ELL363 – Power Engineering II

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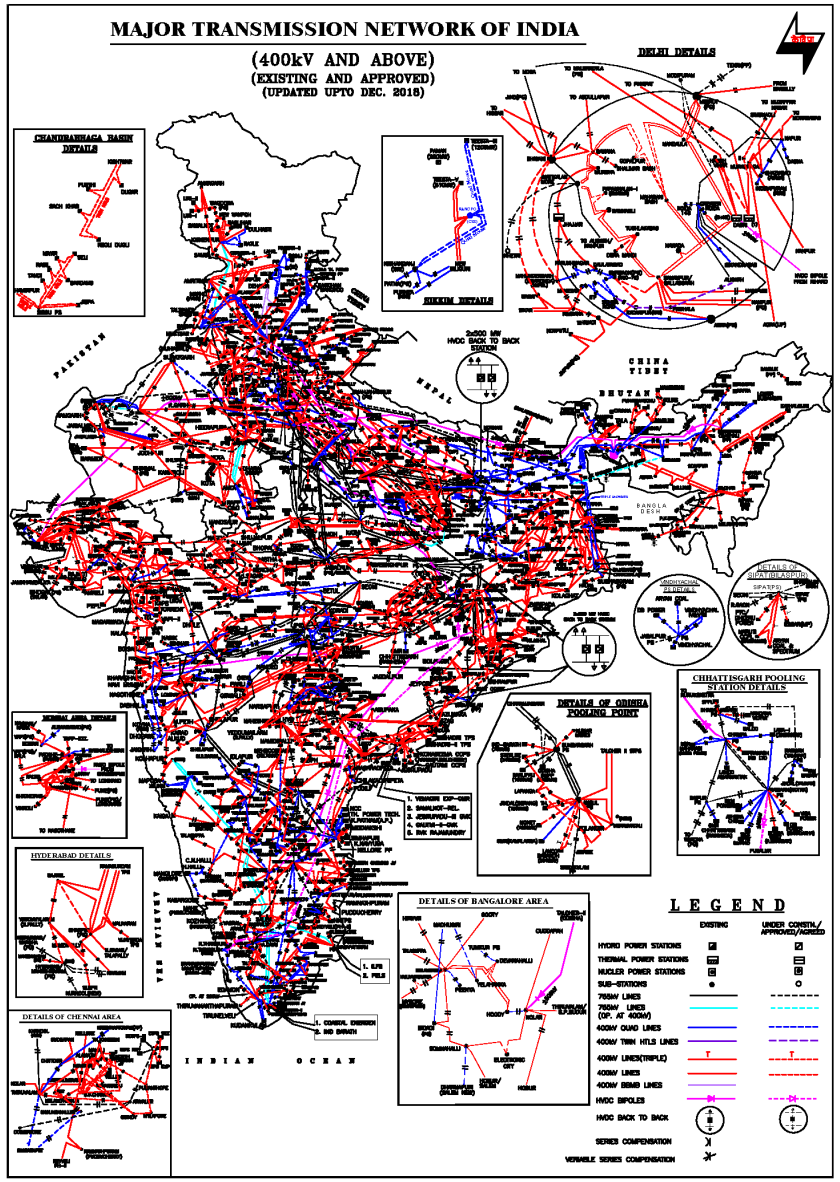


Source: CEA

What is a 'Power Grid'?

- In modern times, electricity is like air.. Its presence is only noticed by its absence

- 'Power Grid' is a complex network to generate and transmit electricity to 300+ million people

The evolution of electric power

1752
Benjamin Franklin

discovers lightening is electricity

observed current b/w metal rods

Alessandro Volta
179

1820
Andre Marie Ampere

first explains current

Ohm's law

George Simon Ohm
1827

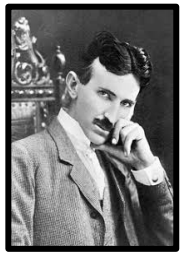
1879
Thomas Edison

invents first light bulb

first DC electric plant in Manhattan

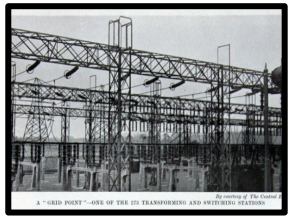
Pearl Street Station
1882

1896
Nikola Tesla



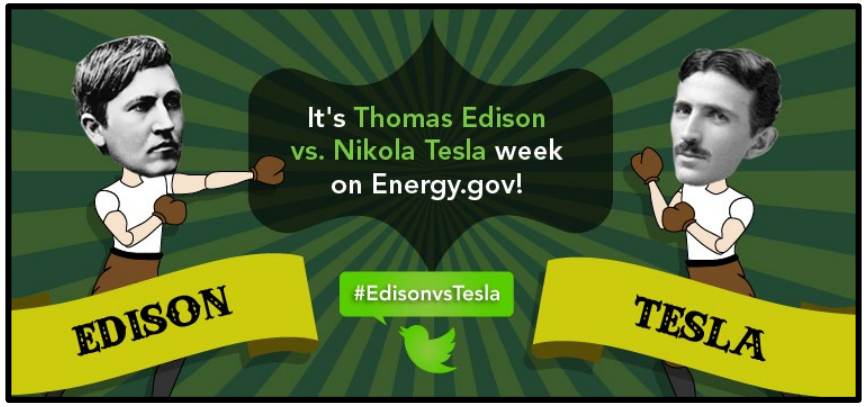
first AC power transfer Niagara Falls to Buffalo, NY

first national grid in the world

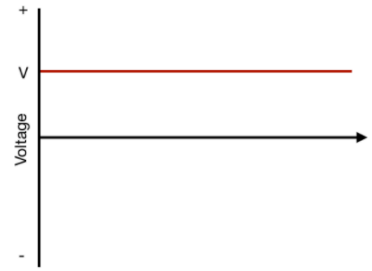
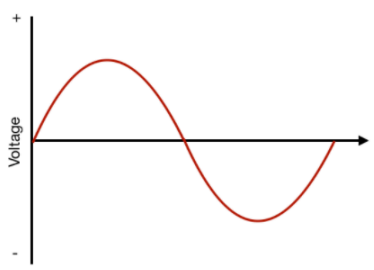


UK grid
1935

The War of Currents



DC v/s AC

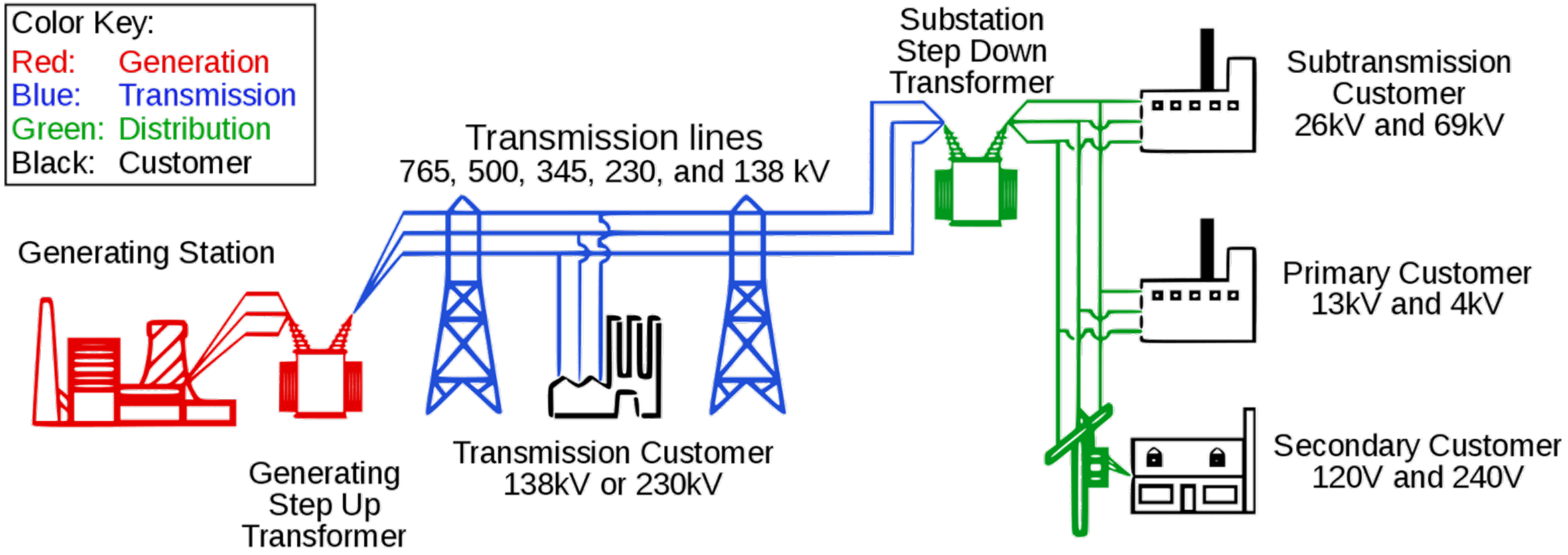
Direct Current	Alternating Current
	

A rivalry which benefited the world!

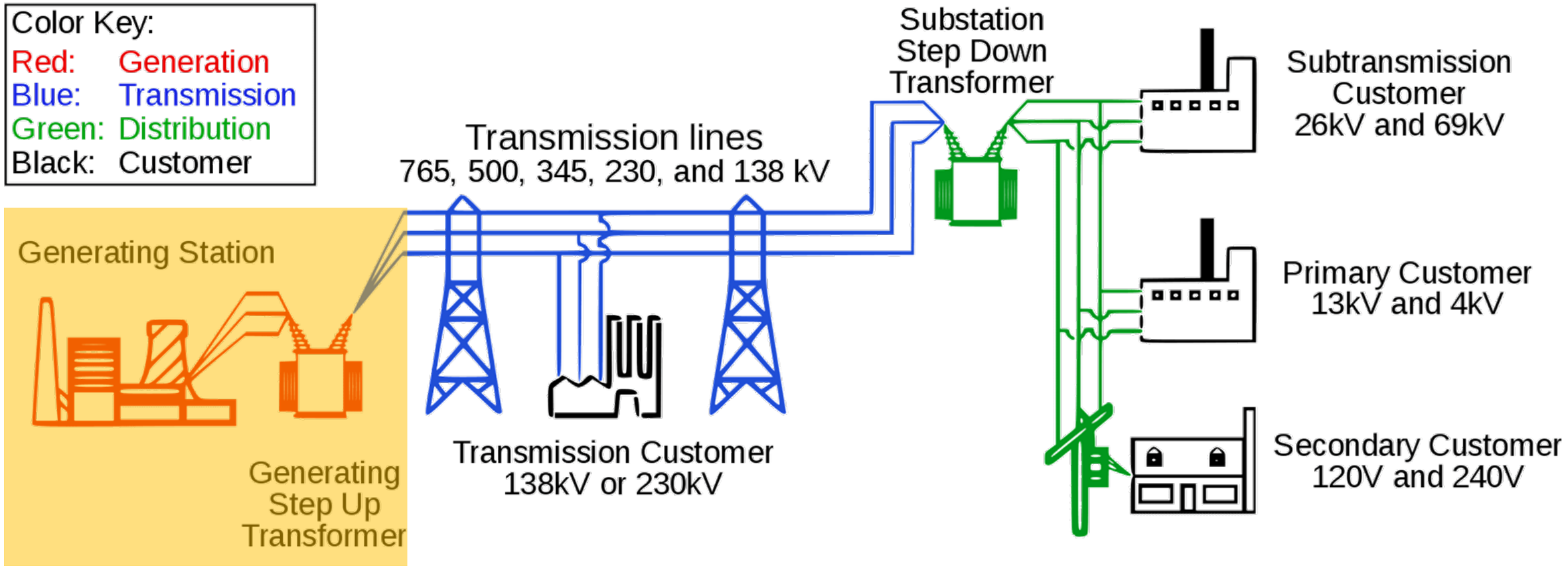
Story of Chicago World's Fair 1893

The War is not over yet!

Power Grid Overview



Generation


Color Key:
Red: Generation
Blue: Transmission
Green: Distribution
Black: Customer
Generating Station
Generating
Step Up
Transformer
Transmission lines
765, 500, 345, 230, and 138 kV
Transmission Customer
138kV or 230kV
Substation
Step Down
Transformer
Subtransmission
Customer
26kV and 69kV
Primary Customer
13kV and 4kV
Secondary Customer
120V and 240V

Generation Sources

Coal

Natural Gas

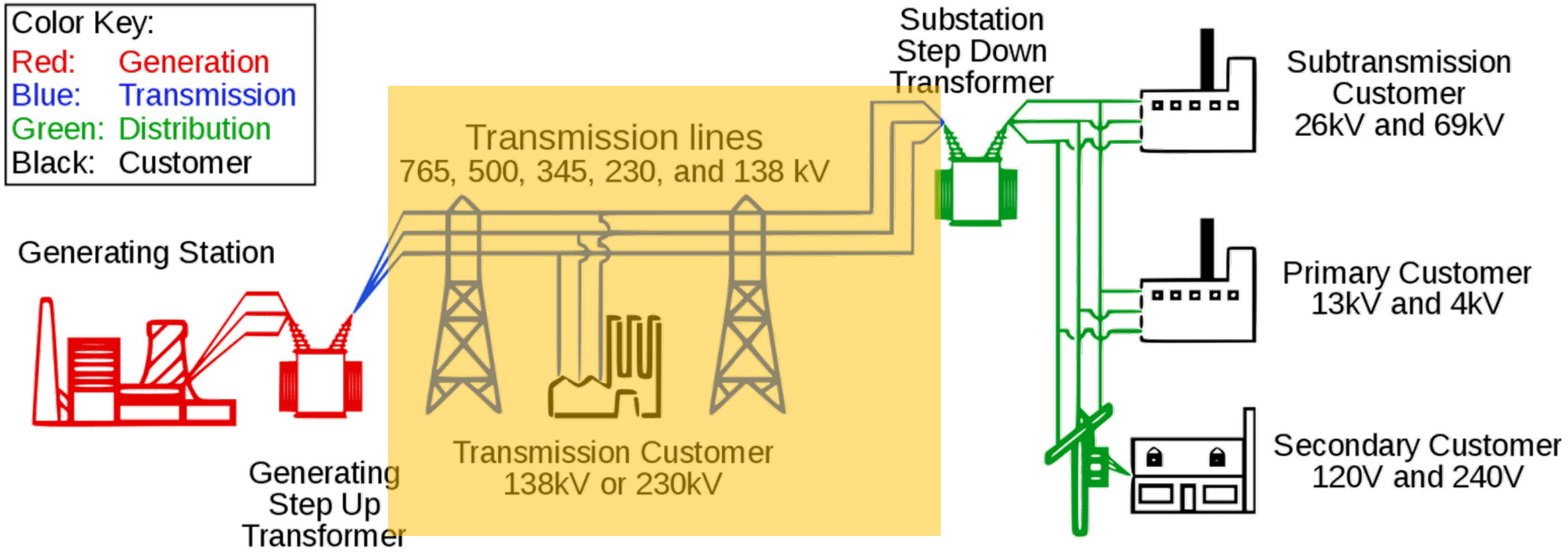
Nuclear

Hydro

Wind

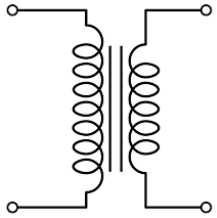
Solar

Transmission System

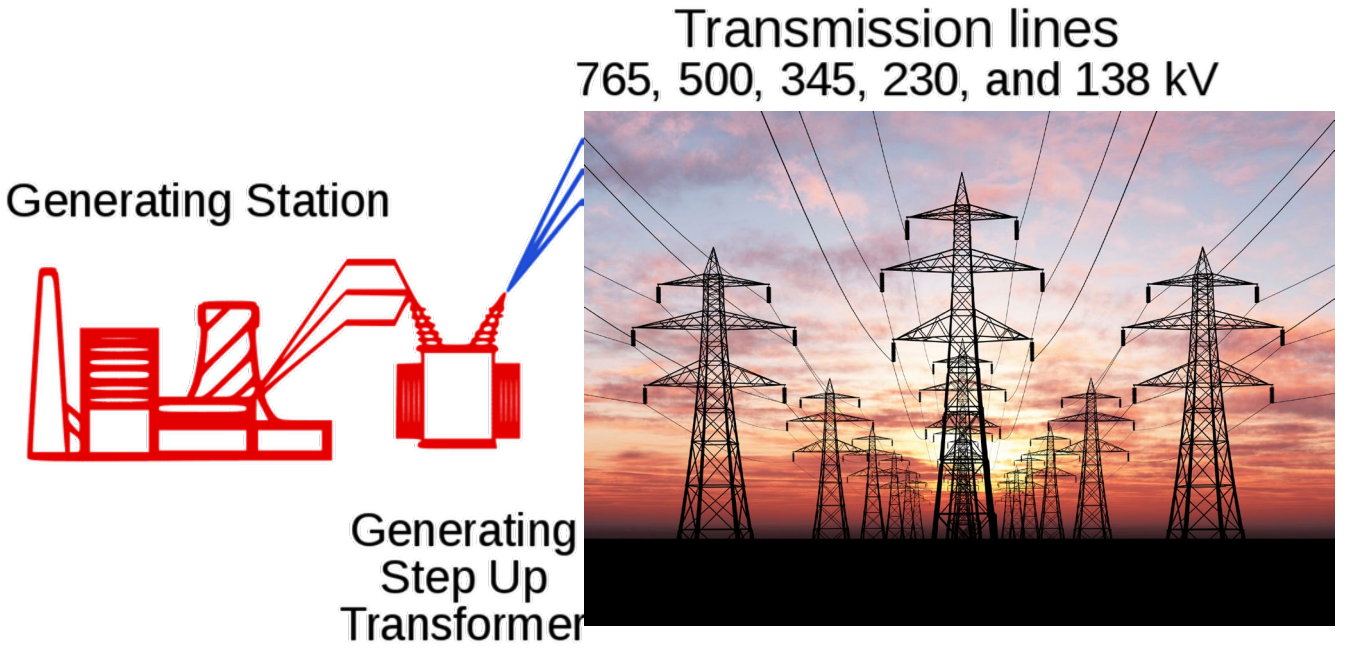


Transformer

V = 2 kV
I = 300 kA
P = 600 MW

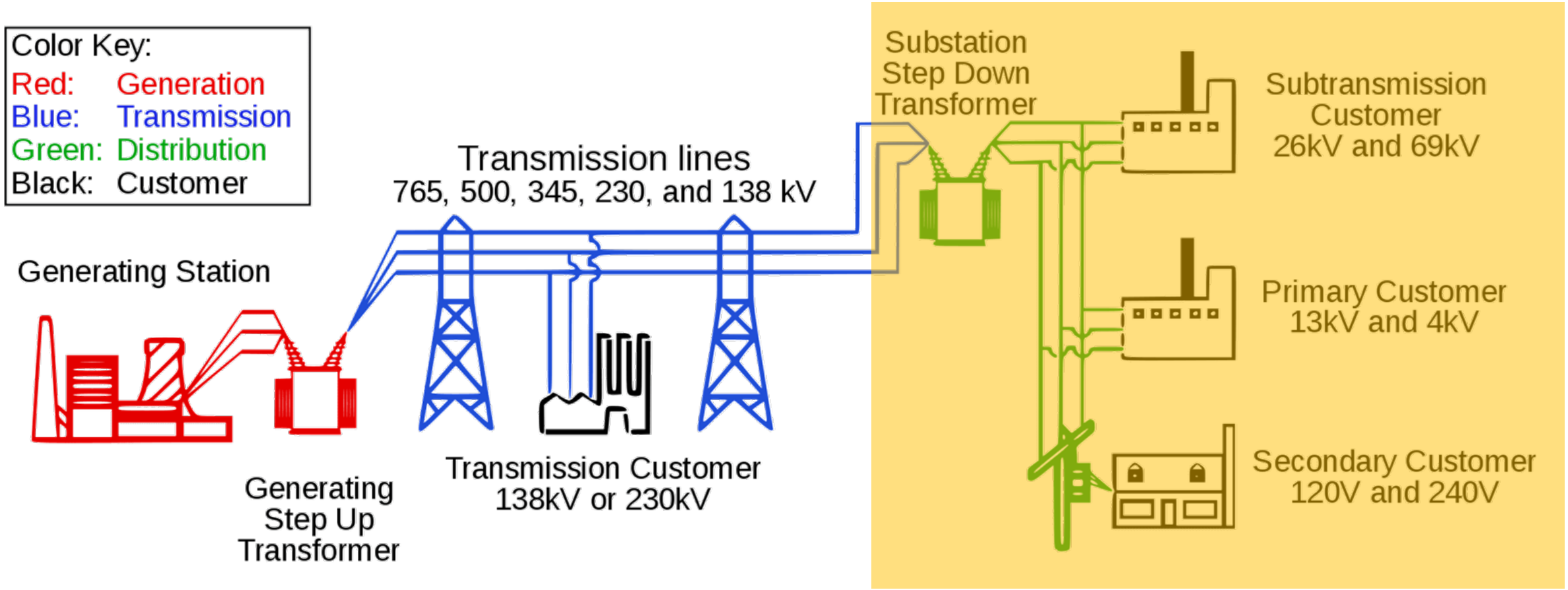


V = 600 kV
I = 1 kA
P = 600 MW



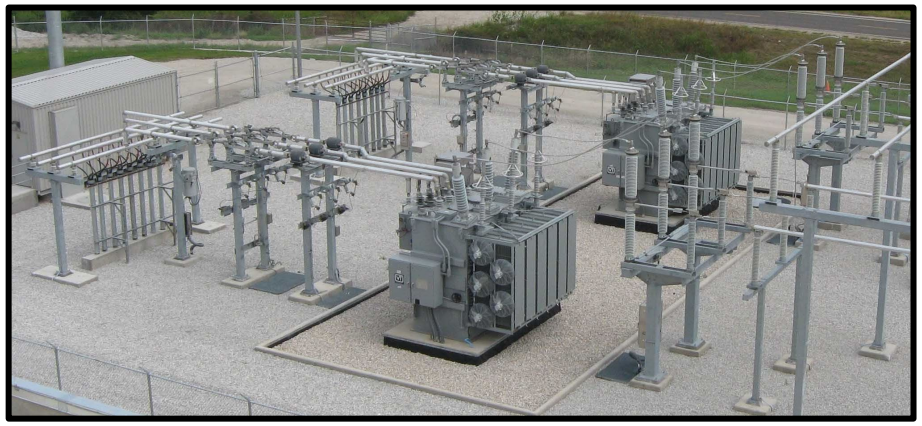
Power transmission on high voltage is economical!

Distribution System



Distribution System

Distribution Substation

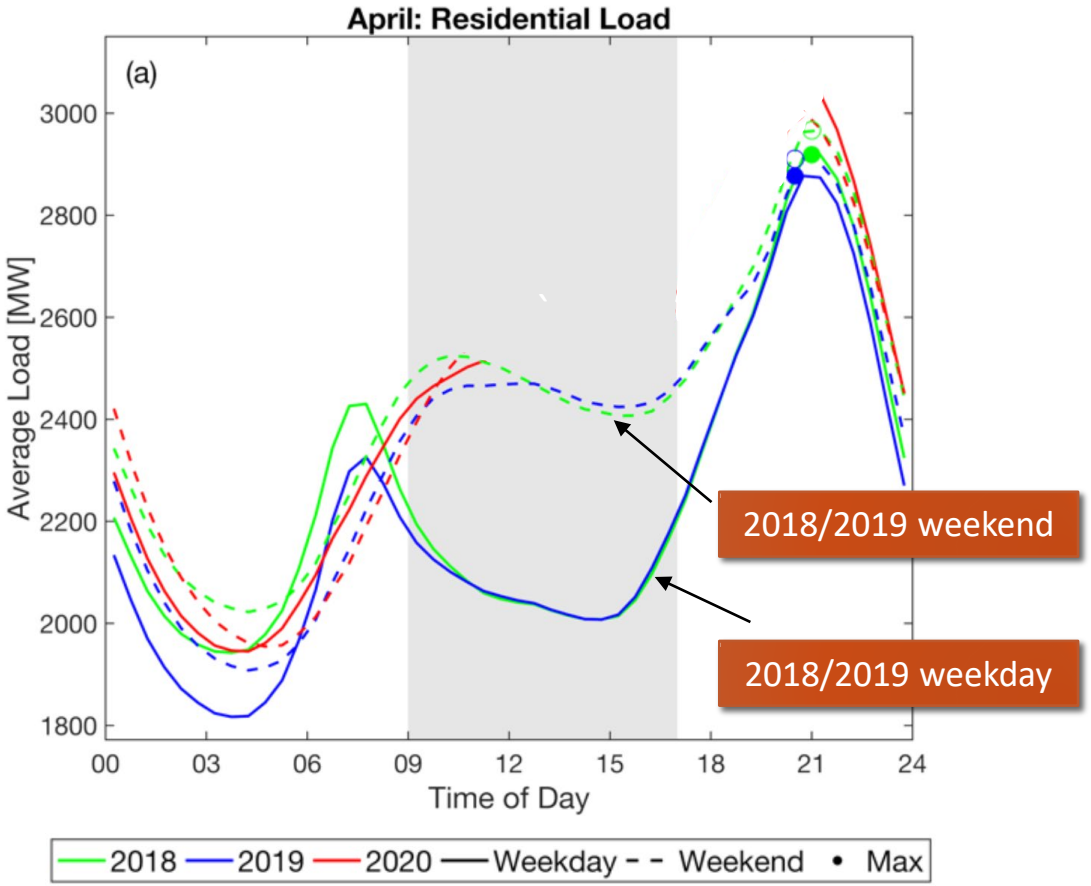


26 kV or 69 kV

Distribution lines and residential transformer

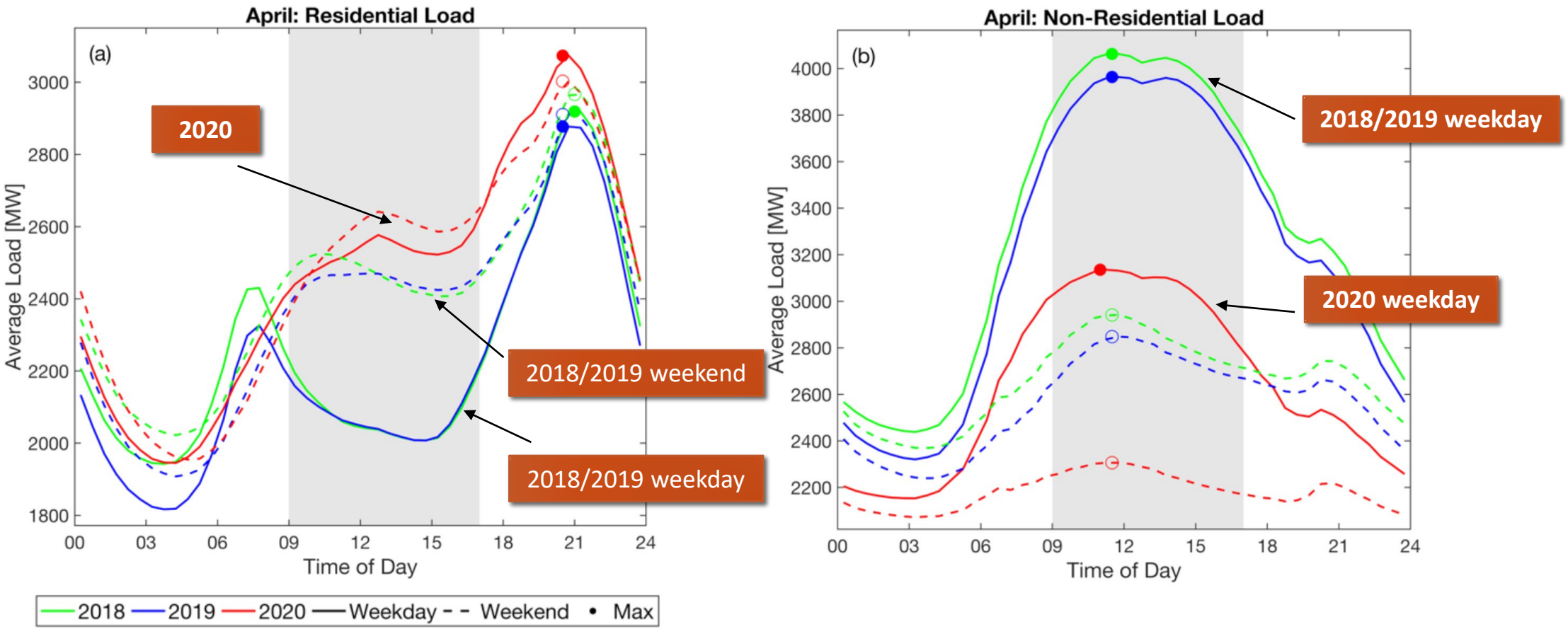
120/240 V

COVID-19 and Load Demand



Ref: Changes in Electricity Load Profiles Under COVID-19: Implications of "The New Normal" for Electricity Demand, Casey D. Burleyson et.al., PNNL, 2021

COVID-19 and Load Demand



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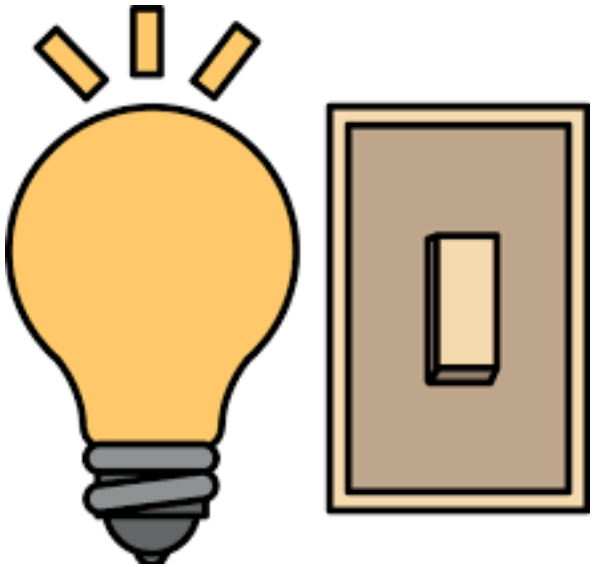

Uniqueness of Power Grid

- Unlike water, natural gas, food, or anything else you consume in your home, electricity is used instantaneously.
- That means that as soon as you flip your light switch on, a generator has to produce more power.
- **Greatest achievement of the 20th century by National Academy of Engineering in 2003**