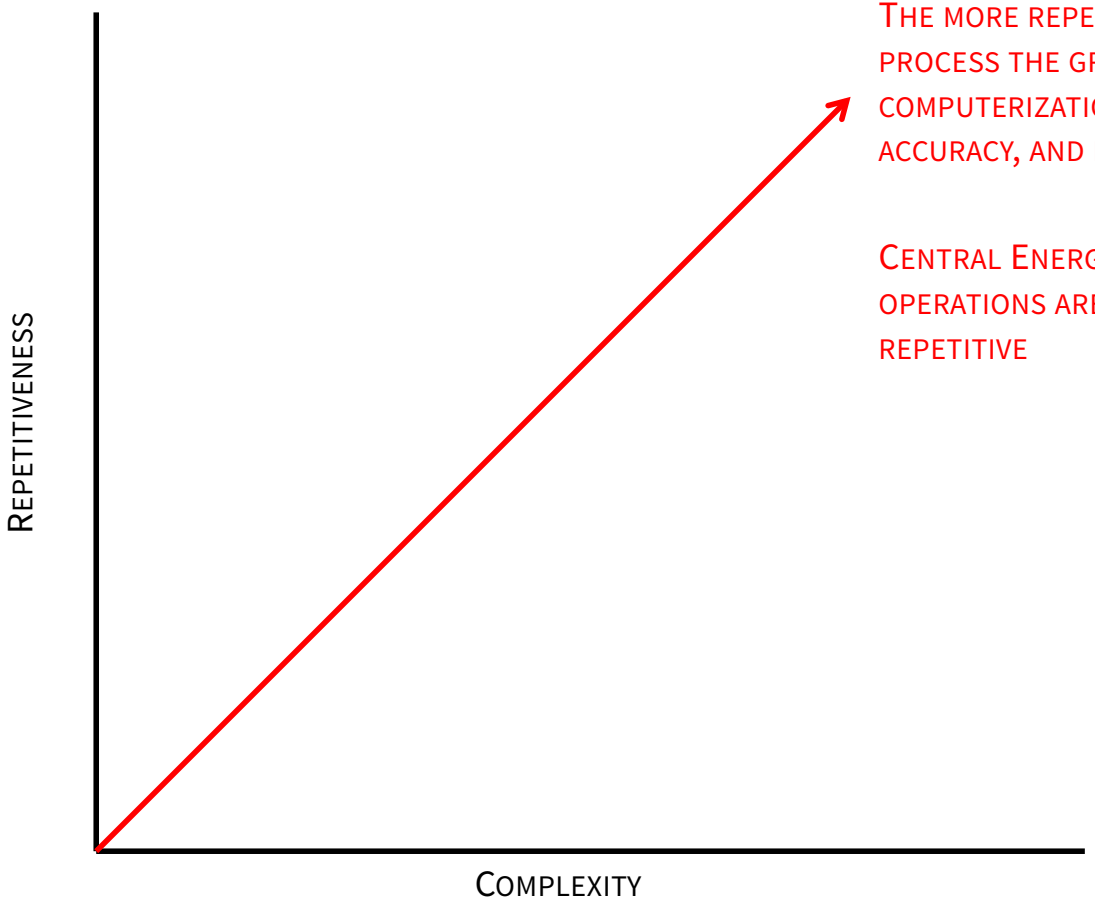
Stanford Energy System Innovations (SESI)

Central Energy Plant Optimization Model

Department of Sustainability & Energy Management

1/17/13

When to Computerize a Process



The more repetitive and/or complex a process the greater the need for computerization for reliability, accuracy, and efficiency

Central Energy Facility (CEF) operations are complex and highly repetitive

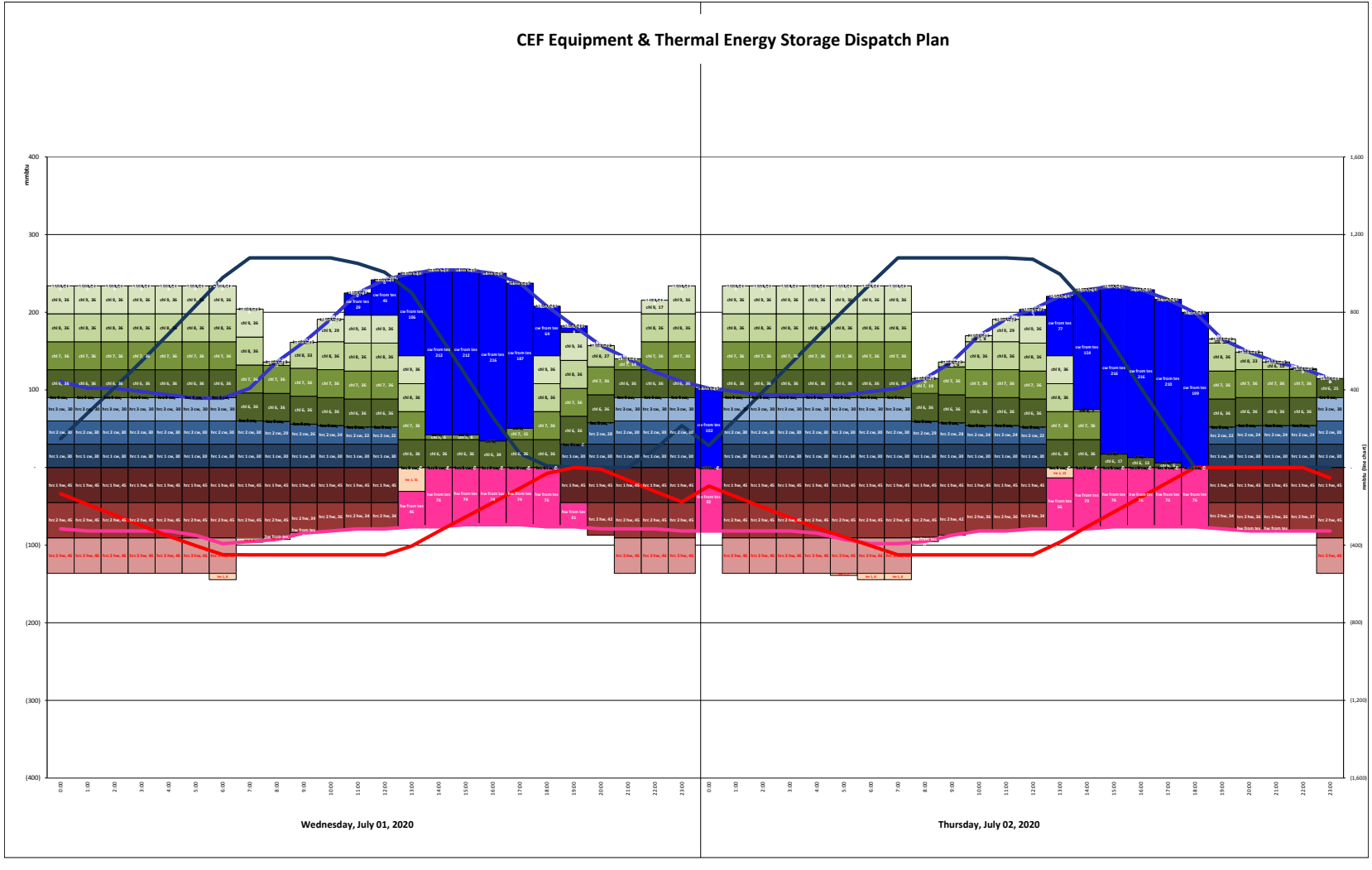
CEPOM computerized tools for modeling, designing, operating, and verifying performance efficiency for Central Energy Facilities

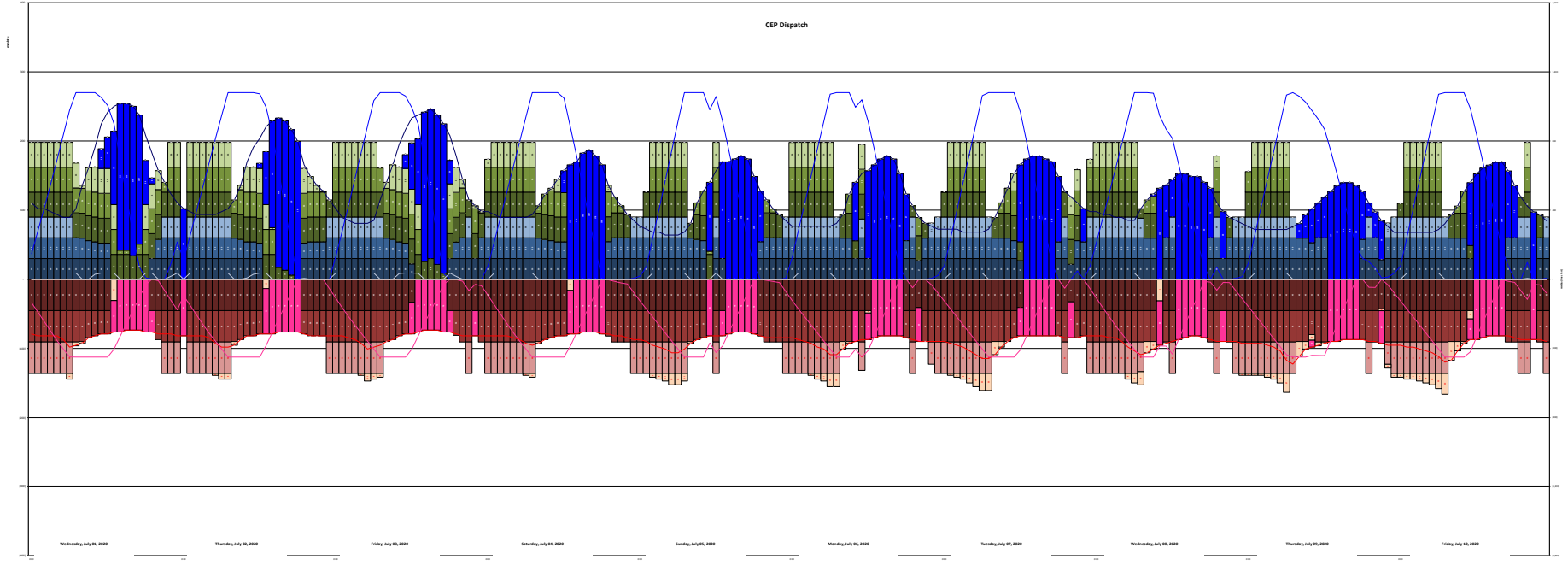
- Predictive analysis:
  - What will loads on the CEF be on an hourly basis over the next 10 days?
  - What will the hourly prices for electricity, natural gas, or other fuels be over those same forward looking 240 hours?
  - What equipment will be available at the CEF each hour over the next 10 days and what is the respective capacity and efficiency of each?
  - If there is hot or cold Thermal Energy Storage (TES) available how much is in storage at the beginning of the period, what is the maximum and minimum storage capacity of the tanks, and how much can be charged or discharged from each every hour?
  - Given these things, what is the optimal CEF hourly dispatch plan over the next 240 hours?
- CEPOM returns the optimal CEF dispatch plan and presents it in tabular and graphical formats
- It can also be used to operate the plant autonomously (autopilot) by continuously rerunning the dispatch optimization process to provide for constant minor course corrections as weather/load forecasts change; equipment availabilities change; energy prices change; etc.

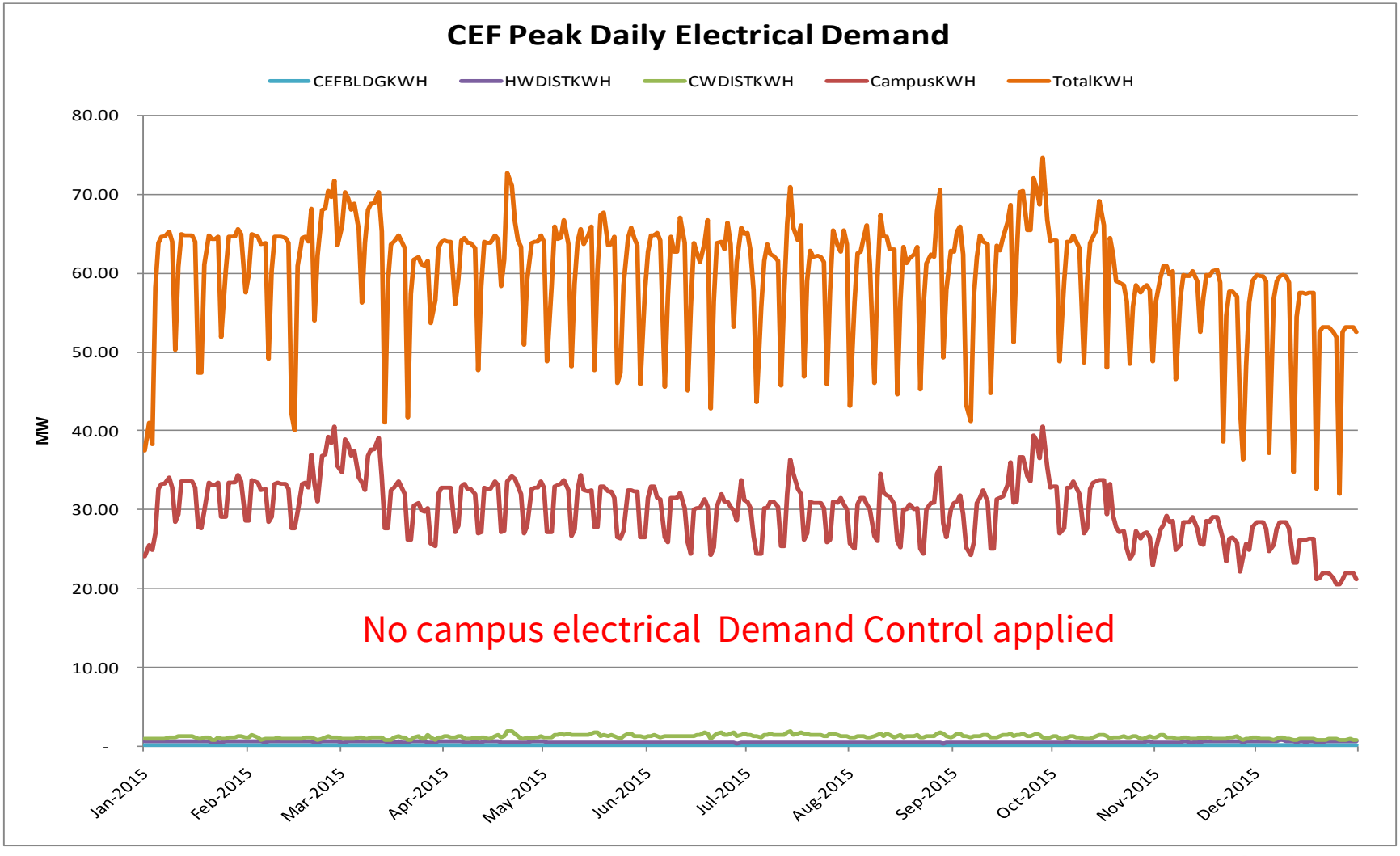
CEPOM for Planning and Design of CEF changes or new CEF

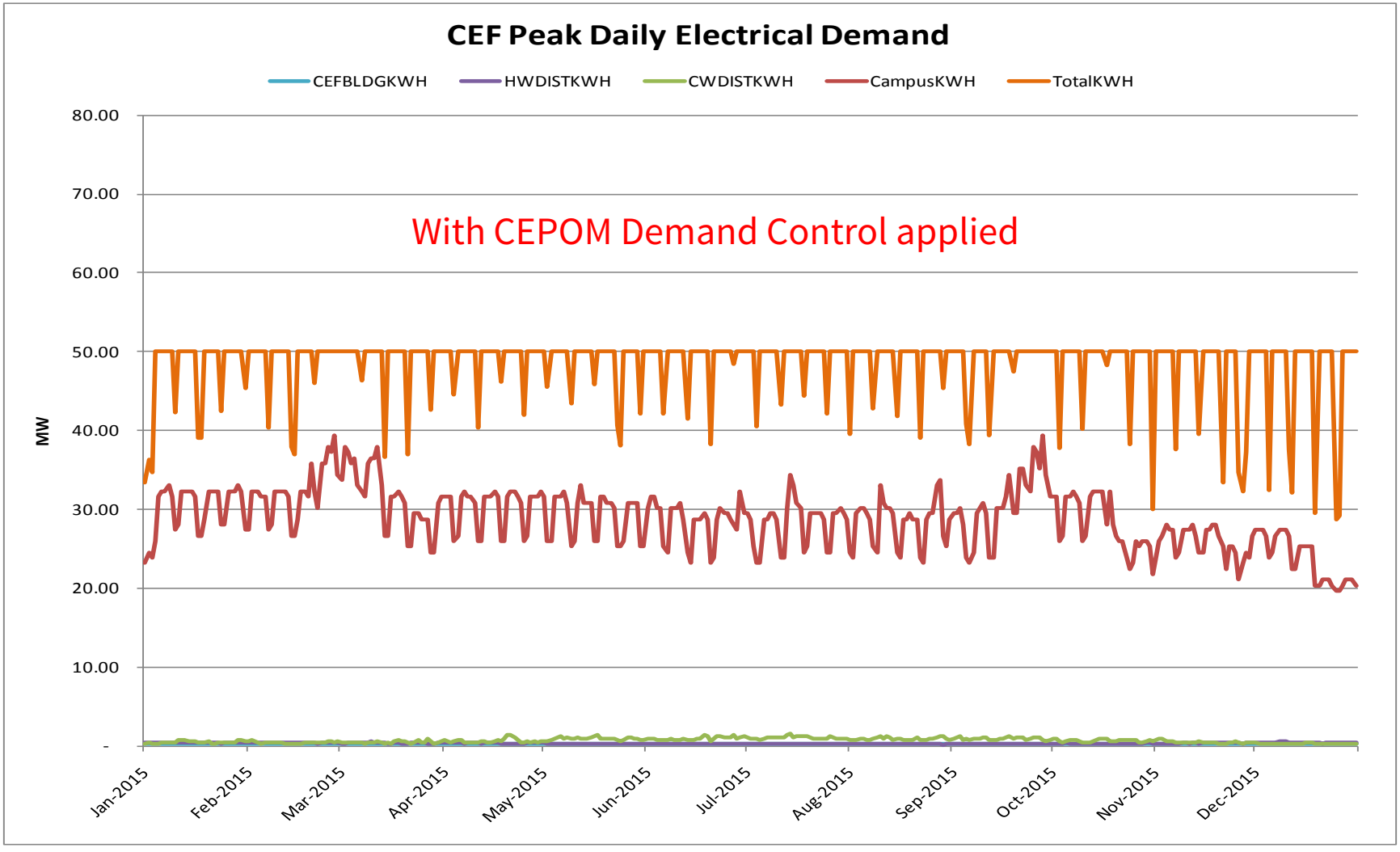
- Run 10 day look ahead Predictive Analysis for entire year
  - Input a full year (8760 hours) of estimated hourly electrical, heating, and cooling loads
  - Input data on existing and/or proposed new equipment and/or thermal energy storage
  - Input data on forecast hourly electricity, gas, or other fuel energy prices
  - Run CEPOM to see how the plant would operate to meet those loads; see if any loads could not be met by the equipment proposed and if so how much shortfall there would be at what precise hours; see the totals for each type of energy consumed to meet those loads and the total costs of each, GHG emissions, and water use.
- Repeat process above for however many combinations of new or existing equipment mixes are to be tested to optimize plant design; repeat process for future years (min 30 years at 5 year increments suggested) to optimize plant design over its life.
- CEPOM can also be used for electrical Demand Control and Demand Response
  - A total campus electricity demand limiter can be applied in increments as small as 1 hour and CEPOM will dispatch the CEF to stay within those limits
- The following charts are examples of the graphical and tabular output of the optimal CEF dispatch plan for a specific scenario, followed by an example of how CEPOM can manage campus electrical demand

CEF Equipment & Thermal Energy Storage Dispatch Plan




CEP Dispatch
Wednesday, July 01, 2020
Thursday, July 02, 2020
Friday, July 03, 2020
Saturday, July 04, 2020
Sunday, July 05, 2020
Monday, July 06, 2020
Tuesday, July 07, 2020
Wednesday, July 08, 2020
Thursday, July 09, 2020
Friday, July 10, 2020


CEF Peak Daily Electrical Demand
CEFBLDGKWH
HWDISTKWH
CWDISTKWH
CampusKWH
TotalKWH
MW
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
-
Jan-2015
Feb-2015
Mar-2015
Apr-2015
May-2015
Jun-2015
Jul-2015
Aug-2015
Sep-2015
Oct-2015
Nov-2015
Dec-2015
No campus electrical Demand Control applied


CEF Peak Daily Electrical Demand
CEFBLDGKWH
HWDISTKWH
CWDISTKWH
CampusKWH
TotalKWH
With CEPOM Demand Control applied
MW
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
-
Jan-2015
Feb-2015
Mar-2015
Apr-2015
May-2015
Jun-2015
Jul-2015
Aug-2015
Sep-2015
Oct-2015
Nov-2015
Dec-2015