



Enhanced Combined Cycle (ECC)

Market Roadmap ID: 2

Issue ID: MR002

Energy Storage Task Force

January 24, 2019



Purpose & Key Takeaways



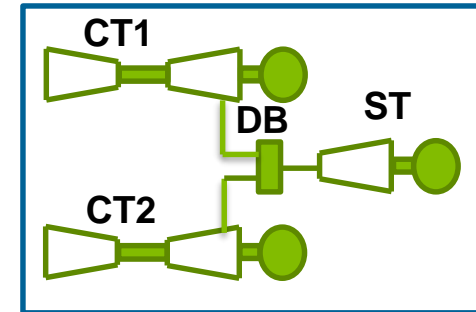
Purpose: Overview of Enhanced Combined Cycle (ECC) model for MISO markets

Key Takeaways:

- Enhanced Combined Cycle (ECC) model for provides expanded capabilities, including **Configurations, Components, and Transitions**
- Future Storage Resources, including Hybrid Resources may be able to leverage ECC capabilities to best operate and optimize assets in MISO's markets

Improved modeling of Combined-Cycle Plants will improve the economics of the MISO markets

- Combined Cycle (CC) plants
 - Multiple physical **Components**
 - Multiple **Configurations**: 1X1, 2X1, 2X1-DB,...
 - Steam Turbine (ST) outputs depends on exhaust heat from Combustion Turbines (CT)
- Current Offers limited to aggregate or individual unit level
- It is difficult to develop aggregate offers and unit parameters that accurately reflect costs and operating characteristics over the entire operating range, including **Transitions**



Issues with Current Aggregate Modeling

- Certain physical characteristics and operating limits of CC plants are not modeled, including:
 - Transition times/costs between configurations, e.g. 1x1 to 2x1
 - Temporal constraints of individual components, such as min-run times of a Steam Turbine or a Combustion Turbine
 - Production costs and operating parameters such as ramp rates can vary significantly for different configurations
- Market Participants must modify their offers, including not offer the actual capabilities/costs of their plants to mitigate operational and financial risks, leading to market inefficiencies

ECC Model Key Features

- Enhanced CCGT modeling will accommodate multiple **Configurations**, distinct **Component** operating characteristics, and **Transition** parameters
- Enhanced model initially allows unit owners to offer up to seven (7) different **Configurations** of the CTs, STs, and other **Components**

Valid Configurations	Physical Units				
	CT1	CT2	CT3	DB	ST
Alloff					
1X1-A	1				1
1X1-B		1			1
2X1	1	1			1
2X1-DB	1	1		1	1
3X1	1	1	1		1
3X1-DB	1	1	1	1	1

	Alloff	1X1-A	1X1-B	2X1	2X1-DB	3X1	3X1-DB
Alloff	±	valid	valid	valid	invalid	⋮	
1X1-A	10min/0min/S0	±	invalid	30min/10min/S900	invalid		
1X1-B	10min/0min/S0	invalid	±	30min/10min/S900	invalid		
2X1	10min/0min/S0	10min/10min/S0	10min/10min/S0	±	10min/0min/S50		
2X1-DB	invalid	invalid	invalid	10min/10min/S0	±		
3X1						
3X1-DB						

Participants can register multiple configurations and specify offers based on actual costs/limits

- Three levels of offer parameters modelled under ECC
 - Resource level
 - Configuration level
 - Component level

Initially allow up to seven (7) configurations

	AllOff	1X1-A	1X1-B	2X1	2X1-DB	3X1	3X1-DB
AllOff	⊥	valid	valid	valid	invalid		
1X1-A	10min/0min/\$0	⊥	invalid	30min/10min/\$900	invalid		
1X1-B	10min/0min/\$0	invalid	⊥	30min/10min/\$900	invalid		
2X1	10min/0min/\$0	10min/10min/\$0	10min/10min/\$0	⊥	10min/0min/\$50		
2X1-DB	invalid	invalid	invalid	10min/10min/\$0	⊥		
3X1							
3X1-DB							

Valid Configurations	Physical Units Usable Capacity			
	CT1	CT2	DB	ST
AllOff				
1Bx0		100		
0x1				50
1x1A	100			80
1x1A-DB	100		On	120
2x1	100	100		200
2x1-DB	100	100	On	250

Configuration name	when start from allOff				
	COLDSTARTUPCOST	INTERSTARTUPCOST	HOTSTARTUPCOST	HOTTOCOLDTIME(h)	HOTTOINTERTIME(h)
1X1-A	1500	1000	500	10	4
1X1-B	1500	1000	500	10	4
2X1	2500	2000	700	12	6
2X1-DB	N/A (invalid to start from AllOff)				
3X1	3500	3000	900	12	6
3X1-DB	N/A (invalid to start from AllOff)				
AllOff					

INDIVIDUAL UNIT NAME	MINDOWNTIME (h)	MINUPTIME (h)	MAXRUNTIME (h)
CT1	8	5	N/A
CT2	8	5	N/A
CT3	8	5	N/A
ST	12	10	N/A
DB	2	2	N/A

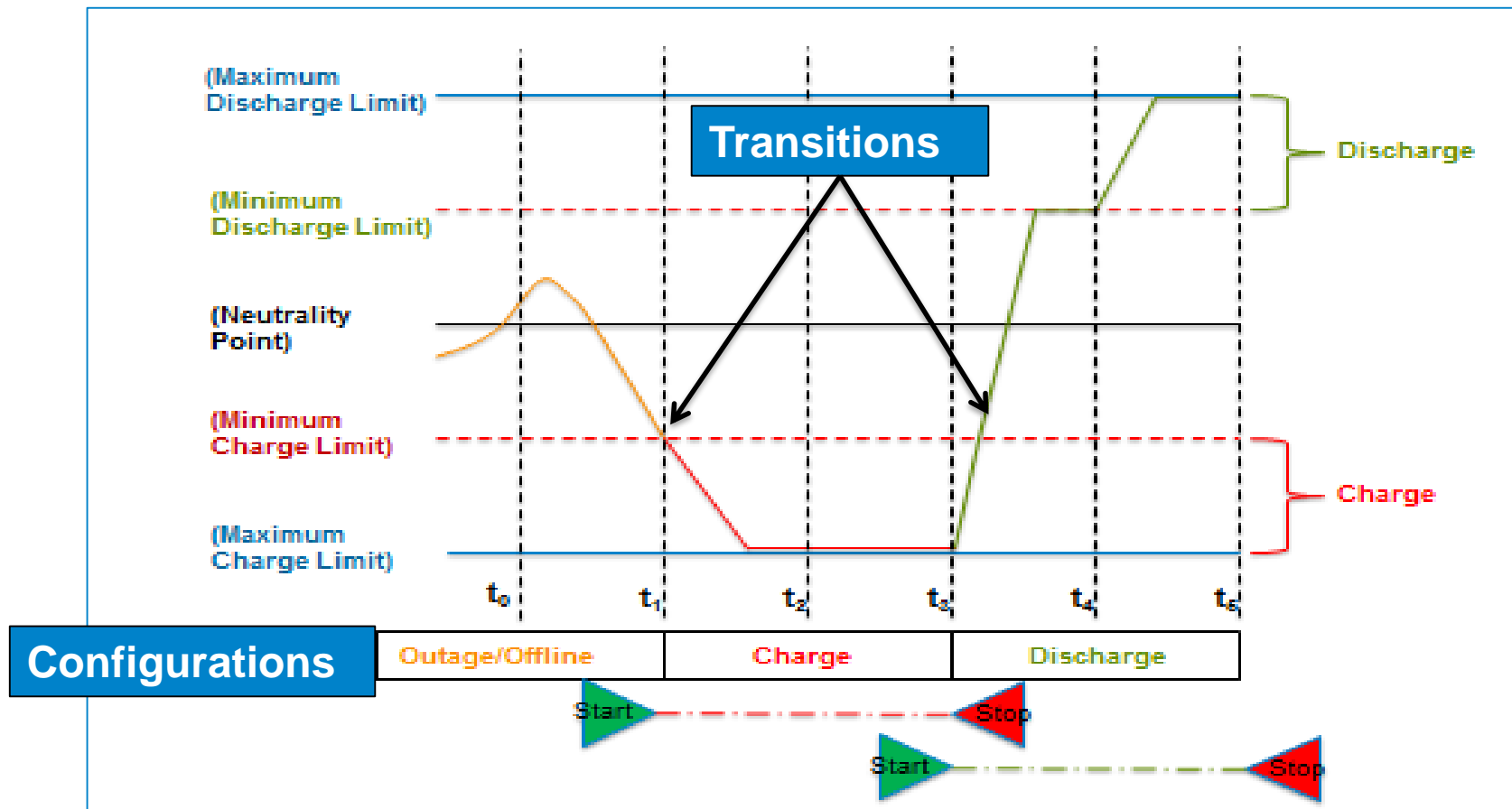
Additional ECC Modeling Features

- Hybrid model includes parameters on the plant, configuration and component levels
- Component substitution allowed
- Reserve disqualification during transitions
- Real-time (e.g. IRAC, LAC) may adjust DA-committed configuration
- Settlement Rules have been extended to consider more complex ECC operation

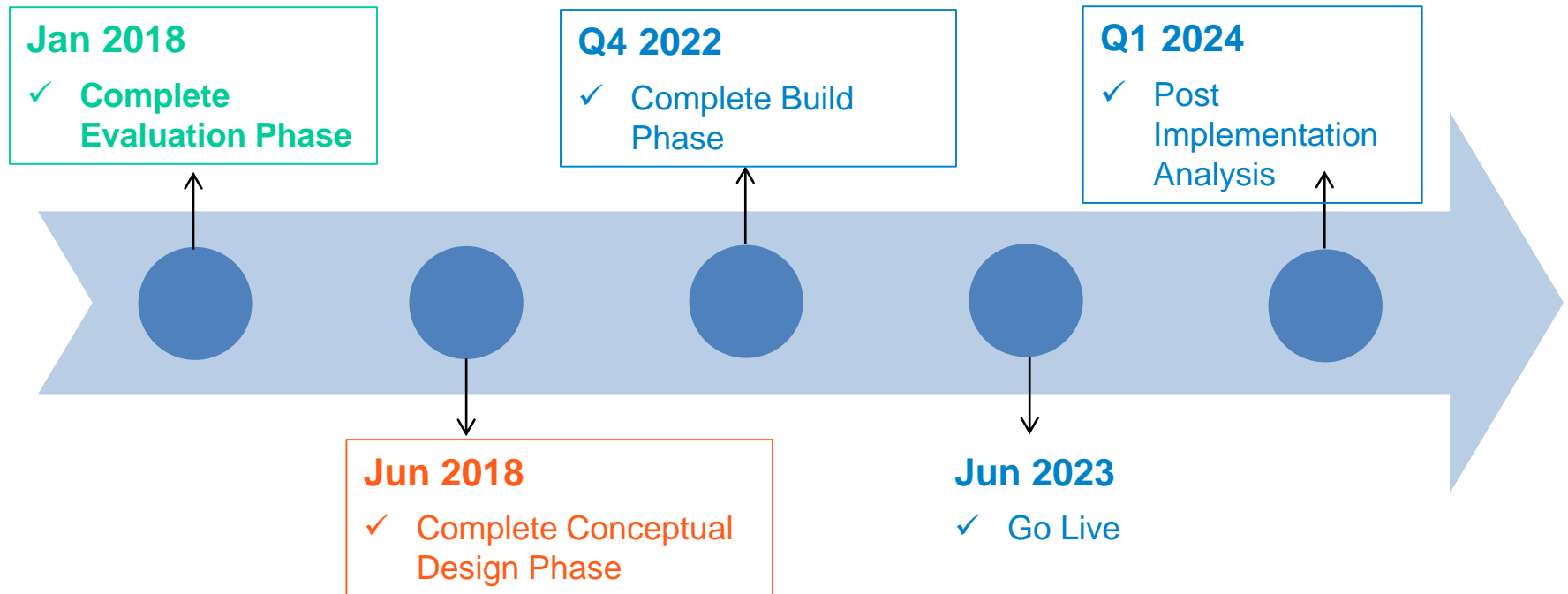
Applicability to Storage or Hybrid Resources

- Model Configurations for Charge, Discharge and Continuous modes
- Model Renewable, Storage Components for Hybrid Resources
- Transitions could capture commitment or other availability costs

Applicability to Storage or Hybrid Resources



Project Timeline



See Issues Tracking Tool for further details

<https://www.misoenergy.org/stakeholder-engagement/issue-tracking/enhanced-modeling-of-combined-cycle-generators/>