

Pumped Storage under FERC Order 841

**Stakeholder Presentation
Ameren, Consumers, and DTE**

August 21, 2018

EXECUTIVE SUMMARY

Purpose:

- Share market experience from pumped storage resource owners
- Quantitatively and qualitatively discuss opportunities to further enhance the access and value of existing energy storage resources (ESRs) and future ESRs to the market through MISO's 841 straw proposal

Key Takeaways:

- \$4.9M of annual production cost savings may be realized through enhancing 5 offer parameters for existing ESRs and could increase value of future ESRs
- MISO's optimization process should change from a \$/MW offer for ESRs and consider an efficiency factor or price spread to ensure maximum utilization of an ESR no matter the market
- Managing state of charge (SOC) hourly is very important for ESRs to manage reliability and anticipated future day markets
- Capabilities vary with SOC for ESRs and may lead to expectations not being met if not properly modeled
- Transition times or start-up/notification times between charge/discharge will allow pumped storage to participate in Continuous Mode, in both DA and RT markets, providing MISO much more flexibility with these resources and may help with ESRs providing multiple services and modeling physical limitations
- Managing the daily maximum starts for charge and discharge may help manage equipment life and will increase reliability by modeling physical unit characteristics

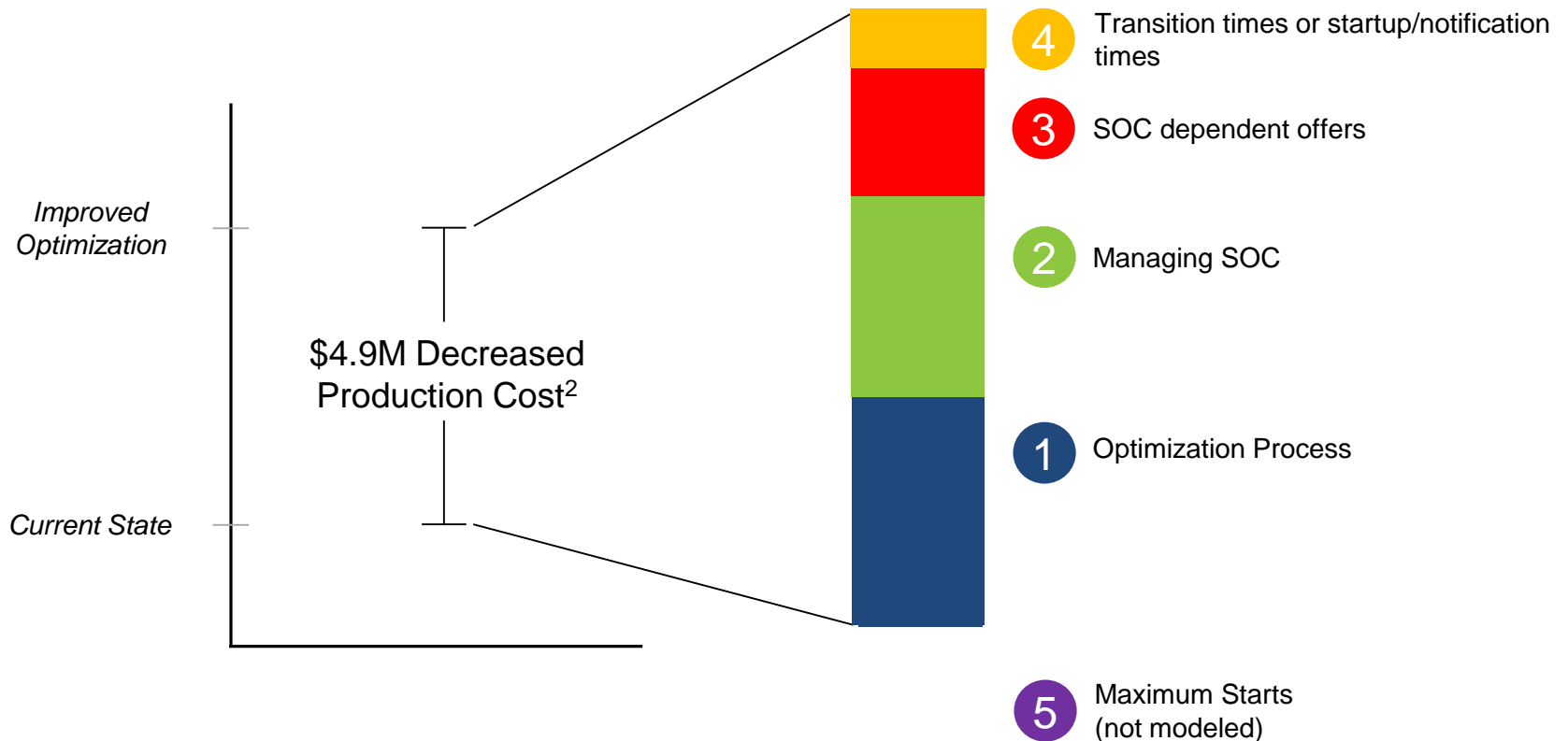
DTE completed two studies:

1 – Increased value from “Ideal optimization”¹, while still respecting physical unit constraints

2 – Value for each proposed additional parameter, determined by adding and removing that parameter in the model and normalizing

Study 1

Study 2



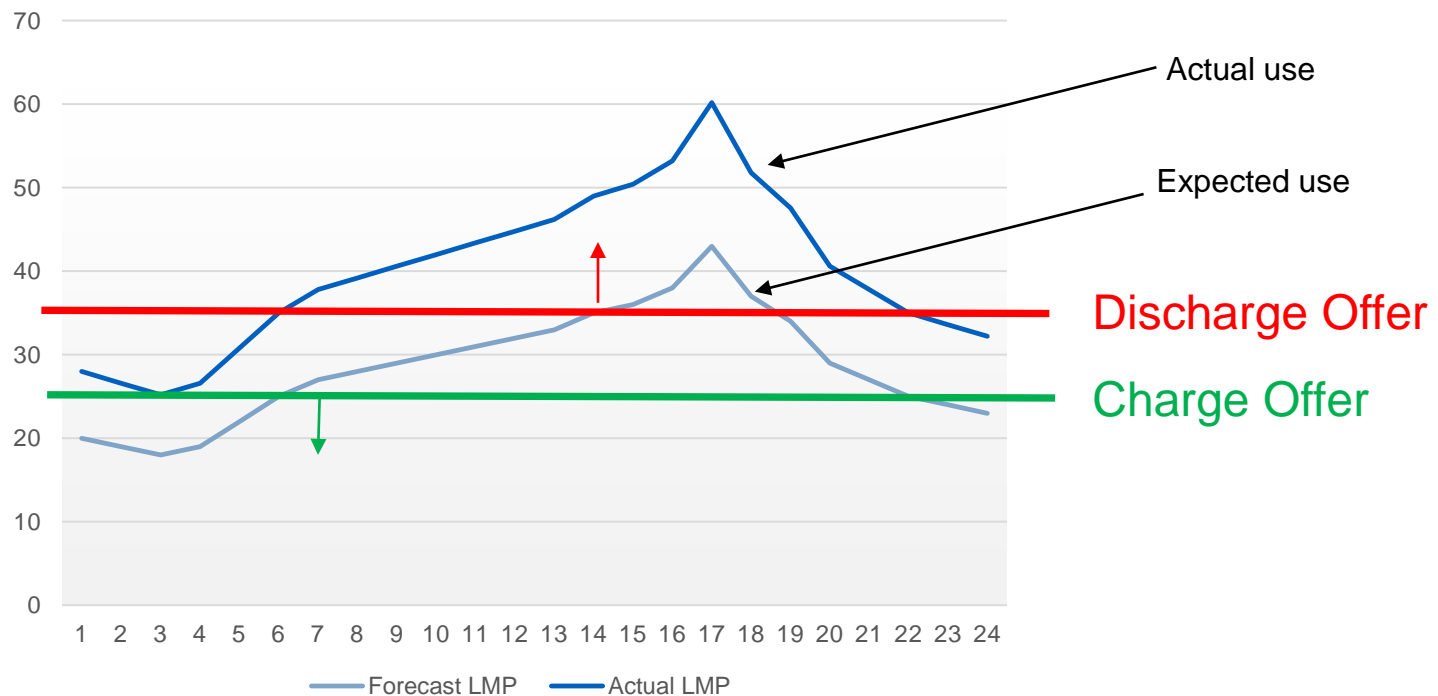
1. Results of internal DTE analysis, assuming perfect optimization (i.e., using actual MISO DA LMPs in place of OD + 1 forecast) within modeled unit constraints. Per MW savings of improved optimization applied to total MISO pumped storage volume

2. Does not include additional benefits of operator visibility into pumping cycles and resulting improvement in reliability

Prioritized Straw Proposal Additions

- 1 Optimization processes
- 2 Managing SOC
- 3 SOC dependent offers
- 4 Transition times or start-up/notification times
- 5 Maximum starts

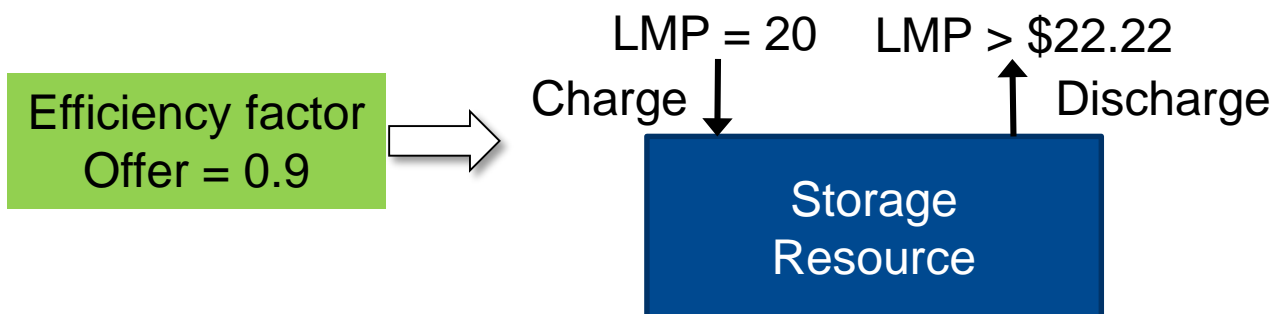
Offering a \$/MW for your charge/discharge cycle assumes you know what the market will be for the next day and if you are wrong, requires suboptimal RT decisions by MP to recover the SOC otherwise there may be reliability concerns



Optimizing using a \$/MW offer may miss opportunity for an ESR and worst case, impact reliability

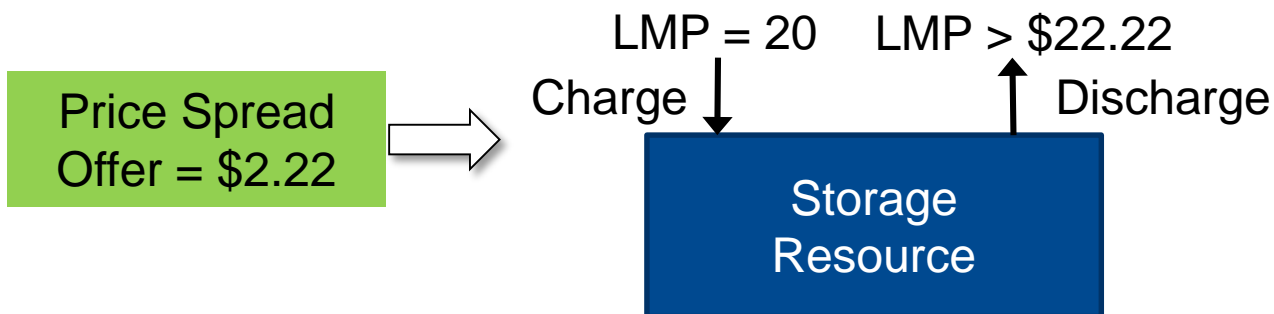
Preferred Alternatives:

1. Offer an hourly efficiency factor



- Offering an efficiency factor opposed to offering a \$/MW threshold ensures maximum utilization of an ESR no matter the market

2. Offer a hourly price spread



- Offering a price spread ensures utilization of an ESR if prices diverge by more than the price spread

Questions?

1 Optimization processes

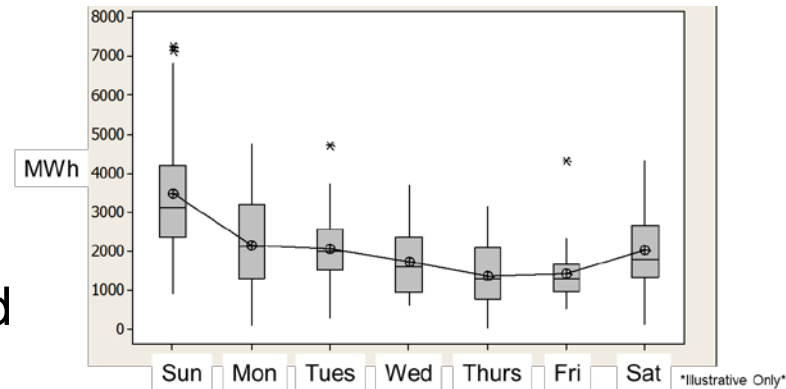
- How does the optimization engine solve without a classic \$/MW offer?
- What if ESRs are large enough to move the market up or down depending on charge/discharge cycle?

Whether you are a pumped storage, battery or something else, managing your SOC is important and could vary based on future market prices

Preferred Alternatives:

1. Offer Continuous Mode DA, vary min SOC hourly, and enable RT offers to change modes (charge/discharge/offline) depending on DA schedule
2. Offer a Charge MWh and Discharge MWh separately in DA (MWh volume offered/bid for DA similar to how energy limited resource offers are made today), and enable RT offers to change modes (charge/discharge/offline) depending on DA schedule

Pumped Storage Example



Questions?

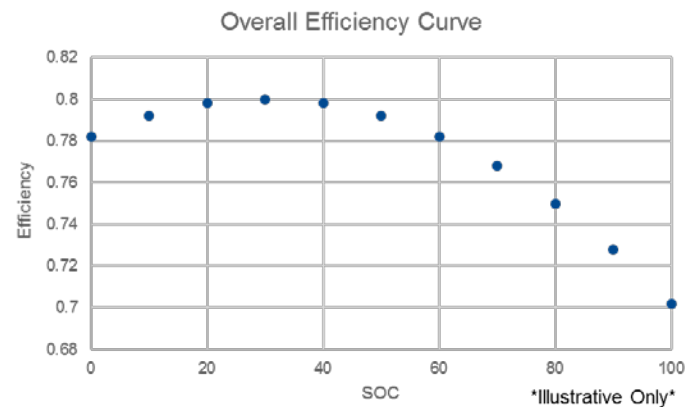
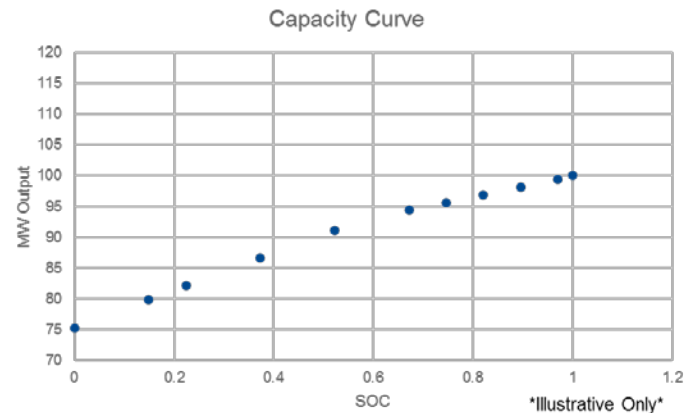
2 Managing State of Charge

- What are the settlement implications for changing offer modes between DA and RT?
- How do we enable the most offer flexibility from these resources without harming them physically and financially?

Maximum limits and efficiency may vary with SOC for ESRs and, if not modeled DA, can lead to expectations not being met

Preferred Alternatives:

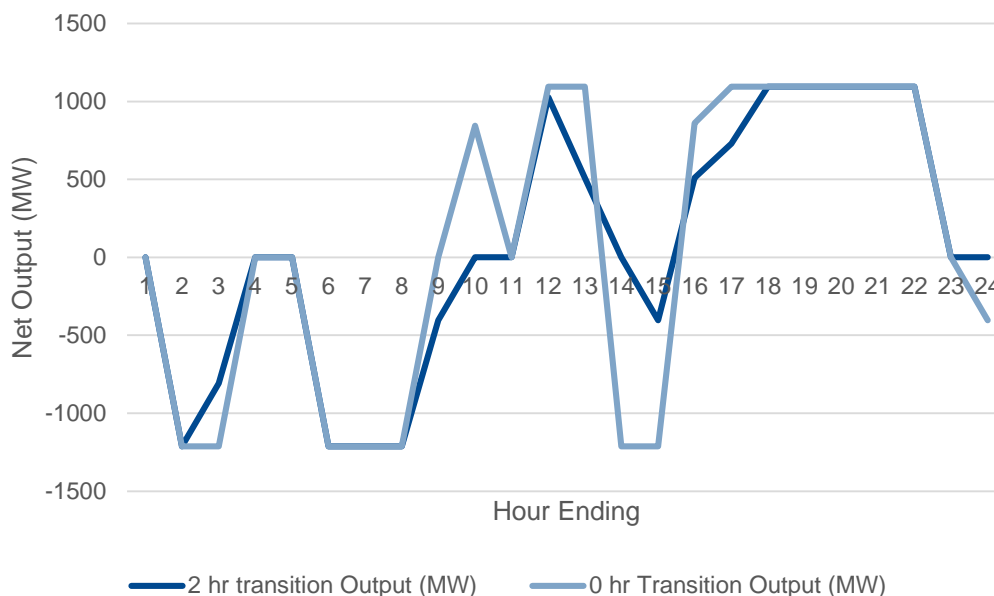
1. Model limits that vary with SOC
2. Model efficiency that vary with SOC



Questions?

- 3 SOC dependent offers
- How much do limits change with SOC and when does it become an issue for MISO?
 - How much does efficiency vary with SOC and how big of an impact is this to an ESR owner?

Allowing an offered transition time between charge/discharge cycle in both DA & RT will allow MISO to fully leverage pumped storage in both markets



If not considered, actual transitions times could impact optimization by
~5%

Questions?

4 Transition times or start-up/notification times

- What if some DA schedules cannot be met due to a resource's transition times?
- How is a transition time different from a start-up time or notification time within the current construct and can this be considered within the ESR construct?
- How might a start-up time or notification time help with ESRs that have bilateral contracts or providing dual or multiple services (i.e. transmission and market services)?

Allowing a maximum # of starts for charge and discharge may help manage equipment life and will increase reliability by modeling physical unit characteristics

**This Offer Parameter
Exists Today**

Through a year long study the maximum starts/day on a DA basis for a charge/discharge was found to be 5

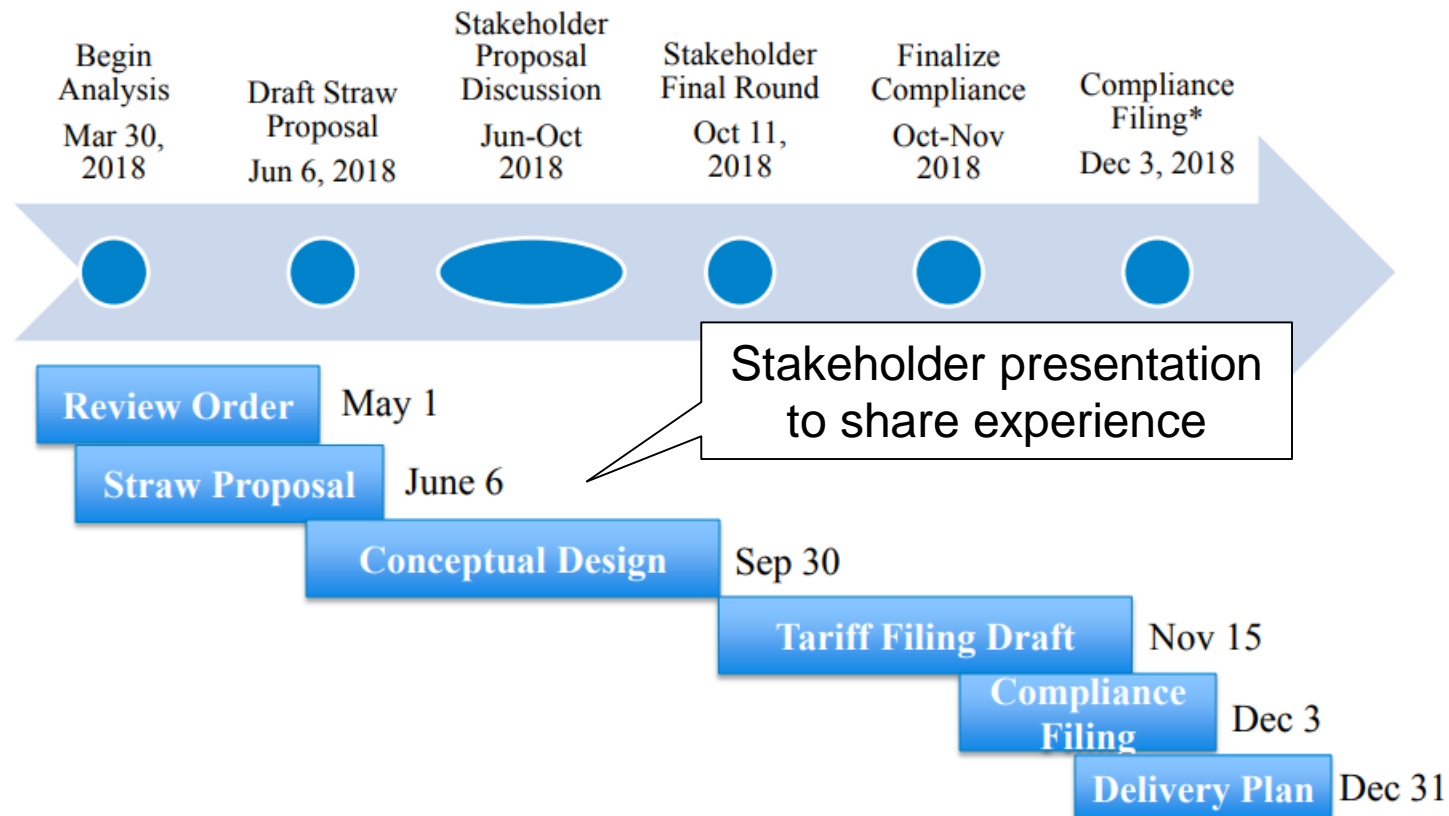
Questions?

5 Maximum starts

- What if some DA schedules cannot be met due to the number of starts?
- How is this different from the current construct and can this be considered within the ESR construct?
- How might having a maximum number of starts help with an ESR's useful life?

What are the next steps to meeting this timeline and how can stakeholders help?

Order 841 Compliance Timeline



APPENDIX

COLLABORATION OF STAKEHOLDERS and MISO

Participating members to date include:

Ameren	Consumers
DTE Energy	

And we welcome more input from others!