Calpine Experience with Combined Cycle Plants in a Formal Market

Background

- Calpine currently operates CC plants in ERCOT, CAISO, PJM, ISO NE
- Various types of CC trains: 1x1, 2x1, 3x1, 4x1
- Some plants have host loads: Steam and Electricity
- Plants are expected to operate under AGC

Key Modeling Concepts

- Areas to Model
  - Real-time economic dispatch
  - Reactive capabilities
  - Day ahead, week ahead Unit Commitment
    - Desire to capture actual operating performance and costs (start-up and shutdown for example)
    - This is critical because not doing so will create unintended consequences
  - Load flow and state estimation studies in real-time and long term study cases
- Key concepts to consider at all points in time
  - Capture how the train operates
    - Transitions from between states: 1x1 to 2x1 and visa versa
    - Power augmentation, where it is deployed in the heat rate curve
    - Cost curve and start-up and shut down costs
    - Time required to change a configuration
    - Ramp rate

Topics for Today

- Real-time dispatch
- Unit Commitment
- Telemetry

Real-Time Dispatch

- The key difference between a CC train from a boiler fired plant is the CC train has a independent unit(s) and dependent unit, the Steam Turbine (ST)
- A CC train can easily support ramping as the sum of 3% of each CT name plate rating.
  - I recommend against include any ramping from the ST
- Incremental Heat Rate:
  - Pick the model you feel works for you, the goal to generate a specific MW at the lowest possible costs
  - Love the term steam adjusted heat-rate, but “buyer be ware”
- Must operate as instructed and the best way tends to follow the KISS principle

Real-time Dispatch Con't Model for a 2x1 Train

A Simple 2x1 train has the following five operating configurations:

- 1a x 0, 1b x 0, 1a x 1, 1b x 1, 2 x 1
  - The ST cannot operate on its own
  - And 2 x 0 is just an extension or restatement of two simple cycle states
- Each operating state has is own unique operating limits, ramp rates, and other characteristics.
- It is a simple calculation in the EMS to determine which configuration the train is in.
  - The calculation looks at Generation breakers and unit gross MW.
- Power Augmentation
  - Must be addressed iand must tie to the actual economic decision in the day ahead

Real-time Dispatch Con't
AGC

- CC train runs on AGC when online
  - Even with Host loads: steam and electricity
  - Ramp Rate is sum of CT name plant times 0.03
  - MW Set Point sent to plant works very well but the old stand by raise/lower pulse will work
    - Typically get NET from the ISO but the value sent to Train DCS must align to its control value: Gross or net. Plant can receive one or the other and convert as needed
    - If plant wants Gross and ISO sends Net figure out the logic to provide a Gross Desired MW value
    - Make sure you have the proper telemetry to support
- Power Augmentation and AGC
- I recommend one set point for each train at the plant, this works for all configs with only exception
- Never assume "that will never happen".

Real-time Dispatch Con't misc topics

Key CC plant operating features that must be addressed:

- Temp Control
  - Get the telemetry
  - understand what it means its impact is and what your response must be
- Base Load
  - Temperature dependent, 5-10 degree change in temps from forecast can leave MWs unutilized.
  - Look into telemetry
- Power Augmentation
  - Get the telemetry
  - Your dispatch decision must align with how the plant and augmentation is offered and this all falls back to how you model.
  - Your model is the model till you change it in the model your submit
  - You must be consistence in the decision process in the engagement of Power Augmentation. Training and engagement is critical
  - Can you power augment and provide AGC?

Real-time Dispatch Con't
Key Quantities

- CC Train/Plant Net MW and Mvar – this is typically measured at the Point of interconnection, the Revenue meters
    - CC Train can have one or more interconnect meter
    - CC train can have interconnections at two different voltage levels
- CC Train/Plant Gross MW and MVAR – typically on the low side and not a revenue quality meter or transducer
- Other points in the data set
  - Unit AVR, PSS, Gen Breaker, Pseudo Gen Breaker
  - Plant breakers and switches
  - Plant Fuel Oil volumes
- Need to perform calcs in EMS when you have to provide by unit MW and Mvar on the a Net and Gross basis

Unit Commitment

This is a very important area

- You must have the ability to offer the plant in the way your are going to operate and then offer
  - Transition between operating state
  - Ramp Rate
  - Min up and down times and for transitions
- Lot of exotic ideas but in the end the true constraint is what the plant can actually do
- Automation helps with UC awards, other wise get several good egg timers

Telemetry

- You will need to get data from
  - Train DCS
  - Revenue meters
  - Gas suppliers
  - TO RTUs
- Don’t ignore or forget EMS quality codes
- have standards and adhere to the standards
- Have EMS polls rates and 2 seconds or faster
- Have remote data collection gateway poll faster

Telemetry (Con't)

A set of calculations will need to be made in the EMS.

- Don't assume the IT EMS team knows what to do, be engaged, create and enforce a process for YOUR calculations
- Have a document readily available that has info on the calculations and if needed the actual telemetry
- Have displays built to help with
  - loss of telemetry (manual overrides)
  - Reactive testing
  - Calculation overview

Telemetry (Con’t)

Remember what your “books” are:

- AGC/Dispatch
- Transmission Support
- Capacity Testing
- Reactive testing

Questions