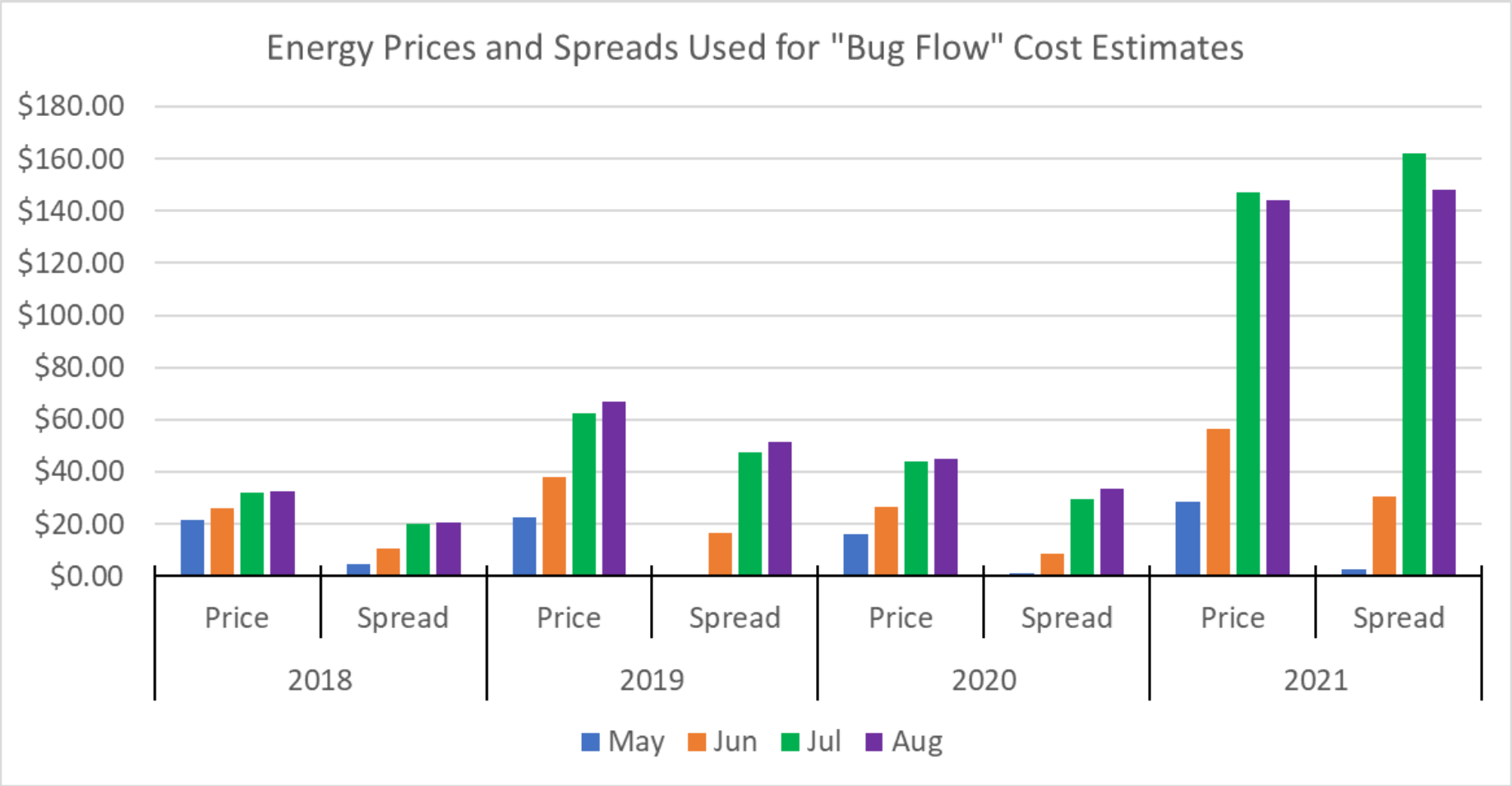
- Hydropower model overview
- Modelling process
- Bug Flow modelling
- Previous Estimates
  - 2018 – 2021
  - Observed 2018 - 2019
- Looking forward
- Questions

Previous "Bug Flow" Estimates



2018 Monthly Cost of Bug Flows




Energy Prices and Spreads Used for "Bug Flow" Cost Estimates
$180.00
$160.00
$140.00
$120.00
$100.00
$80.00
$60.00
$40.00
$20.00
$0.00
Price
Spread
Price
Spread
Price
Spread
Price
Spread
2018
2019
2020
2021
May
Jun
Jul
Aug

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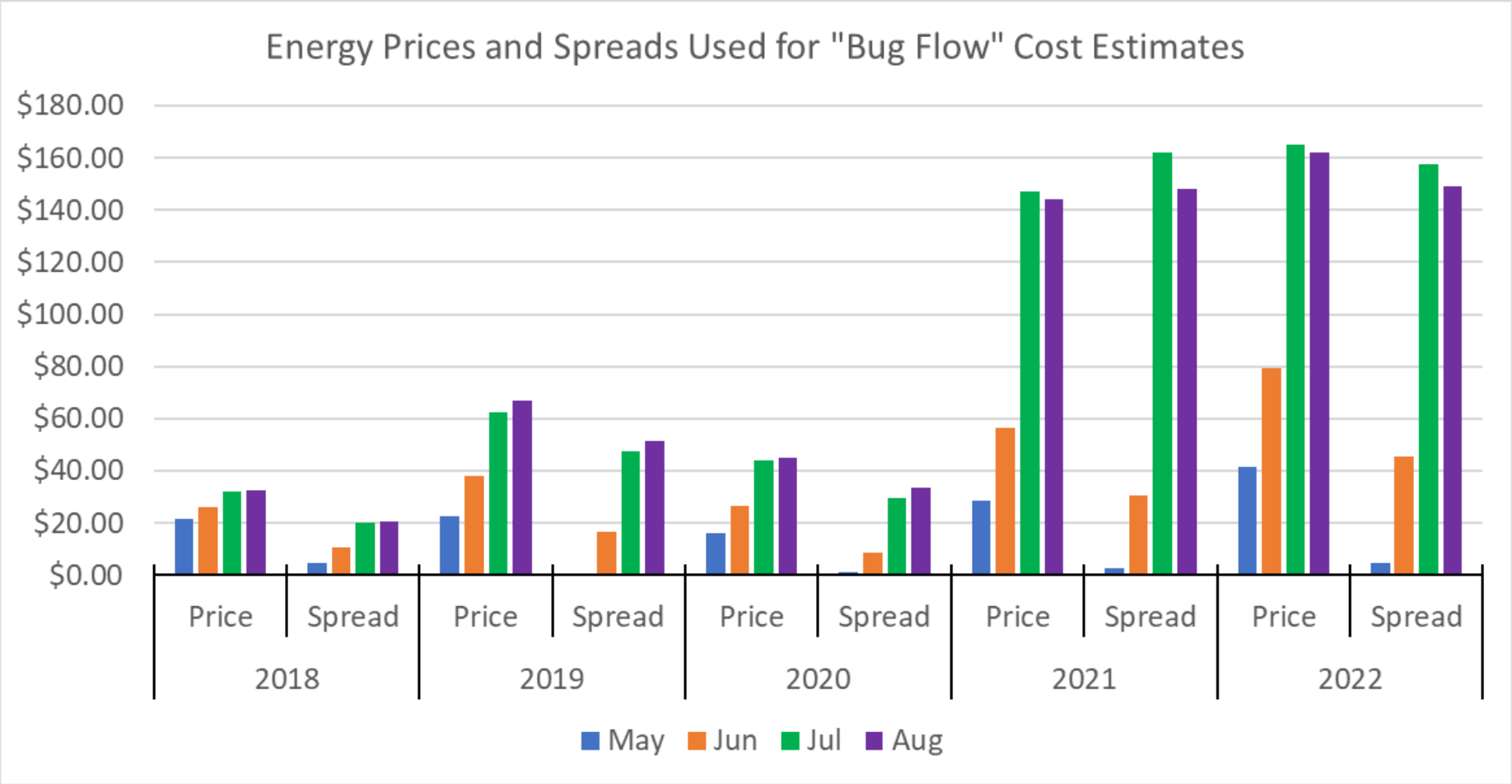
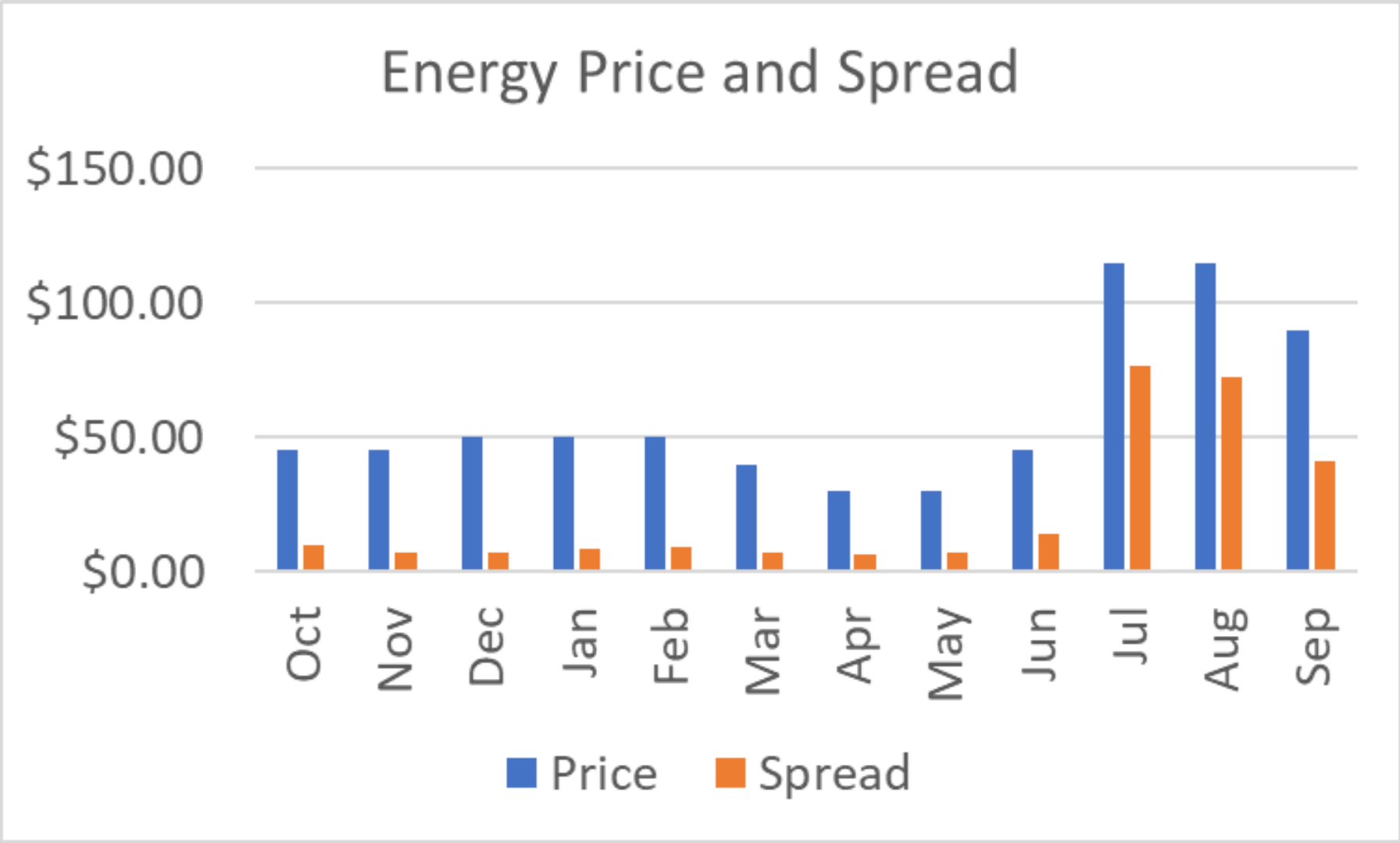
  - 2022
  - Beyond 2022
- Questions

Looking ahead to 2022




Energy Price and Spread
$150.00
$100.00
$50.00
$0.00
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Price
Spread

Ideas for reducing bugflows impacts to hydropower

Things we have learned:

H-value	Number of days	Daily fluctuation level	Type of month	Power prices & onpeak/offpeak spread
• Higher = expensive	• Saturday = weekday • 5 weekends/month	• Is limiting movement of onpeak water	• Power months = expensive	• Higher = expensive

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