Energy Efficiency in Electrical Installations
Part 8 of the IET Regulations

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18th Edition IET Regulations BS7671:2018

- 18th Edition – published 1st July 2018
- New changes incorporated
- Arc Detection
- New certificates
- Foundation Earthing
- **ENERGY EFFICIENCY**

18th Edition

- Usually safety orientated but does include operational matters
- New Part 8 introduced
  - Energy Efficiency of Electrical Installations

Why?

- Energy efficiency usually applies to equipment:
  - Lights, motors, appliances etc

- What about electrical installations:
  - Cables
  - Transformers
  - Motors
  - Position of equipment
  - Power Factor?

Position of equipment

- Distribution equipment should be in centre of load!
  - (Tell that to the architect!!!)
- ‘Barycentre’ method of calculation
- Use distances and load to calculate epicentre.
- Less losses on cables
- Better efficiency of transformers

Calculation for Barycentre Method 1

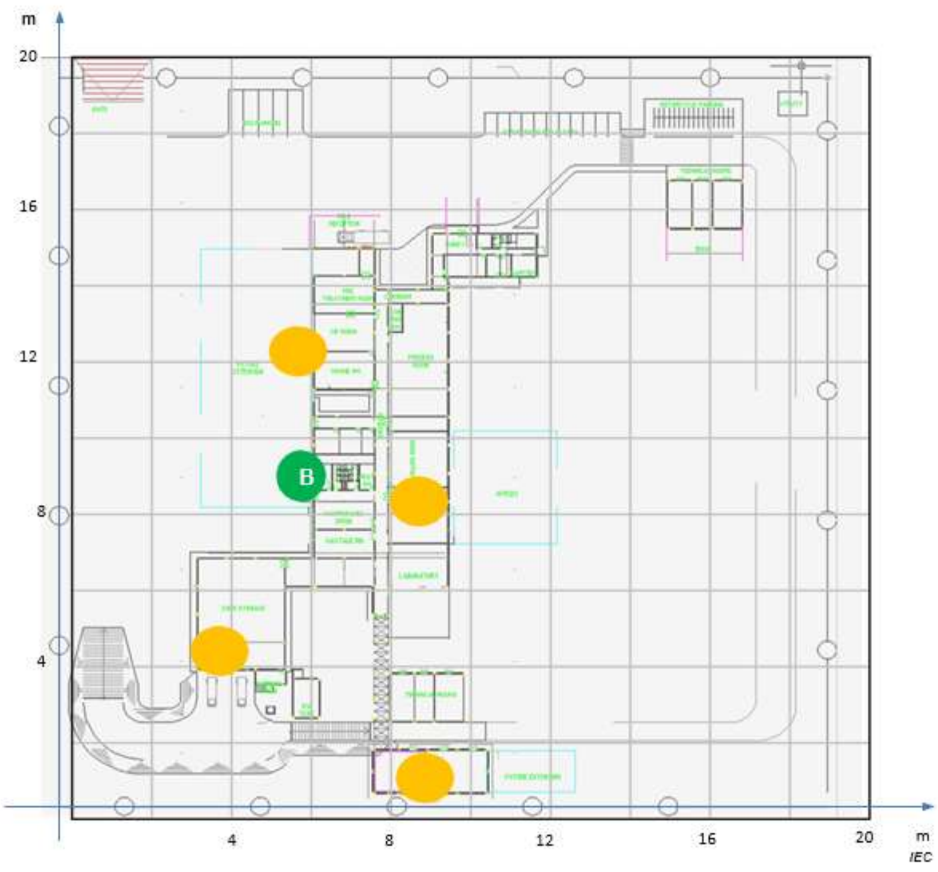

Figure A.1 – Example 1: Floor plan of production plant with the planned loads and calculated barycentre

Calculations for Barycentre method 2

Example 1: calculation of the barycentre in a production plant

The example production plant has the following loads (see Figure A.1):

1)	Logistics storage	EAC_1 = 120 kWh	at the position	x_1 = 4 m;	y_1 = 4 m
2)	Utilities	EAC_2 = 80 kWh	at the position	x_2 = 9 m;	y_2 = 1 m
3)	Office	EAC_3 = 20 kWh	at the position	x_3 = 9 m;	y_3 = 8 m
4)	Production	EAC_4 = 320 kWh	at the position	x_4 = 6 m;	y_4 = 12 m

According to the barycentre formula:

$$(x_b, y_b) = \frac{\sum_{i=1}^{i=n}(x_i, y_i)\cdot EAC_i}{\sum_{i=1}^{i=n} EAC_i}$$

the x position of the barycentre is given by:

$$x_b = \frac{4\,\text{m}\cdot 120\,\text{kWh} + 9\,\text{m}\cdot 20\,\text{kWh} + 6\,\text{m}\cdot 320\,\text{kWh}}{120\,\text{kWh} + 80\,\text{kWh} + 20\,\text{kWh} + 320\,\text{kWh}} = \frac{3300}{540} = 6.11\,\text{m}$$

similarly, the y position of the barycentre is given by:

$$y_b = \frac{4\,\text{m}\cdot 120\,\text{kWh} + 1\,\text{m}\cdot 80\,\text{kWh} + 8\,\text{m}\cdot 20\,\text{kWh} + 12\,\text{m}\cdot 320\,\text{kWh}}{120\,\text{kWh} + 80\,\text{kWh} + 20\,\text{kWh} + 320\,\text{kWh}} = \frac{4560}{540} = 8.44\,\text{m}$$

The resulting barycentre location is shown in Figure A.1, at point B.

Cable Sizing

- What size cables should be used
- Should it be sized according to load?
- Or losses?
- Calculations required
- Client has choice

Other Energy Efficiency Areas

- Power Factor
- Load Profiling
- Harmonics
- Motor and transformer efficiency
- BEMS Controls
- Lighting
- Use of Meshes
- ‘Renewable Energy’
- Client specifications

Position of Main Substation

Table B.2 – Location of the main substation

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	Position of the main substation is within 60 % of the distance from the optimum position to the most distant load	Position of the main substation is within 40 % of the distance from the optimum position to the most distant load	Position of the main substation within 25 % of the distance from the optimum position to the most distant load	Position of the main substation is within 10 % of the distance from the optimum position to the most distant load
Commercial	No consideration	Position of the main substation is within 60 % of the distance from the optimum position to the most distant load	Position of the main substation is within 40 % of the distance from the optimum position to the most distant load	Position of the main substation is within 25 % of the distance from the optimum position to the most distant load	Position of the main substation is within 10 % of the distance from the optimum position to the most distant load
Industrial	No consideration	Position of the main substation is within 60 % of the distance from the optimum position to the most distant load	Position of the main substation is within 40 % of the distance from the optimum position to the most distant load	Position of the main substation is within 25 % of the distance from the optimum position to the most distant load	Position of the main substation is within 10 % of the distance from the optimum position to the most distant load
Infrastructure	No consideration	Position of the main substation is within 60 % of the distance from the optimum position to the most distant load	Position of the main substation is within 40 % of the distance from the optimum position to the most distant load	Position of the main substation is within 25 % of the distance from the optimum position to the most distant load	Position of the main substation is within 10 % of the distance from the optimum position to the most distant load
NOTE The optimum position is determined in accordance with the method described in Annex A.					

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Renewable Energy

Table B.13 – Requirement for renewable energy

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	No consideration	To consider renewable energy source	To install renewable energy source providing at least 4 % of the total installed electrical power available	To install renewable energy source providing at least 6 % of the total installed electrical power available
Commercial	No consideration	To consider renewable energy source	To install renewable energy source	To install renewable energy source providing at least 5 % of the total installed electrical power available	To install renewable energy source providing at least 10 % of the total installed electrical power available
Industrial	No consideration	To consider renewable energy source	To install renewable energy source	To install renewable energy source providing at least 1 % of the total installed electrical power available	To install renewable energy source providing at least 2 % of the total installed electrical power available
Infrastructure	No consideration	To consider renewable energy source	To install renewable energy source	To install renewable energy source providing at least 2 % of the total installed electrical power available	To install renewable energy source providing at least 4 % of the total installed electrical power available
NOTE Values introduced in this table may vary from country to country depending on the maximum total installed electrical power available.					

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Transformers

Table B.6 – Required optimization analysis for transformers

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	No consideration	Selection of all transformers according to life- cycle cost on estimation of magnetic and copper losses or working point losses	Selection of all transformers according to life-cycle cost on estimation of magnetic and copper losses or working point losses	Selection of all transformers according to life-cycle cost on estimation of magnetic and copper losses and working point losses
Commercial	No consideration	No consideration	Selection of all transformers according to estimation of magnetic and copper losses or working point losses	Selection of all transformers according to estimation of magnetic and copper losses or working point losses	Selection of all transformers according to estimation of magnetic and copper losses and working point losses
Industrial	No consideration	No consideration	Selection of all transformers according to estimation of magnetic and copper losses or working point losses	Selection of all transformers according to estimation of magnetic and copper losses or working point losses	Selection of all transformers according to estimation of magnetic and copper losses and working point losses
Infrastructure	No consideration	No consideration	Selection of all transformers according to estimation of magnetic and copper losses or working point losses	Selection of all transformers according to estimation of magnetic and copper losses or working point losses	Selection of all transformers according to estimation of magnetic and copper losses and working point losses

Load profiles

B.1 Energy efficiency parameters

The energy efficiency measures are classified according to five levels (from 0 to 4). Level 4 is considered to be the highest level. Each level includes the preceding ones.

Table B.1 – Determination of load profile in kWh

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	Load profile consumption of the installation for a day	Load profile consumption of the installation for each day of a week	Load profile consumption of the installation for each day of a year	Permanent data logging of the load profile consumption of the installation
Commercial	No consideration	Load profile consumption of the installation for a day	Load profile consumption of the installation for each day of a week	Load profile consumption of the installation for each day of a year	Permanent data logging of the load profile consumption of the installation
Industrial	No consideration	Load profile consumption of the installation for a day	Load profile consumption of the installation for each day of a week	Load profile consumption of the installation for each day of a year	Permanent data logging of the load profile consumption of the installation
Infrastructure	No consideration	Load profile consumption of the installation for a day	Load profile consumption of the installation for each day of a week	Load profile consumption of the installation for each day of a year	Permanent data logging of the load profile consumption of the installation

Annual Consumption

Table B.14 – Minimum requirement for distribution of annual consumption

Sector of activity	EEPL0	EEPL1	EEPL2	EEPL3	EEPL4
Residential buildings (dwellings)	No consideration	No consideration	No consideration	No consideration	No consideration
Commercial	No consideration	80 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	90 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	95 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	99 % of annual consumption can be split between usages (lighting, HVAC, process, etc.) and between zones
Industrial	No consideration	80 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	90 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	95 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	99 % of annual consumption can be split between usages (lighting, HVAC, process, etc.) and between zones
Infrastructure	No consideration	80 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	90 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	95 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	99 % of annual consumption can be split between usages (lighting, HVAC, process, etc.) and between zones

Lighting

Table B.4 – Required optimization analysis for lighting

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	To consider lamp type and position	To consider lamp type and position with natural lighting	Control according to natural lighting source or building use or lamp type	Control according to natural lighting source and building use and to consider lamp type
Commercial	No consideration	To consider lamp type and position	To consider lamp type and position with natural lighting	Control according to natural lighting source or building use or lamp type	Control according to natural lighting source and building use and to consider lamp type
Industrial	No consideration	To consider lamp type and position	To consider lamp type and position with natural lighting	Control according to natural lighting source or building use or lamp type	Control according to natural lighting source and building use and to consider lamp type
Infrastructure	No consideration	To consider lamp type and position	To consider lamp type and position with natural lighting	Control according to natural lighting source or building use or lamp type	Control according to natural lighting source and building use and to consider lamp type

Energy Efficiency Table

Table B.17 – Energy efficiency measures profile

Table	Requirement	EM0	EM1	EM 2	EM 3	EM 4	Points
B.1	Load profile						
B.2	Location of main substation						
B.3	Motors						
B.4	Lighting						
B.5	HVAC						
B.6	Transformers						
B.7	Wiring system						
B.8	Power factor correction						
B.9	Power factor measurement						
B.10	Energy and power measurement						
B.11	Voltage measurement						
B.12	Harmonics and inter-harmonics measurement						
B.13	Renewable energy						
Total EM							

Table B.18 – Energy efficiency performance profile for an industrial installation

Table	Requirement	EEPL0	EEPL1	EEPL2	EEPL3	EEPL4	Points
B.14	Distribution of annual consumption						
B.15	Power factor						
B.16	Transformer efficiency						
Total EEPL							

Calculation example 1

B.5 Example of installation profile (IP) and electrical installation efficiency class (EIEC)

Table B.20 – Example of energy efficiency profile – Efficiency measures

Table	Requirement	EM0	EM1	EM 2	EM 3	EM 4	Points
B.1	Load profile						3
B.2	Location of main substation						3
B.3	Motors						3
B.4	Lighting						3
B.5	HVAC						2
B.6	Transformers						1
B.7	Wiring system						1
B.8	Power factor correction						2
B.9	Power factor measurement						2
B.10	Energy and power measurement						3
B.11	Voltage measurement						0
B.12	Harmonics and interharmonics measurement						2
B.13	Renewable energy						4
Total EM							29

Energy Efficiency Performance Levels

Table B.21 – Example of energy efficiency profile – Energy efficiency performance levels

Table	Requirement	EEPL0	EEPL1	EEPL2	EEPL3	EEPL4	Points
B.14	Distribution of annual consumption						2
B.15	Power factor						1
B.16	Transformer efficiency						3
Total EEPL							6

The total number of points for this installation is 29 + 6 = 35. Referring to Table B.19, this installation is classified EIEC 2.

Energy Efficiency levels

The sum of the total number of points obtained for all energy measures and for all energy efficiency performance levels shall be compared with the number of points needed for each electrical installation efficiency class.

Table B.19 – Electrical installation efficiency classes

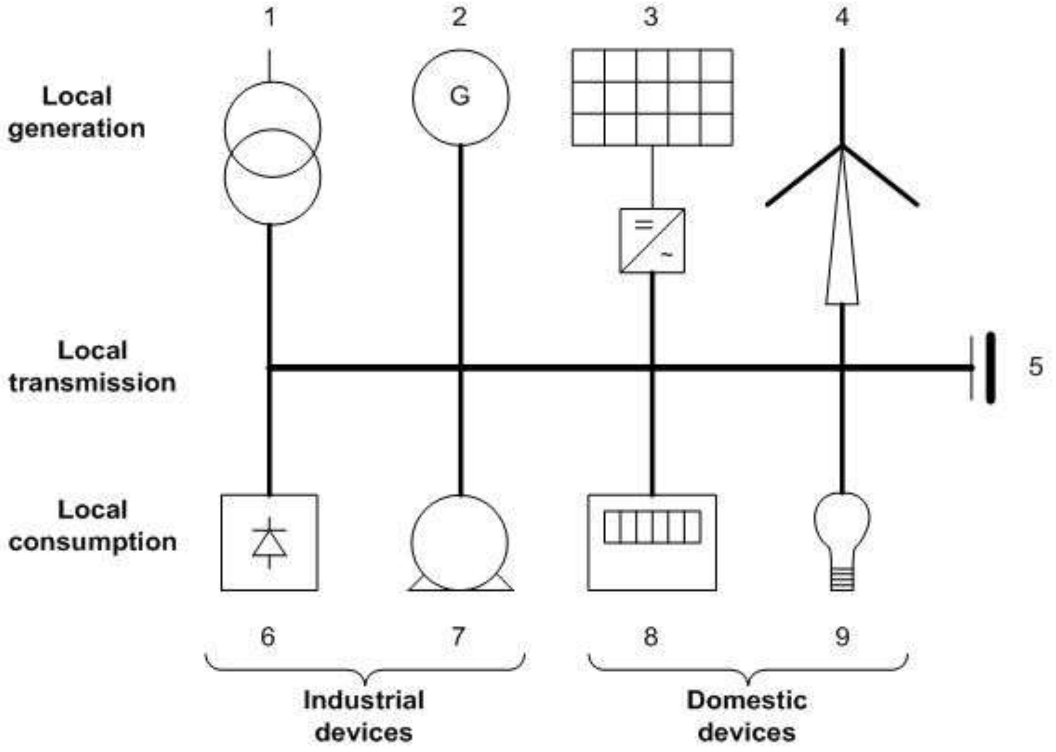
Total for dwellings	Total except for dwellings	Electrical installation efficiency class (EIEC)
<20	<16	EIEC0
<28	<26	EIEC1
<36	<36	EIEC2
<44	<48	EIEC3
<50	<58	EIEC4

Another Energy Related standard

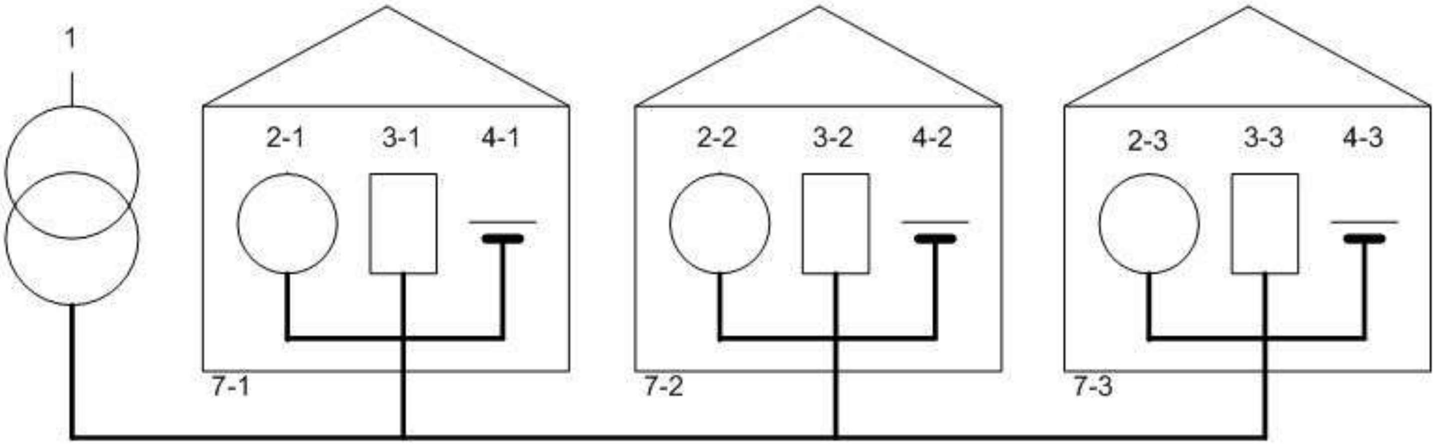
- **IEC 60364-8-2: Low voltage electrical installation -Part 8-2: Prosuming low-voltage electrical installations**

- Details connections and usage of networks with renewable energy and energy storage sources.

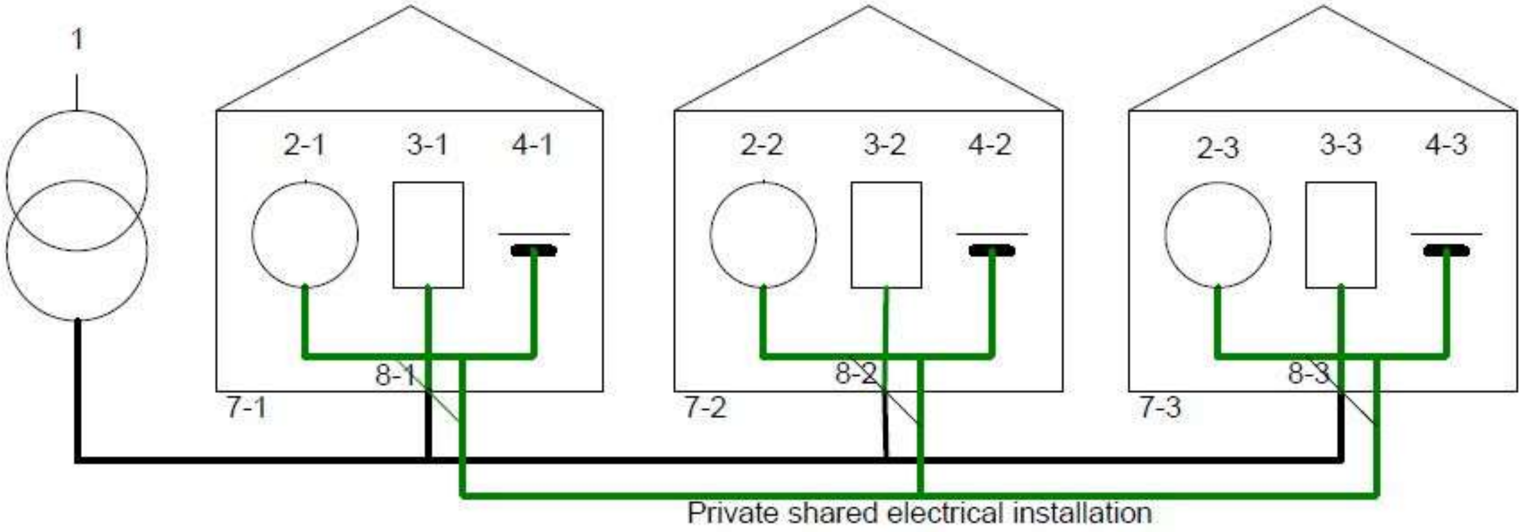
Grid system of distribution



Shared Electrical Installation (SEI)



Collective SEI with private network



Energy Storage – Game Changing

- Tesla have announced 7KWH and 10KWH batteries
- Others such as Bosch and Mercedes entering the market.
- Payback approx 10 years
- Beware connections – fault levels could be high
- Will not provide standby power off grid
- Larger systems being developed at cost down to $150/kwh
- Mass power storage = a real game changer

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Conclusion

- Energy efficient installations are here to stay
- Designers will have to take this into account
- Certification will also be altered to suit the new requirements
- Training will be required
- Coming on the 1st July 2018

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