



How GBI derives BEI, PUE & EUI [& Maximum Demand Limiting] (Day 3)

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BEI

Building Energy Intensity is used to gauge the energy efficiency of a building based on the building floor space.

It is a measurement of the building's annual energy consumption (kWh/yr) divided by its gross floor area (GFA in m²).

GFA to follow the definition by DBKL.

BEI FORMULA

$$BEI = \frac{\text{Building Energy Consumption (kWh/yr)}}{\text{Gross Floor Area (m}^2\text{)}}$$

Building energy consumption shall include all landlord and tenants usage including installations that serve the whole building *except car parks* and Data Centre Equipment.

Gross Floor Area (GFA) shall exclude car park areas and Data Centre Room.

$$BEI = \frac{(TBEC - CPEC - DCEC)}{GFA_{\text{excl. carpark}} - DCA - GLA \times FVR} \times \frac{52}{WOH}$$

This formula is to be applied for office buildings only where the operating hours is based on 52 hours per week.

The term 52/WOH is used to normalise the operating hours for buildings with different operating hours to ensure an 'apple-to-apple' comparison.

However, normalisation should be only for operating office hours within 8.00am to 6.00pm daily. Outside of these 'solar-affected' hours, the actual energy use should be measured and excluded from the BEI computation.

Examples A:

- 1) Office operating 55 hours/wk
- 2) Office operating 48 hours/wk

1) WOH = 55. Then $WOH_{\text{norm}} = \frac{52}{55} = 0.945$

2) WOH = 48. Then $WOH_{\text{norm}} = \frac{52}{48} = 1.083$

WOH shall be during "solar hours"

And within 38 to 62 hours/wk

WHY SO ?

FVR is the weighted floor vacancy rate of a building's GLA. The FVR (%) of GLA is equal to the non-occupied lettable area divided by the GLA

The FVR in the BEI formula is applied at the CVA stage to take into account the actual reading affected by vacancy.

At Design Assessment stage, full occupancy (i.e. **FVR = 0%**) is to be assumed.

The operational hours for other type of buildings are as follows:

Office: 52 hours/wk
 Retail / Mall: 84 hours/wk
 Hotel: 24/7 operation
 Resort: 24/7 operation
 Hospital: 24/7 operation

- The BEI for different category of buildings differs as their usage (installed systems) and operating hours differ.
- The benchmark for BEI credit points is therefore provided for different categories of buildings.

BEI values and credit points for different building category (FAQ 3.12 and [#]Bespoke Tools)

EE5 pts	Office	Retail*	Hotel [#]	Resort [#]	Hospital
2	150	240/350	200/290	245	200
3	140	225/325	190/270	230	190
5	130	210/300	175/250	212	175
8	120	195/280	160/233	196	160
10	110	180/255	150/212	181	150
12	100	160/235	135/195	165	135
15	90	145/210	120/175	148	120

Incorrect ‘Design’ BEI/WOH computation

1. Do not mix-n-match BEI requirements

Example:

Hospital Consultation New Extension Wing that operates 52 hrs/wk (2700hrs/yr)

Computed BEI = 600

‘Classified’ as hospital i.e. operating 24/7, hence

$WOH_{norm} = 2700/8760 = 0.31 !!$

$BEI_{norm} = 600 \times 0.31 = 186 !!$

Then look up FAQ 3.12 table

**BEI values and credit points
(FAQ 3.12)**

EE5 pts	Office	Hospital
2	150	200
3	140	190
5	130	175
8	120	160
10	110	150
12	100	135
15	90	120

Incorrect 'Design' BEI/WOH computation

2. Applying DF on top of DF &
3. No consideration of base loads

Item	Description	Gross kWh/yr	DF	Nett kWh/yr
1	HVAC	600	0.85	510
2	Electrical Lighting	200	0.90	180
3	Electrical Plug Loads	100	0.5	50
4	Hydraulics	50	0.4	20
5	Lifts	50	0.5	25
6	Fire		0.0	0
	TOTAL	1,000		785

THE MISSING ART

**EE5: Understanding BASE LOADS
in both 'design' and 'actual'
computation of BEI, PUE & EUI**

Energy Loads

Typical loads in a building are:

- Lighting Power
- Plug Load
- Air Conditioning and Ventilation
- Elevators and Escalators
- Pumping Energy (incl rainwater, recycling etc)

However for buildings other than offices, there may be other systems that consume energy and these have to be taken into account:

- Swimming Pool Equipment
- Hot Water System
- etc etc

ENERGY USE INCLUDES USE DURING OPERATING HOURS AND NON OPERATING HOURS AKA BASE LOADS

What is Base Building Load?

- For large buildings, there is security activities requiring lighting (internal & external), CCTVs, EMS, Emergency & Exit signs, Plant room ventilation system, sump pumps, etc.
- For high rise buildings, security activities include lift operation, etc.
- Then there is façade lighting, periodic testing of fire related systems, jockey pumps, and so on.

Other Hidden 'Base' Loads?

- **PHANTOM LOAD** – what is that ?
- aka Standby Power aka Vampire Power aka Leaking Electricity
- refers to the electric power consumed by electronic and electrical appliances while they are switched off (but are designed to draw some power) or in a standby mode
- can account for 8 to 22% of the appliance load!

How much can Phantom Loads add up to?

Assume a 1,000m² office floor with full (diversified) plug load use @5W/m².

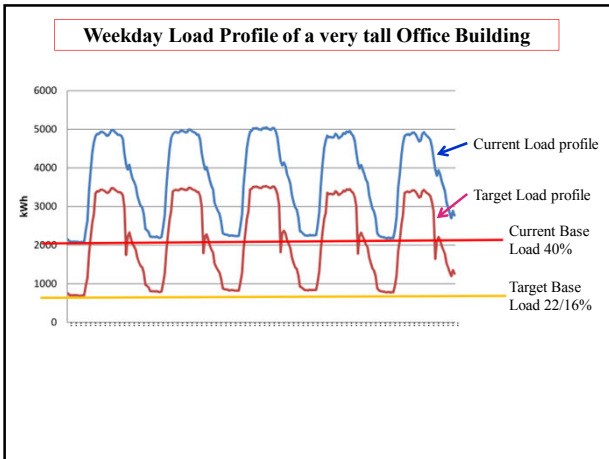
Operates 2,704 hours/yr = 13,520 kWh.

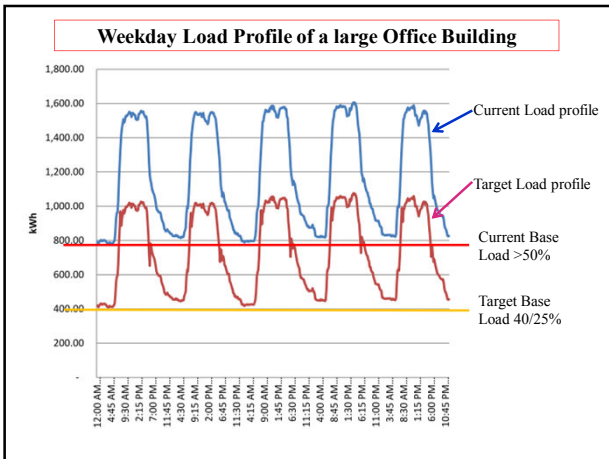
Phantom load remains switched on for the remaining (8,760 – 2,704 =) 6,056 hr/yr.

Phantom Plug Load %	Phantom Plug Load kWh/year	% of Productive Plug Load
8	2,422	18
22	6,662	49

The reality of Base Building Loads

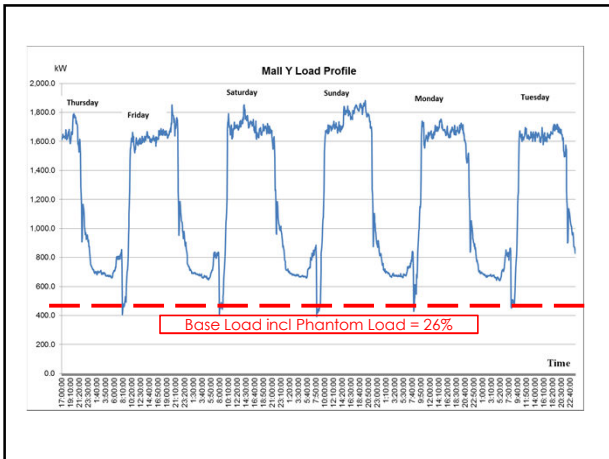


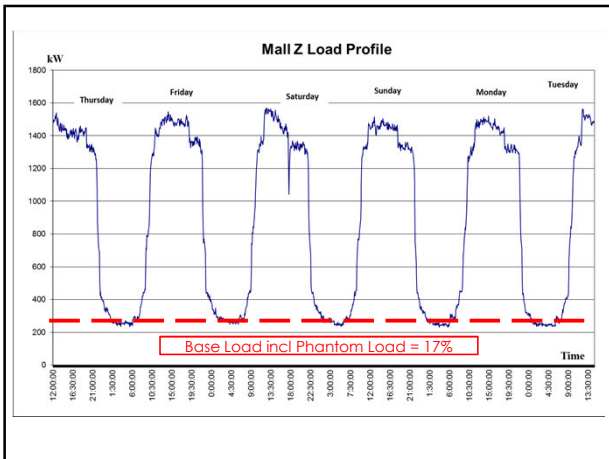


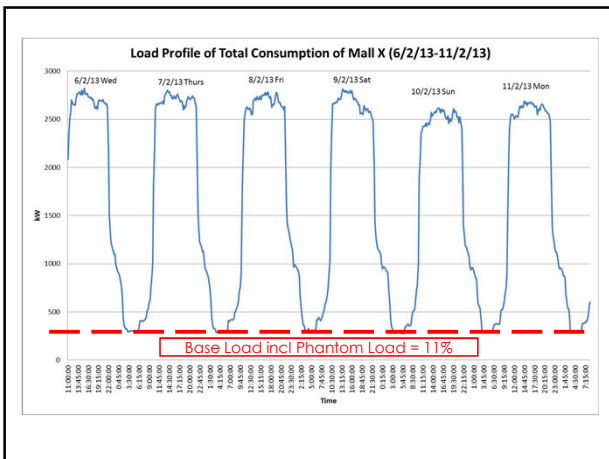


What about Base Building Loads for other Building Typologies?

- <5 storey shoplot offices ?
- Hotels ?
- Hospitals ?
- Retail/Malls ?
- Resorts ?
- Institutional Buildings ?
- Factories ?







How are different BEI values derived?

1. Office – based on industry data (PTM now MGTC) etc and GBI targetted EE standard
2. Retail/Mall – initially based on NUS data & later on fine tuned with local data collated in collaboration with PPK (Malaysia High-rise & Shopping Complex Association) and (for the time being) excludes non-electricity energy use based on operating hours of 84/week or 4368 hours/annum
3. Hotel – initially based on NUS data & later on fine tuned in collaboration with MAH and excludes non-electricity energy use (for the time being) based on 24/7 operation
4. Resort – based upon collaboration with MAH and industry and excludes non-electricity use based on 24/7 operation

How are different BEI values derived?

5. Hospital – based on NUS & now undergoing fine-tuning with local data and exclude non-electricity energy use based on 24/7 operation
6. Airport, Data Centre, etc ? – based on BEI and/or EUI for similar facilities and adjusted to Office BEI equivalent

Derivation of EE5 points for different BEI categories

EE5 pts	Office	Retail	Hotel
Base	250	400	333
0	200	320	267
2	150	240	200
3	140	225	190
5	130	210	175
8	120	195	160
10	110	180	150
12	100	160	135
15	90	145	120

Derivation of EE5 points for different BEI categories

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8	120		160
10	110		150
12	100	160	135
15	90	145	120

**150/250 x
400 = ?**

PUE Derivation for Data Centre

Space	Office	Data/Telco Centre
Area (m2)	3,500	11,500
kWh/annum	500,000	36,000,000
Operating hours/week	50	168
BEI	149	969
WOH		140
Adjusted BEI		904

PUE for Data Centre cont'd

- Alternative to BEI is PUE for IT Industry
- Where Power Usage Effectiveness is defined as:
 $PUE = \text{Total Facilities Power} / \text{IT Equipment Power}$

International PUE Benchmark	
PUE	Level of Efficiency
3.0	Very Inefficient
2.5	Inefficient
2.0	Average
1.5	Efficient
1.2	Very Efficient

PUE for Data Centre cont'd

Local data on PUE

Data Centre	Area (m ²)	PUE
A	24,500	2.29
B	9,000	2.29
C	1,200	1.81
D	22,300	2.04
E	300	1.86
F	7,700	2.18
Mean PUE		2.18

Data Centre Example cont'd

PUE equivalent to BEI (factored for non-seasonal climate)

EES points	BEI	PUE equiv	PUE International
Base	250	(3.1)	3.0 = Very Inefficient
0	200	(2.5)	2.5 = Inefficient
2	150	1.9	2.18 = Local Mean
3	140	1.8	2.0 = Average
5	130	1.7	
8	120	1.6	1.5 = Efficient
10	110	1.5	
12	100	1.4	
15	90	1.3	1.2 = Very efficient

Derivation of EUI for Industries

- Demonstrate that Energy Efficiency (EE) performance exceeds the baseline minimum to reduce energy consumption in the building and/or the industrial plant process.
- For building, improve Building Energy Intensity (BEI) as defined by GBI.
- For industrial plant process, use Energy Use Intensity (EUI) to compare against baseline data for similar plant process [baseline EUI shall be furnished by applicant for GBI acceptance].
- Use BEI or EUI if either building or industrial plant process energy use constitutes more than 75% of the total energy use.
- Otherwise, calculate both BEI and EUI with the lower point score being applicable.

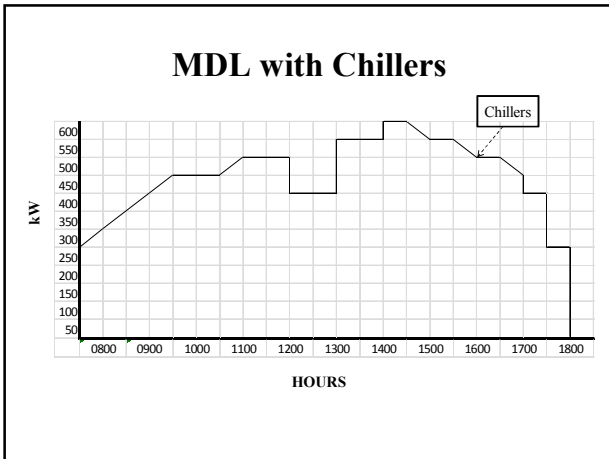
Maximum Demand Limiting (MDL)

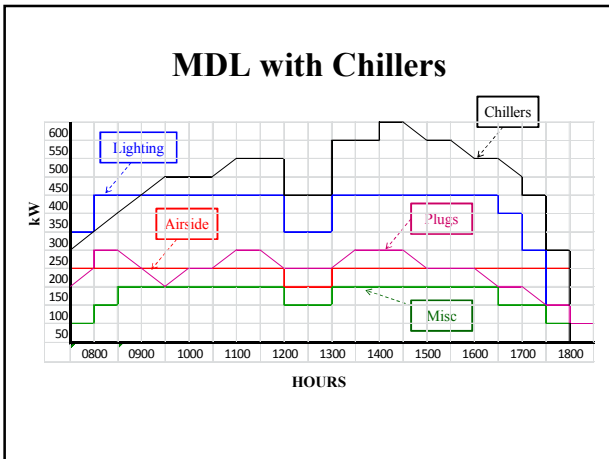
Maximum Demand Limiting (MDL)

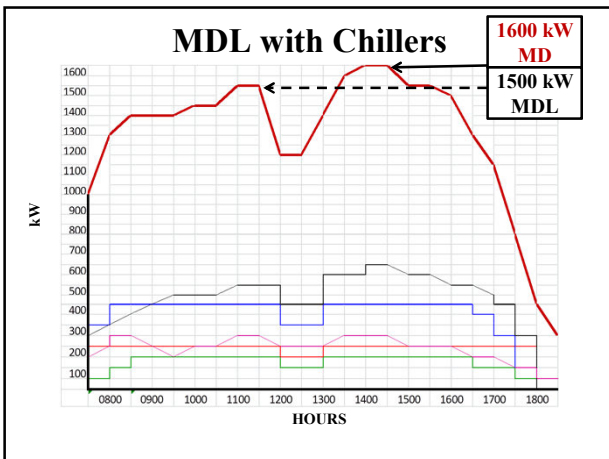
1. Applicable only if the electricity billing is based on tariff C1, C2, E1, E2 or E3 where Maximum Demand charge applies
2. MDL program is readily available in all BAS
3. MDL can only be meaningfully programmed when there is sufficient building loads and is optimal at full building load condition
4. Hence, GBI requires CVA to be conducted only when the building occupancy has reached at least 50%
5. Before the advent of GBI, 99% of building BAS were never 'fully' commissioned as buildings were handed over to the owner as 'vacant possession'.

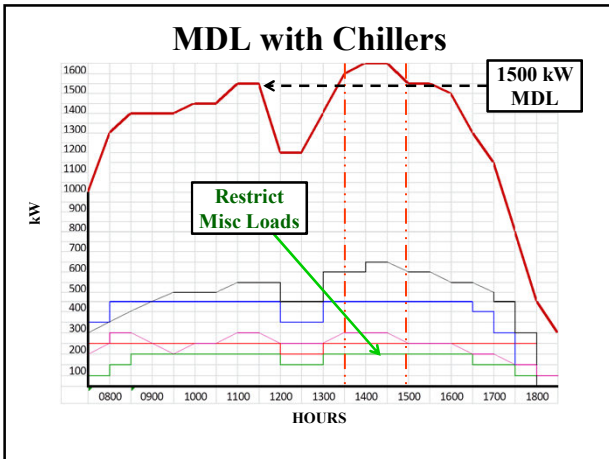
MDL cont'd

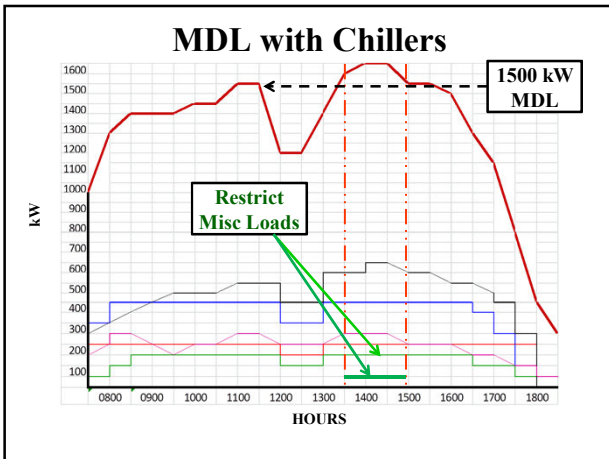
1. How to carry out MDL?
2. Is MDL applicable if there are no chillers?
3. Who should be in charge of, or lead MDL?











THANK YOU
