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School Max Demand Calculator Tool

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September 2024

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Calculating Maximum Demand

- Currently, maximum demand is calculated using watt/meter^2 electrical load estimation method. W/m^2 estimates is given for different area types, heavy loads such as mechanical equipment, lift etc. are added and diversity factor is applied to arrive to a maximum demand figure.
- At early stages of a project, using watt/meter^2 estimates for a building type derived from BSRIA Rules of Thumb (BG9/2011) is widely used in the industry.
- BG9 assumes gas fired heating and hot water, so the loads below are just for power and lighting!

Table 20: Electrical loads for different types of building – continued (W/m^2 gross internal area, unless otherwise stated)

Building type	Rule of Thumb	Comments	Ref
	Electrical load (W/m^2)	These electrical loads cover requirements for lighting, general power and mechanical power for building services systems. Please refer to the glossary for a definition of gross internal area and net internal area	4, 6, 12, 63
Schools – naturally ventilated	35	A figure of 0.35 kW per student can also be employed	
Schools – mechanically ventilated	50	A figure of 0.5 kW per student can also be employed	

Calculating Maximum Demand

- BSRIA Rules of Thumb (BG9/2011) was of course superseded earlier this year by BG86/2024 Electrical Criteria - However, electrical demand guidance for schools remains unchanged
- In a bizarre twist of fate however, these are not far wrong for all-electric schools as we will see

Table 11: Electrical loads (continued)

Building Type	Electrical load	Notes
Schools – naturally ventilated	35 W/m²	A figure of 0.35 kW per student can also be employed.
Schools – mechanically ventilated	50 W/m²	A figure of 0.5 kW per student can also be employed.

Reason for discrepancies

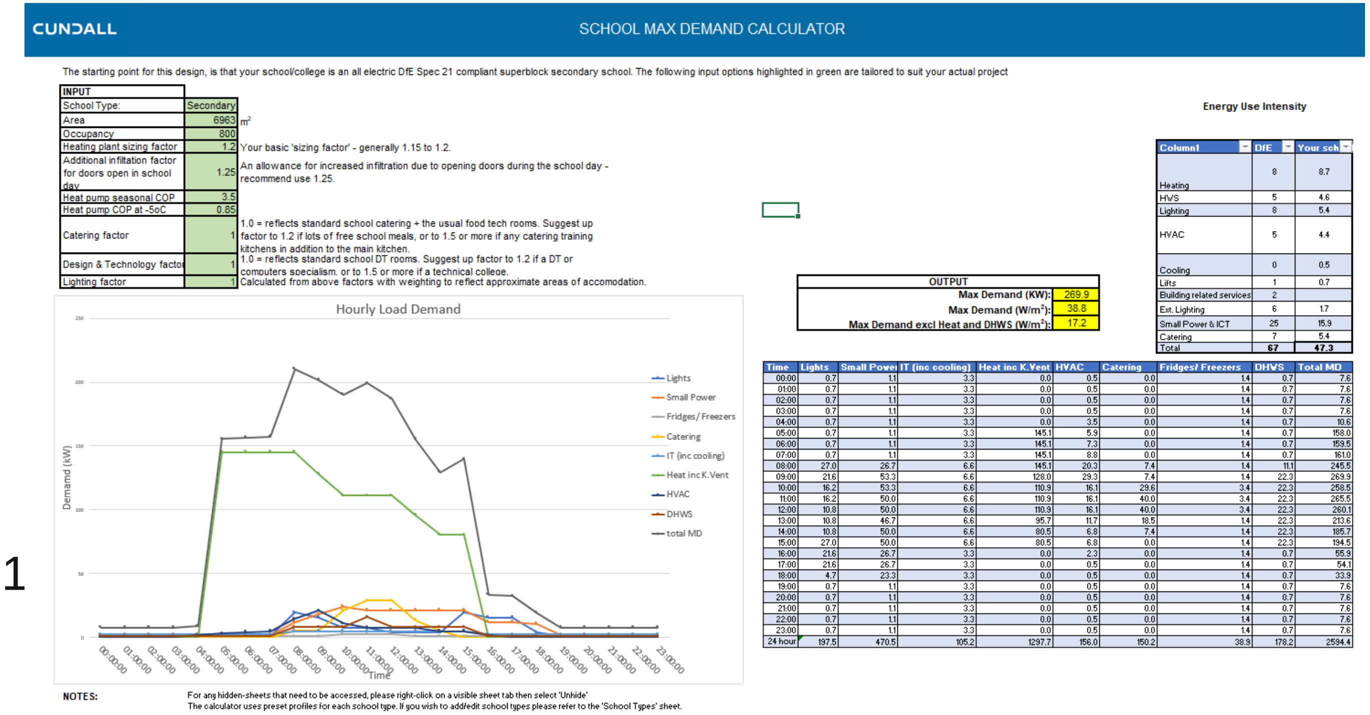
- Oversizing of maximum demand of buildings is prevalent in the industry. It is very common for designer/client to discover real-life energy usage of a building to be lower than calculated during design stage.
- On some TA school schemes we have seen designers suggest that >120W/m2 is required!
- This leads to massive electrical infrastructure requirements, network upgrades, new sub-stations, etc., all of which is likely be totally unnecessary for the scheme.
- Unfortunately, such over-engineering often goes unnoticed and the school ends up paying a lot more for something that they do not need.

Why does this happen?

Because we don't re-visit our previous projects to find out how they really work!

School Max Demand Calculator Tool

- Calculates electrical maximum demand of a proposed school building.
- Implements real-life energy usage of an existing school to produce estimate of future electrical maximum demand.
- Wilsthorpe School was designed by our team under the DFE design framework. Construction was finished in 2018.
- We compiled daily energy usage and maximum demand from energy bills; we went to site in 2021 to measure meter readings to allocate an appropriate split of the energy usage to various services.
- Meter readings were taken during the winter months when the heating load is at its highest.
- We have since then revisited a number of other recently completed schools, including for the West Coventry Academy NZCiO pathfinder scheme.



CUNDALL SCHOOL MAX DEMAND CALCULATOR

The starting point for this design, is that your school/college is an all electric DfE Spec 21 compliant superblock secondary school. The following input options highlighted in green are tailored to suit your actual project

INPUT		
School Type:	Secondary	
Area	6963	m²
Occupancy	800	
Heating plant sizing factor	1.2	Your basic 'sizing factor' - generally 1.15 to 1.2.
Additional infiltation factor for doors open in school day	1.25	An allowance for increased infiltration due to opening doors during the school day - recommend use 1.25.
Heat pump seasonal COP	3.5	
Heat pump COP at -5oC	0.85	
Catering factor	1	1.0 = reflects standard school catering + the usual food tech rooms. Suggest up factor to 1.2 if lots of free school meals, or to 1.5 or more if any catering training kitchens in addition to the main kitchen.
Design & Technology factor	1	1.0 = reflects standard school DT rooms. Suggest up factor to 1.2 if a DT or computers specialism, or to 1.5 or more if a technical college.
Lighting factor	1	Calculated from above factors with weighting to reflect approximate areas of accomodation.

OUTPUT	
Max Demand (KW):	269.9
Max Demand (W/m²):	38.8
Max Demand excl Heat and DHWS (W/m²):	17.2

Energy Use Intensity

Column1	DfE	Your sch
Heating	8	8.7
HWS	5	4.6
Lighting	8	5.4
HVAC	5	4.4
Cooling	0	0.5
Lifts	1	0.7
Building related services	2	
Ext. Lighting	6	1.7
Small Power & ICT	25	15.9
Catering	7	5.4
Total	67	47.3

Time	Lights	Small Power	IT (inc cooling)	Heat inc K.Vent	HVAC	Catering	Fridges/ Freezers	DHWS	Total MD
00:00	0.7	1.1	3.3	0.0	0.5	0.0	1.4	0.7	7.6
01:00	0.7	1.1	3.3	0.0	0.5	0.0	1.4	0.7	7.6
02:00	0.7	1.1	3.3	0.0	0.5	0.0	1.4	0.7	7.6
03:00	0.7	1.1	3.3	0.0	0.5	0.0	1.4	0.7	7.6
04:00	0.7	1.1	3.3	0.0	3.5	0.0	1.4	0.7	10.6
05:00	0.7	1.1	3.3	145.1	5.9	0.0	1.4	0.7	158.0
06:00	0.7	1.1	3.3	145.1	7.3	0.0	1.4	0.7	159.5
07:00	0.7	1.1	3.3	145.1	8.8	0.0	1.4	0.7	161.0
08:00	27.0	26.7	6.6	145.1	20.3	7.4	1.4	11.1	245.5
09:00	21.6	53.3	6.6	128.0	29.3	7.4	1.4	22.3	269.9
10:00	16.2	53.3	6.6	110.9	16.1	29.6	3.4	22.3	258.5
11:00	16.2	50.0	6.6	110.9	16.1	40.0	3.4	22.3	265.5
12:00	10.8	50.0	6.6	110.9	16.1	40.0	3.4	22.3	260.1
13:00	10.8	46.7	6.6	95.7	11.7	18.5	1.4	22.3	213.6
14:00	10.8	50.0	6.6	80.5	6.8	7.4	1.4	22.3	185.7
15:00	27.0	50.0	6.6	80.5	6.8	0.0	1.4	22.3	194.5
16:00	21.6	26.7	3.3	0.0	2.3	0.0	1.4	0.7	55.9
17:00	21.6	26.7	3.3	0.0	0.5	0.0	1.4	0.7	54.1
18:00	4.7	23.3	3.3	0.0	0.5	0.0	1.4	0.7	33.9
19:00	0.7	1.1	3.3	0.0	0.5	0.0	1.4	0.7	7.6
20:00	0.7	1.1	3.3	0.0	0.5	0.0	1.4	0.7	7.6
21:00	0.7	1.1	3.3	0.0	0.5	0.0	1.4	0.7	7.6
22:00	0.7	1.1	3.3	0.0	0.5	0.0	1.4	0.7	7.6
23:00	0.7	1.1	3.3	0.0	0.5	0.0	1.4	0.7	7.6
24 hour	197.5	470.5	105.2	1297.7	156.0	150.2	38.9	178.2	2594.4

NOTES: For any hidden-sheets that need to be accessed, please right-click on a visible sheet tab then select 'Unhide'
The calculator uses preset profiles for each school type. If you wish to add/edit school types please refer to the 'School Types' sheet.

Inputs

- The starting point for this design tool, is that your school/college is an all-electric DfE Spec 21 compliant superblock secondary school.
- The following input options highlighted in green needs to be tailored to suit your project.
- Input shown below is for West Coventry Academy.

Area	11880	m2
occupancy	1400	
Peak heat load W/m2	16.7	From heat loss calculator tool - see Heating Inputs tab - generally a typical OS compliant secondary school with 40% HR efficiency Monodraught HVR's is around 17W/m2. An Primary school might require 10-15% more, and an SEN school 20-40% more During occupied hours an allownace for internal gains is taken. For morning pre-heat no vent loads are included
Heating plant sizing factor	1.2	Your basic 'sizing factor' - generally 1.15 to 1.2
Additional infiltation factor for doors open in school day	1	An allowance for increased infiltration due to opening doors during the school day - recommend use 1.25
Heat pump seasonal COP	4	:1
Heat pump COP at -5oC	1.5	:1
Heat pump COP at 21oC	4.5	:1
Specialist spaces		
Catering factor	1	1.0 = reflects standard school catering + the usual food tech rooms. Suggest up factor to 1.2 if lots of free school meals, or to 1.5 or more if any catering training kitchens in addition to the main kitchen
DHWS factor	1.2	1.0 = direct electric, 1.25 = dir.electric + ASHP to kitchens, 1.5 = dir.electric + ASHP to kitchens, showers, and toilet cores
Design & Technology factor	1	1.0 = reflects standard school DT rooms. Suggest up factor to 1.2 if a DT or computers specialism, or to 1.5 or more if a technical college
Lighting factor	1.1	Calculated from above factors with weighting to reflect approximate areas of accomodation

Heating Inputs

Building Envelope

	Length	Width	Area
Floor/Roof	110	36	3960

	Length	Height	Area
Facade	292	11.25	3285

Number of storeys	3	
Total floor area	*11880*	*m2*

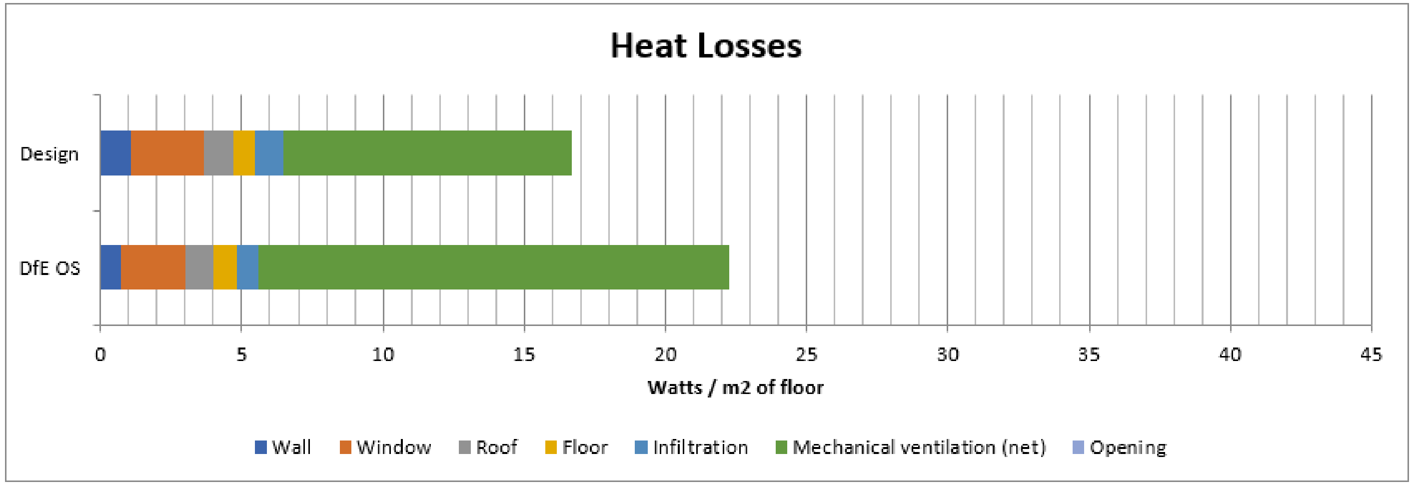
	U-value	% area	DfE OS
Wall	0.15		*0.15*
Window	1.25	30%	*1.1*
Roof	0.12		*0.12*
Floor	0.12		*0.12*
Thermal bridge factor	1.5		
infiltration rate	4	m3/(h.m2)	*3*
air changes	*0.03*		*0.02*
open area @ 5m/s	*0.134*		*0.10*

Occupancy & Ventilation

Occupancy density	8.5	m2 per person	
No. of people	*1397.647*		
Ventilation rate	5	litres / person	
Air Changes Required	*0.564706*	*per hour*	
Internal temp	21	degC	
External temp	-4	degC	
Heat recovery efficiency	38%		*0%*
Heat recovered	*6.3*	*W/m2*	

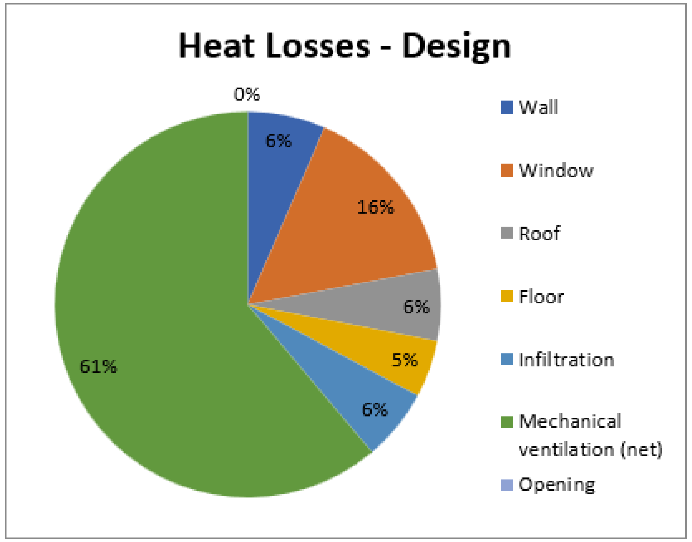
Openings

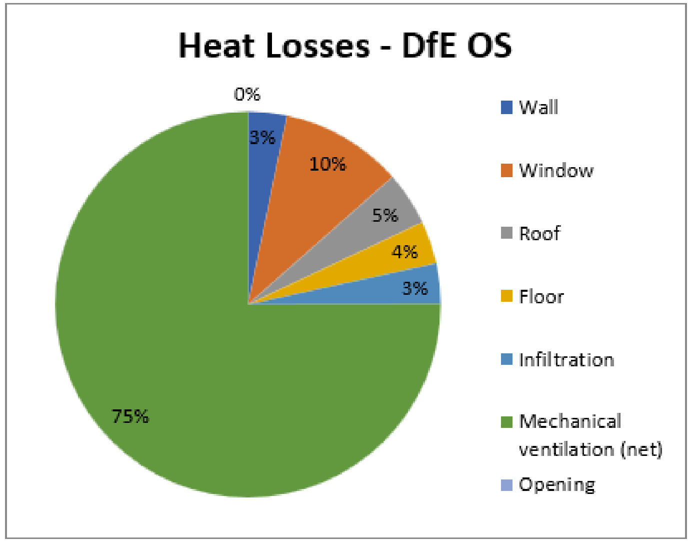
Area of opening	0	m2
Time open	6	mins per hour
Average wind speed	3	m/s
air changes	*0.00*	*per hour*



	Design	DfE
Ave. U-value (fabric only)	0.23	*0.20*
Ave. U-value (fabric + vent)	0.71	*0.94*

	Design	DfE
Design Heat Loss (Watts / m2 of floor)	16.70	22.28
Heat Loss of opening	0.00	*0.00*





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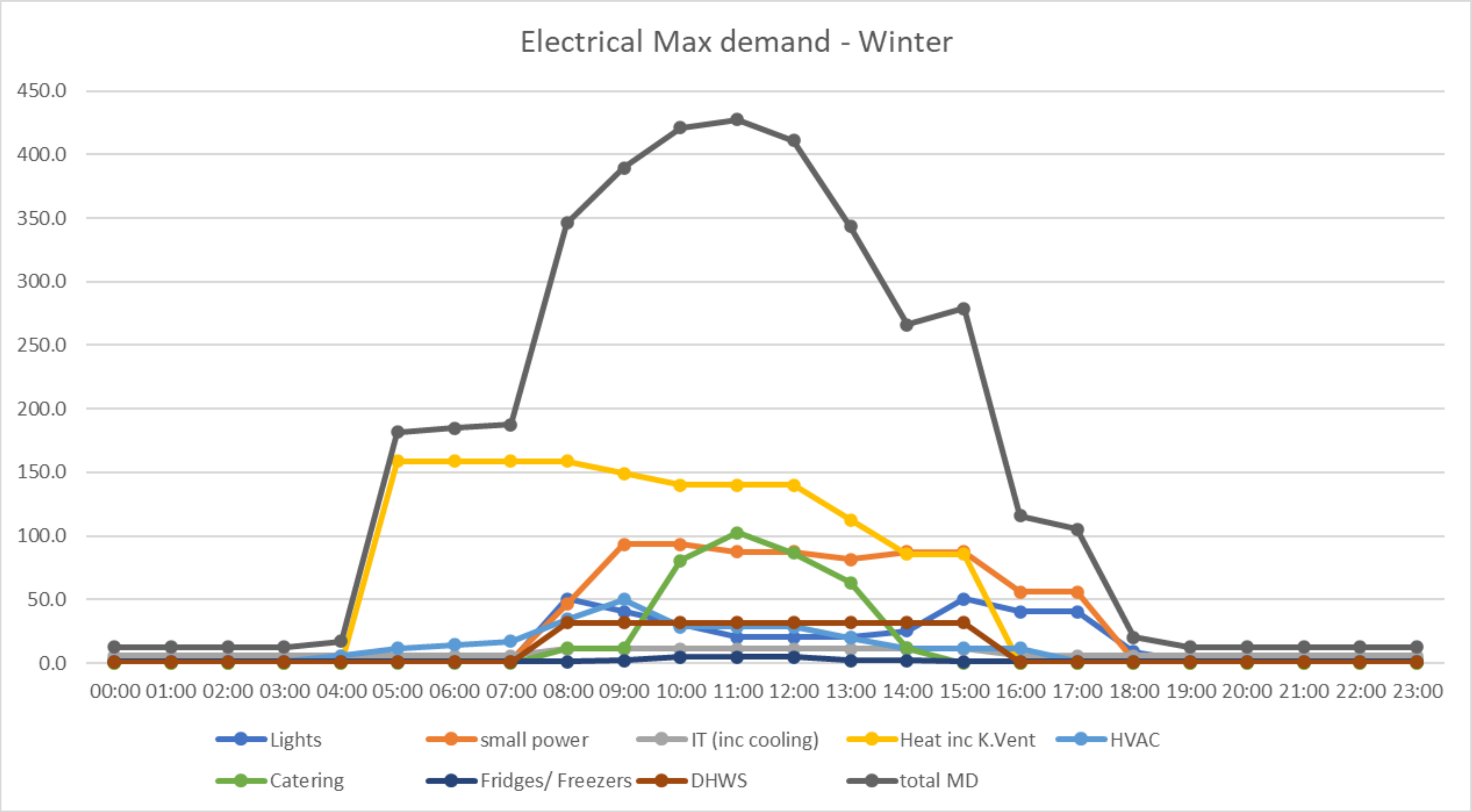
Outputs & Analysis

- For WCA electrical Max demand is calculated to be 427kW (450kVA @0.95 PF) and 35.96 (W/m^2).
- Before we fully developed this tool, our estimate at the original design stage was 550 kVA.



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Outputs & Analysis

- WCA has now experienced the winter of 2023/4 and in particular a -8^{o}C cold snap on the 18th January.
- We visited site a few weeks later to find out for ourselves the data. A maximum demand of 398 kVA (380.2kW) was recorded; 33.7 W/m^2.
- Using BSRIA ROT’s guidance for a mechanically ventilated school of 50 W/m^2 value or 0.5kW per student for a school would result in 600kW max demand figures.
- Although WCA is fully mechanically ventilated (hybrid) in Winter, the BSRIA ROT’s guidance for a naturally ventilated school of 35 W/m^2 is actually spot on, which is an uncanny accident we think.

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Outputs & Analysis

- Energy Use Intensity (EUI) for the School was calculated to be 46.7 compared to DfE's target EUI of 67.0
- The Max demand calculation tool checks itself – it uses the daily loads to calculate an annual EUI - if you over-estimate your loads then it shows you that you will fail to meet the EUI target set by the DfE

	EUI's	
	DfE	Your school
Heating	8	5.4
HWS	5	4.1
Lighting	8	5.8
HVAC	5	4.8
Cooling	0	0.5
Lifts	1	0.7
Building related services	2	
Ext. Lighting	6	1.7
Small Power & Server	25	16.9
Catering	7	6.8
Total	**67**	**46.7**

Outputs & Analysis

- Our calculator takes into account the different usage patterns throughout the day, which the usual percentage based max demand tools do not
- Our calculator does not take in to account various considerations such as inrush current of big loads, EV chargers, PV generation, specialist equipment such as hydro pool. Adjustments will need to be made to the output to factor the above considerations.
- This calculator will be more accurate if we are able to collect energy usage of more operational school buildings in future. The underlying data set and profiles can be updated to suit.
- This calculator can potentially be modified for other types of buildings if we are permitted to take meter readings and compile energy bills of operational buildings.

Time	Lights	small power	IT (inc cooling)	Heat inc K	HVAC	Catering	Fridges/	DHWS	total MD
00:00	1.3	2.8	5.6	0.0	1.2	0.0	1.0	1.0	12.8
01:00	1.3	2.8	5.6	0.0	1.2	0.0	1.0	1.0	12.8
02:00	1.3	2.8	5.6	0.0	1.2	0.0	1.0	1.0	12.8
03:00	1.3	2.8	5.6	0.0	1.2	0.0	1.0	1.0	12.8
04:00	1.3	2.8	5.6	0.0	5.8	0.0	1.0	1.0	17.4
05:00	1.3	2.8	5.6	158.7	11.5	0.0	1.0	1.0	181.9
06:00	1.3	2.8	5.6	158.7	14.4	0.0	1.0	1.0	184.7
07:00	1.3	2.8	5.6	158.7	17.3	0.0	1.0	1.0	187.6
08:00	50.7	46.7	11.3	158.7	34.6	11.5	1.0	31.6	346.0
09:00	40.6	93.3	11.3	149.4	50.1	11.5	2.0	31.6	389.8
10:00	30.4	93.3	11.3	140.1	28.8	80.7	5.0	31.6	421.2
11:00	20.3	87.5	11.3	140.1	28.8	102.7	5.0	31.6	427.3
12:00	20.3	87.5	11.3	140.1	28.8	86.4	5.0	31.6	411.0
13:00	20.3	81.7	11.3	112.8	20.2	63.4	2.0	31.6	343.2
14:00	25.4	87.5	11.3	85.6	11.5	11.5	2.0	31.6	266.4
15:00	50.7	87.5	11.3	85.6	11.5	0.0	1.0	31.6	279.2
16:00	40.6	56.0	5.6	0.0	11.5	0.0	1.0	1.0	115.7
17:00	40.6	56.0	5.6	0.0	1.2	0.0	1.0	1.0	105.3
18:00	8.9	2.8	5.6	0.0	1.2	0.0	1.0	1.0	20.4
19:00	1.3	2.8	5.6	0.0	1.2	0.0	1.0	1.0	12.8
20:00	1.3	2.8	5.6	0.0	1.2	0.0	1.0	1.0	12.8
21:00	1.3	2.8	5.6	0.0	1.2	0.0	1.0	1.0	12.8
22:00	1.3	2.8	5.6	0.0	1.2	0.0	1.0	1.0	12.8
23:00	1.3	2.8	5.6	0.0	1.2	0.0	1.0	1.0	12.8
	365.1	816.2	180.2	1488.2	287.5	367.8	39.0	268.4	3812.3

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Benefits

Why we need to get the design right!

- Cost Savings: An accurate and smaller maximum demand calculation helps avoid over-sizing electrical equipment and infrastructure. Oversizing can lead to unnecessary upfront costs for larger transformers, switchgear, distribution panels, and wiring.
- Avoiding unnecessary infrastructure investments: Oversizing the electrical infrastructure based on inflated maximum demand calculations can lead to investments in HV infrastructure that may not be necessary. An accurate calculation helps avoid unnecessary spending.
- Energy Efficiency: A smaller maximum demand calculation means that the electrical system is designed to handle the actual peak load, which is generally lower than the worst-case scenario. An optimized electrical system results in more efficient energy usage, reducing wasted energy and lowering electricity bills for the building owner.
- Future Scalability: Accurate maximum demand calculations ensure that the electrical system has the capacity to accommodate future growth and expansions. This flexibility allows for easier modifications and additions to the building without the need for significant upgrades to the electrical infrastructure.

Summary

I’m not going to actually share this tool with you – it’s our IP

But I do want to share with you our approach – for you all to develop you own similar tools

As an industry we need to be better at accurately estimating maximum demands, especially now we are moving to an all-electric future.

We MUST revisit completed schemes, undertake meaningful BPE and POE and understand usage patterns.

Empirical data is far better than any spreadsheet or IES model

The proof is in the pudding – we have now gone full circle in our data analysis;

Empirical data sets > Calculation tool > In-use energy

And the results are accurate - there are no more excuses for over-egging design!

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