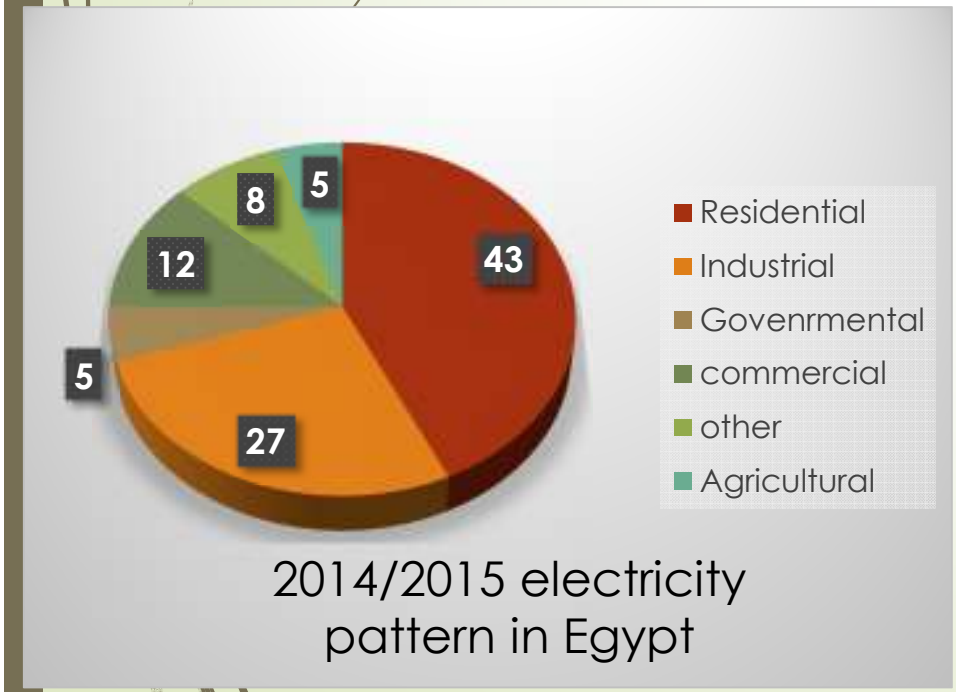
Electrical Load Characteristics

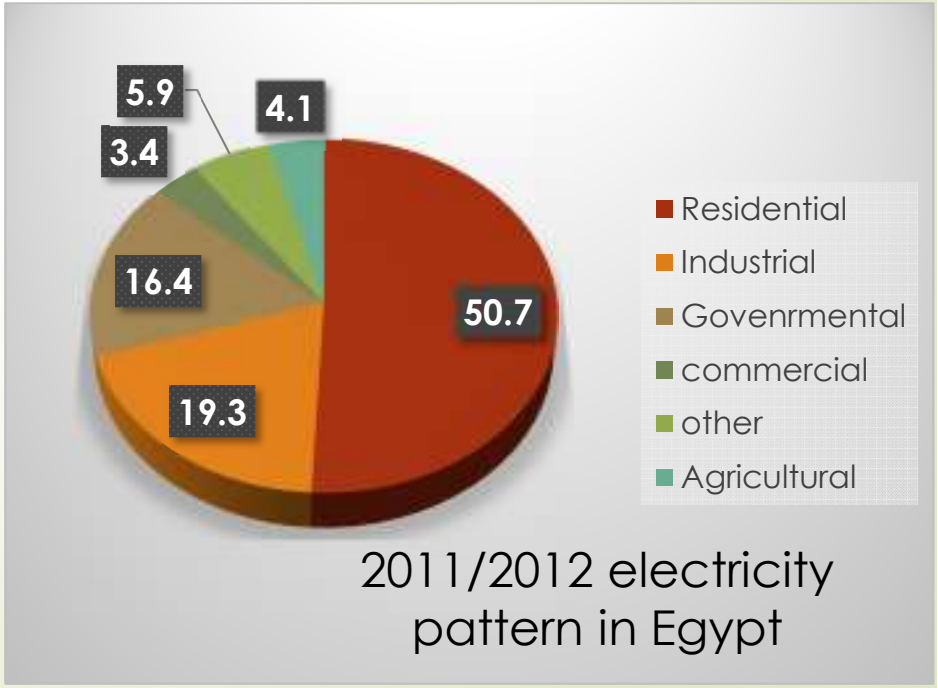
Week 3 and 4

The Nature of Loads

- The load that an individual customer or a group of customers presents to the distribution system is constantly changing.
- Every time a light bulb or an electrical appliance is switched on or off, the load seen by the distribution feeder changes.
- In order to describe the changing load, the following terms are defined;



2014/2015 electricity pattern in Egypt

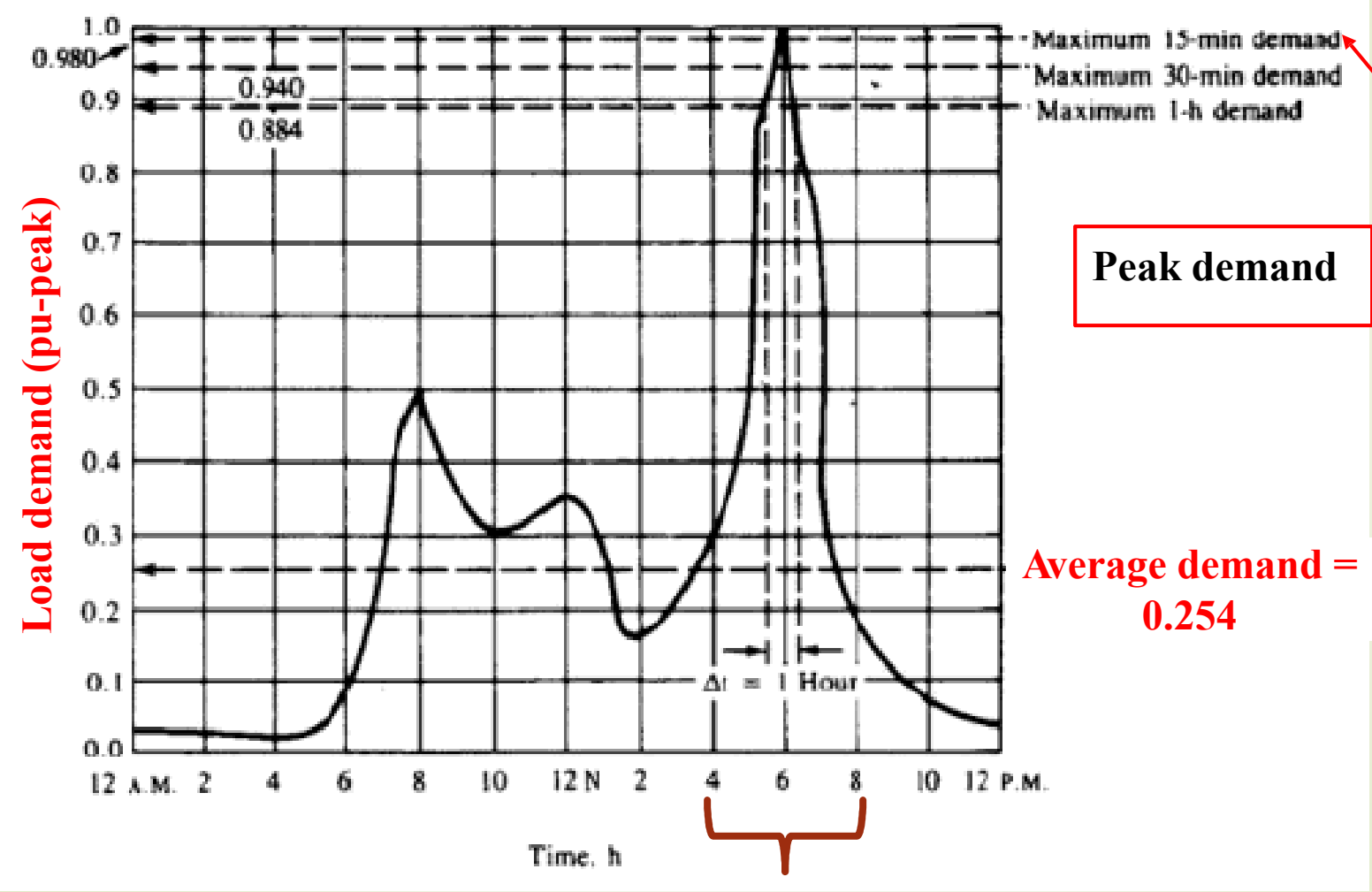


2011/2012 electricity pattern in Egypt

Daily load curve (daily demand variation)

منحني الأحمال يعتمد علي نوع الحمل

الحمل المنزلي أكثر أنواع الأحمال تغيرا



Peak load= peak demand= maximum load

Definitions

Peak load is considered peak if it has been available for more than 15 min according to standards

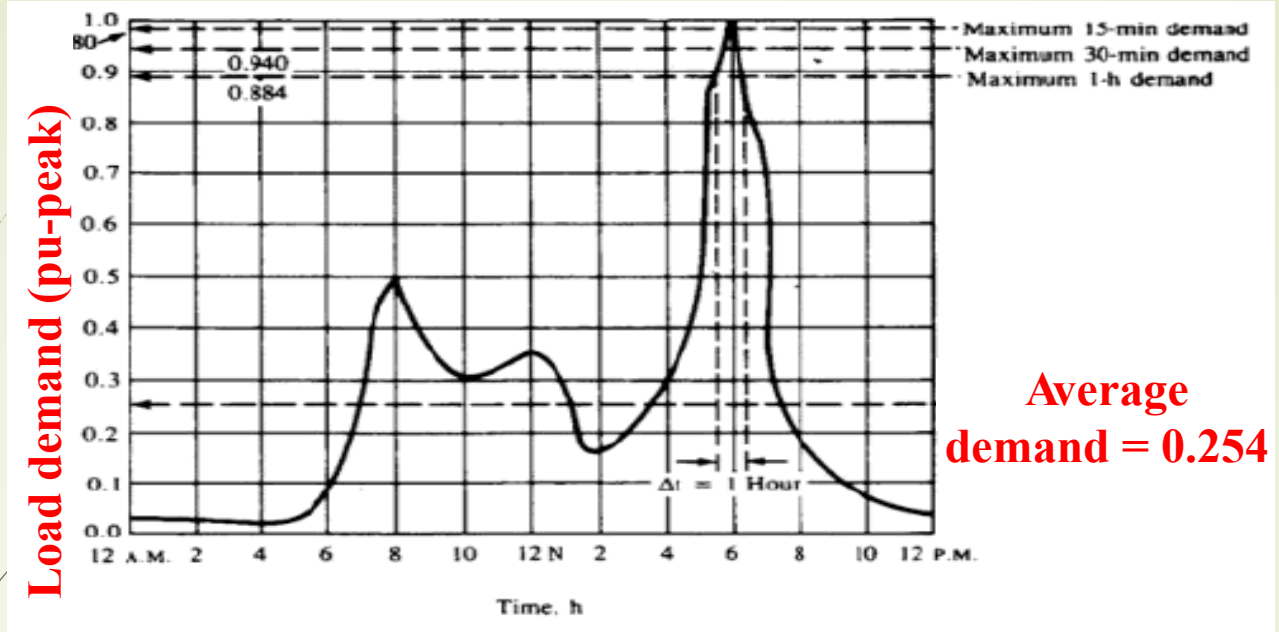
1. **Demand الحمل المطلوب**

- "Load at receiving terminal averaged over a specific period of time"
- Load can be kW, kVA, or A
- Must include the time interval which may range from **15 minutes** to 24 hours
- To calculate the ***average demand***, area under curve is calculated

2. **Maximum Demand أقصي حمل**

- Greatest of all demands that occur during a specific time
- Must include demand interval, period, and units

3. Average load Demand متوسط الأحمال



The average demand of a load curve in kW equals

$$P_{av} = \frac{W}{T}$$

إستهلاك الطاقة الكهربية و التي تحدد قيمة الإستهلاك في الفاتورة= المساحة تحت منحني

W: is the electrical energy consumption in period of T hrs

T: is the periodic time in hours (=24 hrs for daily load curve & 8760 hrs for annual load curve)

4. Load Factor معامل الحمل

- Defined as "the ratio of the average demand to the maximum demand"
- Indicates how well the utility's facilities are being utilized
- From utility stand point, optimal LF would be 1.0 (system consumption approaches the maximum).
- Is reflected on the electricity bill

$$LF = \frac{\text{Average demand}}{\text{maximum demand}} \qquad LF = \frac{P_{av}}{P_{max}}$$

Used after system is designed and affects the price of kwh

The bigger value the better

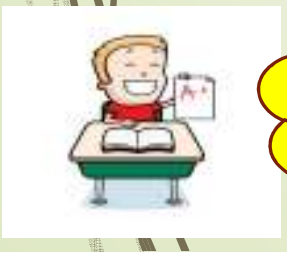
5. Demand Factor معامل الطلب

يستعمل بكثرة للأحمال المنزلية

- Demand factor is the ratio of the **maximum demand** of a system to the total **connected load (maximum demand when all are used)**
- **For example, a large industry might have a connected load of 20 MW, but if only 75% of its electrical equipment is operating, the demand factor would be only 75% of maximum.**
- **It gives the fractional amount of some quantity being used relative to the maximum amount that could be used by the same system**
- **صافي استهلاك الطاقة في فترة محددة من الوقت أثناء التحميل مقسوما على كمية الطاقة التي كانت تستهلك إذا كان الحمل كل يمكن أن يكون متصلا**
- ***Thus the demand factor is usually less than one.** The lower the demand factor, the less system capacity required to serve the connected load*

$$DF = \frac{\text{Maximum demand}}{\text{Maximum possible demand}}$$

يؤخذ من الرسم وهو اعلى طاقة تم استهلاكها فعليا في فترة معينة



The smaller value the better

مثلا: انا اكتر حاجة بستهلكها فعليا علي العداد 3000
بس عندي امكانية استعمال 6000

Residential load calculations- Saudi code

At 50m2 apartment, the contactor will design a 8 kVA (CB will be selected based on this value) BUT electricity company sees this load as 4 kVA, meaning that the demand factor is 0.5

الأحمال الكهربائية التقديرية للمستهلكين المنزليين

حجم عداد الكهرباء أمبير	الحمل التعاقدي		الطلب المقدر	حمل وحدة التكييف	الحمل المترابط	المساحة المغطاة
	ك.ف.أ	مقرر القاطع امبير	ك.ف.أ	ك.ف.أ	ك.ف.أ	متر مربع
3x25(100)	19.74	30	2	2.5	4	25
			4	5.0	8	50
			6	7.5	12	75
			8	10.0	16	100
			9.5	12.4	19	124
3x25(100)	39.48	60	10	12.5	20	125
			12	15.0	24	150
			14	17.5	28	175
			16	20	32	200
			18	22.5	36	225
			20	25	40	250
			21.5	27.5	43	275
			23	30	46	300
			23.5	31.2	47	312
3x25(100)	65.8	100	24	31.3	48	313
			25	32.5	50	325
			26.5	35	53	350
			28	37.5	56	375
			30	40	60	400
			31.5	42.5	63	425
			33	45	66	450
			35	47.5	70	475
			36.5	50	73	500
			38	52.5	76	525
			40	55	80	550
			41.5	57.5	83	575
			42.7	59.9	85	599
3x40(160)	98.7	150	43	60	86	600
			45	62.5	90	625
			46.5	65	93	650
			48	67.5	96	675
			50	70	100	700
			51.5	72.5	103	725
			53	75	106	750
			55	77.5	110	775
			56.5	80	113	800
			58	82.5	116	825
			60	85	120	850
			61.5	87.5	123	875

الأحمال الكهربائية التقديرية للمستهلكين التجاريين

المساحة المغطاة متر مربع	الحمل الترابط ك.ف.أ	حمل وحدة التكييف ك.ف.أ	الطلب المقدر ك.ف.أ	الحمل التعاقدي		حجم عداد الكهرباء أمبير
				ك.ف.أ	مقنن القاطع أمبير	
25	6	3	3.6	19.74	30	3x25(100)
50	10	6	6			
75	16	9	6.9			
92	19	11	11.4			
93	20	11.2	12	39.48	60	3x25(100)
100	22	12	13.2			
125	27	15	16.2			
150	32	18	19.2			
175	38	21	22.8			
200	43	24	25.8			
224	47	26.9	28.2			
225	48	27	28.8	65.8	100	3x25(100)
250	54	30	32.4			
275	59	33	35.4			
300	64	36	38.4			
325	70	39	42			
350	75	42	45			
375	80	45	48			
399	85	47.9	51			
400	86	48	51.6	98.7	150	3x40(160)
425	91	51	54.6			
450	96	54	57.6			
475	102	57	61.2			
500	107	60	64.2			
525	112	63	67.2			
550	118	66	70.8			
575	123	69	73.8			
600	128	72	76.8			
611	130	73.3	78			
612	131	73.4	78.6	131.6	200	محول تيار
625	134	75	80.4			
650	139	78	83.4			
675	144	81	86.4			
700	150	84	90			
725	155	87	93			
750	160	90	96			
772	164	92.6	98.4			

Commercial load calculations- Saudi Arabia code

Case study:

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A building in Saudi Arabia contains an illumination panel board that feeds 5 residential apartments, 200 m2 each and also feeds 3 commercial shops, 100 m2 each. Calculate the estimated load from the electrical designer (contractor) point of view and from the electrical utility point of view.

Using the data for Saudi Arabia load calculation for residential and commercial buildings. For a 200 m2 residential apartment, estimated load is 32kVA, but from utility point of view the load is 16 kVA (DF=0.5). For commercial buildings 100 m2, the estimated load is 22 kVA while based on utility calculations its 13.2 kVA. Thus the total load for the whole building can be calculated as follows:

1- Electrical designer from contracto point of view (where cables and circuit breakers will be calculated) and using the Saudi Arabia code:

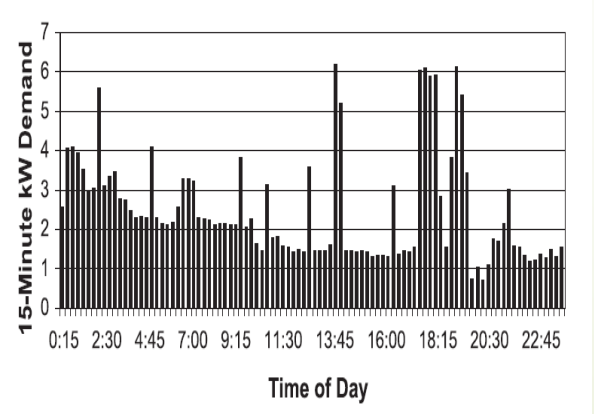
(5*32)+(3*22)= 226 kVA

- **2- Electrical designer from utility point of view (for sizing the distribution transformer feeding the area):**

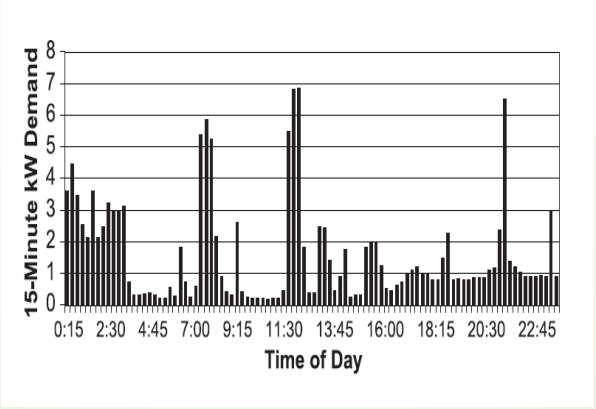
(5*16)+(3*13.2)= 119.6 kVA

6. Diversified Demand الحمل المتباين

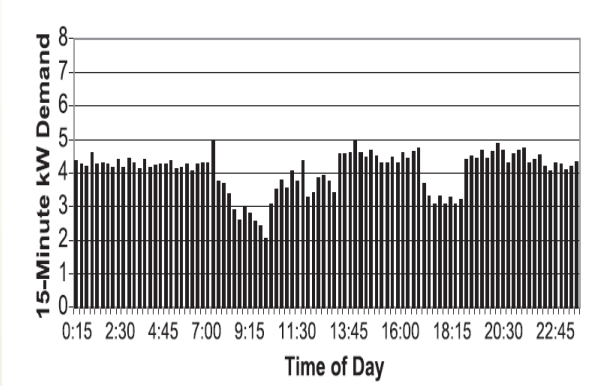
- **Sum of demands imposed by a group of loads over a particular period**
- Must include demand interval, period, and units
- ***Example*: the 15-minute diversified kW demand in the period ending at 9:30PM was 200 kW**
- **يستعمل لمجموعة من الأحمال المختلفة من حيث الإستهلاك، مثلا حمل صناعي و حمل سكني و حمل تجاري**
- **There is diversity between each apartment and another, and also between each load in the apartment**



24-hour demand curve for Customer #1.



24-hour demand curve for Customer #2.



24-hour demand curve for Customer #3.

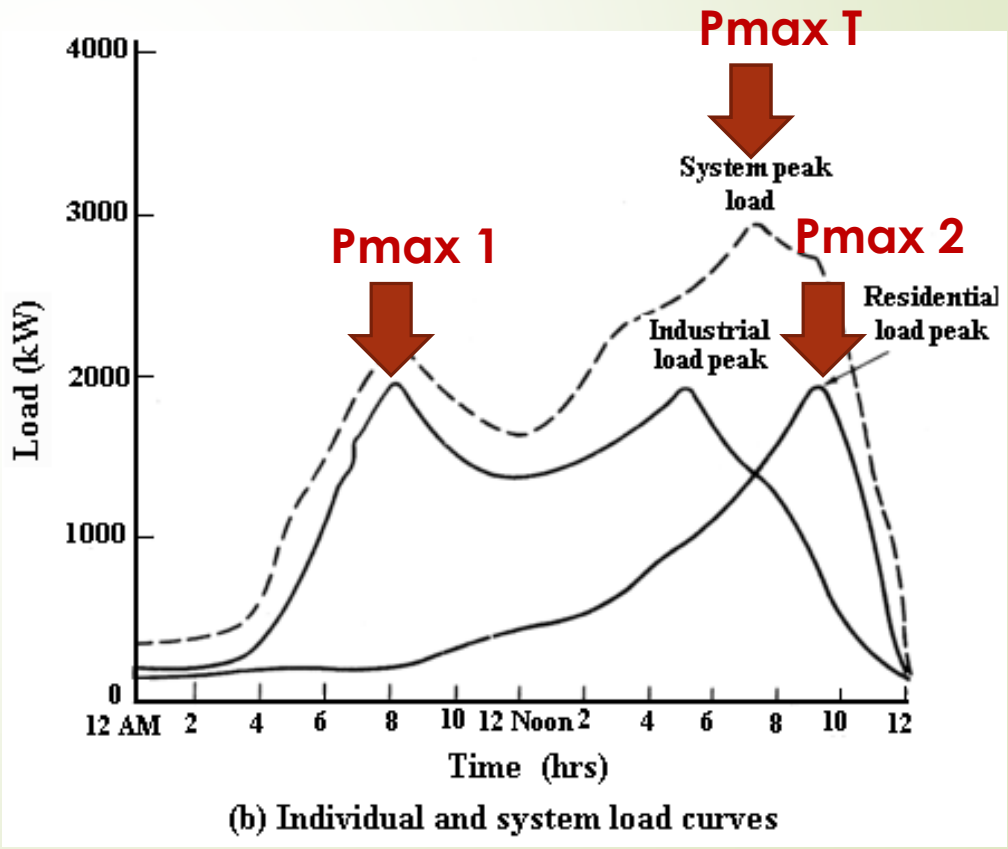
7. Diversity Factor/ Simultaneity Factor (Ks) معامل التباعد أو التباين

- Ratio of the maximum non-coincident demand to the maximum diversified demand (the inverse of Factor of simultaneity (ks)).
- For a quantitative measure of the inherent diversity of individual load peaks a diversity factor is defined as

$$\text{Div. F} = \frac{\sum_{i=1}^{N} P_{max_i}}{P_{max_T}}$$

Greater the diversity factor, lesser is the cost of generation of power.

Term "simultaneity" is used by some and means $\frac{1}{Div.F}$ and is thus higher than 1



(b) Individual and system load curves

7. Diversity Factor معامل التباعد أو التباين

Elements of System	Diversity Factors			
	Residential	Commercial	General Power	Large Industrial
Between individual users	2.00	1.46	1.45	
Between transformers	1.30	1.30	1.35	1.05
Between feeders	1.15	1.15	1.15	1.05
Between substations	1.10	1.10	1.10	1.10
From users to transformers	2.00	1.46	1.44	
From users to feeder	2.60	1.90	1.95	1.15
From users to substation	3.00	2.18	2.24	1.32
From users to generating station	3.29	2.40	2.46	1.45

According to IEC standard

The residential load has the highest diversity factor. Industrial loads have low diversity factors usually of 1.4, street light practically unity and other loads vary between these limits.

7. Diversity Factor معامل التباعد أو التباين

Number of circuits	Diversity Factor (ks)
Assemblies entirely tested 2 and 3	0.9
4 and 5	0.8
6 to 9	0.7
10 and more	0.6
Assemblies partially tested in every case choose	1

According to IEC standard for distribution switchboards

Apartment	Diversity Factor (ks)
2 To 4	1
5To 19	0.78
10To 14	0.63
15To 19	0.53
20To 24	0.49
25To 29	0.46
30 To 34	0.44
35 To 39	0.42
40To 40	0.41
50 To Above	0.40

According to IEC standard for an apartment block

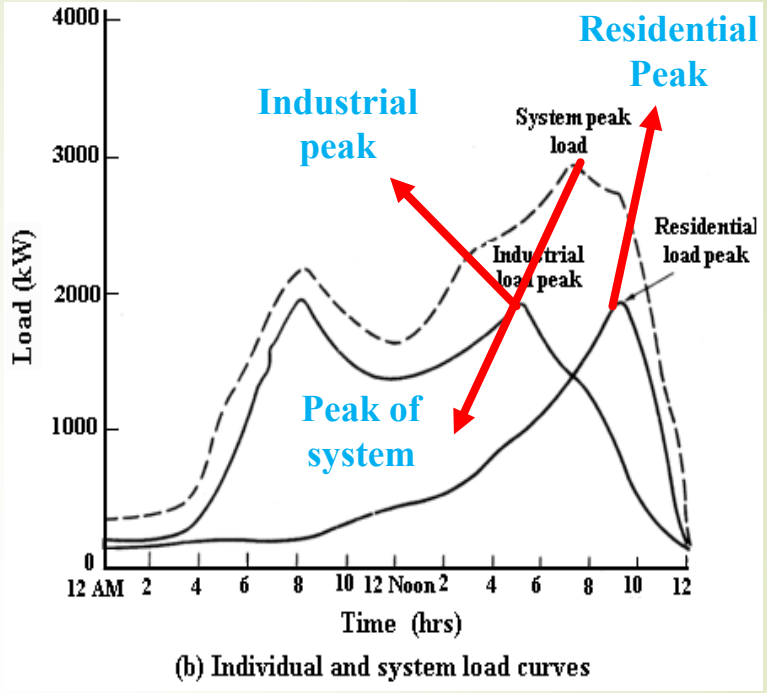
8. Maximum Diversified Demand

Maximum of the sum of the demands imposed by a group of loads over a particular period

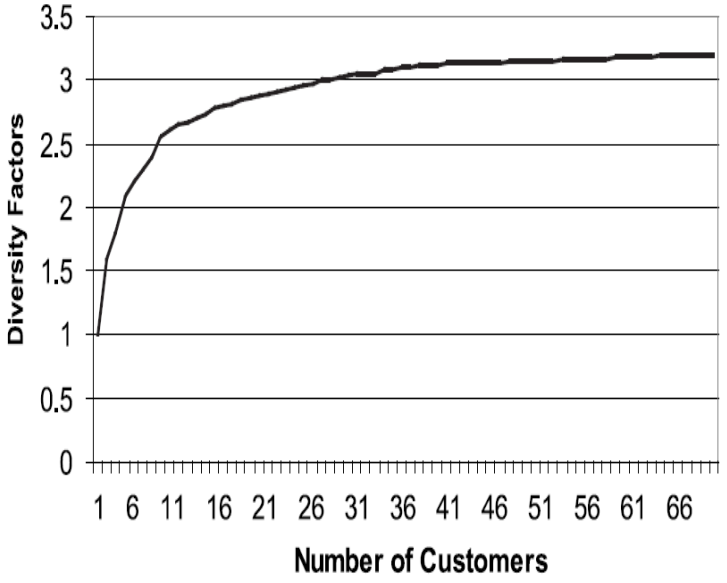
- Must include demand interval, period, and units

Diversity factor changes according to social standard, number of customers, equipment's used…..etc

The greater value the better



(b) Individual and system load curves



9. Utilization Factor

The time that an equipment is in use divided by the total time that it could be in use.

- In normal operating conditions the power consumption of a load is sometimes less than that indicated as its nominal power rating, a fairly common occurrence that justifies the application of an utilization factor (ku) in the estimation of realistic values.
- The motor may only be used for eight hours a day, 50 weeks a year. The hours of operation would then be 2000 hours, and the motor Utilization factor for a base of 8760 hours per year would be 2000/8760 = 22.83%. With a base of 2000 hours per year, the motor Utilization factor would be 100%. The bottom line is that the use factor is applied to get the correct number of hours that the motor is in use.
- . In an industrial installation this factor is estimated on an average at 0.75 for motors.
- For incandescent-lighting loads, the factor always equals 1.
- For socket-outlet circuits, the factors depend on the type of appliances being supplied from the sockets concerned.

Connected loads for high load density apartment building 200m²

Connected loads		Connected Loads	
Load Type	***Specifications***	**Unit load**	**Total Load**
L_1	Lighting and general use receptacles used for desk lamp, TV, radio cassette, etc.	30 VA/m² (Area=200 m²)	6000 W (P.F≈1)
L_2 (Small appliance circuits)	Vacuum cleaner Refrigerator Small oven toaster Kitchen-machine	1000 W 500 W 600 W 500W	2600 W
L_3 (Fixed appliance circuits)	Full-automatic washing machine Dishwasher Oil deep frying Water heater Ironing	2500 W 2500 W 2000 W 2000 W 1000 W	10000 W
L_4	Electric cooker	1500 W	1500 W
L_5	Two air-conditioning units each rated 3.5 HP (Cold & Hot)	≈3500 VA (each)	7000 VA

الأحمال الخفيفة

حمل متحرك ممكن كل 6 مع بعض

حمل ثابت يحتاج بريزه خاصة واخذ مباشرة من اللوحة

Categorized according to IEC

Residential Load estimated values that are typically used in Egypt

م	الجهاز أو المعدة	القدرة (وات)	معامل القدرة
1	فرن كهربائى	2000	1
2	مسطح تسخين (قرص)	2000	1
3	سخان مياه كهربائى	1500	1
4	مجفف ملابس	1200	0,9
5	فرن ميكروويف	1000	0,9
6	غسالة ملابس	1000	0,95
7	غسالة أطباق	1000	0,95
8	مكواه كهربية	1000	1
9	فرن تسخين الخبز	1000	1
10	مكنسة كهربية	1000	0,95
11	مجفف شعر	1000	0,95
12	طابعة	750	0,9
13	خلاط	500	0,85
14	طلمبة مياه	500	0,95
15	جهاز إنتاج الثلج	250	0,9
16	مبرد مياه	200	0,9
17	ثلاجة	150	0,5
18	دبب فريزر	150	0,5
19	حاسب آلى	200	0,8
20	ماكينة خياطة	125	0,9
21	تليفزيون	100	0,9
22	نظام إذاعة إستريو	100	0,9
23	مستقبل أقمار صناعية	100	0,9
24	مروحة	60	0,95
25	جهاز إتصال داخلى	50	0,9
26	مسجل فيديو	50	0,9

IEC recommendations for estimating the diversified peak demand of residential building consists of multi-dwelling units are:

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- *Illumination*: **50%** of total connected load.
- *Small appliance circuits:* **100%** of rated load for maximum outlet wattage in the circuit plus **40%** of the total connected loads of other outlets in the circuit.
- *Fixed appliance circuits & Fixed electric ranges:* **100%** of rated load of largest equipment plus **50%** for rated load for the 1st equipment following the largest one plus **33%** for the 2nd equipment following the largest load plus **20%** of total connected load of other equipment.
- *Electric water heaters:* **100%** of rated load of largest equipment plus **100%** for rated load for the 1st equipment following the largest one plus **25%** of total connected load of other equipment.
- *Air-conditioning units:* **100%** of total connected load in all cases.

This way of calculating the DF is per standard and does NOT depend on social category or environment

Applying IEC recommendations for the connected loads of the high load density apartment building gives:

$L_1 = 0.5 \times 6000 = 3000$ W

$L_2 = 1000 + 0.4 \times (500+600+500) = 1640$ W

$L_3 = 2500 + 0.5 \times 2500 + 0.33 \times 2000 + 0.2 \times (2000+1000) = 5010$ W

$L_4 = 1500$ W

$L_5 = 7000$ W

$\mathbf{P_{max} = 3000 + 1640 + 5010 + 1500 + 7000 = 18150\ W}$

Σ connected load demands = 6000+2600+10000+1500+7000 = **27100 W**

$$DF = \frac{18150}{27100} = \mathbf{0.67}$$

Very common value in residential buildings

The more the equipment, the lower the DF

Demand factor calculation as per IEC standard and as used in Egypt for all types of building

جدول 3-7 : معاملات التخفيض في الدوائر المختلفة

نوع الحمل	عمارات تتكون من عدة وحدات سكنية	وحدة سكنية أو وحدات سكنية خاصة	فنادق صغيرة أو مبانى عامة للنوم والمعيشة	مكاتب ومتاجر ومبان عامة مختلف الورش والمصانع
الإنارة	50٪ من الحمل الكلي	66٪ من الحمل الكلي	75٪ من الحمل الكلي	90٪ من الحمل الكلي
المآخذ الكهربائية (البرايز)	100٪ من التيار التصميمي لأكبر مأخذ بالدائرة. + 40٪ من مجموع التيارات التصميمية لباقي مآخذ الدائرة	100٪ من التيار التصميمي لأكبر مأخذ بالدائرة. +40٪ من مجموع التيارات التصميمية لباقي مآخذ الدائرة.	100٪ من التيار التصميمي لأكبر مأخذ بالدائرة. +40٪ من التيار التصميمي لباقي مآخذ الدائرة. +75٪ من التيار التصميمي لباقي المآخذ في دوائر الأماكن العامة بالمبنى.	100٪ من التيار التصميمي لأكبر مأخذ بالدائرة +75٪ من مجموع التيارات التصميمية لباقي مآخذ الدائرة
الأجهزة الكهربائية الثابتة مختلف المحركات والسخانات وأجهزة الطهي	100٪ من الحمل الكامل لأكبر جهاز. +50٪ من الحمل الكامل للجهاز الأول الذي يلي أكبر جهاز +33٪ من الحمل الكامل للجهاز الثاني الذي يلي أكبر جهاز +20٪ من الحمل الكامل لباقي الأجهزة	100٪ من إجمالي الحمل الكامل لمجموع الأجهزة حتى سعة 10 أمبير +50٪ من الحمل للأجهزة التي حملها يزيد عن 10 أمبير	100٪ من الحمل الكامل لأكبر جهاز +80٪ من الحمل الكامل للجهاز الأول الذي يلي أكبر جهاز +60٪ من الحمل الكامل لباقي الأجهزة	100٪ من الحمل الكامل لأكبر جهاز +75٪ من الحمل الكامل لباقي الأجهزة.
أجهزة الطهي الثابتة	100٪ من الحمل الكامل لأكبر جهاز +50٪ من الحمل الكامل للجهاز الأول الذي يلي أكبر جهاز 33٪ من الحمل الكامل للجهاز الثاني الذي يلي أكبر جهاز +20٪ من الحمل الكامل لباقي الأجهزة	100٪ من الحمل الكامل للأجهزة حتى 10 أمبير. +30٪ من الحمل المعادل الزائد على 10 أمبير +5 أمبير إذا كان يوجد بالجهاز مخرج إضافي.	100٪ من الحمل الكامل لأكبر جهاز. +80٪ من الحمل الكامل للجهاز الأول الذي يلي أكبر جهاز. +60٪ من الحمل الكامل لباقي الأجهزة	100٪ من الحمل الكامل لأكبر جهاز. +80٪ من الحمل الكامل للجهاز الأول الذي يلي أكبر جهاز. +60٪ من الحمل الكامل لباقي الأجهزة
المحركات الكهربائية "خلاف محركات المصاعد التي لها اعتبارات خاصة"	100٪ من الحمل الكامل لأكبر محرك + 50٪ من الحمل لباقي المحركات	100٪ من الحمل الكامل لأكبر محرك + 50٪ من الحمل لباقي المحركات	100٪ من الحمل الكامل لأكبر محرك +50٪ من الحمل الكامل لباقي المحركات.	100٪ من الحمل الكامل لأكبر محرك +80٪ من الحمل الكامل للمحرك الذي يلي أكبر محرك. +60٪ من الحمل الكامل لباقي المحركات.
السخانات الكهربائية متقطعة التشغيل	100٪ من الحمل لأكبر سخان +100٪ من الحمل الكامل للسخان الذي يلي أكبر سخان +25٪ من الحمل الكامل لباقي السخانات.			تقدر بمعرفة المختصين نبعاً لظروف التشغيل الفعلية المحتملة.
السخانات الكهربائية مستمرة التشغيل	100٪ من الحمل الكامل في جميع الحالات.			

Summary of Terms

•Diversity factors are used by utilities for distribution transformer sizing and load predictions. Commonly used with loads that are different among each other

يعني تباعد بين احمال ذات طبيعة مختلفة Div factor

•Demand factors are more conservative and are used by NEC for service and feeder sizing.

يعني تباعد بين احمال من نفس النوع Demand factor

•Demand factors and diversity factors are used in design. Load factor is calculated after system is being designed and is in operation and is used for determining the overall cost per unit generated.

Load factor indicates how efficiently the customer is using peak demand

Project:

Perform a load study for the following USING EGYPTIAN CODE:

1- Total luminaires (for illumination) total 15000 W
2- Electrical sockets: rated 2A each, 30 circuits (each circuit consists of 6 sockets)
3- Electrical equipment:
    a- Garage door with 1.2 hp motor (0.895 kW)
    b- Trade mill, 1400 watt
    c- 7 air conditioning units:
        i- 2 unit each rated 3.5 hp (2.6 kW)
        ii- 3 units each rated 2.5 hp (1.9 kW)
        iii- 2 units each rated 2 hp (1.5 kW)
4- Cooking equipment:
    a- electric cooker rated 6000 W
    b- 2 small electrical cookers each rated 2000 W
    c- electric heater rated 1200 W
5- Water pumps operating with electric motors:
    a- water pumping each rated 1.6 kW
    c- water irrigation each rated 2.8 kW
    d- basement pumps each rated 0.6 kW
6- Water heaters:
    a- 2 heaters continuously working each rated 3 kW
    b- 1 heater continuously working each rated 2 kW
    c- 1 heater for kitchen each rated 6 kW
    d- Jackoozy heater each rated 5 kW
    e- Sawna heater each rated 4 kW

Assume 1 hp= 746 W, heating load pf= 1, inductive load pf= 0.85, rated voltage 220V

Phase Balance (اتزان الاحمال)

1. الغرض من اتزان الاحمال هو جعل الحمل متقارب علي الثلاث فيزات و هذا يمنع فصل المفتاح الرئيسي بالخطأ ، لتقليل حمل التصميم النهائي.

		R	B	Y
1	lighting	1000		
2	lighting		800	
3	lighting			950
4	sockets	1200		
5	sockets		1500	
6	sockets			1000
7	water heater	1500		
8	air conditioner		2000	
9	air conditioner			3500
10	hand dryer	1500		
	sum	5200	4300	5450

How to calculate and apply load study on a group of apartments

- To make necessary calculations for the apartment cable and DB for an apartment:
  - Each apartment will follow the exact same way that was explained in the previous slides using the IEC standards
- To make necessary calculations for the floor cable and DB for a group of apartments ??
  - Follow the same as for a single apartment, but in this case treat each apartment as a load

Are there other ways???? YES THERE ARE

Electrical Load Estimation: **NON industrial loads**

1. **Lighting and Illumination:** Includes indoor and outdoor lighting. This includes normal and emergency lighting
2. **Small appliances:** general purpose sockets and office appliances, TV and refrigeration
3. **Space conditioning: heating and air conditioning**
4. **Water pumping, sewage, fire fighting and water heaters**
5. **Light loads:** Alarms and telephones
6. **Dynamic loads:** Lifts and elevators

Electrical Load Estimation: **Industrial loads**

1. Heavy load
2. Light load
3. Moderate load

Requires a bit of information about the type of load

Load estimation is based on experience and occupancy per m^2 (per area). This stage is very important in licensing, estimation of appropriate transformer, and sizing of space required for the electrical components

1- General lighting loads according to occupancy:

- Illumination represents from **20-50%** of total electrical load
- Ranges from 2 W/m^2 as in storage spaces to 50 W/m^2 as in stadiums and varies according to the standard used.
- The range for W/m^2 has changed over the years due to the use of energy saving lamps.

نوع الحيز أو المرفق	الحمل النوعي لكل متر مربع (واط)
البنوك	25
أماكن العبادة	20
النوادي الملاعب	50-20
المستشفيات	35-20
الفنادق ومباني الشقق المفروشة	15
المدارس	20-16
المكتبات	20-15
المتاجر	25
السلالم	10

NEC 220.14

15 W/m^2	في المباني السكنية .
30 W/m^2	في المكاتب .
60 W/m^2	في المحلات و المولات الكبيرة .
30 W/m^2	في المساجد والمدارس والصالات العامة.

Kuwait code

2- General Purpose Sockets

- Many methods are used, for example
  - it is estimated that each socket can carry up to 180 VA
  - Or each socket carries 1.5 A
  - Or using tables according to the load itself as in the table below
- Generally, we can say that each socket must tolerate 100 W, unless the socket is designed for a specific load such as 500 W for an electric water heater socket.
- The number of general purpose sockets connected on one radial is between **2-5** connected in a ring form
- The presence of range is due to electronic and computer load increase in recent years

جدول 3-2 : الأحمال القياسية لبعض الأجهزة المنزلية

الجهاز	الحمل التقديري (W)
جهاز تكييف :	
0.5 tan	800
0.75 tan	1200
1 tan	1600
2 tan	3000
سخان مياه	6000-3000
فرن كهربي	5000-3000
تلفزيون	1000-300
ميكروويف	1000-500
غسالة	1200-800

NEC

جدول 3-3 : أحمال تقديرية للمخارج العامة

المكان	الحمل التقريبي W/m^2
المكاتب / الشقق السكنية	50 - 30
المحلات	60 - 40
الفصول	20-10
المطابخ	2 : 6 Circuits (each of 20A)

NEC

2- General Purpose Sockets

- This type of load increases with time, for example in the past it was 20 W/m^2 then this number increased to 50 W/m^2

Place	Approximate load W/m^2
Office/ meeting rooms/ houses	30-50
Shops	60-40
classrooms	20-10
kitchens	2-6 circuits (each 20A)

Kuwait

3- General Purpose Appliances الخدمات العامة

- They are appliances for general use like lifts, water pumps, stairs lighting.
- This type of load is selected by the mechanical engineer. The typical value for the lifts are 15-25 kW depending on the building height and number of users. Typical values for water pumps are 5kW.

4- General air conditioning loads according to occupancy

Type of occupancy	Load VA/m^2
Bank	70
Department store	30 – 50
Hotel	60
Office building	60
Restaurant	80
Small shop	40 – 120
Telephone exchange	70 – 80

IEC standard

Central Air Conditioning W/ M², BTUs/Hour/SF of Floor Area, and SF/Ton of Air Conditioning

Type of Building	Watts per M²	BTUH per S.F	S.F per Ton
Apartments, Individual	33.3	26	450
Corridors	27.8	22	550
Auditoriums & Theaters	36.7	40	300/18*
Banks	63.3	50	240
Barber Shops	61.1	48	250
Bars & Taverns	166.7	133	90
Beauty Parlors	84.4	66	180
Bowling Alleys	86.7	68	175
Churches	36.7	36	330/20*
Cocktail Lounges	86.7	68	175
Computer Rooms	177.8	141	85
Dental Offices	66.7	52	230
Dept. Stores, Basement	44.4	34	350
Main Floor	50	40	300
Upper Floor	37.8	30	400
Dormitory, Rooms	50.0	40	300
Corridors	37.8	30	400
Dress Shops	54.4	43	280
Drug Stores	100	80	150
Factories	50	40	300
High Rise Off.Ext. Rms.	57.8	46	263
Interior Rooms	46.7	37	325
Hospitals, Core	54.4	43	280
Perimeter	58.9	46	260
Hotels, Guest Rooms	55.6	44	275
Public Spaces	68.9	55	220
Corridors	37.8	30	400
Industrial Plants, Offices	47.8	38	320
General Offices	44.4	34	350
Plant Areas	50	40	300
Libraries	63.3	50	240
Low Rise Off. Ext.	47.8	38	320
Interior	42.2	33	360
Medical Centers	35.6	28	425
Motels	35.6	28	425

4- General air conditioning loads according to occupancy

Application	
Residential	65 W/m2
Offices	70 W/m2
Shops	90 W/m2
Big malls	80 W/m2
Worship places	120 W/m2
Schools	100 W/m2
Public spaces	145 W/m2

Kuwait standard for central air conditioning
MEW/R-6

Electrical load characteristics

- Utilities supply a broad range of loads, from **rural areas** with load densities of ***10 kVA/m²*** to **urban areas** with ***300 kVA/m²***.
- Some ***typical*** load density values are as follows,

For buildings:

- Lighting	***10 – 25 W/m²***
- Air conditioning	***1 – 3 kW/equipment***
- Office buildings	***100 W/m², 2 kVA per workplace***
- Lifts	***10 – 50 kVA / lift***
- Hotels	***3 – 4 kVA / room***

Electrical load characteristics

- For industrial and trading centers:

  - Repair workshops, automatic lathes,
    weaving and spinning mills, ***50 – 100 kW/mil^2***
  - Machine tool manufacture,
    mechanical workshops and welding plants, ***70–300 kW/mil^2***
  - Press shops, hardening,
    steel smelting and rolling mills, ***200 – 500 kW/mil^2***

Load Calculation (Egypt)

- VA / m^2 is used in buildings that do not exceed 15 floors according to table 1 and for more than 15 floors according to table 2

Less than 15 story building		
kVA /m^2		
Commercial	Residential	
12-6	Low منخفض التكاليف	1.5-2
	Medium standard	2.5-4
	High standardاسكان فاخر	8-10

More than 15 story building	
kVA /m^2	
Commercial	Residential
12	8-10

Demand factor- A different perspective
عامل الطلب

- As mentioned earlier, since not all "lamps" will operate at the same time. This means that our demand is not 100% and hence the term "demand factor" is being utilized.
- Demand factors differ depending on the type of load, and depends on the building type (residential, commercial…etc)
- Typical demand factors for residential illumination= 90% and for general purpose sockets is 20%. DF differs from one country to another

Demand factor for different types of load (Excluding air conditioning and space heating)

Type of load	Demand Factor
Cinemas	0.7 – 0.9
Shops	0.5
Theaters	0.6 – 0.8
Lifts	
Two	0.95
Four	0.85
Hospitals	
Kitchen	0.6
Lifts	1.0
Laundry	0.6
Sterilization	0.4
Medical equipment	0.6
Industry	
Lighting	1.0
General purpose equipment	0.4
Semi-continuous operations: paper mills, refineries, rubber, etc.	0.6
Continuous operations: textile mills, chemicals etc.	0.9
Welding	
Arc welders	
100% loading time	1.0
80%	0.9
60%	0.8
40%	0.65
20%	0.5
Resistance welders	
50% loading time	0.75
30%	0.55
15%	0.4
≤ 5%	0.22

Projects – Week 5

- Perform load calculation for a typical mosque/church whose area is 500 m2
- Perform load calculation for a residential building of 12 apartments, each apartment is 150 m2

Indicate which code will you be using, hand written calculations with clear mathematical workout and steps