Continuous API plant for Building 70, Development Pures Facility:

Combined energy target (Electricity + Steam)

Summary

This report details an energy consumption target for the future operation of the DPF building, including a continuous API plant to be installed within. The results are as follows, with backing calculations throughout pages 2-3 and an error discussion in page 4:

Total steam target of **87.6MWh/month or 1.051GWh/annum**

Total electricity target of **36.3MWh/month or 435.6MWh/annum**

Total combined energy target of **123.9MWh/month or 1.487GWh/annum**

This accounts for the building services (HVAC) base load, the process load for the one batch line already in DPF and finally, the estimated process load for the continuous API plant.

The following measures are recommendations that should be explored during concept design, to help meet or improve upon this target:

- Steam metering for DPF/Building 70 to be investigated and fixed
- Huber units to be optimised with possibility of heat recovery
- Downflow booths; maximise percentage recirculation
- HVAC control and demand response, investigate heat recovery options
- Sub-metering strategy to increase visibility of process loads

Methodology

As the plant is to be installed in an existing building, historical data from energy meters in building 70 were used as the basis for most of the energy estimate. This approach was taken as the processing loads were observed to be a relatively small proportion of the total building energy consumption. The steam and heating loads were estimated and calculated using data from the adjacent buildings 71/72 and adjusted for DPF because the metered steam data for building 70 was found to be infeasibly small and incomplete. All energy figures were obtained from eSight Energy and process uptime taken retrospectively from DSM manufacturing plans.

Data

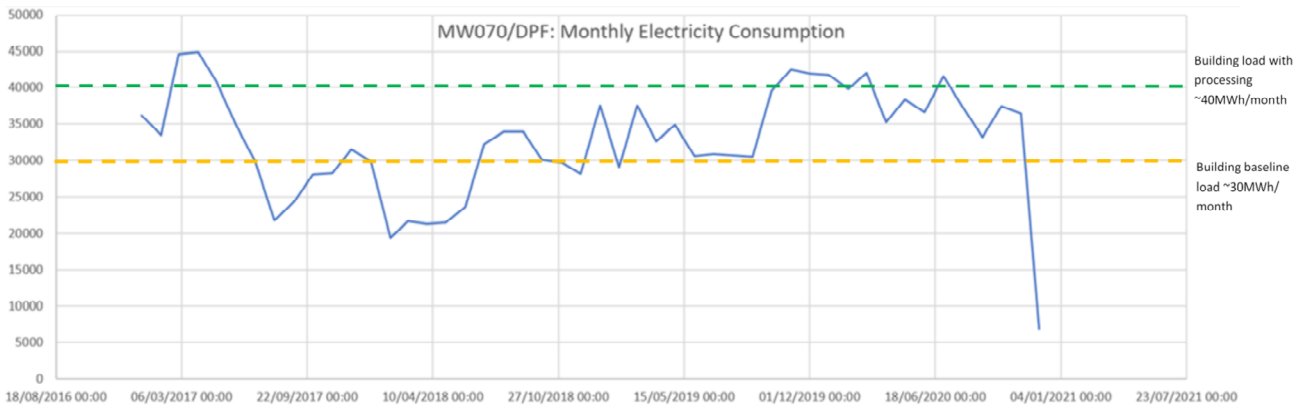

Figure 1: Building 070/DPF -> Electrical Consumption 2017-2020

Electricity:

Building 070, when processing, seems to use ~40MWh/month and ~30MWh/month when not processing, as indicated in Figure 1. The processing load appears to be ~10MWh/month. This can be attributed to the one process line which has operated in DPF since 2017. The peaks in electrical load are shown to roughly coincide with periods of process uptime, as shown below:

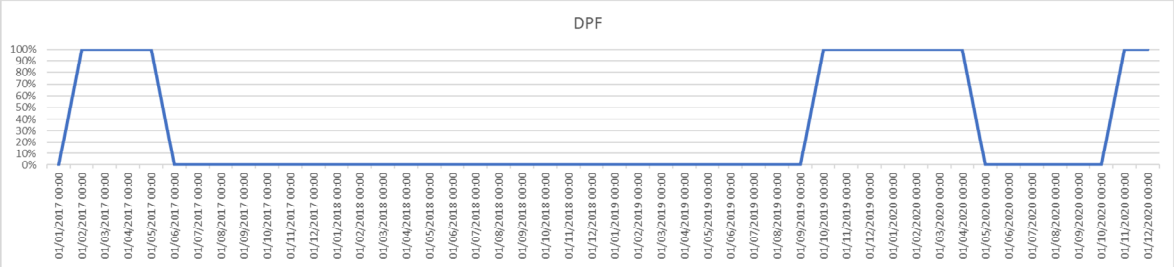

Figure 2: Building 070/DPF -> Process uptime 2017-2020

If we expect to reduce the background electrical load by 20% = 0.8 x 30 MWh/month,

-> Target background electrical load for Building 070 = 24MWh/month

If the existing (batch) process line continues to operate at 10MWh/month and we assume the electrical load in the new (continuous) production line is 50% more efficient

->Target process electrical load for API plant = 5MWh/month

Total building electrical consumption when lines are running = (24MWh/month) + (10MWh/month) + (5MWh/month) = 39MWh/month

Total building electrical consumption when lines are not running = 24MWh/month = background building load, as previously established.

If we take the mean average of these two values (39 vs 24 MWh/month) = 31.5 MWh/month which we propose as the target. This is equivalent to 378MWh/annum.

NB: The monthly average for DPF over the past 4 years has been 33MWh/month = 396MWh/annum. The target, going forward, is therefore lower than historical use, even though there will be 2 lines running rather than 1. This is because the suggested reduction to the building background load is greater than the additional load anticipated from the API plant (process load is relatively small compared to total building load).

Steam/Heat:

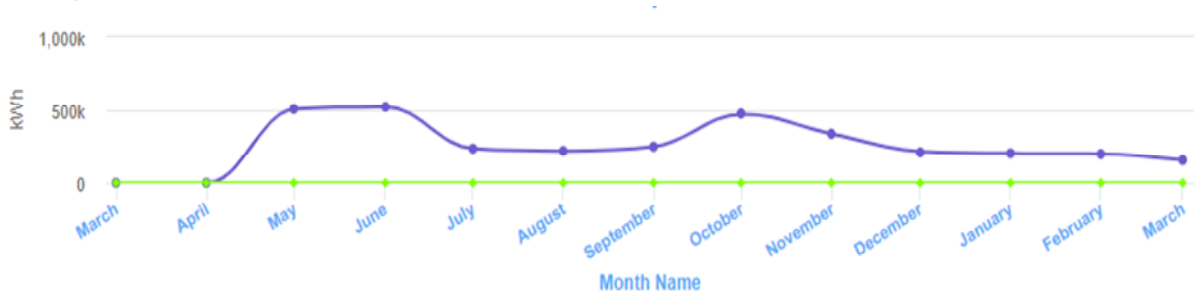

Figure 3: Building 071/DA1 -> Steam Consumption throughout 2020

Building 70 (DPF) steam metering has extremely low figures so it is suspected that the metering may not be reading correctly. Data has therefore been used from DA1/Building 71 and divided into the fraction assumed to be equivalent to DPF. Using the steam figure for Building 71 (DA1) above:

Consumption steps from 250MWh/month (for 75% of the months) to 500MWh/month (25% of months). Load peaks seem as likely to be in summer as winter, so it is assumed that the majority of load is process load – the HVAC background winter load seems to be <250MWh/month.

This steam serves 4 lines across 2 buildings (DSP1, DSP2, DSP3 and DSP4)

Average steam use across the year= 313MWh/month for all 4 lines

Therefore, for 2 lines, the average steam load is 157MWh/month

Say 20% of this is for HVAC = 31.4MWh/month (of which we expect to save 20%)

Therefore the likely building services steam load for 2 lines in DPF = 0.8 x 31.4 = 24.8MWh/month

The remaining 80% (of 157MWh/month) is attributable to the process load of the 2 lines, once the HVAC is accounted for. Half again, is representative of the process load of one batch plant,

Therefore, the likely process steam load for the existing plant in DPF = 62.8MWh/month

The breakdown of the components of the total heating load, is as follows:

Existing batch processing steam heating load = 62.8MWh/month

The likely HVAC steam load of both the continuous plant and the batch plant, together in DPF, is 24.8MWh/month

Continuous processing steam heating load = 0, as no steam is used in the continuous API process

However, the API process still has a heating load (electrical) derived from the presence of 5 Huber units @ 10kW, assumed to operate 8 hours/day for 12 days/month = 50kWh x 8 x 12 = 4.8MWh/month

The estimated combined heating load for DPF is therefore 62.8 + 24.8 + 4.8 = 92.4MWh/month

Note that this comprises 87.6MWh of steam and 4.8MWh electricity

Therefore, when combined with the electrical estimations:

Total steam target (Building base load + existing batch load) **= 87.6MWh/month or 1.051GWh/annum**

Total electricity target [(Building base load & existing batch load & pure electrical load for API plant) + API plant heating load] = 31.5 + 4.8 = **36.3MWh/month or 435.6MWh/annum**

Total combined energy target = 87.6 + 36.3 **= 123.9MWh/month or 1.487GWh/annum**

Assumptions and errors

In the electrical calculation a mean average was taken between the load when running and when not running, this indicates a 50/50 split of uptime vs downtime. This is unlikely to be the case and so will need to be revised with information from future DPF production schedules, so the electrical target is reflective of the true ratio of uptime/downtime going forward. Further consideration is also needed as to whether the two process lines will run independently of each other; the current calculation assumes 'uptime' means both lines run together when both could operate independently, the 50/50 ratio will need to be further revised if this is to occur.

Furthermore, the fraction of the future electrical load that is attributed to the continuous API plant is simply 50% of the existing batch load. Though there is good reason to suspect that the continuous process will use less energy than an equivalent batch process (smaller volumes required at any given time to obtain the same weight of product) – it is not known at this time whether this fraction is correct. This will likely only be determined after comparison of both lines in operation. There are also assumptions made about the likely operating cycles and quantity of Huber units (at full power for 8 hours/day for 12 days/month) that need verifying further down the project.

In the steam calculation, the data for DPF fell so short of expectations that data was instead used from the neighbouring DA1 building. The steam data for DA1 was split between the HVAC (assumed proportion of 20%) and its 4 process lines. ¼ of the steam consumption (after the HVAC was subtracted) was assumed to be equivalent to the one process line in DPF. The four process lines of DA1 are therefore considered to be identical to each other and to the one in DPF; this assumption requires closer investigation. This is before considering that the building services steam infrastructure will differ between DA1 and DPF as well.

Additionally, as the steam data was given for the whole DA1 building, it was very complex to correlate the peaks in steam load with the alternating uptime/downtime of each of the four lines. This has been neglected and simplified using the fractions previously discussed. Finally, it is recommended that the steam meters and their data for DPF be investigated; the average monthly consumption between 2017 and 2020 was found to be 190kWh/month which is 0.24% of the monthly consumption of an equivalent process line in DA1.