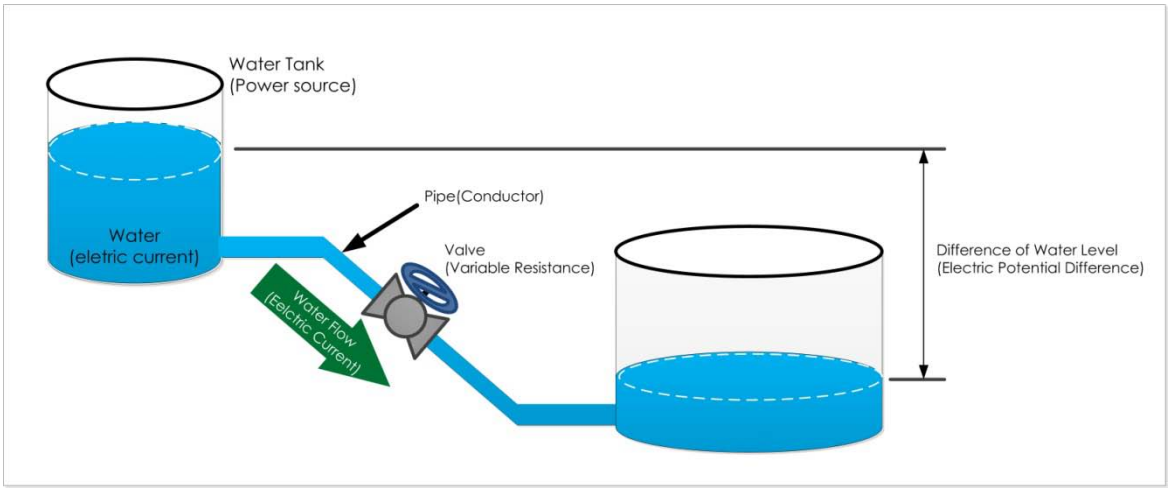
V. Basic Electrical Knowledge

1. Electricity

1) Voltage, Electric Potential Difference



• Definition

Like water flows from high location to low location, also electric energy (electric charge) moves from the high potential to the low potential. At this point, the difference of potential energy between the high and low point is defined as Voltage.

Like the falling water from high point has more energy than from low point, more difference of the potential energy, the more difference the potential energy has, the more amount electric energy creates.

Like water cannot flow in the condition of being on a flat, electric current (electric energy) cannot be created in the condition of no voltage (electric potential difference).

• The Unit of Voltage

V (volt) is the unit of voltage which means the magnitude of voltage.

1V is the electric potential difference under the condition that work is 1J (Joule) when the electric charge of 1C (Coulomb) moves between two points.

2) Electric Current

• Definition

Like water flows from high location to low location, also electric energy (electric charge) moves from the high potential to the low potential.

Like the gravitation of earth is the source of force creating a water flow, Electromotive Force is the source of force creating electric current

Electric circuit is the way for electric current, which is corresponding a water way.

And the equipment or device that uses electric energy for operation is called Load which corresponds with a waterwheel revolved by water.

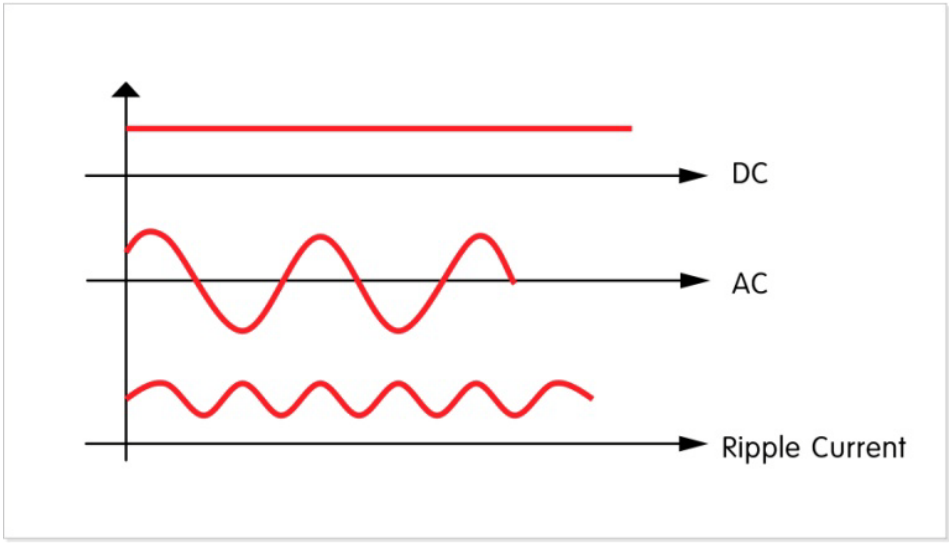
• The unit and type of electric current

A (Ampere) is the unit of electric current which means the magnitude of electric current.

1A is the magnitude of electric energy in the condition that 1C of electric charge passes through a certain cross section during 1 second.

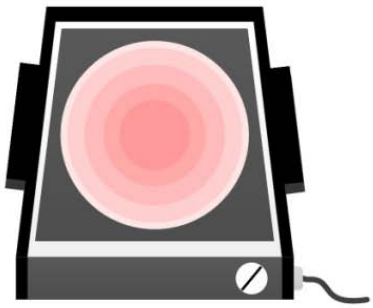
The direction of the (electric) current is decided by the moving direction of static electric charge (positive electric charge) as the moving direction of static electric charge is defined as positive(+) direction.

The current is classified as two types. One is **D**irect **C**urrent that the direction and magnitude is unchangeable. Another is **A**lternating **C**urrent that the direction and magnitude is changeable at a certain interval of time.

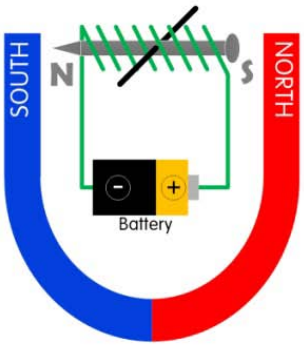


• The Action of Electric Current

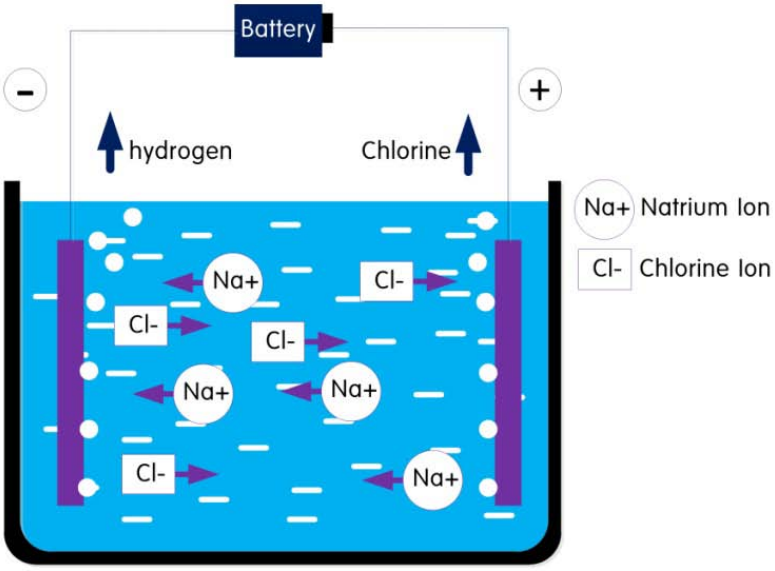
If electric current flows in a wire, it generates the heat by the collision of free electron and atom or another electron. This phenomenon can be easily detected through electric heating devices such as electric bulb, electric rice cooker, electric iron. However, if the generation of heat occurs in general electric devices, it may cause an electric loss and degrade the material property of insulation.



Generation of Heat



Magnetic Action



Chemical Action

In addition, the current makes a magnetic field around a wire in which current flows.

Based on such magnetic phenomenon, the current (electric energy) is able to be converted into dynamic energy such as an electric magnet, ammeter, electric motor and the magnetic levitation train. And chemical decomposition occurs when the current flows at an electrolyte liquid. For example, when creating electric current in water, electrolysis is caused. It generates the hydrogen in the cathode and the oxygen in the anode.

On the other hand, a battery, storage battery creates electric energy by means of chemical decomposition.

3) Electrical Resistance

• Definition

When an object is moving, there can be the resistance against the direction of the movement. For example, air resistance acts on the wing of an airplane when the airplane is in flight. Resistance hinders movement. Moreover, resistance exists even in the movement of heat or electricity. Of things, the resistance on the movement of electricity is called electric resistance.

Therefore, the electric resistance decreases the conductivity, which means the current is hard to be created.

• The Unit and Characteristic of Electric Resistance

Ω (Ohm) is the unit of magnitude of electric resistance. 1Ω is the magnitude of resistance on 1A of electric current created by 1V.

In general, the resistance of material varies according to temperature. In the case of conducting material, resistance tends to be changed in proportion to the change of temperature while semiconductor and insulating material are opposite.

• Ohm's Law

Ohm's Law is experimental law, which was established by German physicist "Georg Simon Ohm" in 1827 as the magnitude of electric current is proportional to voltage and inversely proportional to resistance.

Voltage(V)	=	Current(I)	x Resistance(R)
Current (I)	=	Voltage(V)	/ Resistance(R)
Resistance(R)	=	Voltage(V)	/ Current(I)

• Reactance

In AC circuit, resistance is defined as Impedence(Z). The element of Impedence is Resistance(R) and Reactance(X). and its unit is Ω.

The role of Reactance is to obstruct the creation of current as the same as resistance. But it makes the phase difference between voltage and current, which only appears in AC.

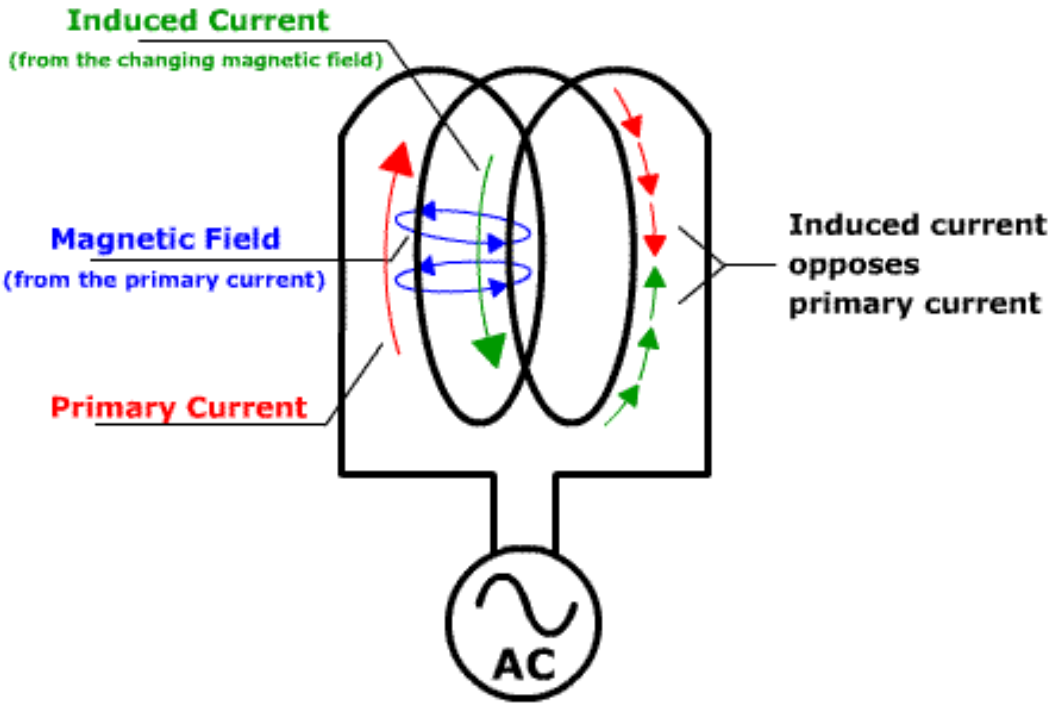
X_L stands for Inductive Reactance which is caused by Inductor. And **Xc** stands for Capacitive Reactance which is caused by Capacitor.

The detailed phenomenon of obstructing the flow of current is different between resistance and reactance.

In case of resistance, it is caused by the provided electric current itself. Because the movement of electron causes heat energy by the collision with molecules. On the other hand, Reactance is caused by a certain characteristic of circuit components as maintaining their electrical status. That is to say, inductive reactance is the energy by magnetic field, and capacitive reactance is the energy by electric field. And both tend to maintain electric status.

For example, in case of inductive reactance, it's the resistance by the characteristic of hindering the change of current. In case of capacitive reactance, it's the resistance by the characteristic of hindering the change of voltage. And both reactances exist only in AC.

Thus, such hindrance based on directivity is the cause of the phase difference.



2. Electric Power

1) the classification of power

• Apparent Power

- The original quantity of power provided from power plant.
- The value calculated by multiplying the effective voltage and current.
- The perfect condition of using 100% quantity of power originally provided from power plant without any loss.
- Unattainable value in natural condition

$$\text{Apparent Power(Pa)} = V \cdot I = \sqrt{(P^2 + Pr^2)}\,[VA, KVA]$$

• Active Power

- The quantity of effective power consumed in load, actual amount of power, except for the part of loss in the whole.
- In AC circuit, the phase difference occurs due to the resistance of electric cable and the resistance by the characteristic of components such as coil and capacitor. This difference is called **Power Factor** (COS θ). Power Factor is the indicator of the ratio of effective power in the whole.

$$\text{Active Power(P)} = V \cdot I \cdot \cos\theta = I^2 \cdot R\ [W, KW]$$

• Reactive Power

- The quantity of unusable power,
- In other words, the amount of power which cannot be used by load despite being supplied. Its amount is proportional to the phase difference.
- Generally, it's expressed as SIN θ.

$$\text{Reactive Power(Pr)} = V \cdot I \cdot \sin\theta \text{ [VAR,}$$

2) Power Factor*

- Definition

  - The value calculated by dividing Active power by Apparent power.
  - In AC circuit, it is defined as COS value of the phase difference between voltage and current.

$$\text{Power Factor(COS}\theta\text{)} = V \cdot I \cdot \cos\theta \ / \ V \cdot I = P / Pa$$

- the magnitude of power factor and its meaning

High value

A. Load (customer) — High use efficiency on the device of the same capacity

B. Source(provider) — High use efficiency on the power generating facility due to the optimization of power transmission.

Low value

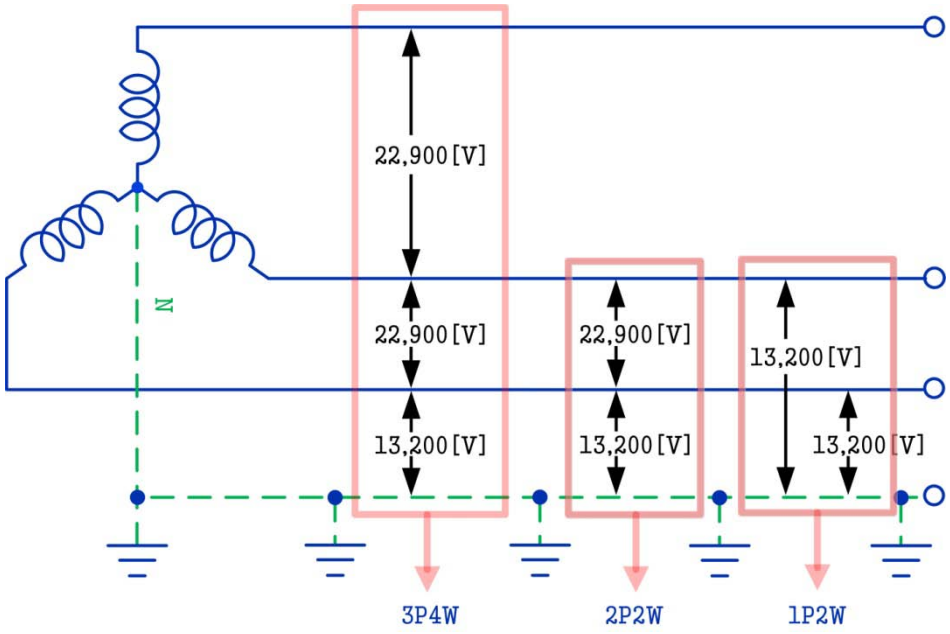
A. Load (customer) — Low use efficiency. And penalty charge has to be paid in case that power factor is less than 95%.

B. Source(provider) — Low efficiency of electric delivery. Less amount of electricity is delivered than the originally created amount, Which means the increase of cost for electric supply in comparison with the condition of high value of power factor in spite of delivering the same quantity.

To offset such inefficient cost for electric supply, electric provider demands penalty charge in the case of less than 95% power factor.

3. AC power distribution system

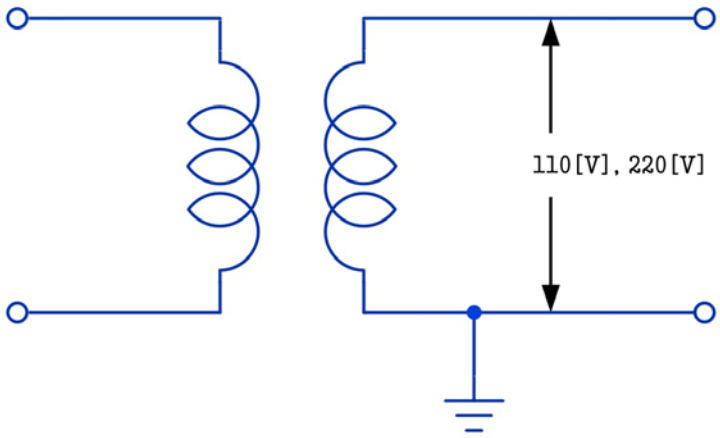
1) High Voltage Power distribution



- In case of a densely populated area, each pole transformer is grounded.
- In case of a sparsely populated area, pole transformer is grounded at the interval of not more than 300m.

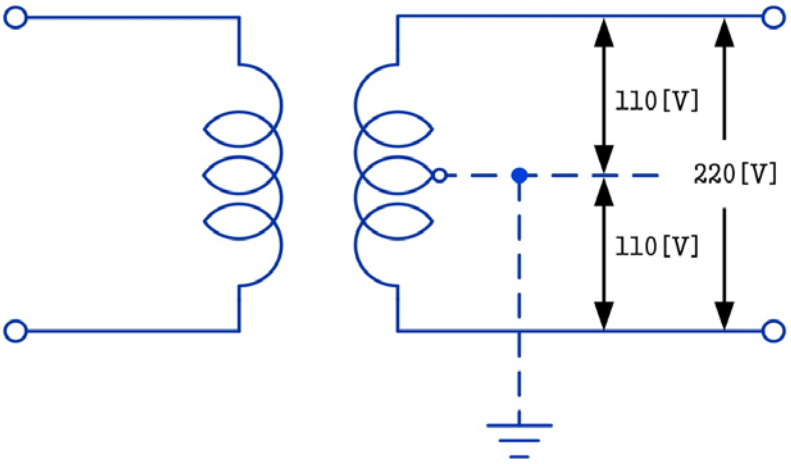
2) Low Voltage power distribution system

• 1 Phase 2 wire (110[V], 220[V])



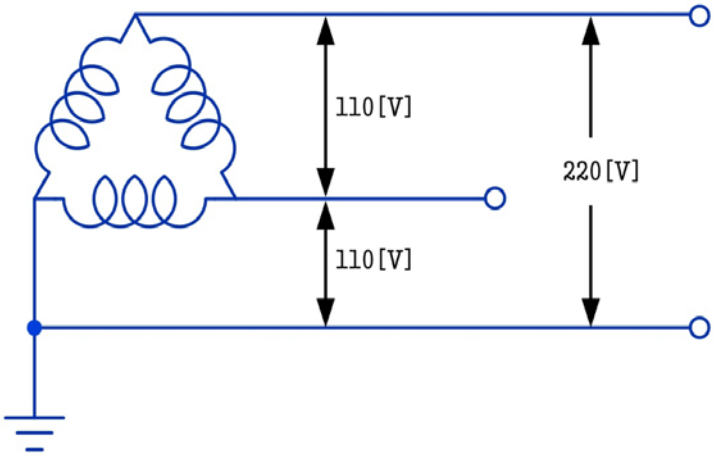
- Generally, used for most of residential places
- 110 or 220V is induced dependent on the connection of the secondary part (of transformer).

• 1 phase 3 wire(110[V], 220[V])



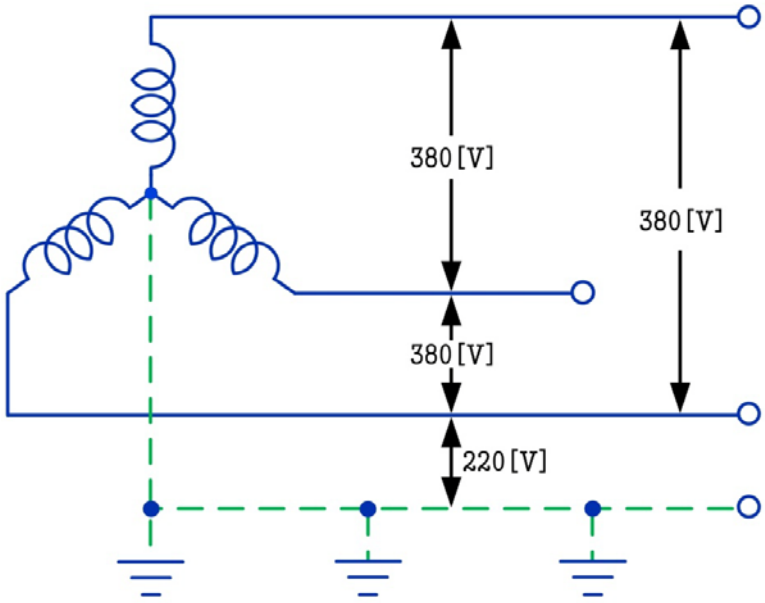
- Used for small-sized factory or the lighting load in residential place.
- In case of needing two types of voltage in one place
- It may cause an accident by overcurrent in the case of cutting a neutral wire, because overvoltage is caused to a terminal of low resistance.

• 3 phase 3 wire (110[V], 220[V])



- Generally, used for a part of the place in need of high voltage.

• 3 phase 4 wire (110[V], 220[V])



- Used for a place in need of both power-driven machine and lighting load.
- The system has two types. First is to use three transformers of the same capacity. Second is to use two transformers of the same capacity and one transformer of bigger capacity than the others.
- Superior to 1 phase 2 wire system in aspect of power loss and voltage reduction.
- In case of cutting off the neutral wire, overvoltage is able to be caused to single phase load.

4. Classification of load.

1) Resistive Load

- The load having the characteristic of resistance
- In AC, a little amount of a voltage drop occurs, while the phase difference doesn't occur.

Ex) Electric heater, lighting, electric coffee pot, electric blanket

2) Inductive Load*

- The load having the characteristic of inductor
- Generally, the permissible current value of load is low in comparison with resistive load, because the instant consumption is higher than resistive load.
- In AC, the phase difference is caused.

Ex) Motor(electric fan, Blender, washing machine), transformer

3) Capacitive Load

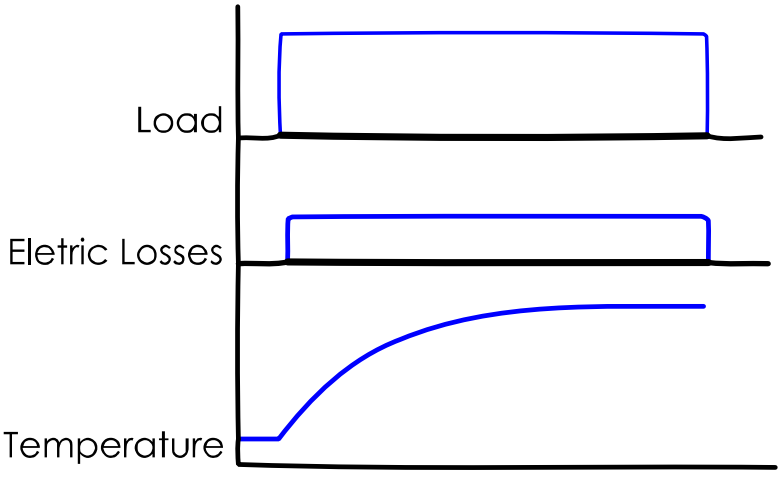
- The load has the function of charging and discharging like a battery
- In AC, the phase difference is caused.

Ex) Capacitor, batter

5. Operation of Inductive Load

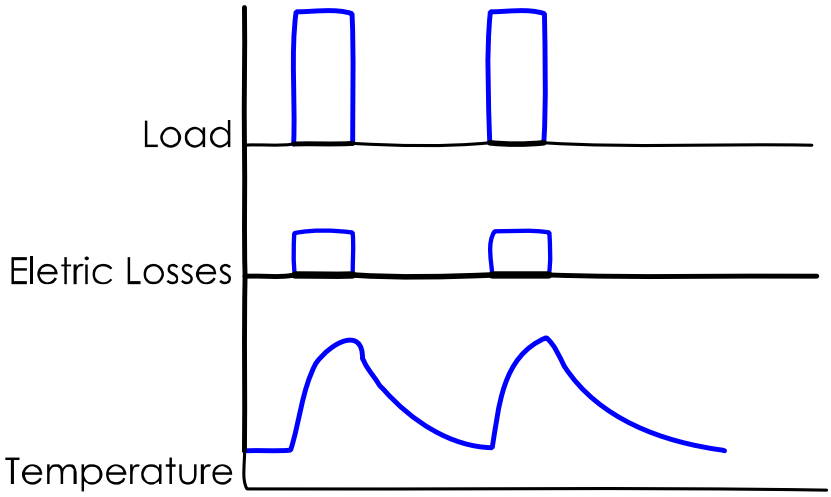
Inductive load has various operating modes according to its specific use. Of them, the stop-and-starting operating mode shows the best saving performance. This chapter explains each operating mode and their expected saving.

1) Continuous operating (S1)



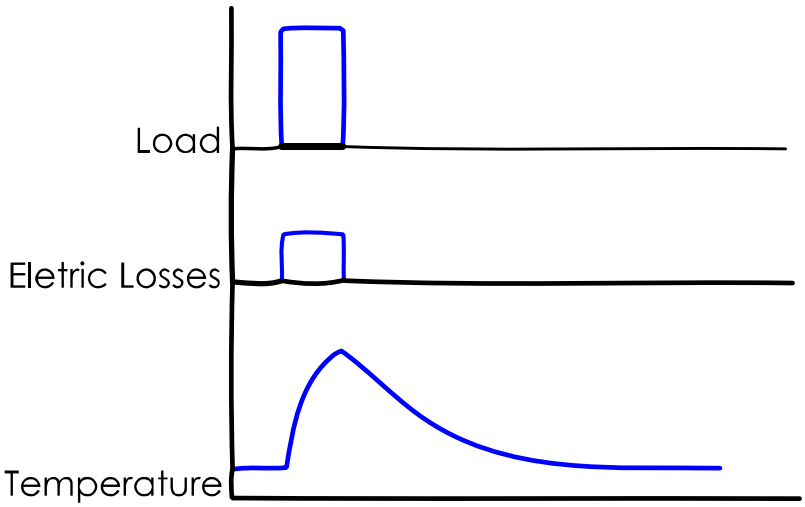
: A motor operates continuously until reaching to the status of thermal balance, and then stops. After a stop, the motor doesn't operate until the temperature of the motor becomes sufficiently dropped to a suitable low temperature.

2) Short-period operating (S2)



: A motor stops before reaching the thermal balance, and has an intermission until the temperature of the motor is balanced.

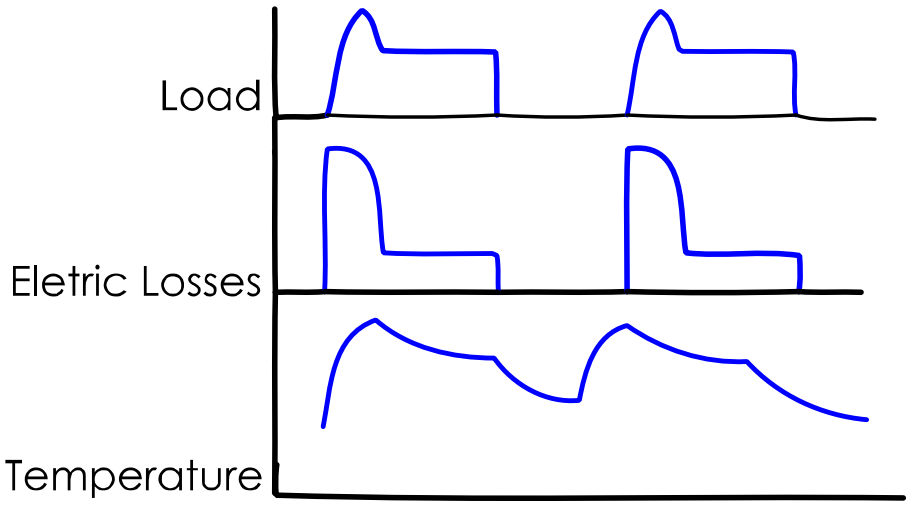
3) Intermittent operating (S3)



: A motor operates in the way of repeating the cycle of a short operating and short intermission. The operating period is not enough time to reach to thermal balance. The staring current doesn't affect on the increase of

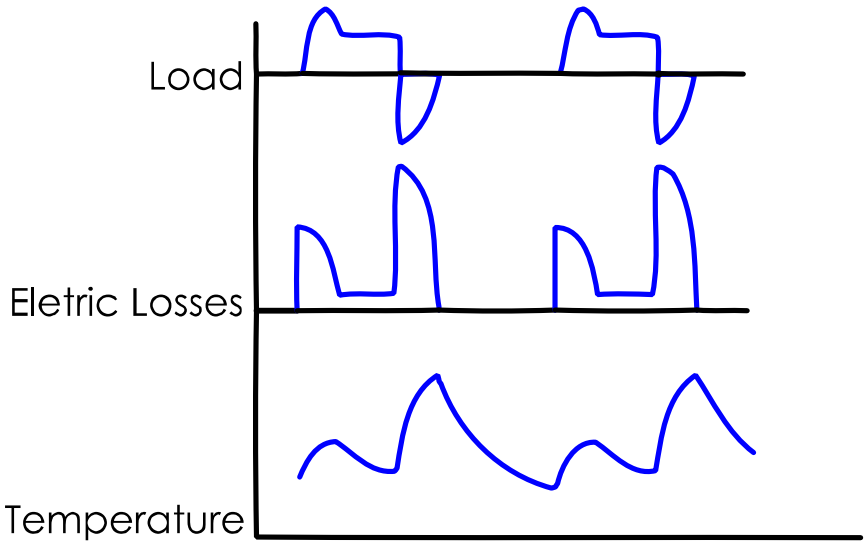
temperature.

4) Intermittent operating with a staring mode (S4)



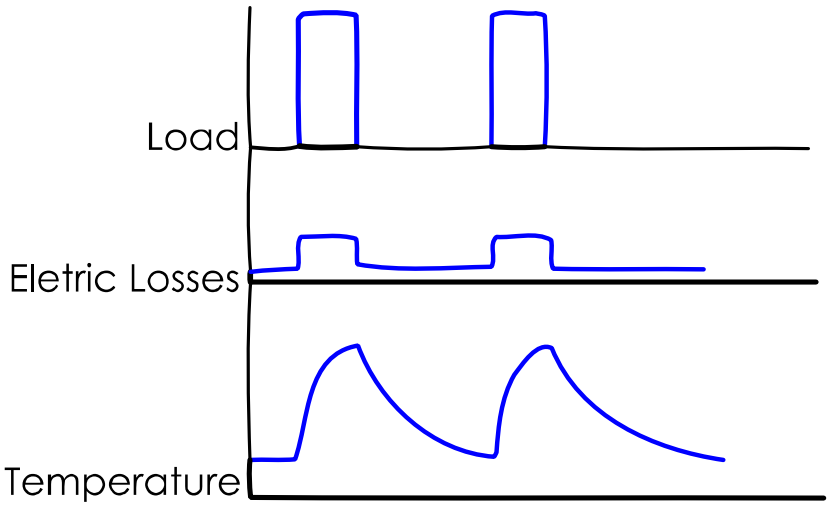
: Basically, the operating form is almost the same with “S3”, but having a starting mode which affects on the increase of temperature,

5) Intermittent operating with a damping mode(S5)



: Basically, the operating form is almost the same with “S4”, but having the electrical damping mode which affects on the increase of temperature,

6) Stop-and-Starting operating (S6)



: The Motor operates in the way of the specific operating cycle that consists of starting and stop mode. Regarding the stop mode, it is defined as the operating with idle load or low work intensity. Each of operating mode is converted before reaching to thermal balance.

VI. Selection of Suitable place

1. Test condition and requirement

Unchangeable condition during whole testing period is the basic rule of all kind of tests.

At this point, someone can think that's not a problem if perfectly controlling all factors that is able to affect on test result. However, the perfect management of all possible factors needs a very complicated calculation and analysis inevitably.

If ULTA test is only for a researcher or technical people like us, the matter would be much easier. Because, such people have the amicable mind to make an effort for the related preparation such as a study, analysis, calculation.

However, we should have not to forget that unfortunately most of people that you and I have to meet and talk and persuade are not technical people.

That is to say that the analysis and calculation for ULTRA test should be simple and clear as possible. To do so, the related variables must be minimized.

1) The place showing a stable consumption pattern.

- In case that a testing place shows the frequent fluctuation of an electric consumption, it becomes really hard to conduct a relevant data analysis as before and after the installation. Therefore, you have to find the place showing stable consumption pattern as possible.

2) The place having the needed data form of kWh.

- Someone simply thinks the average value form of consumption data is enough for ULTRA test as not recognizing the average value cannot show the maximum and minimum value of the related period, which lowers the reliability and accuracy of the test result because it's a rough analysis at most.
  Therefore, KESECO strongly advises for partners that the relevant data collecting during the whole test period be conducted by additional measuring equipment which can offer at least an hourly form of consumption data.

3) The place not showing irregular operation of load

- In case of manufacturing facility, a product and production quantity shouldn't be changed during the whole testing period. Because such two components is the main factors causing the change of consumption.
  In addition, if the information of the production quantity and operating time

can be obtained, the analysis of using kWh per a unit production is available as more objective analysis method.

- In case of commercial facility, the floating population (the number of visitors) is the main factor causing the change of consumption. So, various standardization methods are needed to effectively control the testing condition and environment.

4) The place of using inductive load in high ratio

- The recommended place is where there is the high percentage of inductive load, because the best load for ULTRA is inductive load.

- In case of the place having the mixed structure of R, L, C, ULTRA shows more than 5% energy saving in condition of more than 70% of inductive load also.

- However, the inductive load applied to ULTRA has to have the specific operating mode of the stop-and-starting operation. Without such mode, the energy saving rate may be decreased than 5%.

5) The place of providing the necessary data for analysis

- The electric diagram is the most important and usable information which shows load type and capacity, the connection structure of loads.

- The data of the accumulated electric consumption for last 2 years is very conducive information to analyze the consumption pattern in an install-planned load or system. This makes it possible to reflect the seasonal characteristic of electric consumption although it is less accurate than the data from conducting an actual measurement. Hence, the accumulated consumption data and the measurement data are complementary relation with one another.

2. The example of recommended places.

1) The recommended place for Commercial Model

 Mart	• Stable consumption pattern. a. Convenient for analyzing the number of visitor as weekly unit. • High percentage of inductive load a. enough possession of refrigerating facility b. High work intensity on cooling and freezing equipment
 Fast Food Store	• Stable consumption pattern a. Expectable pattern of floating population. b. According to the level of relevant system, the totalization of floating population in a certain of unit period is available • High percentage of inductive load a. enough possession of refrigerating facility b. High work intensity on cooling and freezing equipment

2) The recommended place for industrial model

 Press Factory	• Very high percentage of inductive load a. Work intensity and operating time is very high b. Frequent use of the stop-and-starting mode • Available to analyze in the form of kWh per a unit manufacturing a. High work intensity b. Through the information of the product type and output record, available to analyze the result in the form of kWh per a unit production.
 Injection factory	• High percentage of inductive load a. Load intensity and operating time of inductive load is very high b. Frequent use of stop-and-starting mode • Available to analyze in the form of kWh per a unit manufacturing a. High load intensity b. Through the information of the product type and output record, available to analyze the result in the form of kWh per a unit production.

3. Avoidable place due to the difficulty for data analysis

The following places are the representative examples of being hard to calculate and analyze a collected data only in the beginning stage of business. In other words, a problem suggested in this chapter can be solved after going through the experience of a lot of cases, because it is related with the expertness of the data management.

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Service Station</td>
<td>• High load intensity and enough operating time of load

a. High work intensity

b. Frequent use of stop-and-staring mode

Extreme fluctuation of consumption

It's hard to make an objective analysis result due to the fluctuating number of daily visitor.</td>
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<td> 
Storage in cold weather</td>
<td>• Cold Storage of being not isolated from external temperature environment.

In the truth, it's an unusual case, because most of cold storage is sufficiently isolated from external temperature. In this general case, this terms are not applied.

• Low percentage of inductive load, plus the low work intensity.

The work intensity is very low due to the influence of the already low degree of external temperature.</td>
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Pump Station

- Very high percentage of inductive load

  a. High capacity of inductive load is used

  b. High working intensity

  c. Frequent use of the stop-and-starting mode.

- The influence of the water pressure and the flow rate

The operation of pump is greatly influenced by the water pressure and the flow rate. To suitably control such factors, high precision equipment or corresponding equipment should be needed.

Resistive Load

- The fundamental characteristic of load

Energy saving technology is to reduce an energy loss caused in course of operating a load. Hence, energy saving rate doesn't become high if the applied load doesn't create much amount of energy loss. In this context, the possible energy saving is up to 3%, because resistive load causes an only little amount of energy loss. However, additionally less than 5% of increase of illumination intensity is possible.

VII. Estimation of ULTRA capacity

1. The estimation basis for selecting a proper model capacity

The correct process of estimating proper ULTRA capacity is the same as the exact understanding on the electric consumption pattern of an install-planned place. This chapter shows how to decide a suitable consumption of the place through the recommended values at general electric system. And the number of each item indicates the priority of recommendation.

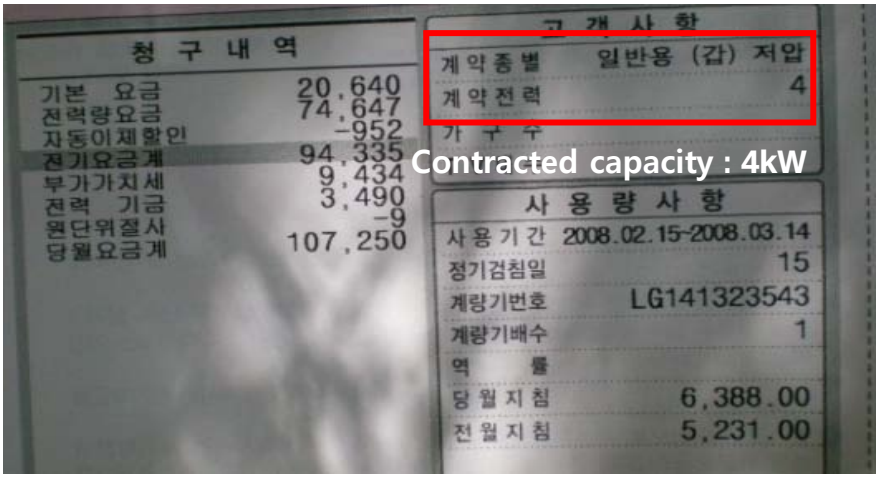
1) Main Transformer capacity

Main Transformer can be regarded as practical power source in the sight of the customer side, except for supplementary components such as electric cable, pole transformer...etc

When mulling the previous sentence over, it can be recognized that the consumption of the place cannot exceeds the Main transformer capacity.

In other words, it means ULTRA can wholly cover the max consumption of the place if selected based on Main transformer capacity.

2) Contracted capacity

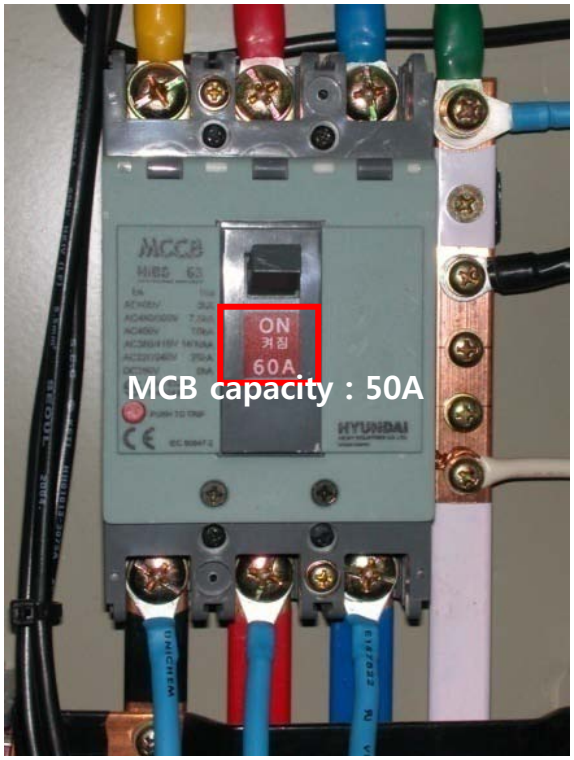


Contracted capacity means the possible max capacity of a place decided by the electric use contract between a provider and customer.

When adopting this basis, ULTRA can cover the max consumption of a related place, because the detailed decision of the contract capacity is in consideration of evaluating the total capacity of related loads.

However, in case of the increase of consumption by the expansion of facility or some reason of changing the operating environment, it may need an additional ULTRA unit. Because, the possible max capacity defined by contracted capacity is decided by the evaluation at the specific condition at that time when conducting the evaluation. In short, it's not the unchangeable definition.

3) Main Circuit Breaker capacity



MCB capacity is the sub-conception of Main Transformer Capacity

The role of MCB is to control the electric supply to the sub-section belonged to Main Transformer. Therefore, when adopting the MCB capacity basis, ULTRA can cover the max capacity caused from the connected loads.

However, in case of the increase of consumption by the expansion of facility or some reason of changing the operating environment, it may need an additional ULTRA unit, which is in the same context of Contracted Capacity.

The following formula is for the calculation of MCB capacity by using the current value stated on MCB.

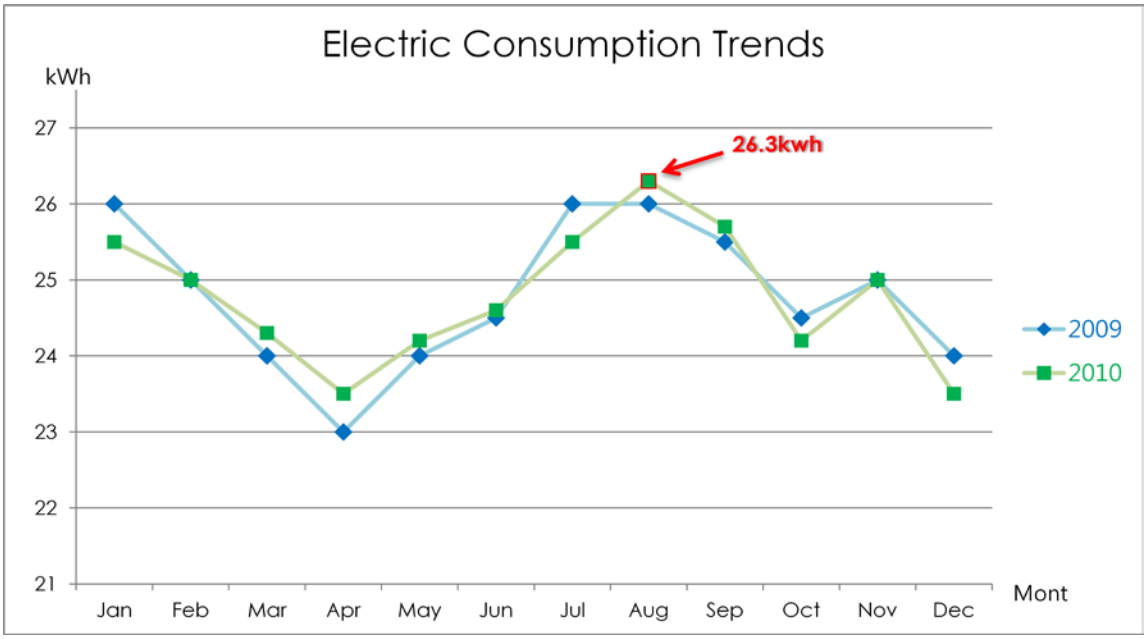
- **1 phase** = Voltage(V) · Current(A) · Cos θ
- **3 phase** = √3 · Voltage(V) · Current(A) · Cos θ

4) Total Load capacity

The meaning of Total load capacity is not different from the terms of Contracted capacity, because the capacity evaluation for deciding contracted capacity is to determine the possible max consumption of all connected loads as the sum of each load capacity. Hence, ULTRA can cover the possible max capacity caused from the relevant area when adopting this basis.

However, in case of the increase of consumption by the expansion of facility or some reason of changing the operating environment, it may need an additional ULTRA unit, which is in the same context of Contracted Capacity and MCB capacity.

5) Actual Peak Consumption



Actual Peak Consumption Basis is to decide the proper capacity based on the peak consumption in last 2 years. Therefore, to be effective, it requires the precondition that the consumption of an installed place will not exceed the decided peak value in future. If not, energy saving rate may be low than expected.

This basis can make the low product price of ULTRA, but the continuity of proper performance might be able to be broken easily in case of the increase of consumption in comparison with the former bases such as Main Transformer capacity, Contracted capacity, Total Load capacity.

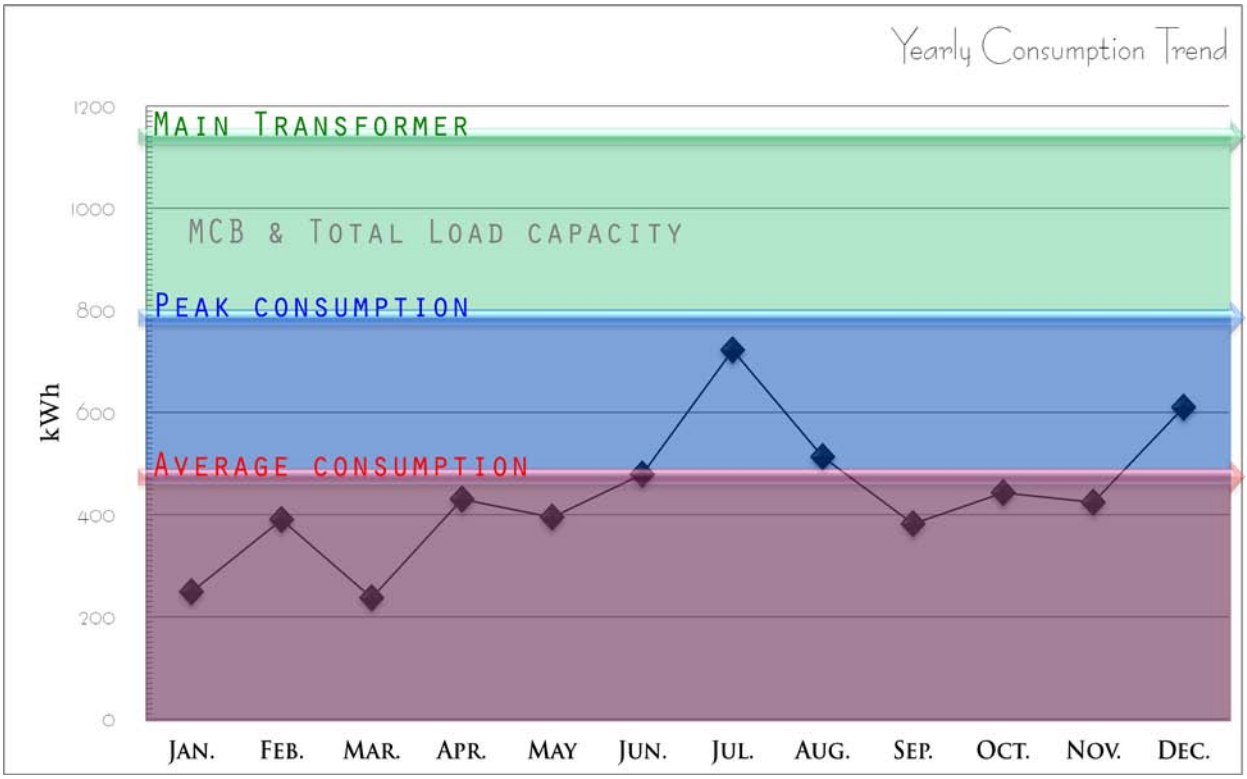
On that ground. KESECO recommend using an estimation basis according to the priority of recommendation as possible.

The below is the minimum condition for applying the actual consumption basis.

- **Check a stable consumption pattern** – through the last 2 years monthly consumption
- **Check the feasibility of maintaining a stable consumption in future** – analyzing potential variables
- **Minimum 30 min. of data collecting interval** – conduct a measurement during whole test period including the adaptation period.
- **Agree with a customer on Installation of an additional ULTRA** – in case of the increase of consumption in future

2. The Relation among the recommended estimation bases

This chapter gives the explanation on the characteristic of each estimation basis and their relation.



The way of increasing the ULTRA benefit is very simple, which is the satisfaction of both low initial investment and high rate of energy saving. But the fact is that the initial investment cannot decrease endlessly, and the energy saving rate cannot increase endlessly also.

Let's look closely in this terms. The initial investment indicates the purchasing price of the product. If so, what case can make the increase of the product price? That's the increase of the product capacity. Hence, the decrease of the initial investment means the minimization of the product capacity.

Average Consumption

It's the most preferred estimation basis of customers. But the preference is not always proportional to reliability. The reason of the preference is simple and clear as customers think it's the best method to minimize the initial investment without disturbing the proper performance.

However, the fact is somewhat different from their positive thought which contains the misunderstanding on the exact meaning of the average

consumption. The meaning of average value is not to cover whole consumption range, in other words, it cannot represent max value of consumption. So, if the consumption exceeds the average consumption, the energy saving rate decreases in proportional to the amount of increase like the above graph, but it doesn't mean the decrease of ULTRA effect in itself.

As known, the proper use of ULTRA is in condition that the consumption of an installed place is in the range of installed ULTRA capacity. Accordingly, the situation of exceeding the installed ULTRA capacity means the consumption of the place is over the acceptable capacity for showing proper performance. In short, it's the wrong use of the product.

As looking more closely in such terms, ULTRA shows the proper performance even in the area of showing the decreased saving rate which is just calculated including the not affected consumption area of ULTRA as the exceeding consumption on the installed ULTRA capacity.

Peak Consumption

If correctly understanding the characteristic of adopting Average consumption basis, the others will be easily understood.

In case of adopting Peak Consumption basis, ULTRA can cover to the extent of peak consumption. So, this might be the most reasonable estimation basis only if it's guaranteed that the consumption will not increase in future. If so, really will it be possible?

That is probably not, because generally energy consumption becomes increased unless an installed place becomes lost their potential or in a decline. As known, the development and improvement of industry needs more amount of energy unexceptionally. So, if it isn't considered in course of deciding a proper ULTRA capacity, the energy saving rate may be able to decrease before long.

So, in case of using Peak Consumption basis, KESECO recommend to comply with the specific condition (explained in 44page, chapter 5).

MCB & Total Load Capacity

MCB & Total Load Capacity are the strongly recommended estimation basis due to being more reliable in comparison with actual consumption basis.

Normally, MCB & Total Load capacity have higher value than Peak Consumption, but lower than Main Transformer Capacity. Therefore, it's not easily affected by the increase of consumption than Peak consumption as relatively. In addition, the initial investment is also cheaper than being based on Main Transformer capacity although Main transformer capacity basis is more effective in the aspect of embodying the best performance even in consideration of future demand.

Main Transformer Capacity

Main Transformer capacity is the ideal basis in the aspect of performance. So, it is the most recommendable. Main Transformer capacity can cover the possible max consumption including the future demand while MCB & Total Load capacity only cover the possible max capacity decided on the specific time of being applied.

As obstinately finding a disadvantage, its initial investment is the highest price in all estimation bases. However, when considering the accumulated benefit of energy saving for the 10 years of product life time, it's the most clever choice to adopt Main Transformer capacity basis which can maintain the best performance since the first installation.

3. Selection of Proper model.

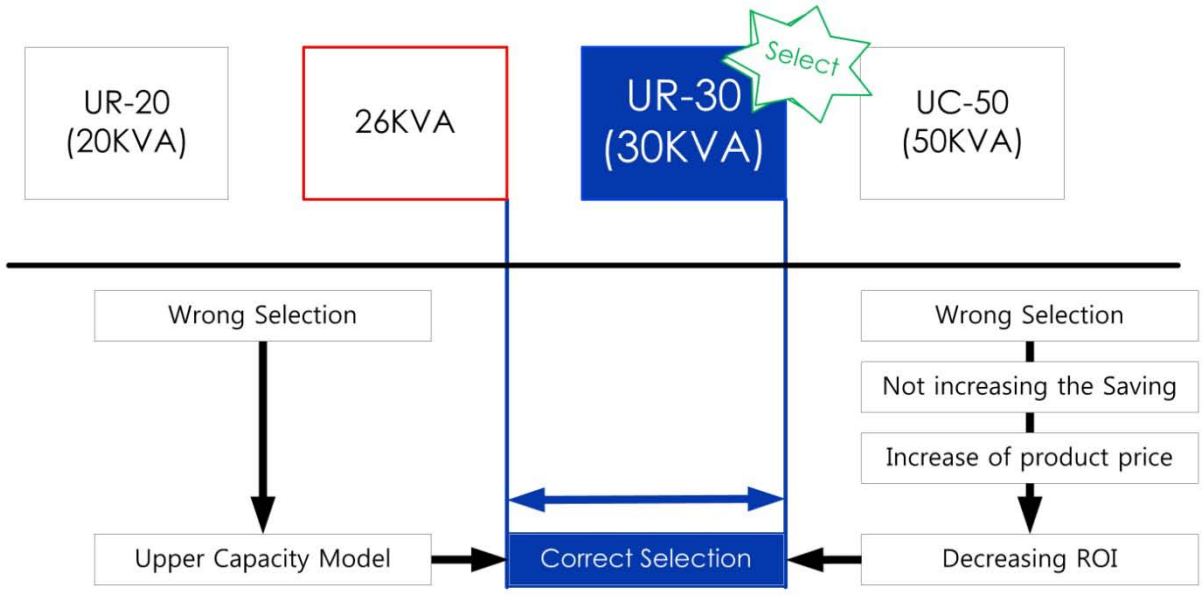
This chapter explains the appropriate method of selecting the proper model based on the understanding of electric consumption in an install-planned place.

1) The Correct method of selecting proper model.

『 The ULTRA model of upper capacity than the decided value by the recommended capacity estimation bases 』

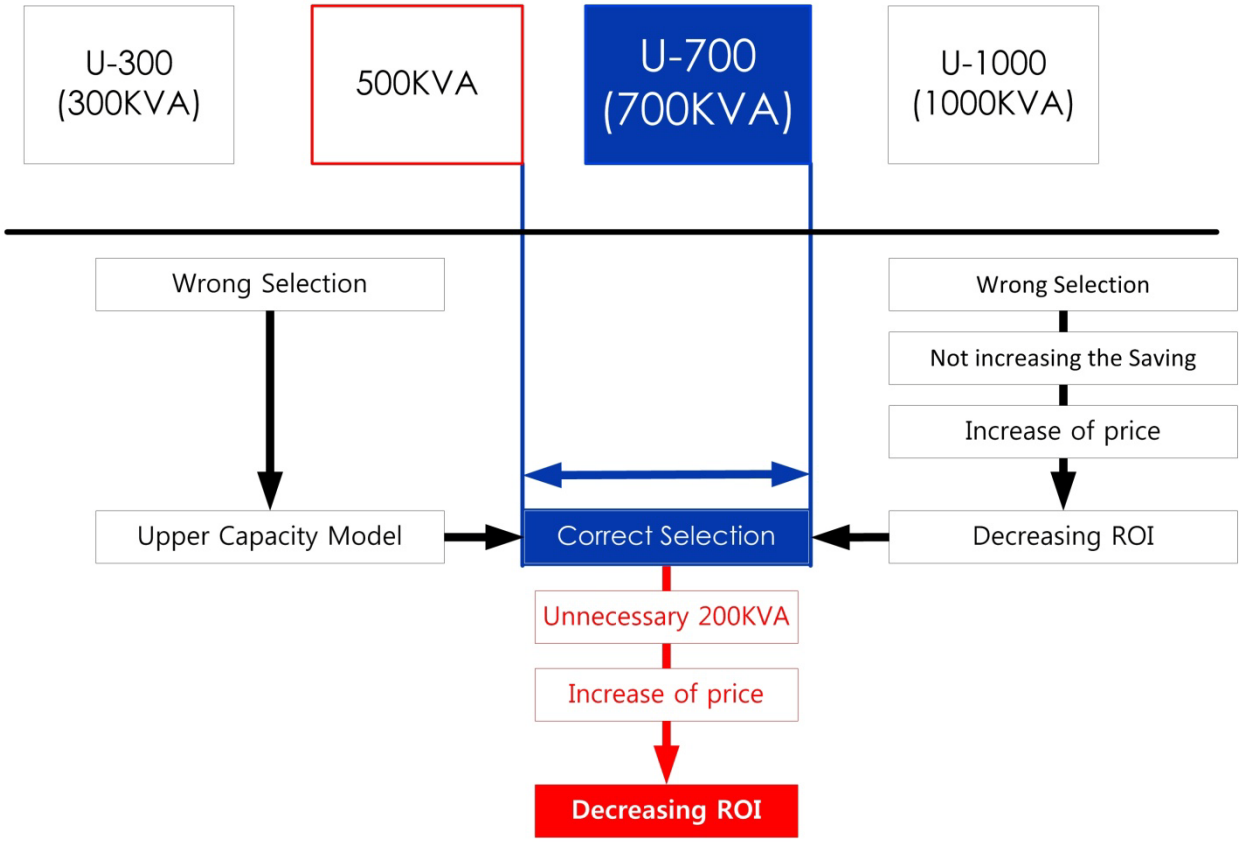
2) The example of proper model selection.

- **In case of 26kVA – the case of less than 50kVA**



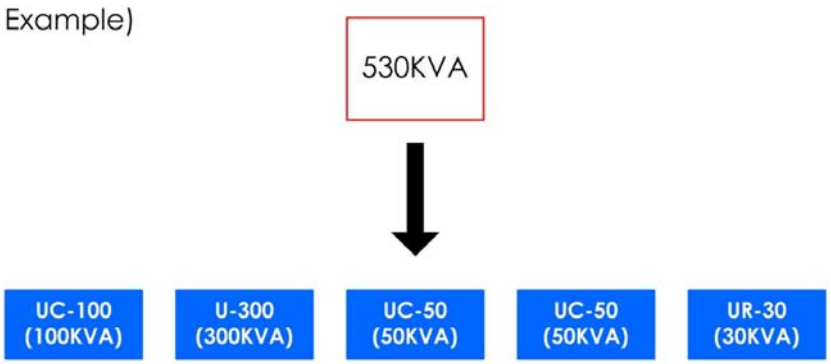
In case of less than 50kVA, simply choose the upper capacity of ULTRA model.

• In case of 530kVA – the case of more than 50kVA



If simply selecting one upper capacity of ULTRA model even in the case of more than 50kVA, it can reduce the purchasing power due to giving a economic burden to a customer. Therefore, in this case, KESECO strongly recommend using the Dispersive installation method which can provide not only the solution for this economic burden but also technical benefit. (Regarding technical benefit, it will be dealt with in next chapter).

Then, firstly let's review the economic benefit. The example shows the somewhat complicated situation that a customer has to pay for 170 kVA of unnecessary capacity despite being only in need of 530kVA, because the upper ULTRA model is 700kVA. In this case, a reasonable solution is to offer the optimized design which makes avoiding the additional purchase of the 170kVA. But such solution is only possible when applying the combination of different units like below.



The above is the simple example of Dispersive Installation to take away the economical burden of a customer. Of course, it is possible to make various combinations, except for the example. If so, a reasonable question that could be raised at this point is like that "what is the rule for the capacity distribution?".

The detailed capacity distribution rule needs the technical approach, because the ultimate purpose of correct design is to have to satisfy with both the reasonable price and proper performance. With respect to the matter of reasonable price, it is solved already as the suggestion of Dispersive installation itself. Then, let's review the imperative consideration for the embodiment of proper performance, particularly, through Dispersive Installation in next chapter.

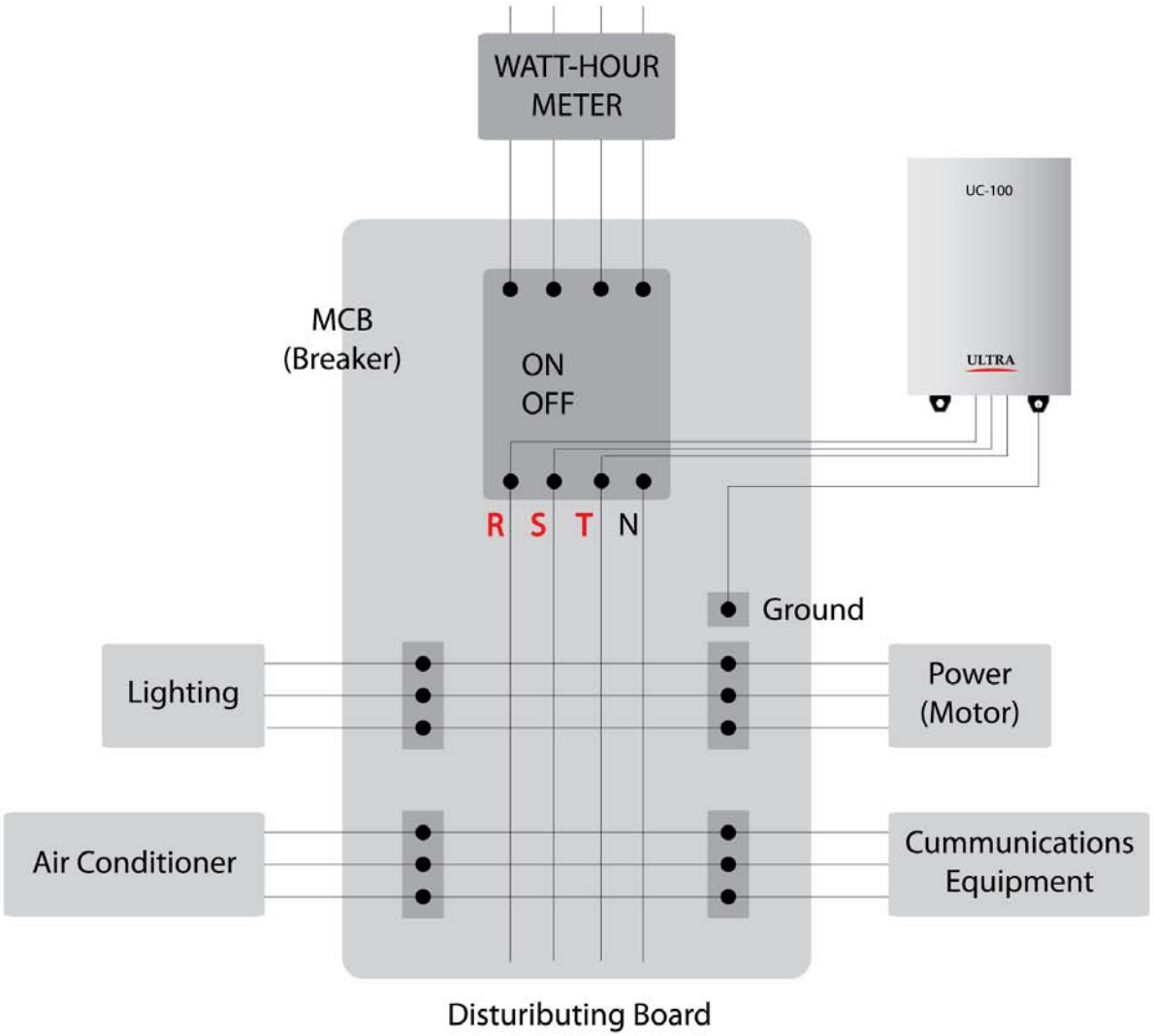
※In consideration of the design instruction of KESECO, the proper capacity has to reflect a certain amount of future demand (add the 20% of the present peak consumption), therefore all of 170kVA is not regarded as the exceeding capacity.

- 20% of 530kVA → 106kVA

Consequently, only 64kVA is regarded as the exceeding capacity.

IV. Installation Method

1. Install location & Instruction



① Turn off small switches First, and tum off main breaker last

② Check No current and voltage with using volt and clamp meter

③ Connect main leads to R,S,T, and ground wire to Ground bar

④ Turn on main breaker, turn on small switches

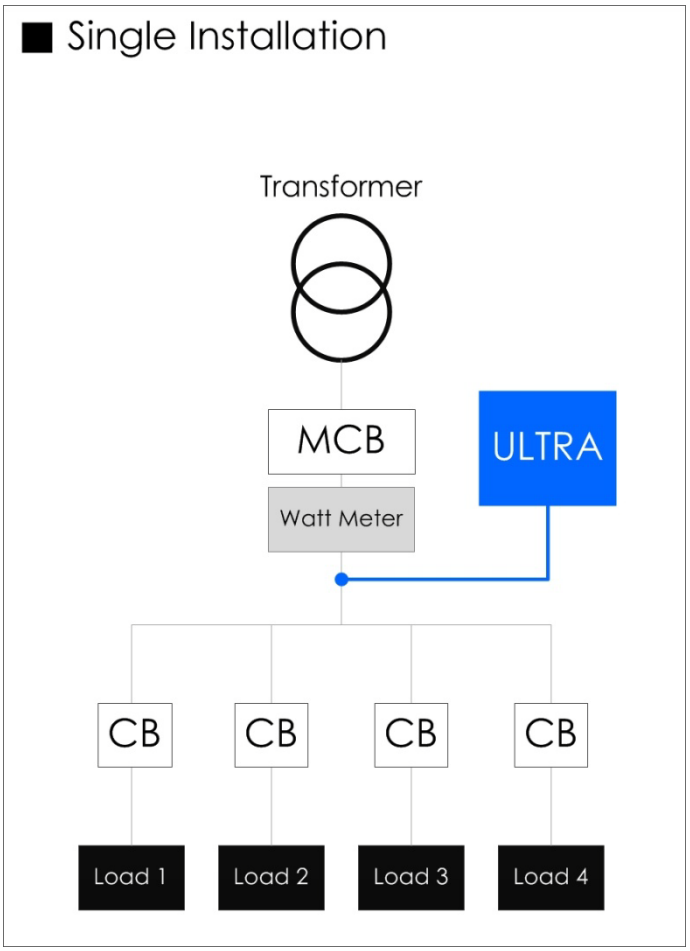
※Ultra does NOT need “Neutral wire(N) in 3phase 4wire system

2. Design Process

1) Singular Installation

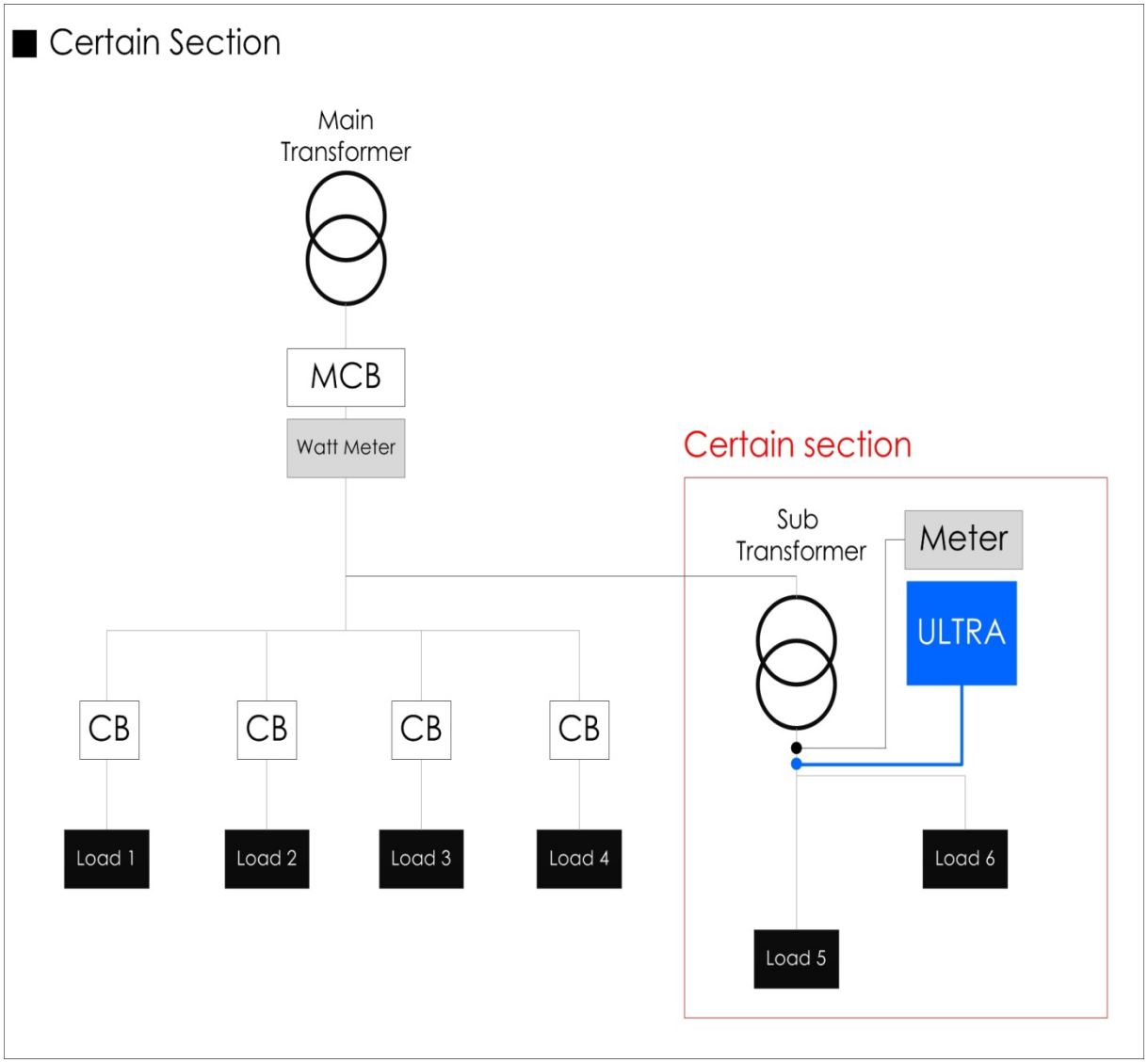
The definition of Singular Installation is to install only one model decided by being based on the recommended capacity estimation basis such as Main Transformer capacity, Contracted capacity, MCB & Total Load capacity and Actual Peak Consumption. This method is basic design method of ULTRA. And three types of the application are available pursuant to the test purpose and environment.

- Apply to whole facility



In case of less than 50kVA, the installation of one unit is enough to make a suitable performance.

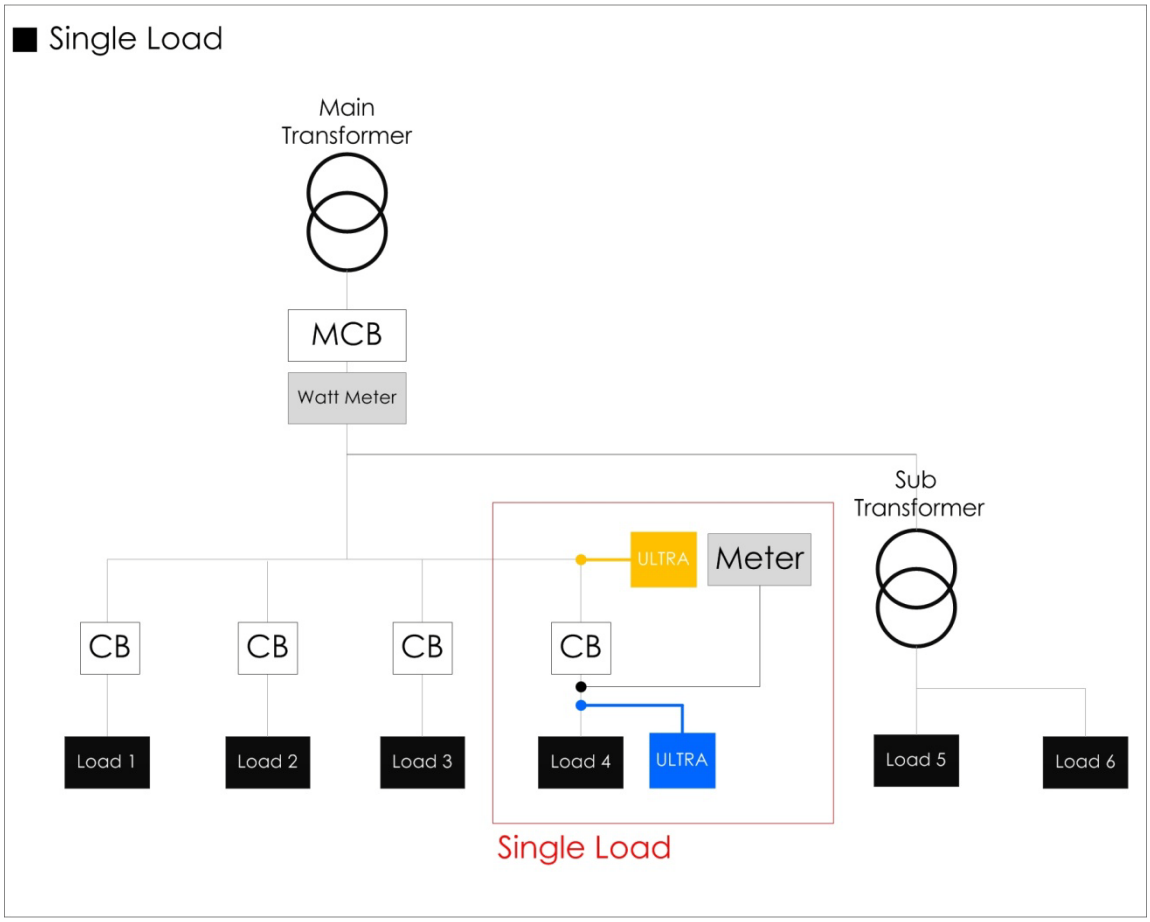
• Apply to a specific area in whole facility



In case that a customer wants to install only to a certain area of less than 50kVA, also the one unit installation is enough to make a suitable performance.

If there is a place of more than 50kVA but having simple load structure, the one unit installation is enough to make a suitable performance as well.

• Apply to a single load in a certain facility



In case that a customer wants to apply to only a single load in a certain area, it can be solved as installing one upper capacity unit to the target load.

However, if the characteristic of the test is to obtain the strong reference for expanding ULTRA business or attaining important certification, KESECO recommends to install the additional unit for the use of preventing an influence of unexpected variable.

Regarding the specific capacity of the additional unit, it is recommended to adopt the corresponding unit to the half of Transformer capacity located at the upper position of the target load. If unknown, U-300 or U-500 is recommended.

※ Regarding the additional unit, it can be re-used after being stored in low temperature condition(10℃±5℃) during the time corresponding with the adaptation period of a relevant model.

1) Dispersive Installation

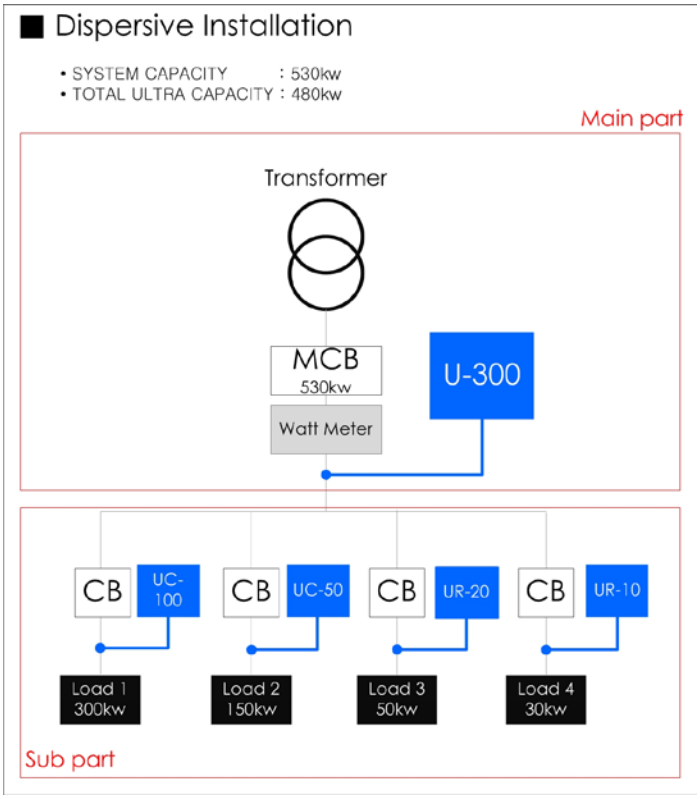
In case of exceeding 50kVA, the combination of different capacity unit can be applied. Its technical advantage is to minimize the disturbing factor of transferring ULTRA effect, particularly, in the place having various loads.

• The Basic Rule of Capacity Distribution

- **Main Part** = Main TR capacity / 2 = □ → **Selecting Upper capacity model**
- **Sub Part** = MCB or Load capacity / 2 = □ → **Selecting Lower capacity model**

The suggested formula is just basic rule which doesn't consider actual variables.

• The example design of dispersive installation managing general variables



Main Part

MCB 530kw / 2 = 265kw → Upper capacity model : U-300(300KVA)

Sub Part

LOAD 1 300kw / 2 = 150kw → lower capacity model : UC-100(100KVA)
LOAD 2 150kw / 2 = 75kw → lower capacity model : UC-50(50KVA)
LOAD 3 50kw / 2 = 25kw → lower capacity model : UR-20(20KVA)
LOAD 4 30kw / 2 = 15kw → lower capacity model : UR-10(10KVA)

The above picture shows the example design of dispersive installation based on the basic formula of capacity distribution. As seen, the total ULTRA capacity is 480kW although the whole load capacity of the system is 530kW. So, it needs to add an additional model corresponding with the remaining capacity because the present design cannot cover the exceeding capacity than the designed ULTRA capacity.

If so, how to decide the install location of the additional model for covering the remaining capacity? This point is not to be dealt with by the basic formula, which is dependent on the practical environment of the system. However, the essential consideration for solution can be suggested like below.

First, the equal transfer of ULTRA effect → Add to Main part

Second, the Concentration of ULTRA effect on the more effective load add to secondary point MCB of relevant section.

The first case is able to be effective in case that all connected loads are useful loads for ULTRA such as inductive load.

Hence, a lot of actual cases are solved by the second cases. At this point, the important items that must be checked is as follows

- Load intensity
- Rated Consumption
- Operating time

V. Data Analysis Method

1. General Analysis

1) The method of using the existing system

- According to an applied model, this method is to compare the data before and after installation. The recommended data collecting period is from at least 7days to more than 30 days.
- Generally, data collecting is conducted by smart meter or watt meter equipped in an installed place.
- The recommended data collecting interval is every 15 min. or 30 min.`If the place shows very stable consumption, Also daily or weekly cumulative consumption is able to be used.

• Example Data sheet

Date	Day	Time	kW (watt meter)	Culmulative Consumption (kwh)	note
1	Mon.	01:00 02:00 03:00 ↕ 22:00 23:00 24:00			
2	Tue.				
↕					
6	Sat.				
7	Sun.				

• The calculation formula for energy saving rate

Energy Saving Rate

A) the cumulative consumption Before installation

B) the cumulative consumption After installation

Rate (%) =[(A – B) / A] * 100

1) The analysis of using measuring equipment

- Normally, the recording unit of collected data is hard to be accurate more than hourly form when using watt meter and smart meter. So, the use of measuring equipment is recommended to obtain more accurate data form.

• Example Data sheet

Date	Time	Avg. Voltage			Avg. Current			P.F	Active Power	kwh
		R	S	T	R	S	T			

• The calculation formula for energy saving rate

Energy Saving Rate

A) the cumulative consumption Before installation

B) the cumulative consumption After installation

Rate (%) =[(A – B) / A] * 100

1. Data Analysis in reflection of seasonal consumption trend.

1) Definition

This method is to reflect the characteristic of seasonal consumption trend which is regularly repeated.

2) Process

- Understand the yearly consumption trend through checking the electric consumption of the last 2 years
- Compare the collected data after installation with the analyzed consumption trend to check its correspondence.
- If not corresponding with each other, check the details in the inconsistent period.
- The common causes of inconsistency are the change of the operating time and production, the expansion of facility, the breakdown of some loads. If not checked in the suggested items, ask a person in charge for giving more information about system.
- If complied with each other, it can be used as the objective index of reflecting the characteristic of consumption of the place. In this case, the result can be calculated simply by the calculation formula.

• Example Data sheet

	Before Installation (Without)			After Installaton(With)
월	Monthly Consumption Before installation			Monthly Consumption Before installation
	2009	2010년	Avg.	2011
Jan				
Feb				
Mar				
Apr				
May				
Jun				
Jul				
Aug				
Sep				
Oct				
Nov				
Dec				
SUM				

Average				

• The calculation formula for energy saving rate

Energy Saving Rate

A) the cumulative consumption Before installation

B) the cumulative consumption After installation

Rate (%) =[(A − B) / A] * 100

3) Analysis of consumption per a unit production

1) Definition

- In case of a manufacturing facility, the consumption per a unit production can be calculated by using the information of the production quantity and electric consumption.
- This consumption unit can make more objective and reliable analysis result.
- To use this method, the manufactured product must not be changed.

2) Application

• Example Data sheet

Start			End			Analysis			Consumption	
time	reading	reading	time	reading	reading	time	kwh CT 배 K=	unit	kwh/h	kwh/unit

• The calculation formula for energy saving rate

Energy Saving Rate

A) the consumption per a unit production Before installation
B) the consumption per a unit production After installation

Rate (%) =[(A − B) / A] * 100

VI. Maintenance

1. Caution

- The storage in the high temperature may cause damage to the product.

  Recommended Storage Condition : 10℃ ± 5℃
  Installation Temperature : -40℃ ± 2℃ ~ 70℃ ± 2℃

- Do not allow water to seep into the product or to wet the surface of the product
  The humidity range must be less than 90%

- Do not change or remodel the specification of the product.

- After installing, do not change the connection and disconnection repeatedly for the effect analysis of the product,
  - The product specification is decided by KESECO as the manufacturer and inventor of the product.
  - If deliberately modifying, the proper performance cannot be guaranteed.
  - However, if the system environment of the install-planned place is unusual, the product specification is able to be changed by the consent of KESECO.

- If the installed place expands more than 10% of the existing facility, additionally the corresponding capacity of ULTRA model must be installed.

- Regularly check the exterior of the product.

2. Maintenance

- The proper performance can be continuously maintained by carrying out regular maintenance.

  - Regular monitoring on the change of Monthly consumption

  - Check the expansion or reduction of related facility

  - Check the breakdown of a related load

- Check the use of private electric generator

- Check the change on the facility, except for the suggested items

- If the installed place expands facility exceeding the applied ULTRA capacity, additionally the corresponding capacity of ULTRA model must be installed.

3. A/S

- If the product shows unusual operation, contact with the headquarter or near agency for A/S.

- A/S is free of charge during warranty period.
  (except when the necessity of A/S is caused by the user or when the warranty period expired, in which case, A/S is charged at actual cost)

- If the power saving appliance has to be moved and re-installed, please call your agency or head office.

- Be sure to present Warranty Certificate when A/S is done, otherwise A/S will be charged.

- The warranty period according to the Consumer Damage Compensation Rule is 3 years from purchase date.

  - The charged A/S includes cost of parts and traveling expenses.
  - The Damage Compensation Rule applied to this product is accordance with Consumer Damage Compensation regulation notified by the Ministry of Finance and Economy.