Power Apparatus and System Design (EE49004)
Spring-2021-22
Assignment 1

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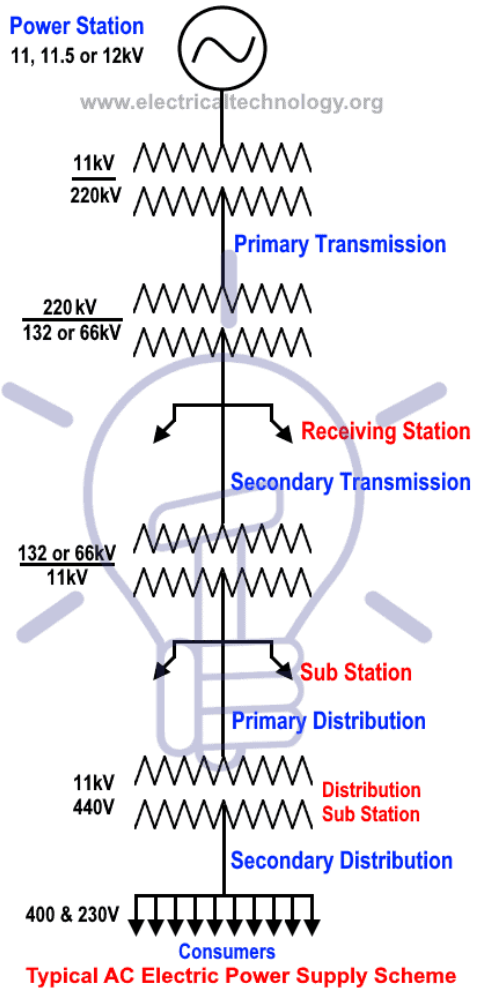
1. Electric power transmission and distribution in India (different stages, and their voltage levels from generation/powerplant to your home with suitable diagram). Also, include the present electrical power generation scenario in India
(source:https://powermin.gov.in/en/content/power-sector-glance-all-india)

(a)
Electric power transmission and distribution in India (different stages, and their voltage levels from generation/power-plant to our home)

Serial No.	Stage	Voltage Level	Loss (% of power left in the previous stage)	Power left(%)
1	Power Station	11, 11.5 12 kV	65	35
2	Primary Transmission	220kV	33	23.45
3	Secondary Transmission	132 or 66 kV		
4	Primary Distribution	11 kV		
5	Secondary Distribution	440 V		
6	Consumers	440 V or 230 V		



Typical AC Electric Power Supply Systems Scheme (Generation, Transmission & Distribution)

Source: typical-ac-power-supply-system-scheme

(b)Present electrical power generation scenario in India

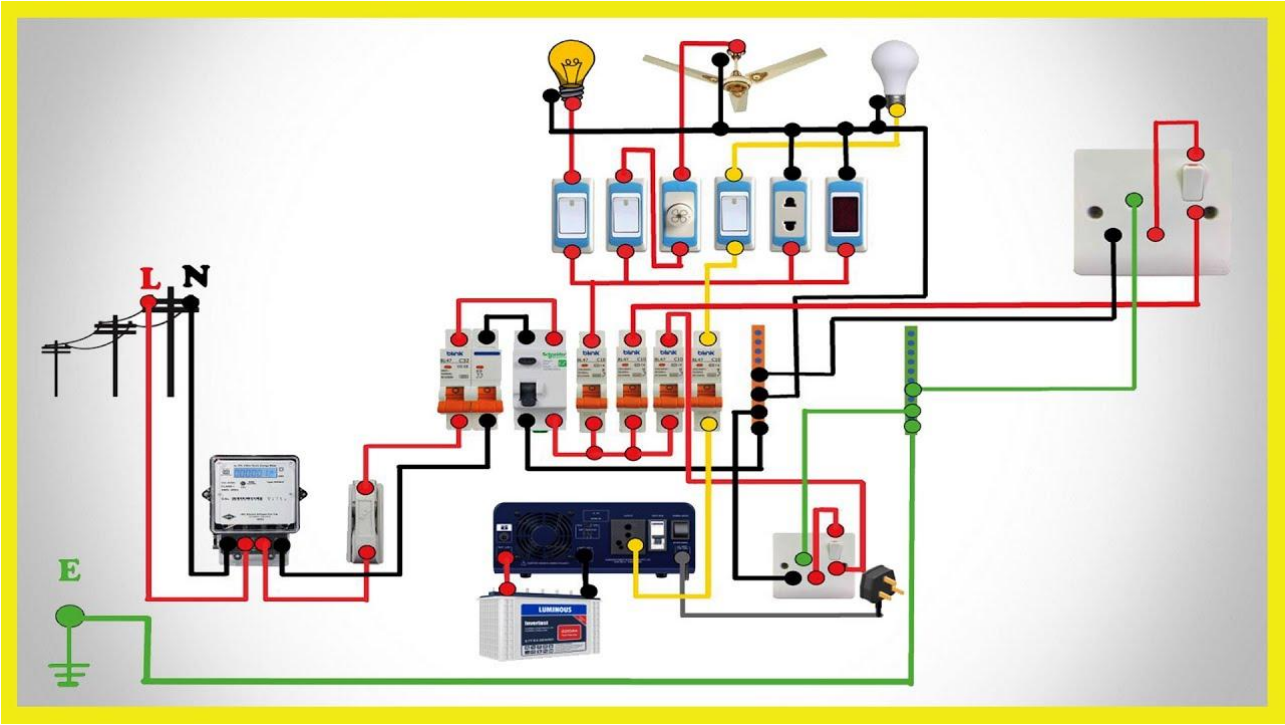
Total installed generation capacity of India as per **31/01/2022** is **3,95,075 MW**.

Sector	**(in MW)**
Central Sector	98,327 (24.9%)
State Sector	1,01,314 (26.7%)
Private Sector	1,91,434 (48.5%)

Generation from other sources:

Source		**(in MW)**
Coal	59.7%	2,03,900
Lignite		6,620
Gas		24,900
Diesel		510
Renewable Energy Sources	38.5%	1,52,366
Nuclear	1.7%	6,780

2. Electrical wiring at your home (starting from incoming power supply what are the equipment connected in sequence, and how their ratings are chosen)



House Electrical Wiring

Source: House Electrical Wiring

- Supply to Electrical Meter to check the flow for billing purposes
- MCB(Miniature Circuit breakers) are the fuses to save from excess current
- RCCB(for residual current, and earth current leak protection)
- Single-pole MCBs which distribute power to a part of the house

Following things to care about while choosing their ratings:

1. Load characteristics, such as motors, fluorescent lighting, LED lighting etc.
2. Presumed short-circuit current at the point of installation
3. The ampacity of cable and wire or the circuit has to be protected by the CB

3. What is the total power demand, and energy consumption at your home (list of all electrical appliances, their power rating, and energy demand) (maybe useful: https://www.youtube.com/watch?v=lP1c3eItwCM&t=6s)

Table consisting of all electrical appliances, their power rating and energy demand (same is posted in attached excel sheet)

Appliance	Rating(W)	Number	Total Watts	Avg use in day(hr)	Energy in day(W-hr)	Energy in month(W-hr)	Number of Units for month(kWh)
Ceiling fan	70	4	280	0.5	140	4200	4.2
Electric Iron	1000	1	1000	0.2	200	6000	6
Electric Kettle	1200	1	1200	0.06	72	2160	2.16
Electric water pump	1100	1	1100	0.15	165	4950	4.95
Exhaust fan	30	1	30	1	30	900	0.9
Laptop Charger	45	1	45	0.5	22.5	675	0.675
LED Bulbs	25	4	100	5	500	15000	15
Oven	1150	1	1150	0.2	230	6900	6.9
Miscellaneous	50	1	50	0.2	10	300	0.3
Mixer	500	1	500	0.2	100	3000	3
Mobile charger	10	2	20	1	20	600	0.6
Refrigerator	100	1	100	20	2000	60000	60

Tubelight	20	5	100	5	500	15000	15
TV	150	1	150	2	300	9000	9
Washing machine	500	1	500	0.5	250	7500	7.5
Water purifier	60	1	60	0.4	24	720	0.72
Total			**6385**		**4563.5**	**136905**	**136.905**

Sorry, I could not attach copy of an original bill as it is not available. But from last month's bill, I remember it was around **Rs. 900**.

4. Calculate the energy bill from your collected data and verify it with your energy bill (submit a copy of your electricity bill if there is no problem otherwise) (may be useful: https://www.youtube.com/watch?v=MUguFjdCHZ4)

Number of units per month (from the table) = **136.905 kWh**

My house lies in Urban Household Section and from Bihar Tariff Rate,
Tariff Charge for consumption < 100 units: **Rs. 6.10**
Tariff Charge for consumption between 101-200 units: **Rs. 6.95**

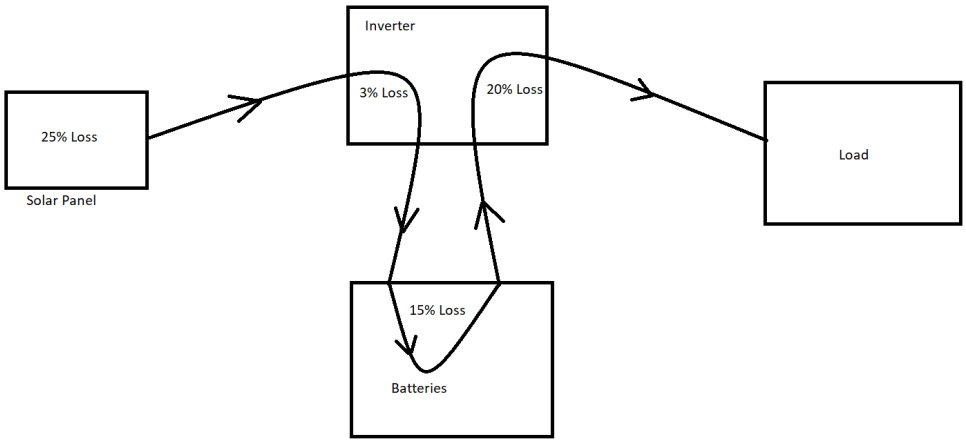
So **Energy Charge** = Rs. (100*6.10 + 36.905*6.95) = **Rs. 866.48975**

Fixed Charge for loading > 6k W: **Rs. 40**

Total Charge = **Energy Charge** + **Fixed Charge** = **Rs. 906.48975 ~ Rs. 907**

So our estimated calculation is exceeding the original bill by **Rs. 7**. The reason is we have calculated the consumption from our average ratings and usage, but in the original bill, the consumption would have been less that is why we are getting more price from our estimated calculation.

5. If you want to surrender your electric connection, and want to install solar photovoltaic with suitable energy storage, can you estimate the sizing for solar and battery, and also estimate the capital cost and payback period? (maybe useful: https://www.youtube.com/watch?v=8Eiel2_e17Q&t=1055s)



A typical Solar Panel System Configuration

Calculating energy for solar panels and quantities of panels and batteries required

Load: **6.385 kW**
Energy Consumption: **4.5635 kWh/day**

Inverter Rating: 8 kW
Typical Inverter Loss (on Load Side) = 20% of 4.5635 kWh/day = 0.9127 kWh/day
So, Input ENergy at inverter from battery = 4.5635 + 0.9127 kWh/day
= **5.4762 kWh/day**

Lead battery: Depth of Discharge = 0.5
Battery Storage = 5.4762/0.5 = 10.9524 kWh Storage
Battery Specification: 1.8kWh
So, number of batteries required = 10.9524/1.8 = 6.0846 = **7 batteries**

Typical Battery Loss = 15% of 5.4762 kWh/day = 0.82143 kWh/day
So, battery Input Energy = 5.4762 + 0.82143 kWh/day
= **6.29763 kWh/day**

Typical Inverter Loss (on Panel Side) = 3% of 6.29763 kWh/day = 0.1889289 kWh/day
So, Total input energy = 6.29763 + 0.1889289 kWh/day
= **6.4865589 kWh/day**

Typical Panel Loss = 25% of 6.4865589 kWh/day = 1.621639725 kWh/day
So, total energy generated by solar panel = 6.4865589+1.621639725 kWh/day
= **8.108198625 kWh/day**

Number of Peak Solar Radiation hours (in **Motihari, Bihar**) = **5hr/day**
Power of Solar Panels = (8.108198625 kWh/day)/(5hr/day) = **1.621639725 kW**

Solar Panel Specification: **350 W**
Then, number of panels required = (1.622*1000)/350 = 4.63 => **5 Panels**

Calculating cost of the above mentioned quantities

Component	**Total wattage (kW)**	**Cost(in Rs)**
Solar panel	1.621639725	32432.7945
Inverter	8	80000
Batteries	12.6	52500
Total		164932.7945

So, total investment cost = **Rs. 164933**
Total Payback Period(in years) = 164932.7945/(12*906.48975)
= **15.16222278**
~ 15 Years 3 months

Note: This number would not be accurate as we have not considered the **maintenance cost** of the panels and some other factors like the **increment of the electrical tariff charge** over the years.