

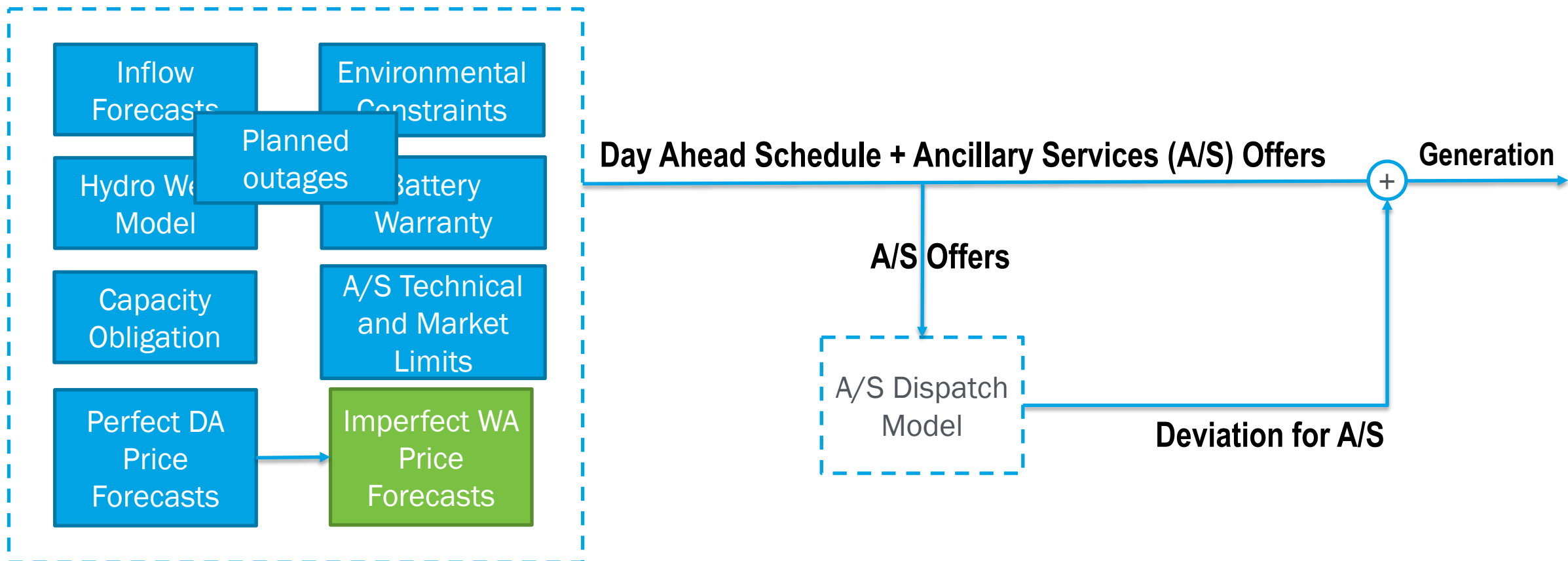
INL, ANL

Hill Balliet, Matt Mahalik, Jonghwan Kwon, Tyler Phillips, Venkat Durvasulu, Thomas M Mosier

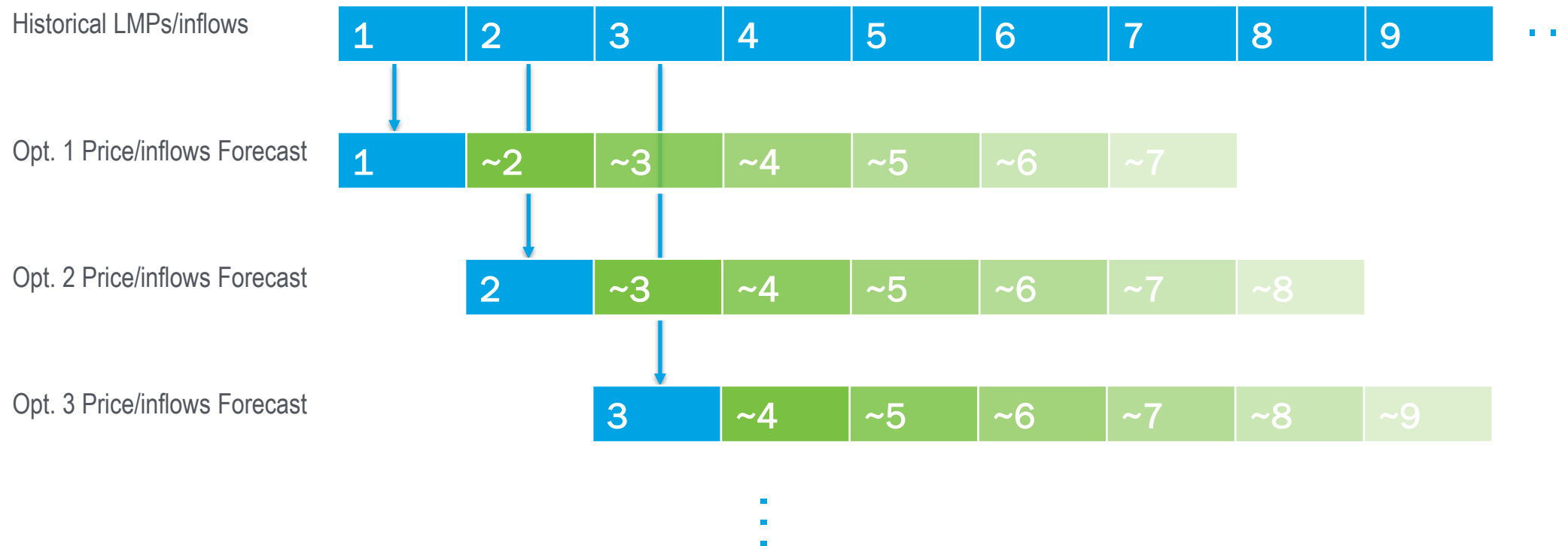
Tool Description
26 February 2024

- Hourly inflows for modeled year
- Hourly locational marginal prices for modeled year
- Hourly ancillary services prices for modeled year
- Reservoir min/max
- Flow min/max
- Seasonal water use rules
- Battery size
- Water to power curve
- Regulation market signals

Optimization

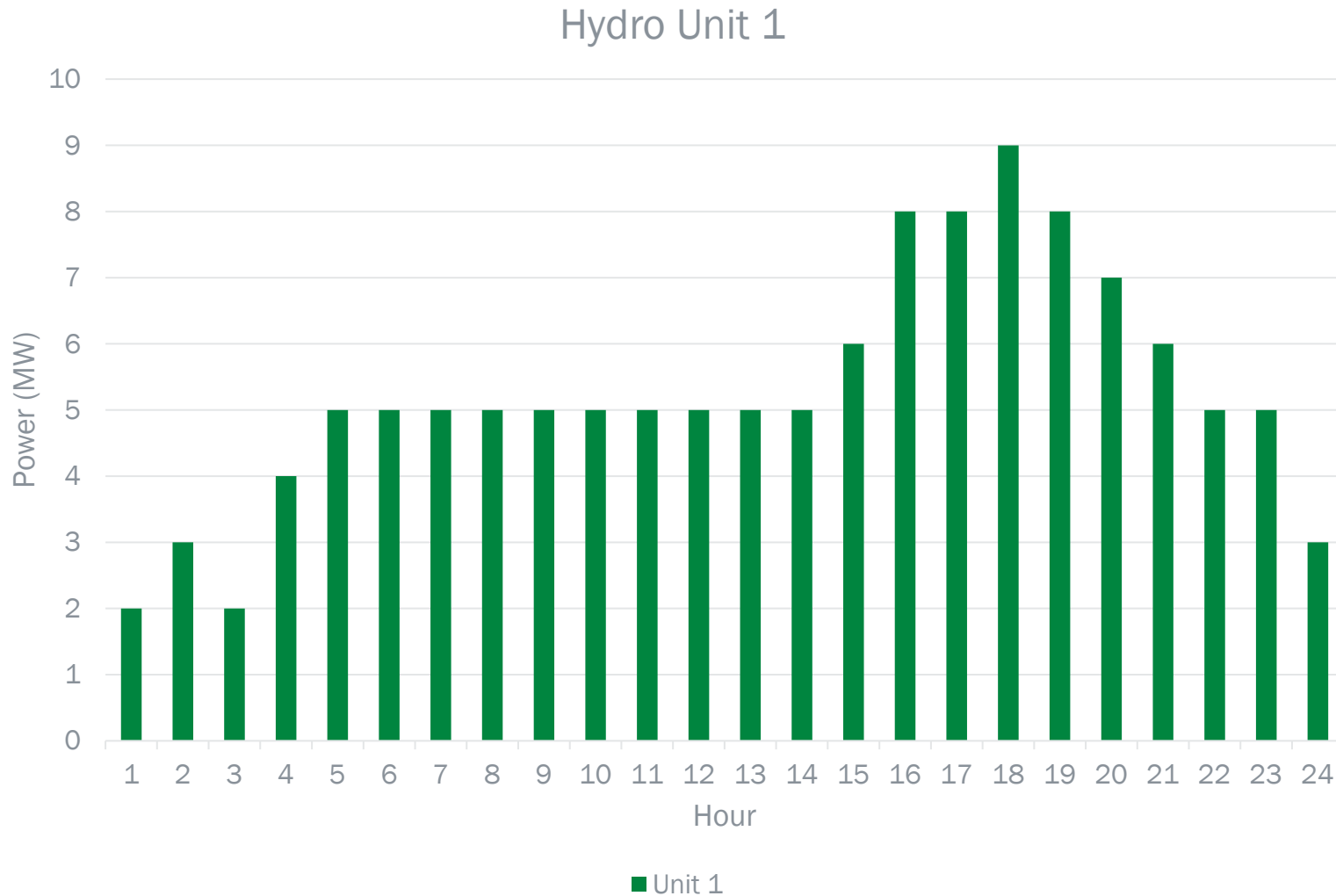


- Perfect foresight 1 day ahead with imperfect foresight beyond that



Example Outputs

Hybrid Power Output – Unit 1



▼ Hydro Unit 1

- Hydro Unit 1
- Hydro Unit 2
- All Hydro
- Battery
- Total

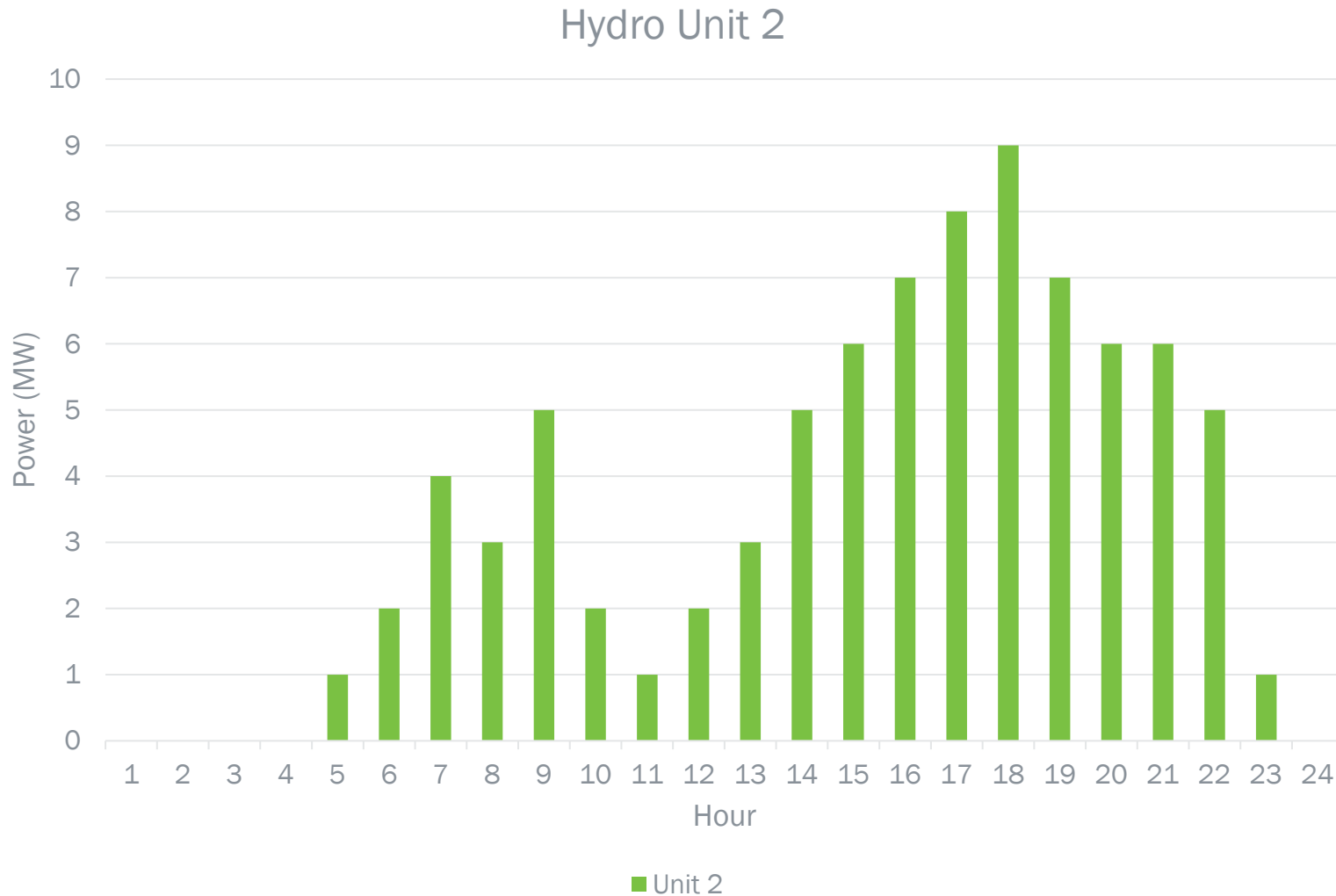
Start

1/1/2023

End

1/2/2023

Hybrid Power Output – Unit 2



▼ Hydro Unit 2

- Hydro Unit 1
- Hydro Unit 2
- All Hydro
- Battery
- Total

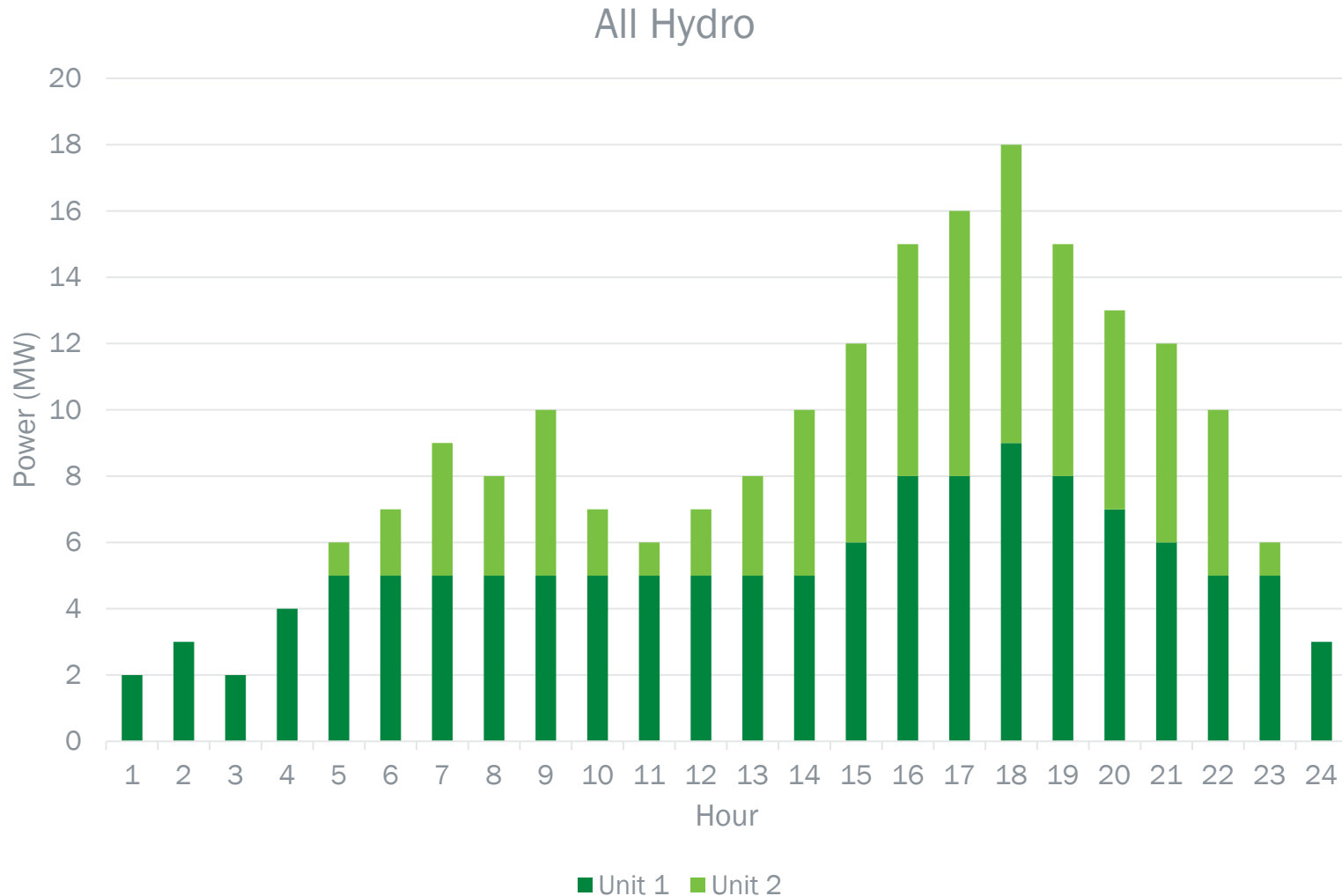
Start

1/1/2023

End

1/2/2023

Hybrid Power Output – All Hydro



▾ All Hydro

Hydro Unit 1
Hydro Unit 2
All Hydro
Battery
Total

Start

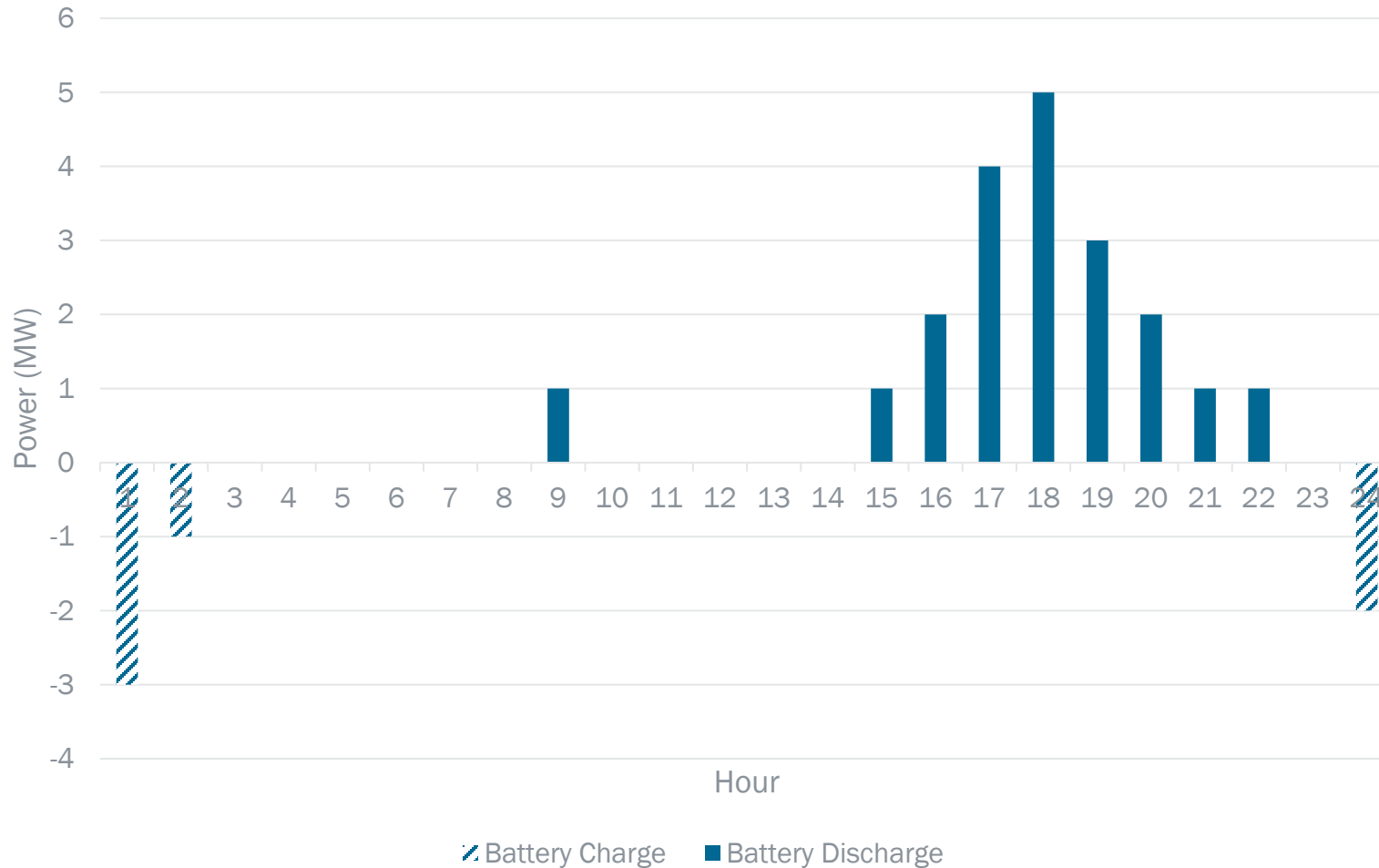
1/1/2023

End

1/2/2023

Hybrid Power Output - Battery

Battery Power



↓ Total

- Hydro Unit 1
- Hydro Unit 2
- All Hydro
- Battery
- Total

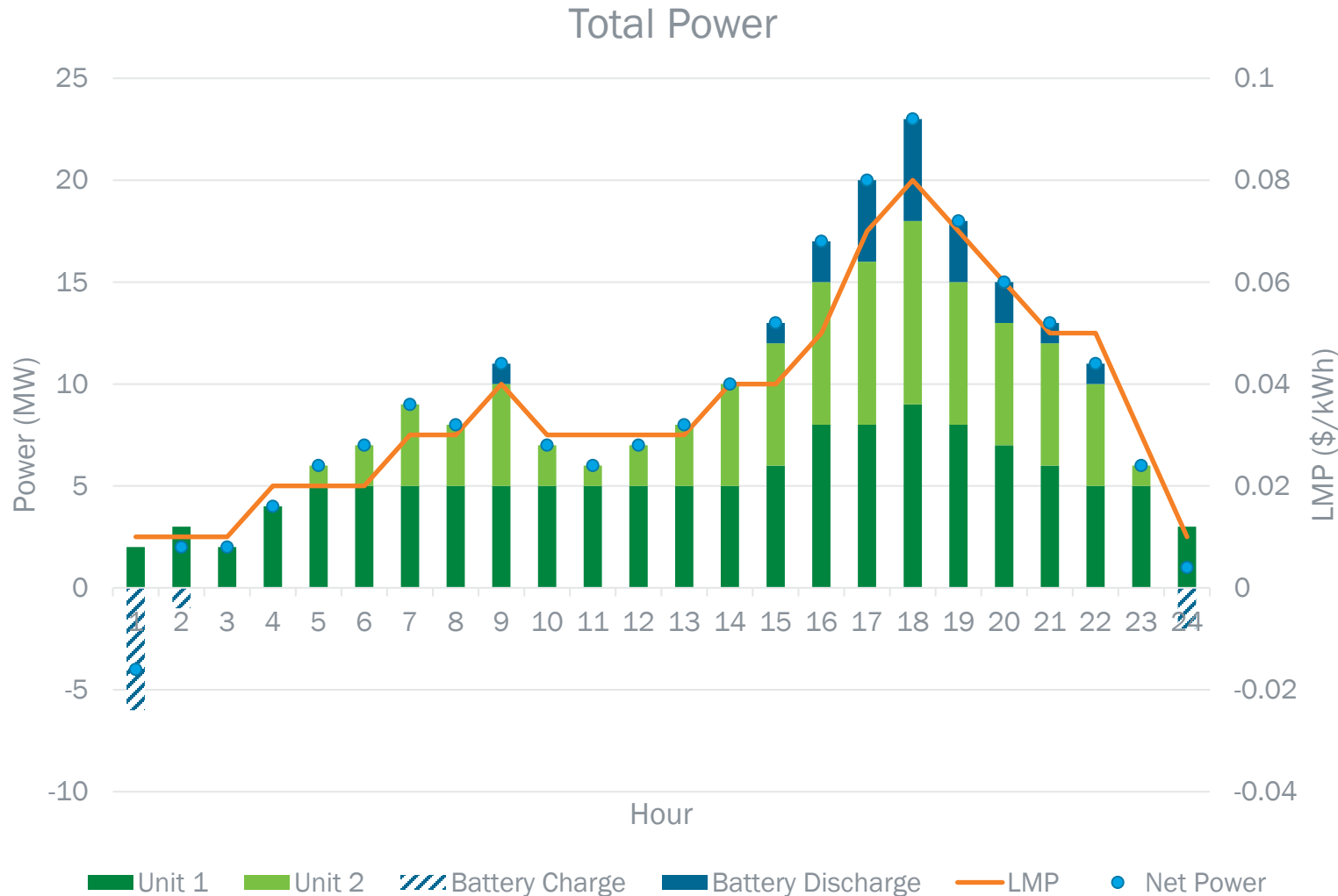
Start

1/1/2023

End

1/2/2023

Hybrid Power Output - Total



Total
 Hydro Unit 1
 Hydro Unit 2
 All Hydro
 Battery
 Total

Hourly (daily by default)

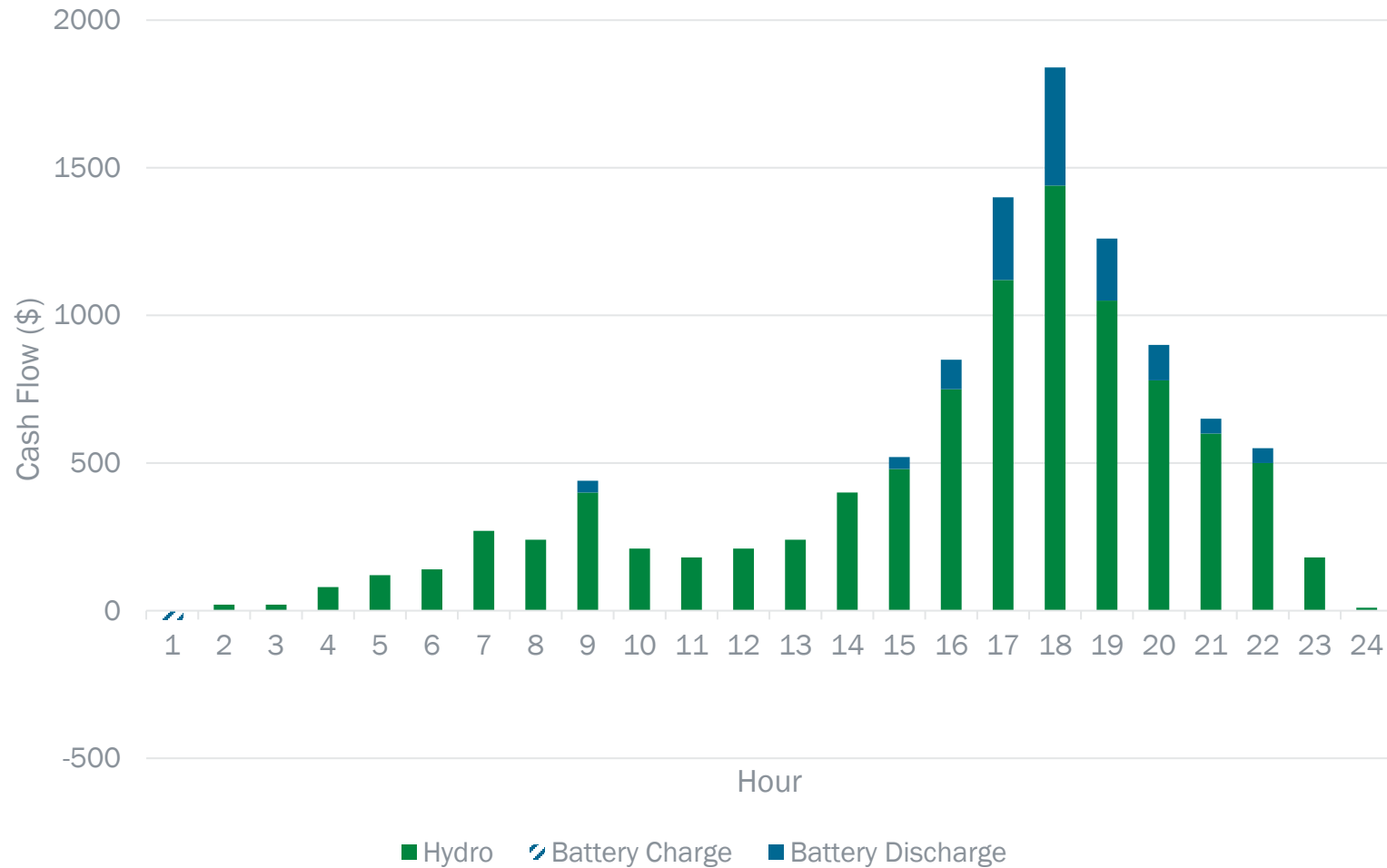
Overlay prices

Start
1/1/2023

End
1/2/2023

Hybrid Cash Flow

Total Cash Flow



↓ Total

Hydropower

Battery

Total

Start

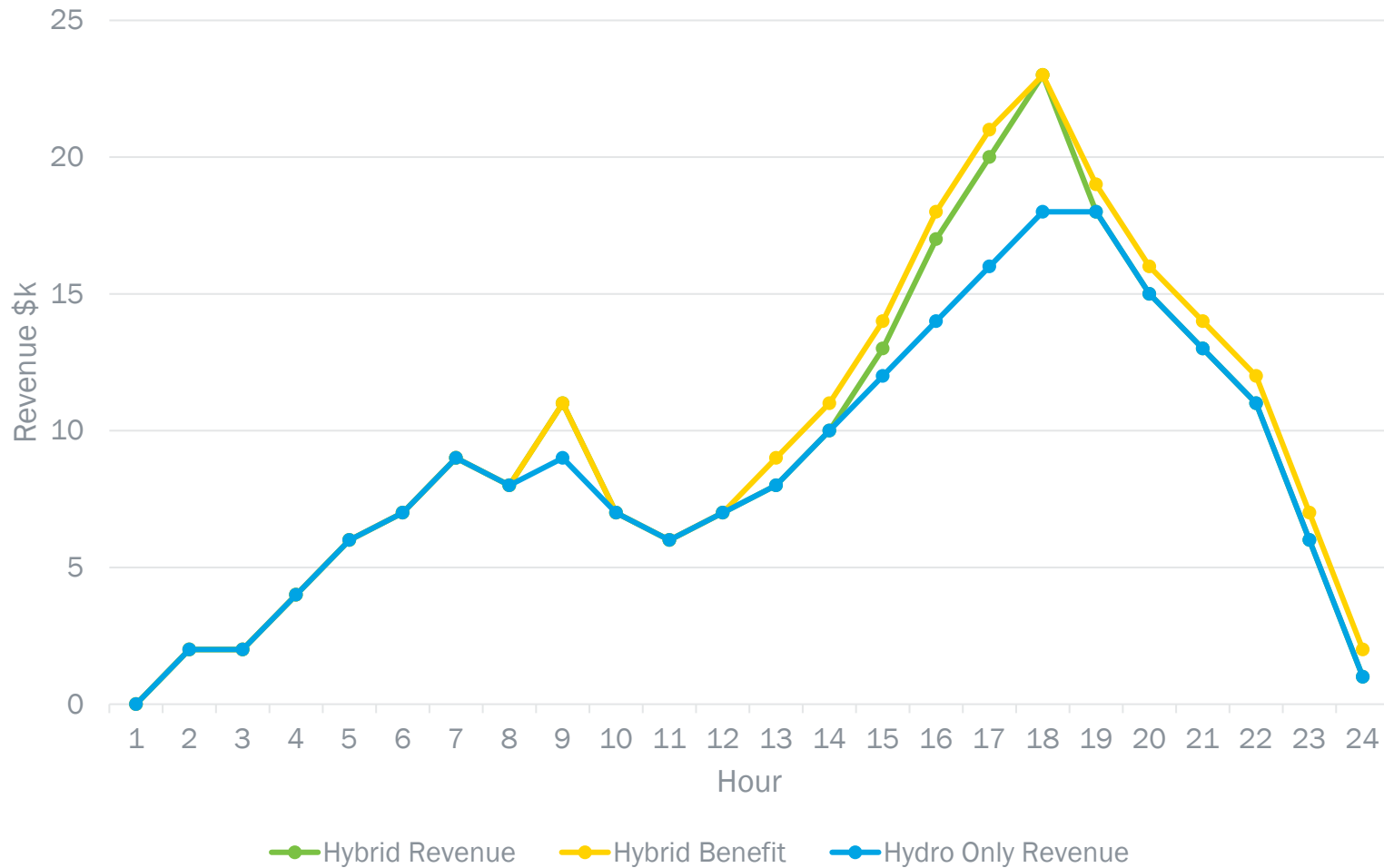
1/1/2023

End

1/2/2023

Hydro only vs. Hybrid Benefits

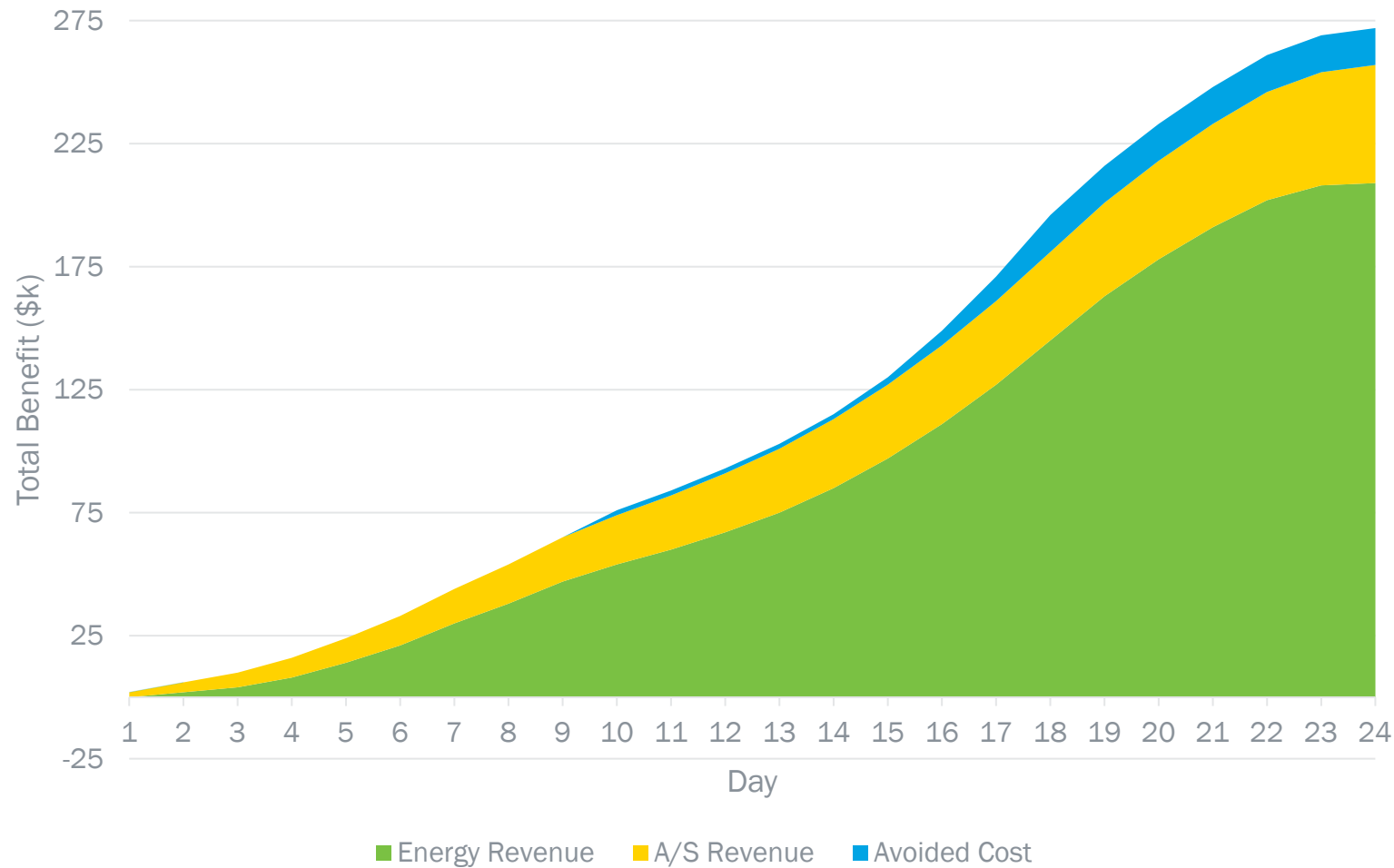
Total Revenue



This chart would be generated for revenue and power generation

Cumulative Benefit (nominal)

Cumulative Benefit



↓ **Total**

- Energy Revenue
- A/S Revenue
- Avoided Cost
- Total**

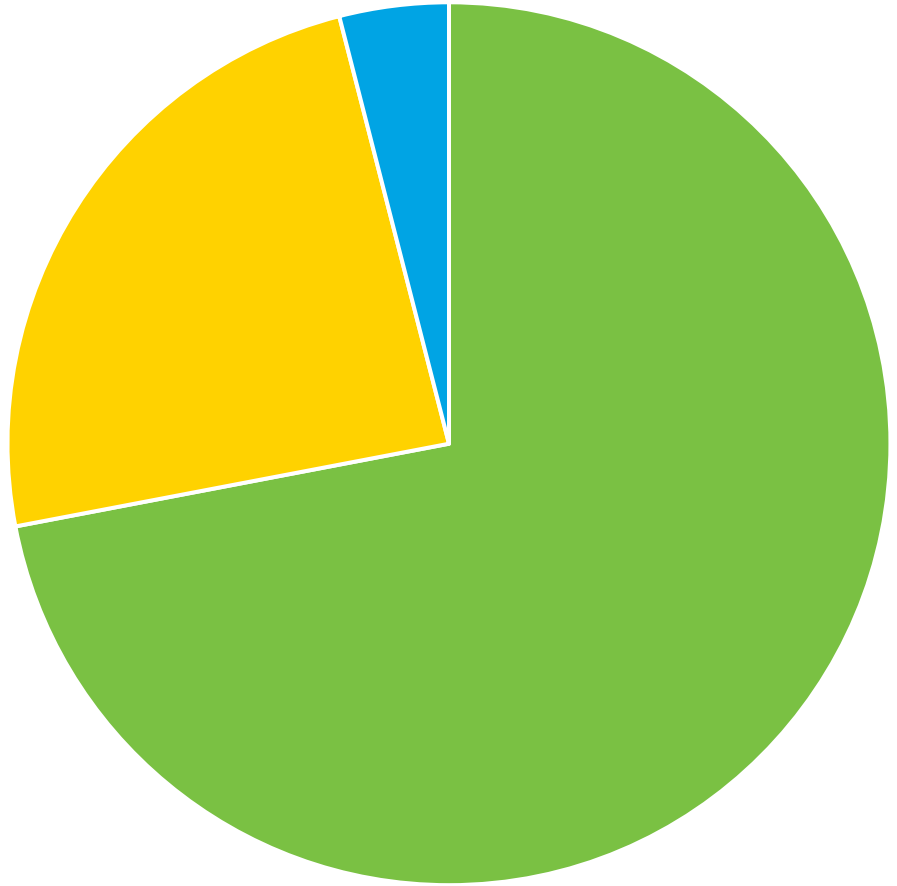
Start

1/1/2023

End

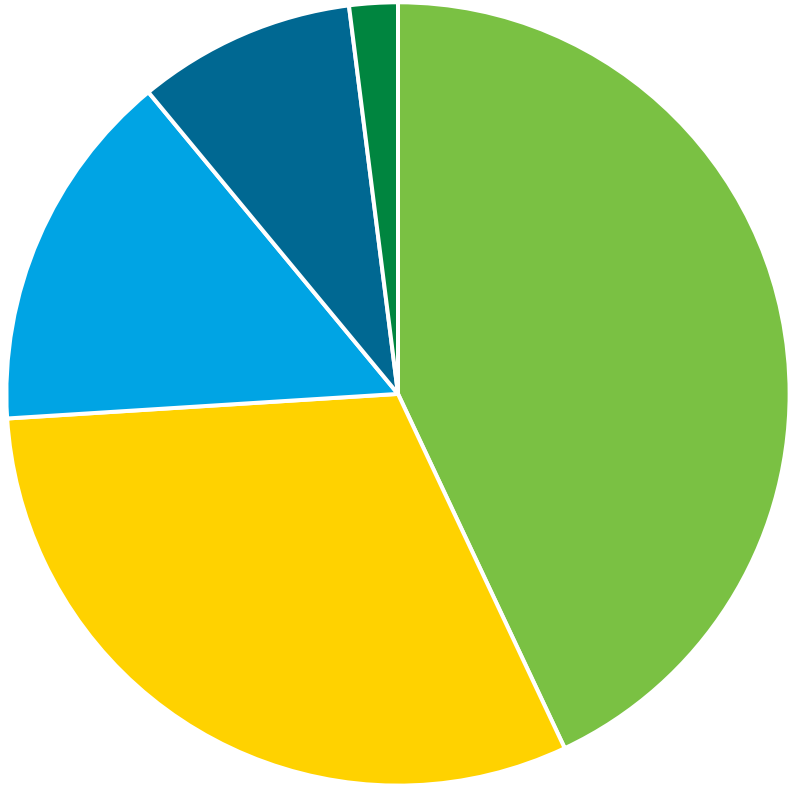
1/24/2023

Total Benefit



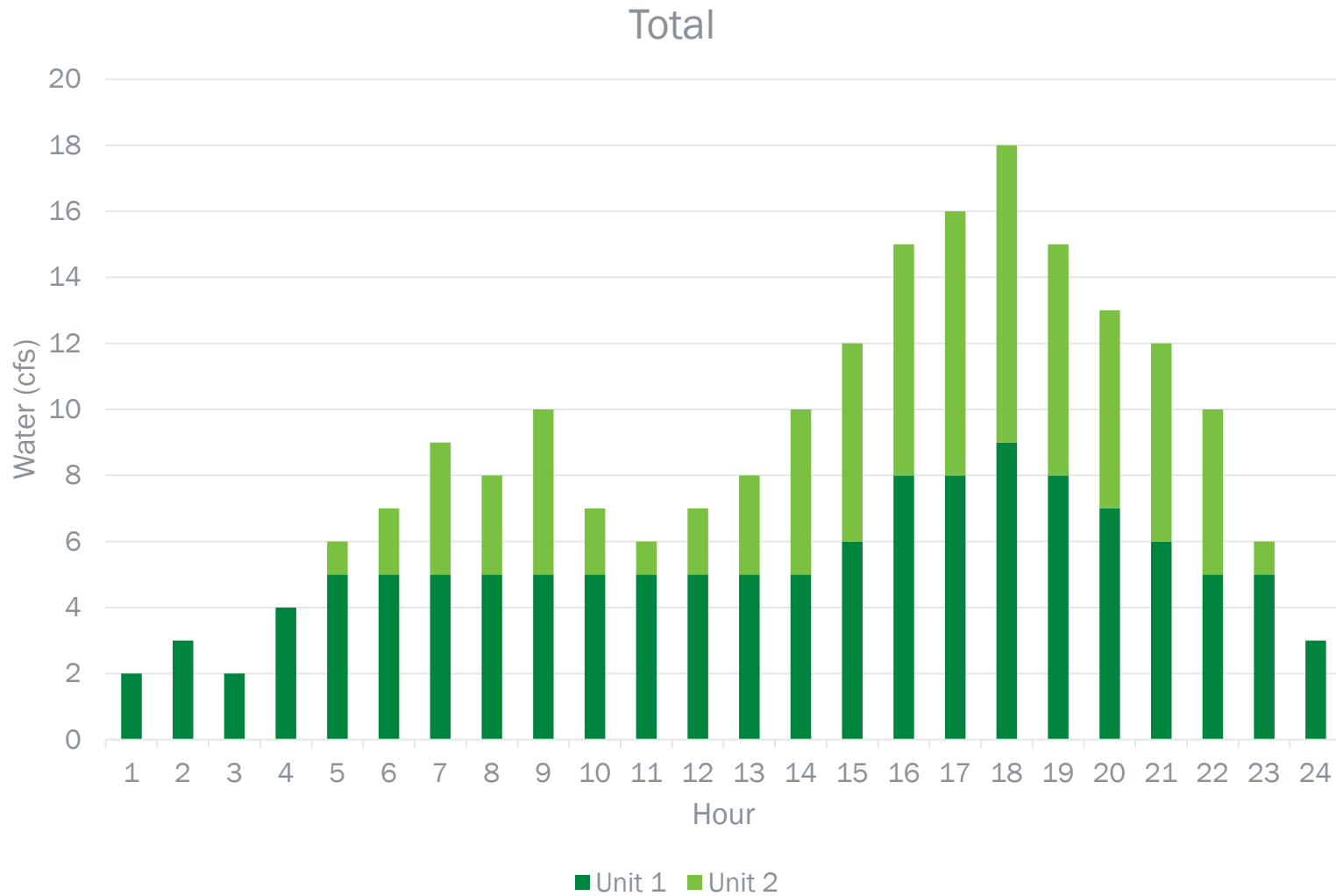
■ Hydro Revenue ■ Battery Revenue ■ Avoided Cost

Battery Benefit



■ Energy Arbitrage ■ Capacity Market
■ Ancillary Services ■ Avoided Hydro O&M
■ Avoided Environmental Cost

Water Flow



☑ All Hydro

Hydro Unit 1

Hydro Unit 2

Total

Start
1/1/2023

End
1/2/2023

Reservoir Volume over Time

Reservoir Level



Start

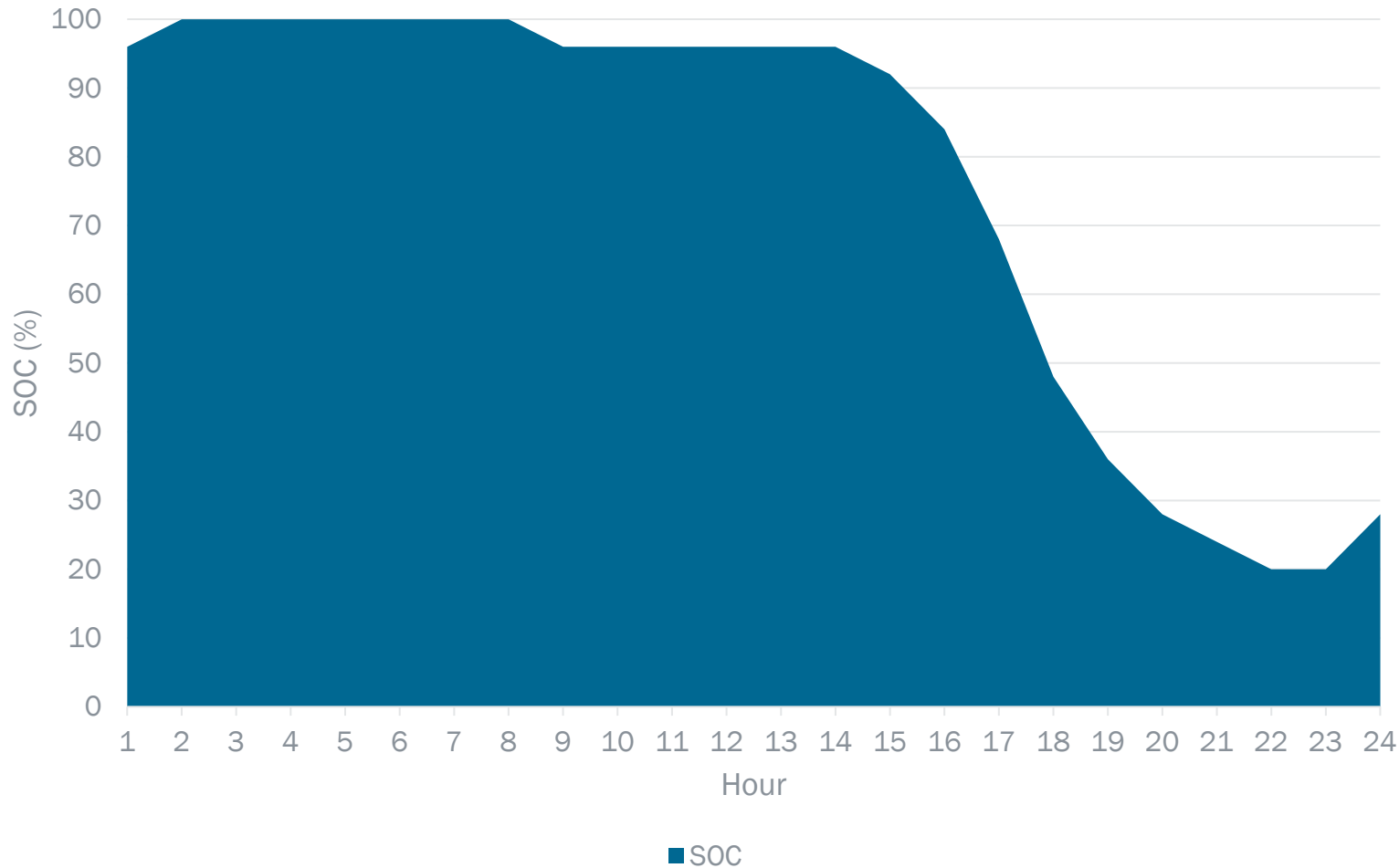
1/1/2023

End

1/2/2023

Battery SOC over Time

Battery SOC



Start

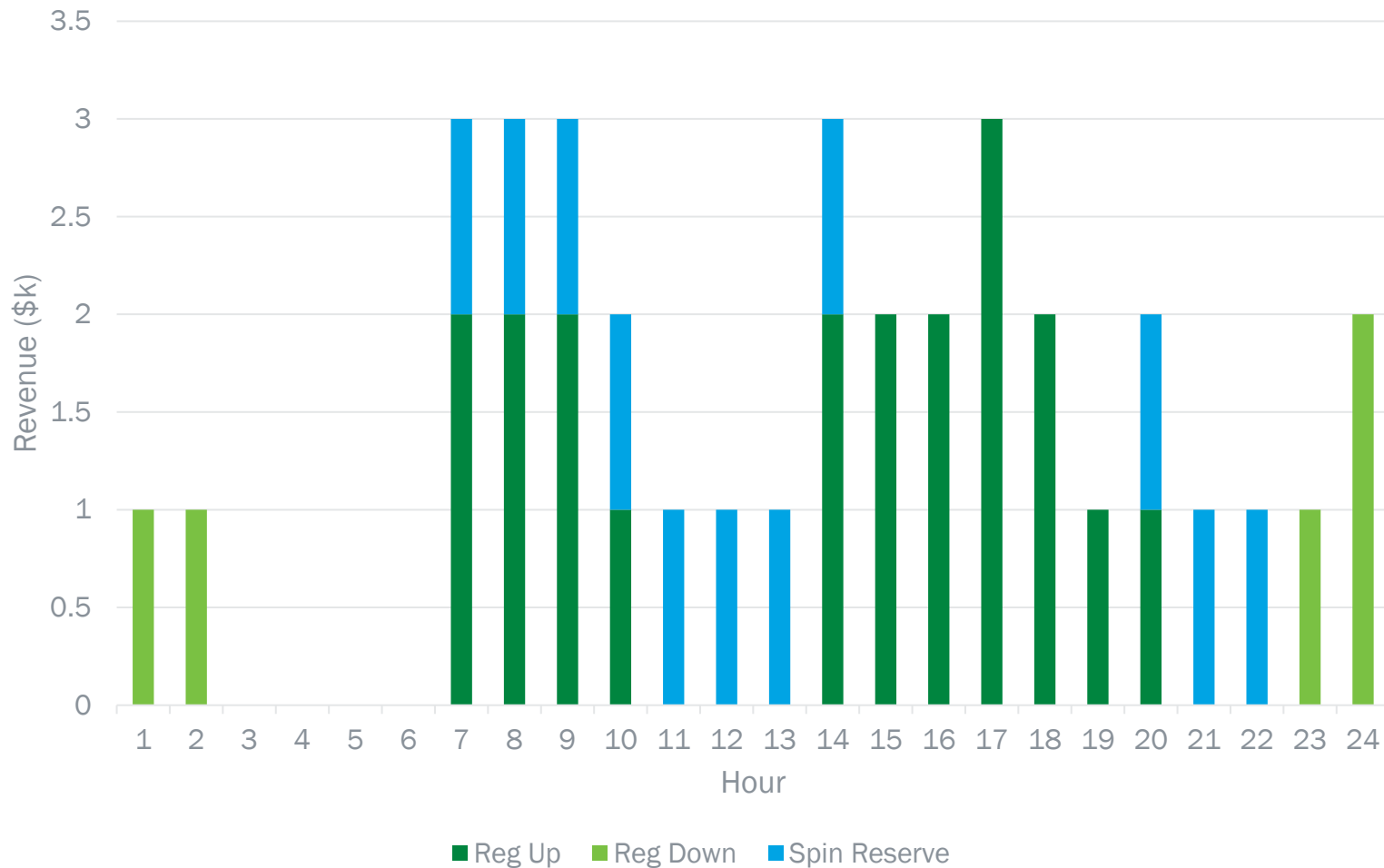
1/1/2023

End

1/2/2023

Ancillary Services

Total Ancillary Services Revenue



↓ All Hydro

- Reg Up
- Reg Down
- Spinning Reserve
- Non-Spinning Reserve

Start

1/1/2023

End

1/2/2023

Thank You!

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