Impact of Station Service Rates on Start-Up Cost Calculations

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Start-Up Cost Changes Effective June 1, 2023

- For units without a soak process (combustion turbines, reciprocating engines), Start-Up Cost include costs from PJM notification to first breaker close and from last breaker open to shutdown (Status Quo).
- For units with a soak process (steam, combined cycle, nuclear) Start-Up Cost include costs from PJM notification to dispatchable output and from last breaker open to shutdown.

M15 Section 2.4.1 Start-Up Cost Equation

$$Start-upCost\ (\$/Start) =$$

$$[StartFuel\ (MMBtu/(Start))*TotalFuelRelatedCost(\$/MMBtu)*PerformanceFactor]$$

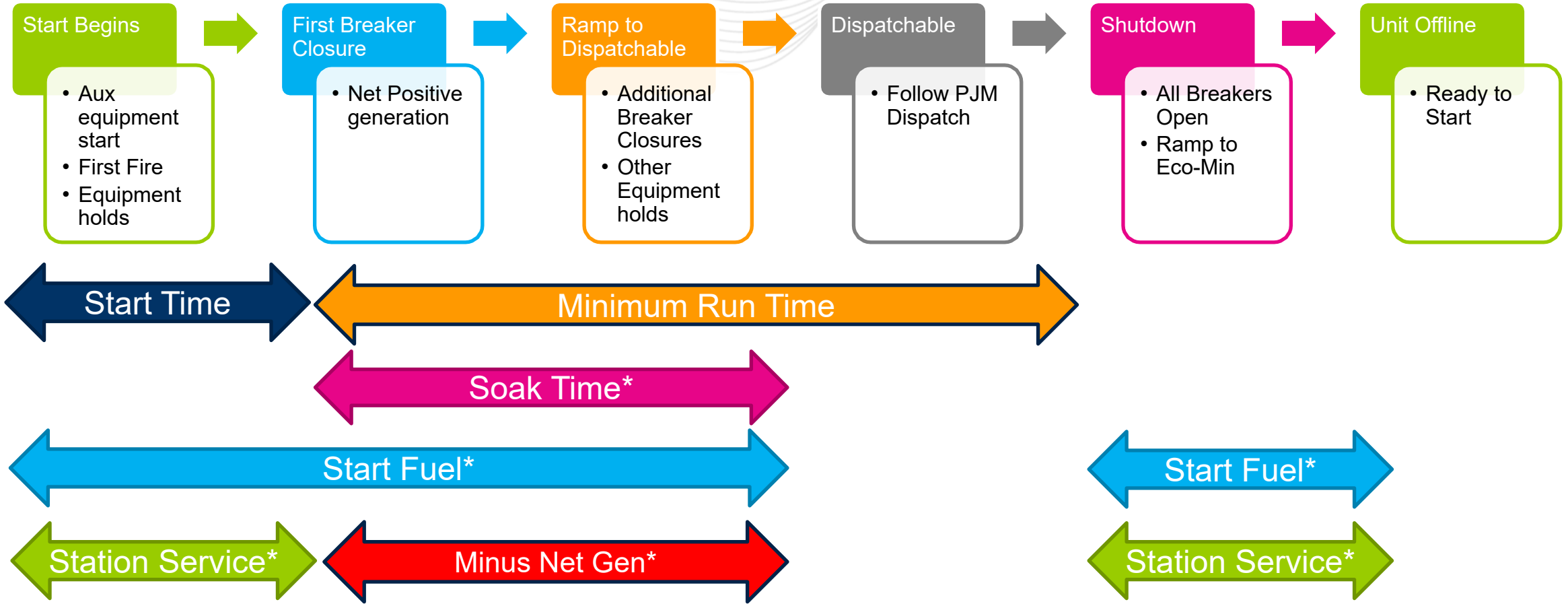
$$+[StationService(MWh)*StationServiceRate(\$/MWh)] + StartMaintenanceAdder(\$/Start)\ \cdot$$

Where

$$TotalFuelRelatedCosts =$$

$$FuelCosts + SO_2\,AllowanceCost + CO_2\,AllowanceCost + NO_x\,AllowanceCost + MaintenanceAdder + OperatingCostAdder$$

Generic Unit with Soak Process



* Duration limited to unit specific start and soak time or M15 defaults

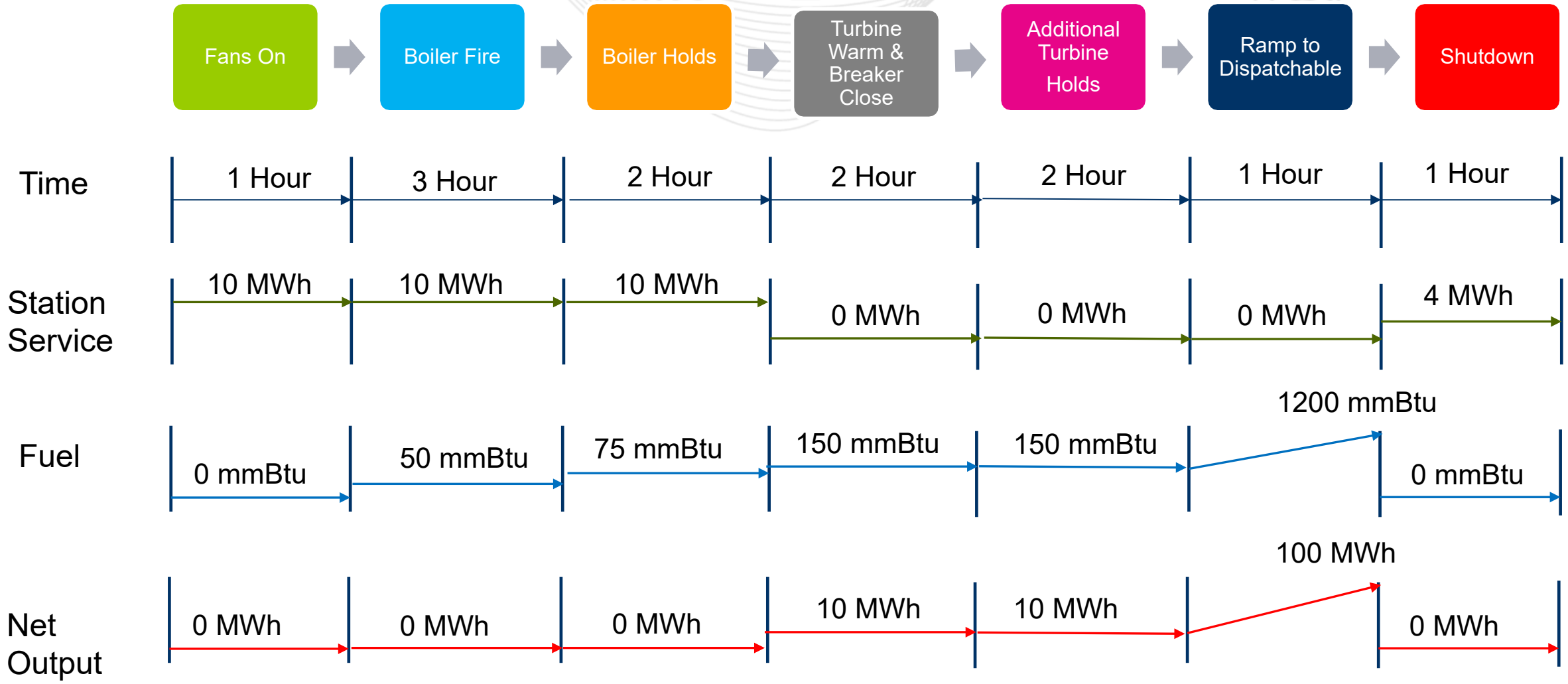
Start-up Cost Calculation Comparison

- Start-Up Costs were calculated for a Steam Unit and a Combined Cycle Unit using both a 12 Month Station Service Average and a 3 Month Station Service Average
- PJM is demonstrating this calculation to show the impact of a change in the Station Service Rate on the Start-Up calculation. It does not indicate that PJM favors a 3 Month Average over a 12 Month Average

Steam Unit Start-Up Example – 12 Month Average

- 100 MW Steam Unit
- Fuel Cost = $4/mmBtu
- Performance Factor = 1.02
- Allowance Cost = $0.10/mmBtu
- Maintenance Adder = $0.25/mmBtu
- Operating Cost Adder = $0.05/mmBtu
- Station Service Rate = $55.84/MWh (12 Month Average)
- Unit Specific Start Time = 8 Hour
- Unit Specific Soak Time = 3 Hour

Steam Unit Start-Up Example



Steam Unit Start-Up Example

- Total Fuel Related Cost = $4/mmBtu + $0.10/mmBtu + $0.25/mmBtu + $0.05/mmBtu = $4.40/mmBtu

- Start Fuel = (50mmBtu/hr * 3 hr) + (75mmBtu/hr * 2 hr) + (150mmBtu/hr * 2 hr) + (150mmBtu/hr * 2 hr) + (1200mmBtu/hr * 1 hr) + (0mmBtu/hr * 1 hr) = 2,100mmBtu

- Station Service = (10 MWh * 1 hr) + (10MWh * 3 hr) + (10MWh * 2 hr) - (10MWh * 2 hr) - (10MWh * 2 hr) - (100MWh * 1 hr) + (4MWh * 1 hr) = -76 MWh

Steam Unit Start-Up Example - 12 Month Average

$$Start-upCost\ (\$/Start) =$$
$$[StartFuel\ (MMBtu/(Start))*TotalFuelRelatedCost(\$/MMBtu)*PerformanceFactor]$$
$$+[StationService(MWh)*StationServiceRate(\$/MWh)] + StartMaintenanceAdder(\$/Start)\ .$$

- Start-Up Cost = (2,100mmBtu * $4.40/mmBtu * 1.02)
  + (-76 MWh * $55.84/MWh)
  + $0/Start
  = $5,180.96/Start

Steam Unit Start-Up Example – 3 Month Average

- 100 MW Steam Unit
- Fuel Cost = $4/mmBtu
- Performance Factor = 1.02
- Allowance Cost = $0.10/mmBtu
- Maintenance Adder = $0.25/mmBtu
- Operating Cost Adder = $0.05/mmBtu
- Station Service Rate = $24.04/MWh (2023 Q3 3 Month Average)
- Unit Specific Start Time = 8 Hour
- Unit Specific Soak Time = 3 Hour

Steam Unit Start-Up Example – 3 Month Average

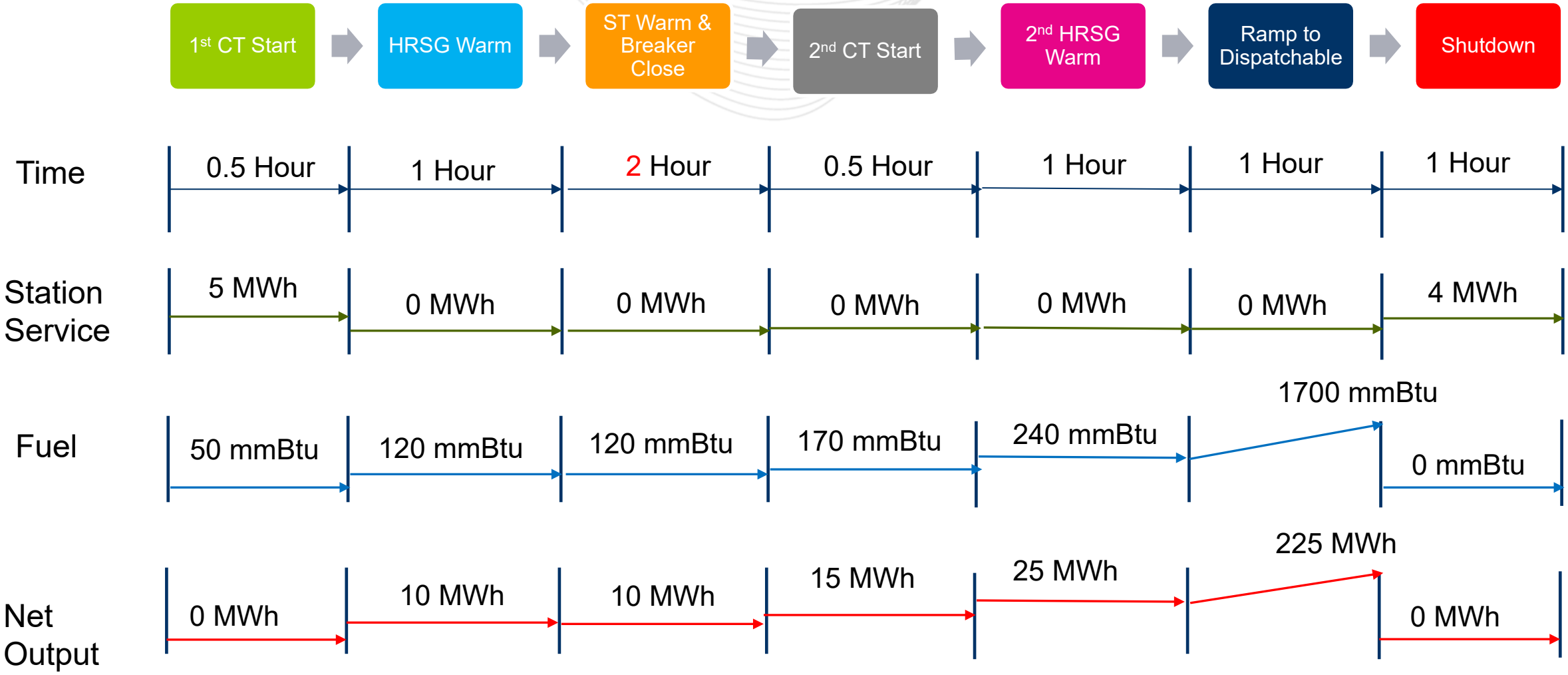
$$Start-upCost\ (\$/Start) =$$
$$[StartFuel\ (MMBtu/(Start))*TotalFuelRelatedCost(\$/MMBtu)*PerformanceFactor]$$
$$+[StationService(MWh)*StationServiceRate(\$/MWh)] + StartMaintenanceAdder(\$/Start)\ .$$

- Start-Up Cost = (2,100mmBtu * $4.40/mmBtu * 1.02)
  + (-76 MWh * $24.04/MWh)
  + $0/Start
  = $7,597.76/Start

Combined Cycle Unit Start-Up Example – 12 Month Average

- 2 X1 Combined Cycle
- (2) 100 MW CTs
- 100 MW ST
- Fuel Cost = $4.00
- Performance Factor = 1.20
- Allowance Cost = $0.10/mmBtu
- Maintenance Adder = $2000/CT/Start
- Station Service Rate = $55.84/MWh (12 Month Average)
- Unit Specific Start Time = 0.5 Hour
- Unit Specific Soak Time = 4.5 Hours

Combined Cycle Unit Start-Up Example



Combined Cycle Unit Start-Up Example

- Total Fuel Related Cost = $4/mmBtu + $0.10/mmBtu
  = $4.10/mmBtu

- Start Fuel = (50mmBtu/hr * 0.5 hr) + (120mmBtu/hr * 1 hr) + (120mmBtu/hr * 1 hr) + (170mmBtu/hr * 0.5 hr) + (240mmBtu/hr * 1 hr) + (1700mmBtu/hr * 1 hr) + (0mmBtu/hr * 1 hr)
  = 2,290mmBtu

- Station Service = (5 MWh * 0.5 hr) - (10MWh * 1 hr) - (10MWh * 1 hr) - (15MWh * 0.5 hr) - (25MWh * 2 hr) - (225MWh * 1 hr) + (4MWh * 1 hr) = -271 MWh

Combined Cycle Unit Start-Up Example – 12 Month Average

$$Start-upCost\ (\$/Start) =$$
$$[StartFuel\ (MMBtu/(Start))*TotalFuelRelatedCost(\$/MMBtu)*PerformanceFactor]$$
$$+[StationService(MWh)*StationServiceRate(\$/MWh)] + StartMaintenanceAdder(\$/Start)\ .$$

- Start-Up Cost = (2,290mmBtu * $4.10/mmBtu * 1.02)
  + (-271 MWh * $55.84/MWh)
  + ($2000/Start * 2 Starts)
  = $-1,555.86/Start

  Since Start-Up Cost cannot be less than zero
  = $0/Start

Combined Cycle Unit Start-Up Example – 3 Month Average

- 2 X1 Combined Cycle
- (2) 100 MW CTs
- 100 MW ST
- Fuel Cost = $4.00
- Performance Factor = 1.20
- Allowance Cost = $0.10/mmBtu
- Maintenance Adder = $2000/CT/Start
- Station Service Rate = $24.04/MWh (2023 Q3 3 Month Average)
- Unit Specific Start Time = 0.5 Hour
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Combined Cycle Unit Start-Up Example – 3 Month Average

$$Start-upCost\ (\$/Start) =$$
$$[StartFuel\ (MMBtu/(Start))*TotalFuelRelatedCost(\$/MMBtu)*PerformanceFactor]$$
$$+[StationService(MWh)*StationServiceRate(\$/MWh)] + StartMaintenanceAdder(\$/Start)\ .$$

- Start-Up Cost = (2,290mmBtu * $4.10/mmBtu * 1.02)
  + (-271 MWh * $24.04/MWh)
  + ($2000/Start * 2 Starts)
  = $7,061.94/Start

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