

Unit - I

Work, Power, Energy, Energy Sources and its Conversion

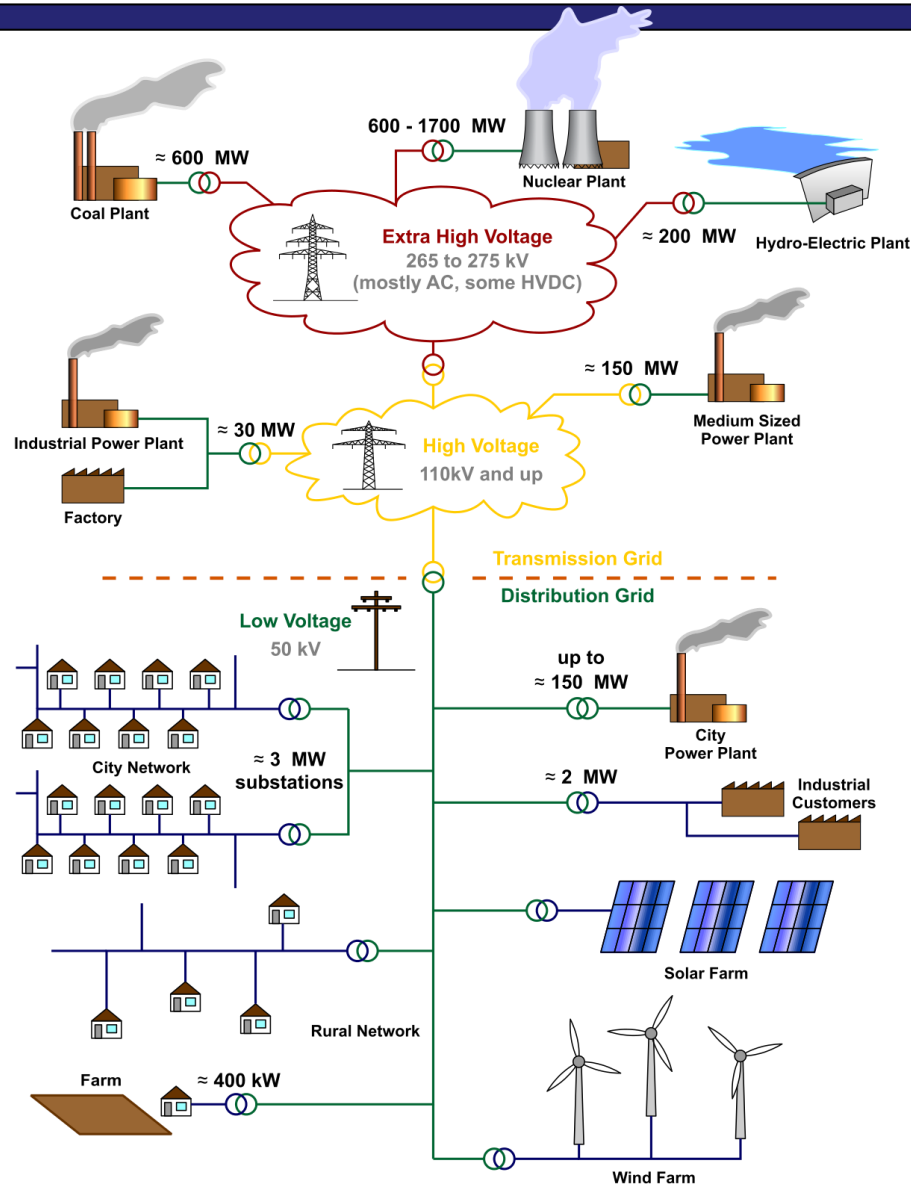
Dr.Santhosh.T.K.

UNIT – I

10 Periods

Introduction and Basic Concepts: Concept of Potential difference, voltage, current - Fundamental linear passive and active elements to their functional current-voltage relation - Terminology and symbols in order to describe electric networks - Concept of work, power, energy and conversion of energy- Principle of batteries and application.

Principles of Electrostatics: Electrostatic field - electric field intensity - electric field strength - absolute permittivity - relative permittivity - capacitor composite – dielectric capacitors - capacitors in series & parallel - energy stored in capacitors - charging and discharging of capacitors.



Simple Power System

- Every large-scale power system has three major components:
 - **generation**: source of power, ideally with a specified voltage and frequency
 - **load** or **demand**: consumes power; ideally with a constant resistive value
 - **transmission system**: transmits power; ideally as a perfect conductor
- Additional components include:
 - **distribution system**: local reticulation of power (may be in place of transmission system in case of microgrid),
 - **control equipment**: coordinate supply with load.

Power System Examples

- Interconnection: can range from quite small, such as an island, to one covering half the continent:
 - there are five major interconnected ac power systems in India each operating at 60 Hz AC is used in some other countries.
- Airplanes and Spaceships: reduction in weight is primary consideration; frequency is 400 Hz.
- Ships and submarines.
- Automobiles: DC with 12 volts standard and higher voltages used in electric vehicles.
- Battery operated portable systems.

- Power:
 - Instantaneous rate of consumption of energy,
 - How hard you work!
- Power = voltage x current for dc
- Power Units:
 - Watts = amps times volts (W)
 - kW – 1×10^3 Watt
 - MW – 1×10^6 Watt
 - GW – 1×10^9 Watt

- Energy:
 - Integration of power over time,
 - Energy is what people really want from a power system,
 - How much work you accomplish over time.
- Energy Units:
 - Joule = 1 watt-second (J)
 - kWh – kilowatthour (3.6×10^6 J)
 - Btu – 1055 J; 1 MBtu=0.292 MW

What is energy ?

- Energy is the power to change things. It is the ability to do work.
- Energy lights our cities, powers our vehicles, and runs machinery in factories. It warms and cools our homes, cooks our food, plays our music, and gives us pictures on television.
- **Joule** - A unit of energy. One joule equals 0.2388 calories

Main forms of energy are:

- Chemical
- Electromagnetic
- Nuclear
- Mechanical

All forms of energy can be converted into other forms.

- The sun's energy through solar cells can be converted directly into electricity.
- Green plants convert the sun's energy (electromagnetic) into starches and sugars (chemical energy).
- In an automobile engine, fuel is burned to convert chemical energy into heat energy. The heat energy is then changed into mechanical energy.

Electrical energy conversion

- In an electric motor, electromagnetic energy is converted to mechanical energy.
- In a battery, chemical energy is converted into electromagnetic energy.
- The mechanical energy of a waterfall is converted to electrical energy in a generator.

The Law of Conservation of Energy

- Energy can be neither created nor destroyed by ordinary means.
 - It can only be converted from one form to another.
 - If energy seems to disappear, then scientists look for it – leading to many important discoveries.

- **RENEWABLE:**

--can be regenerated in a relatively short period of time; unlimited

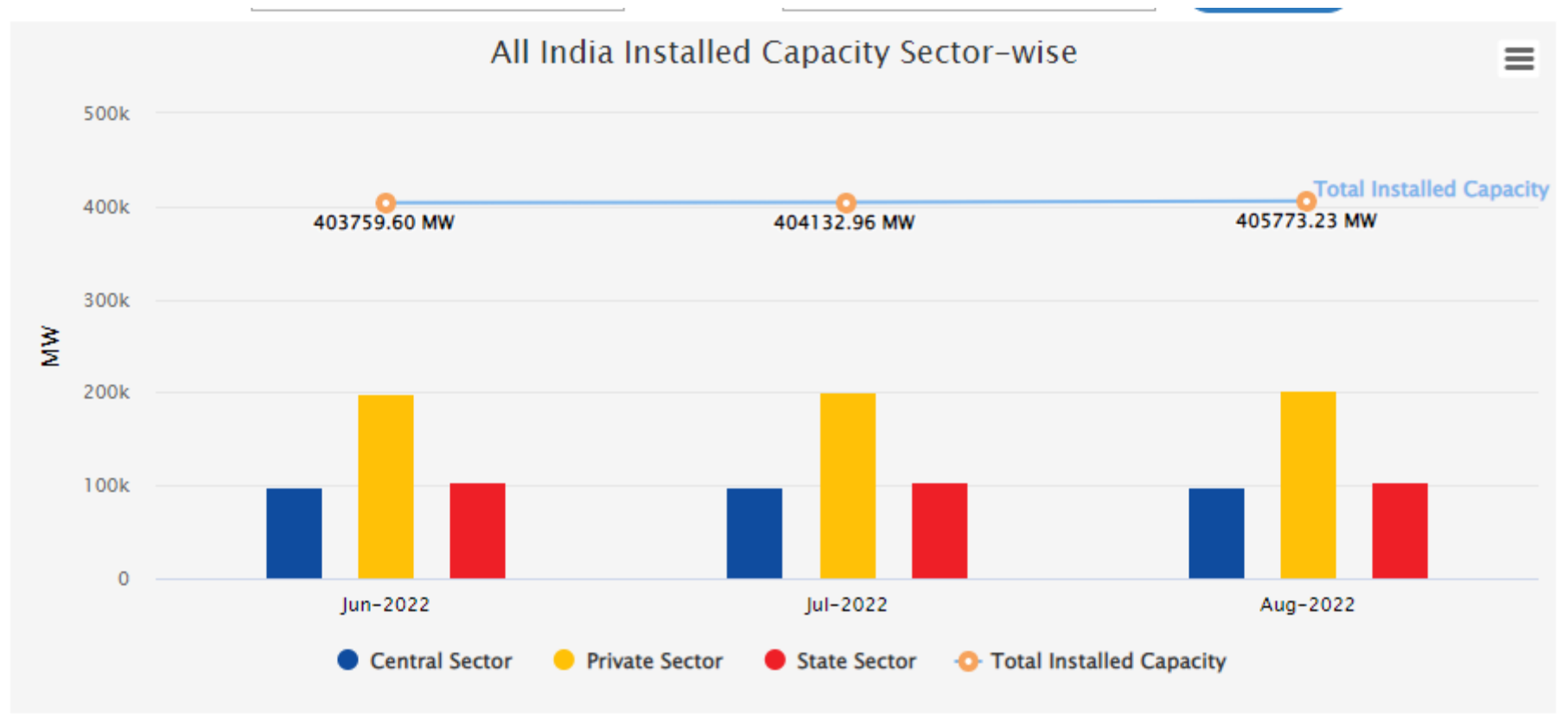
- **NON-RENEWABLE:**

--can not be replaced in a short amount of time; limited

Energy Sources

- Solar
- Wind
- Nuclear
- Hydroelectric
- Thermal
- Tidal
- Geothermal

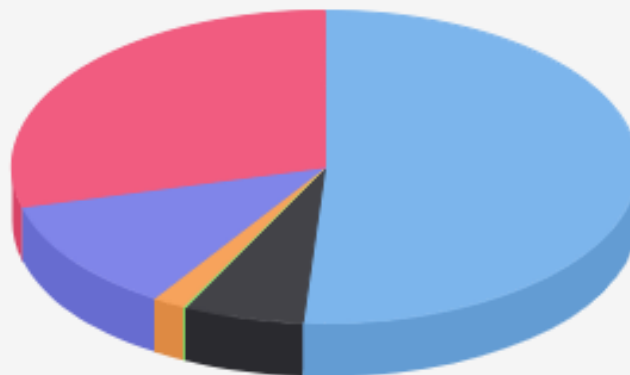
Installed Capacity



Source : <https://cea.nic.in/dashboard>

Installed Capacity Category wise(Aug-2022)

Total Installed Capacity : 405773.230000000004 MW



[Dashboard - Central Electricity Authority \(cea.nic.in\)](http://cea.nic.in)

Generation Capacity

Source : National Power Portal <https://npp.gov.in/publishedReports>

ALL INDIA									
16	STATE SECTOR	66921.50	7119.85	236.01	74277.36	0.00	26958.50	2381.03	103616.90
17	PVT SECTOR	76003.00	10598.74	273.70	86875.45	0.00	3394.00	85216.08	175485.53
18	CENTRAL SECTOR	62930.00	7237.91	0.00	70167.91	6780.00	15346.72	1632.30	93926.93
Total of ALL INDIA		205854.50	24956.51	509.71	231320.72	6780.00	45699.22	89229.42	373029.35

Break up of RES all India as on 30/09/2020 is given below (in MW):

Small Hydro Power	Wind Power	Bio-Power		Solar Power	Total Capacity
		BM Power/Congen	Waste to Energy		
4739.97	38124.15	10145.92	168.64	36050.74	89229.42

ALL INDIA									
16	STATE SECTOR	66871.50	7087.35	236.01	74194.86	0.00	27114.50	2403.27	103712.64
17	PVT SECTOR	75403.00	10574.24	273.70	86250.95	0.00	3751.00	97497.27	187499.22
18	CENTRAL SECTOR	66340.00	7237.91	0.00	73577.91	6780.00	15646.72	1632.30	97636.93
Total of ALL INDIA		208614.50	24899.51	509.71	234023.72	6780.00	46512.22	101532.85	388848.78

Break up of RES all India as on 30/09/2021 is given below (in MW):

Small Hydro Power	Wind Power	Bio-Power		Solar Power	Total Capacity
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4809.81	39870.45	10175.61	401.84	46275.14	101532.85

Generation Capacity

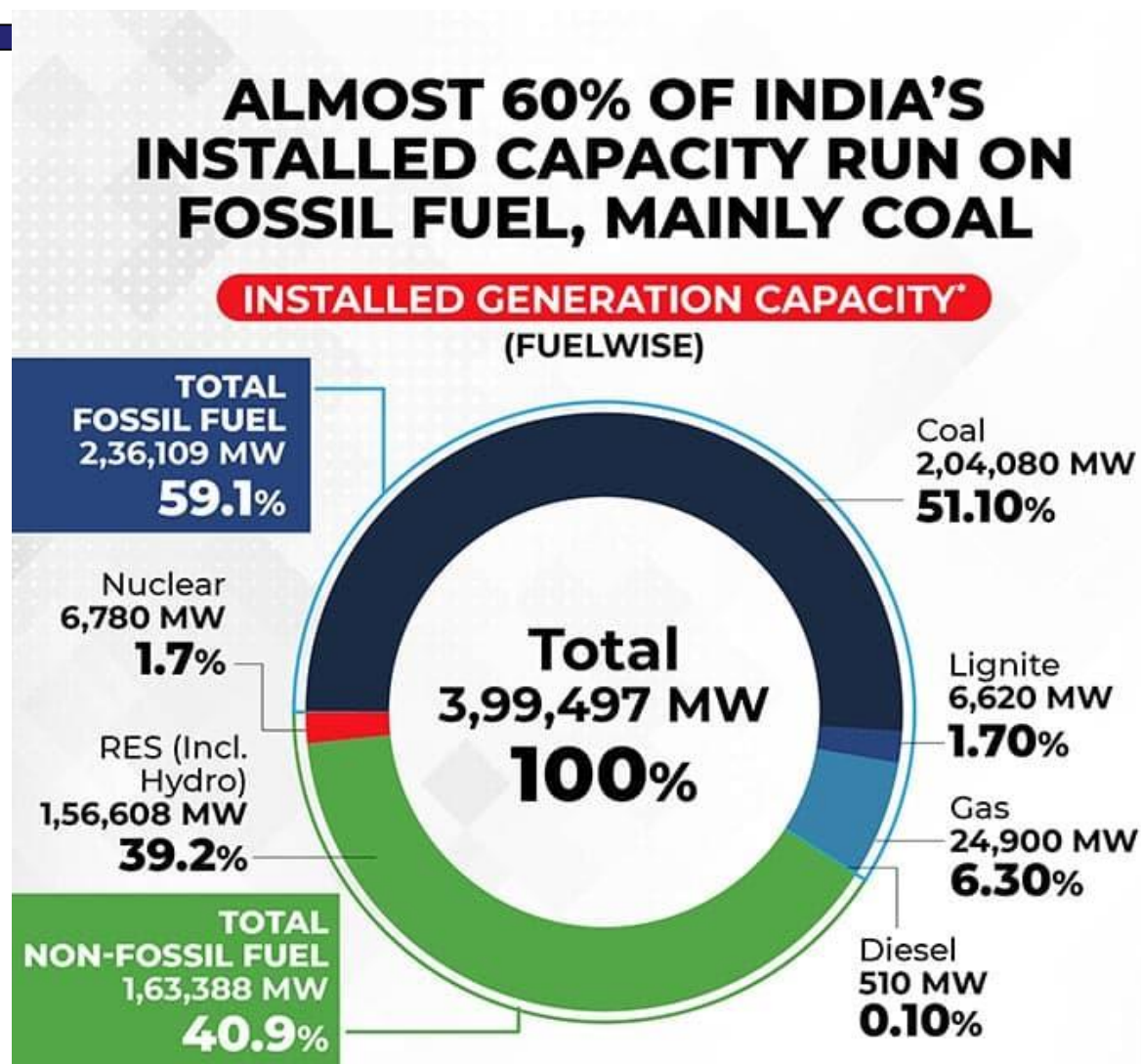
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Source : National Power Portal
<https://npp.gov.in/publishedReports>

Power Generation - 2022



[Power-Sector-at-a-Glance-ALL-INDIA3.jpg](#)
 (700×700) (moneycontrol.com)

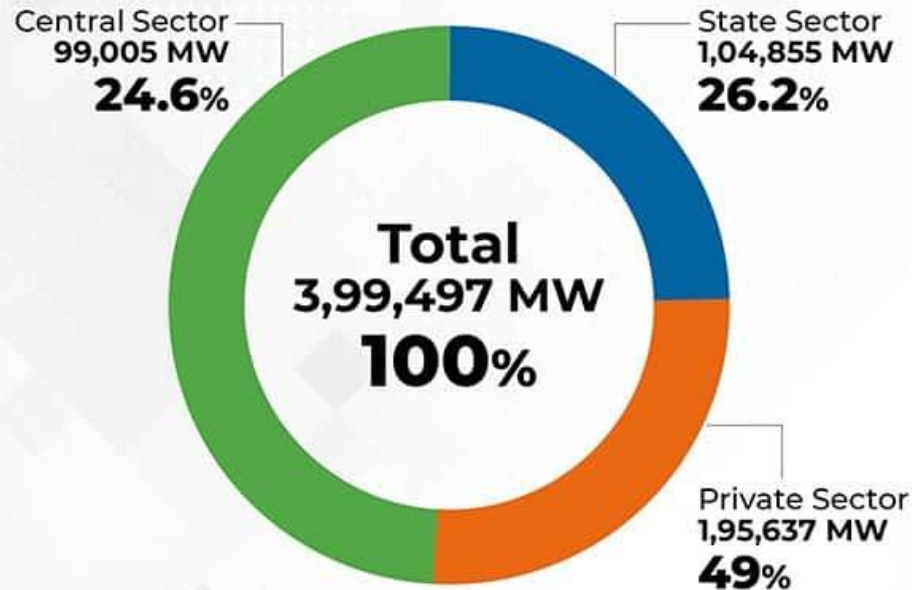
* AS ON 31.03.2022;

Source : Central Electricity Authority (CEA)

Power Generation – 2022 (Sector wise)

HALF OF INDIA'S POWER GENERATION CAPACITY IS RUN BY THE PRIVATE SECTOR

INSTALLED GENERATION CAPACITY* (SECTOR WISE)



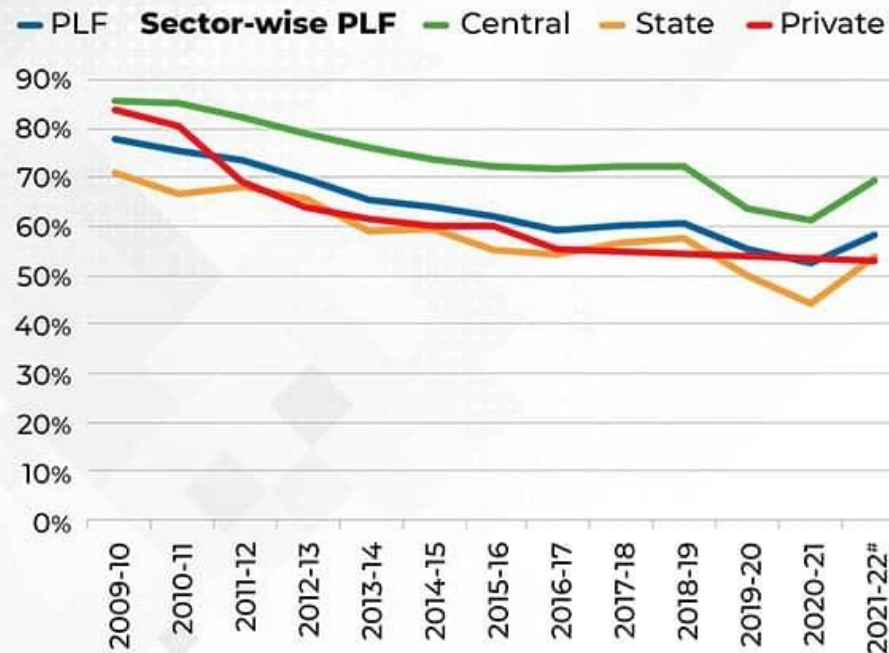
*As on 31.03.2022;
Source : Central Electricity Authority (CEA)





INSTALLED CAPACITY HAS GROWN BUT CAPACITY UTILIZATION HAS DECLINED

THE PLF IN THE COUNTRY* (COAL & LIGNITE BASED)

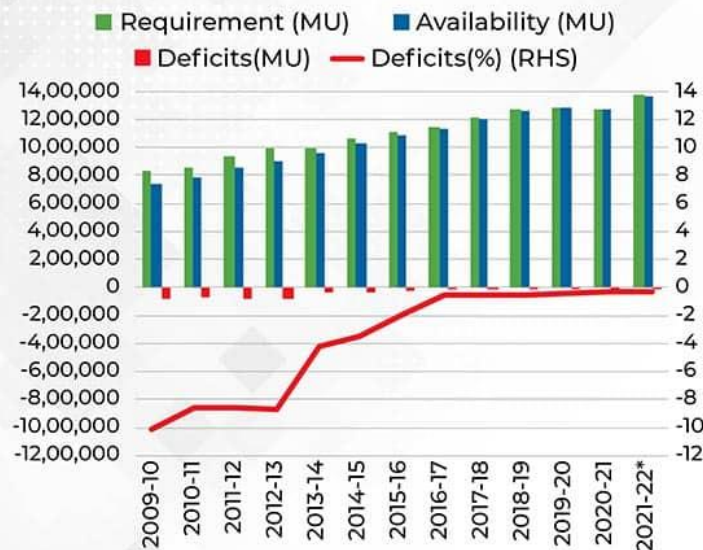


*From 2009-10 to 2021-22; #Upto March 2022 (Provisional); Source : CEA



POWER DEMAND HAS PICKED UP POST-COVID AFTER REMAINING STAGNANT FOR ALMOST 6 YEARS

ENERGY

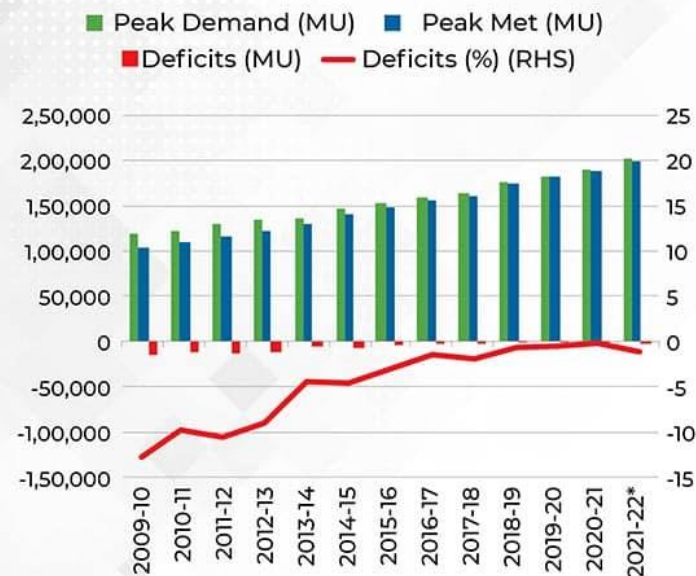


*Upto March 2022 (Provisional), Source : CEA



PEAK DEFICIT INCREASED IN FY2021-22

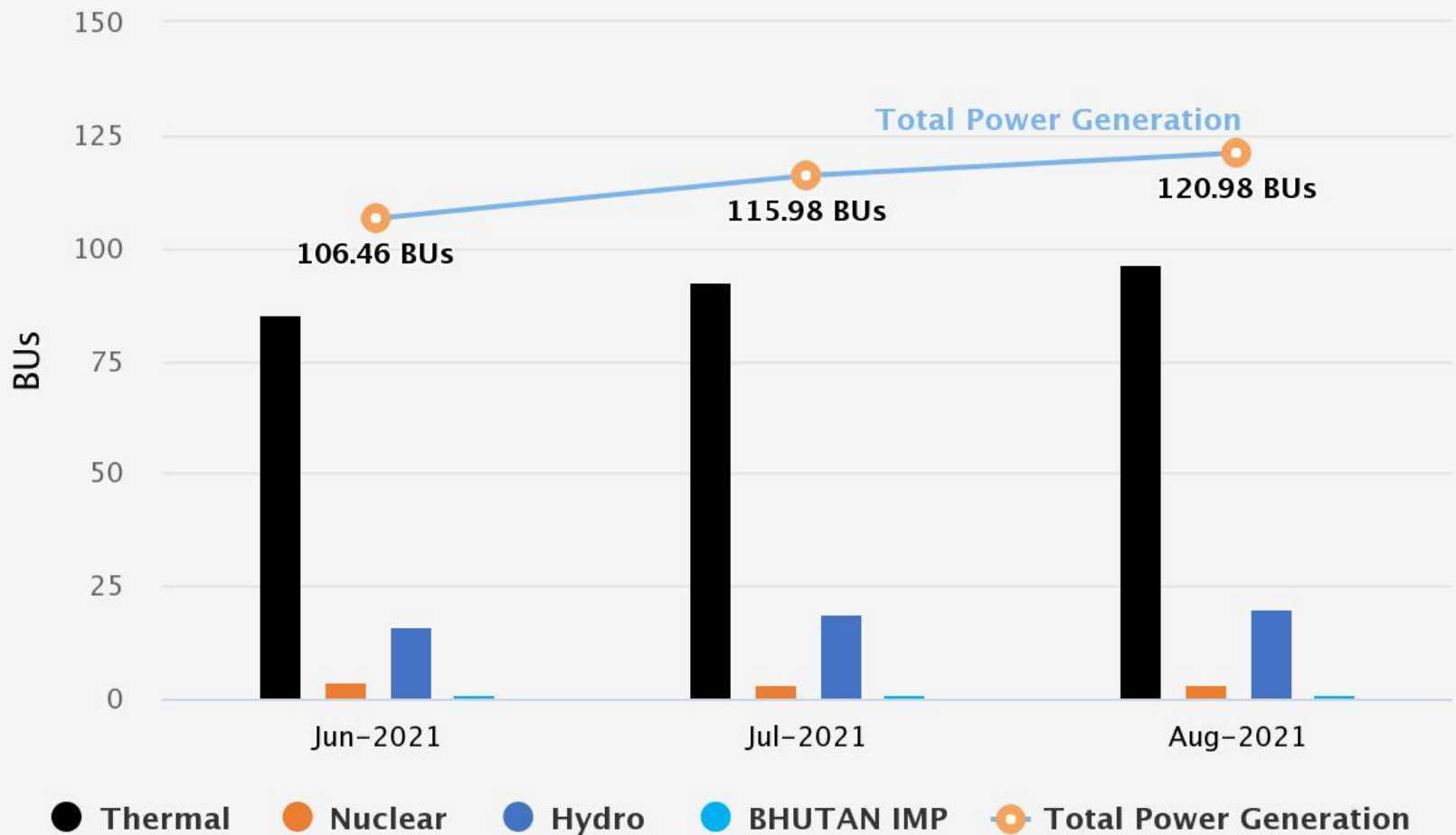
PEAK



*Upto March 2022 (Provisional), Source : CEA



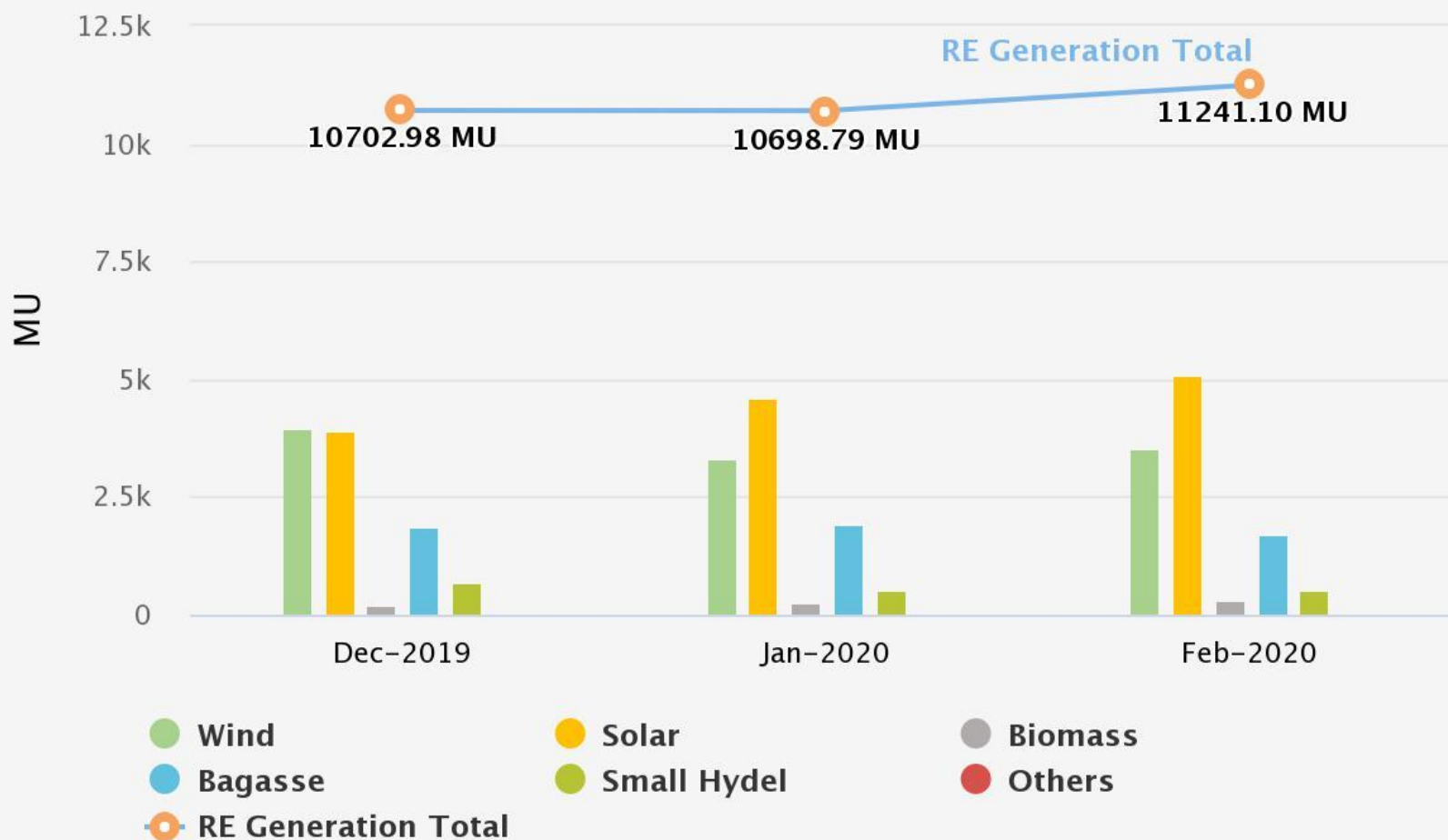
All India Power Generation from Jun-2021 to Aug-2021)



Source : <https://cea.nic.in/dashboard/?lang=en>



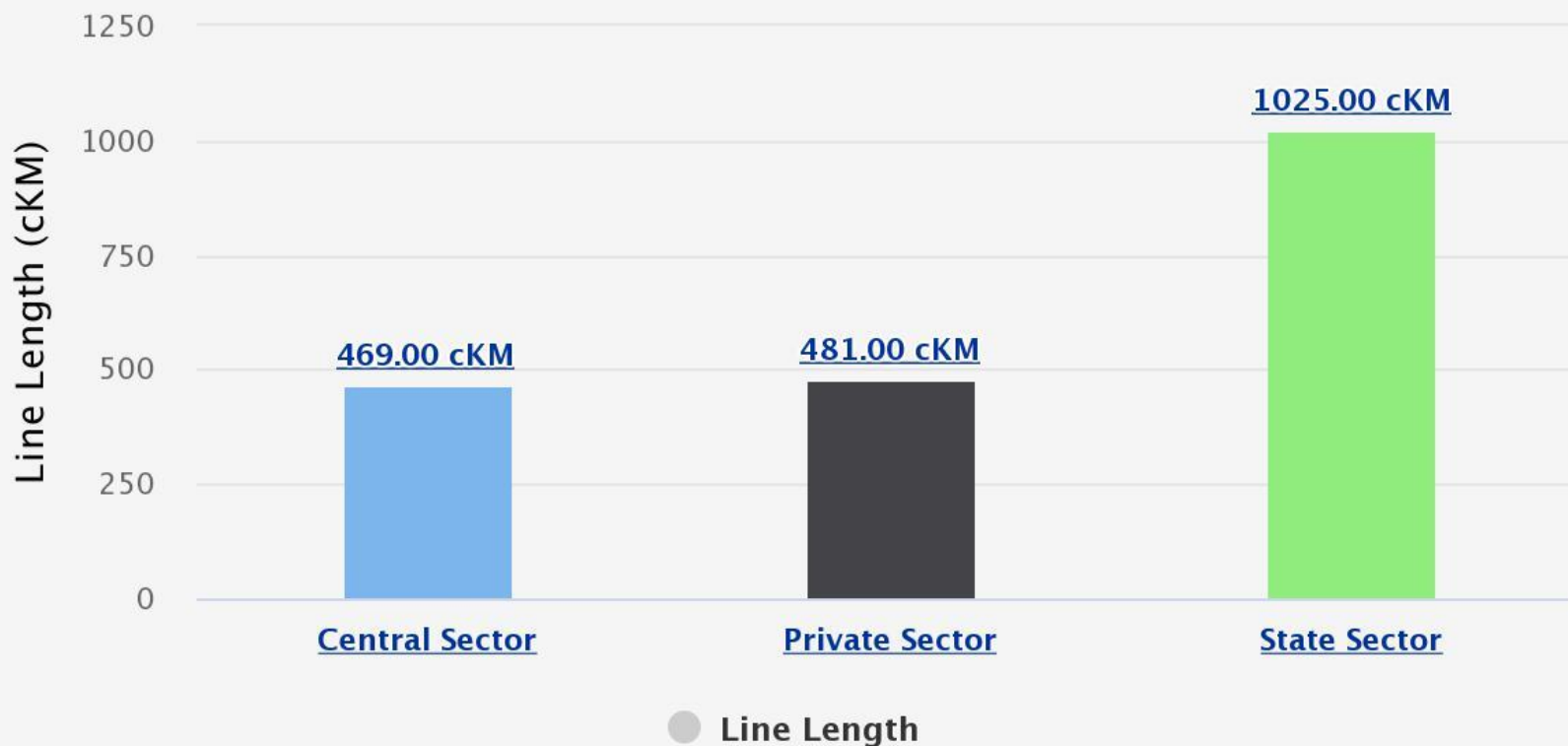
All India Renewable Generation





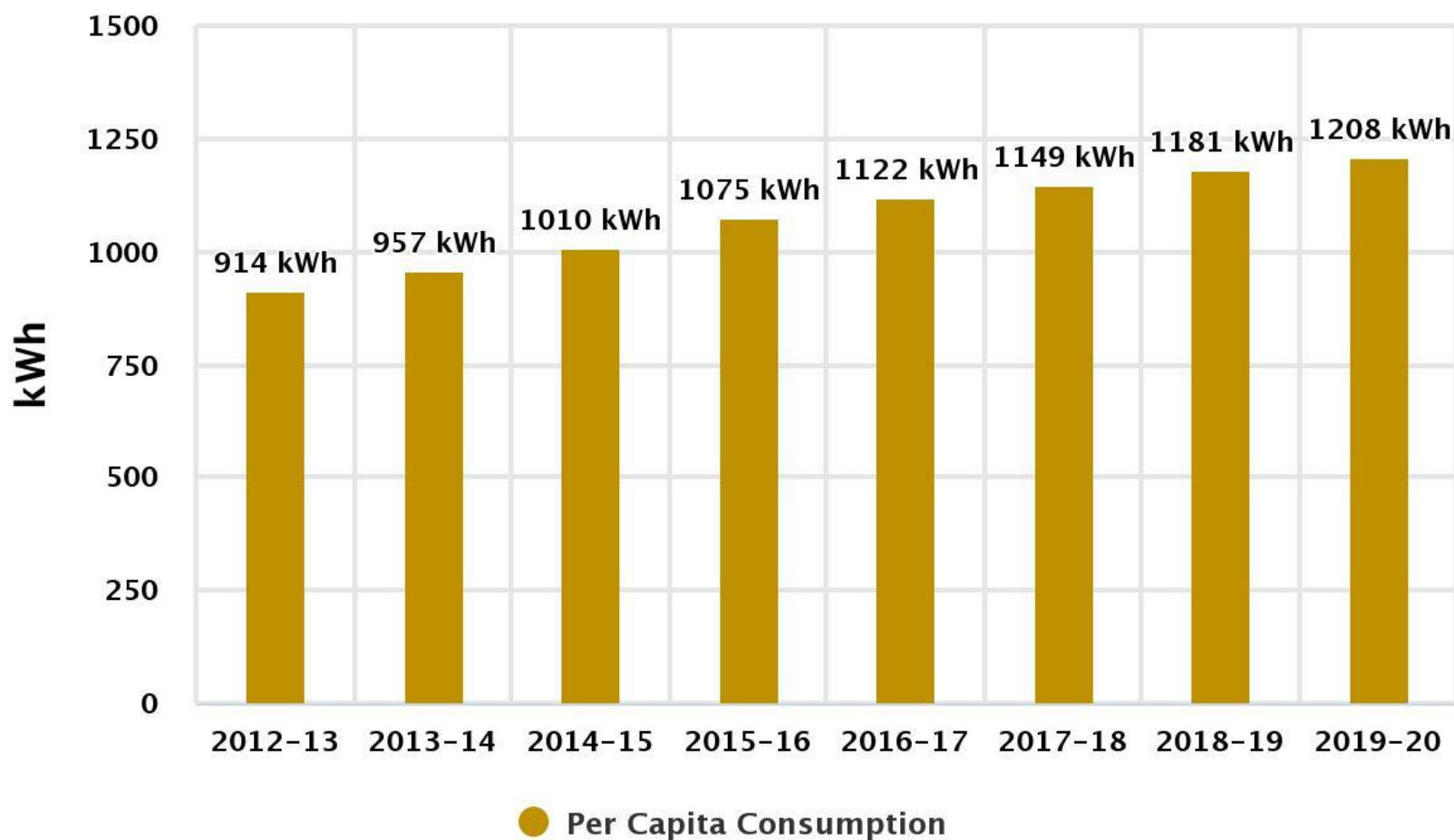
Transmission Lines (220 kV and above) Commissioned/Ready for commissioning During Aug-2021

Click the columns to view further distribution.



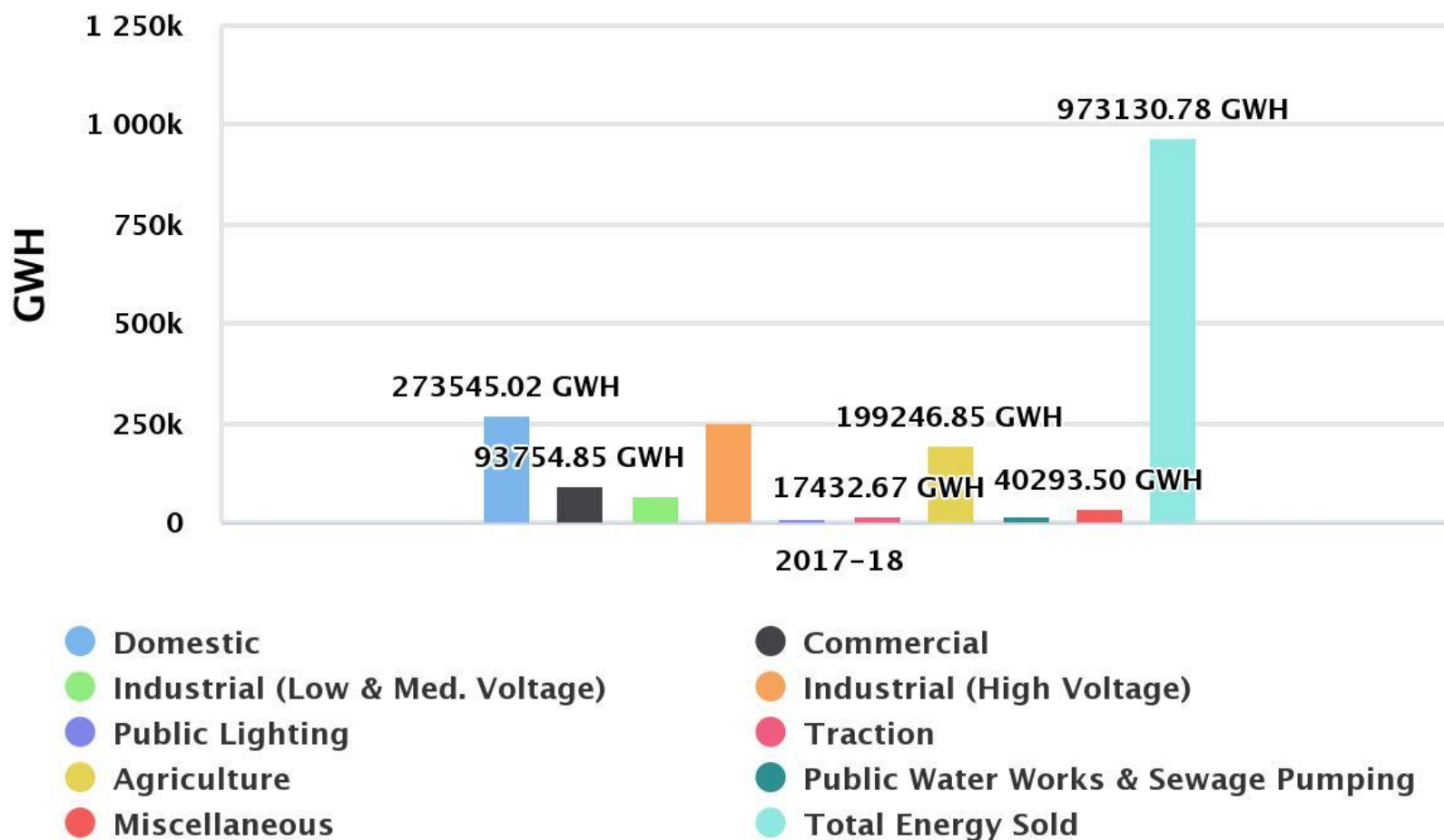


Per Capita Consumption (kWh)



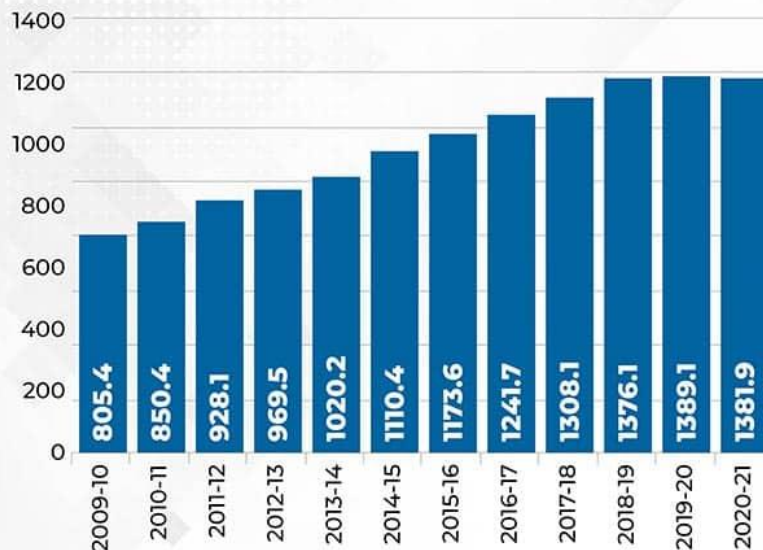


Electrical Energy Sales to Ultimate Consumers (2017-18)



INDIA'S POWER CAPACITY HAS GROWN STEADILY IN THE LAST DECADE EXCEPT IN FY21

TOTAL GENERATION
(INCLUDING RENEWABLE SOURCES)

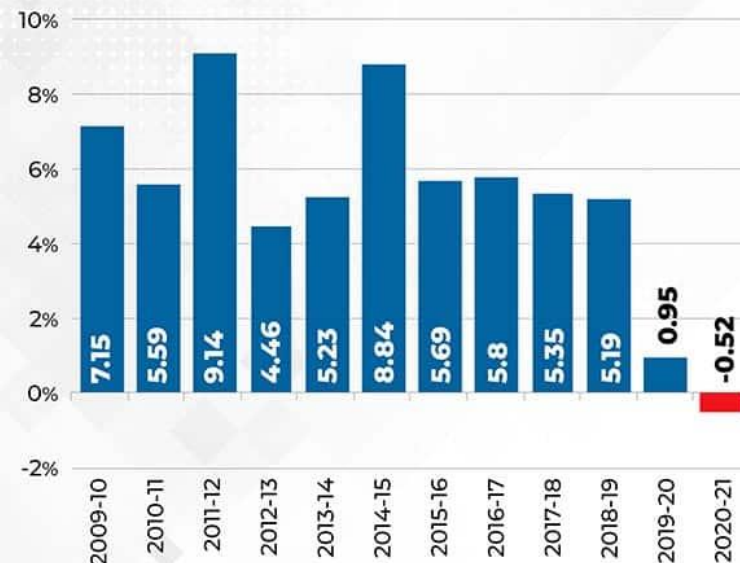


In billion units; Source: Ministry of Power



INDIA'S POWER GENERATION GROWTH HAS SEEN SLOW DECLINE SINCE 2014-15

GROWTH IN TOTAL GENERATION



Source: Ministry of Power





SASTRA
ENGINEERING · MANAGEMENT · LAW · SCIENCES · HUMANITIES · EDUCATION

DEEMED TO BE UNIVERSITY
(U/S 3 OF THE UGC ACT, 1956)

THINK MERIT · THINK TRANSPARENCY · THINK SASTRA

RECORD LOW SOLAR TARIFF

₹ 2.44 / UNIT ACHIEVED

IN BHADLA, RAJASTHAN



HIGHEST EVER

WIND CAPACITY ADDITION OF

5.5 GW IN 2016-17



**WORLD'S LARGEST
RENEWABLE ENERGY
EXPANSION PROGRAMME**

175 GW TILL 2022



Progress Through Quality Education



SASTRA

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THINK MERIT / THINK TRANSPARENCY / THINK SASTRA

Menu



GOVERNMENT OF INDIA
MINISTRY OF NEW
AND RENEWABLE ENERGY



En हि - A + Subscribe

ACHIEVED IN
BHADLA,
RAJASTHAN

40GW

ABOUT 19 TIMES HIGHER SOLAR
PUMPS INSTALLED BETWEEN 2014-19 |
2.25 LAKH VERSUS UPTO 2014 - 11,626

SOLAR POWER
TARIFF REDUCED
BY MORE THAN
75% USING
PLUG AND PLAY
MODEL

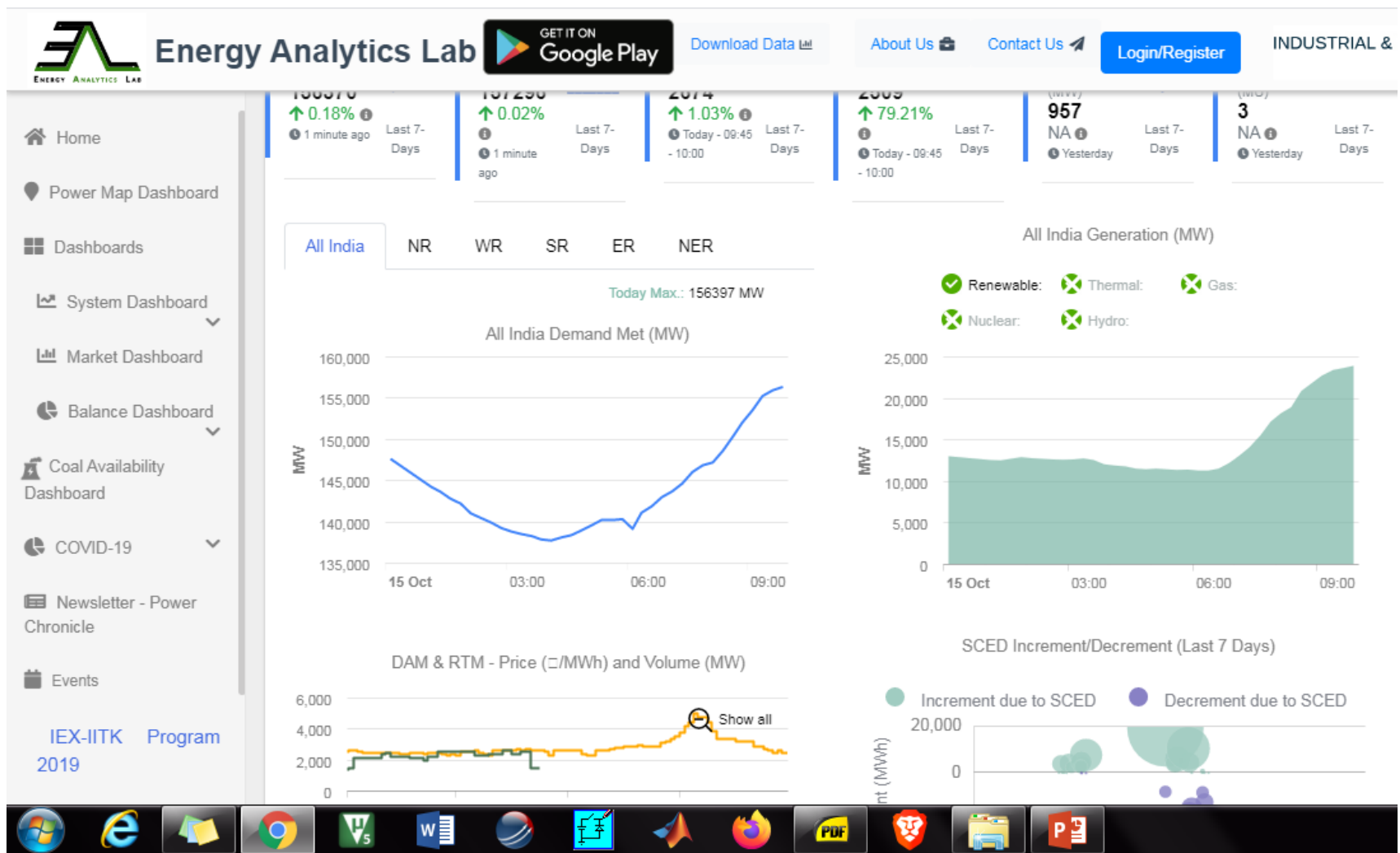
India now at
**5TH GLOBAL
POSITION**
for overall
installed
renewable energy
capacity

RENEWABLE ENERGY HAS A SHARE OF
23.39% IN THE TOTAL INSTALLED
GENERATION CAPACITY IN THE
COUNTRY i.e. **368.98 GW** (Upto
29th February, 2020).

WORLD'S LARGEST RENEWABLE ENERGY EXPANSION
PROGRAMME **175 GW TILL 2022**

SOLAR CAPACITY INCREASED IN THE LAST 5.5 YEARS FROM
AROUND **2.6 GW TO MORE THAN 34 GW**

Demand Last Year



- <https://eal.iitk.ac.in/>



Demand Yesterday

Demand Met
(MW)

162200

↑ 0.31%

ⓘ

⌚ 3 minutes ago



Last 7-Days

Generation
(MW)

165392

↑ 0.7%

ⓘ

⌚ 3 minutes ago



Last 7-Days

DAM Price
(₹/MWh)

2642

↓ 2.38%

ⓘ

⌚ Today - 12:15 - 12:30



Last 7-Days

RTM Price
(₹/MWh)

↓ 100%

ⓘ

⌚ Today -



Last 7-Days

Daily Peak
Shortage
(MW)

943

↓ 0%

ⓘ

⌚ Yesterday



Last 7-Days

Daily Energy
Shortage
(MU)

45

↓ 0%

ⓘ

⌚ Yesterday



Last 7-Days

All India

NR

WR

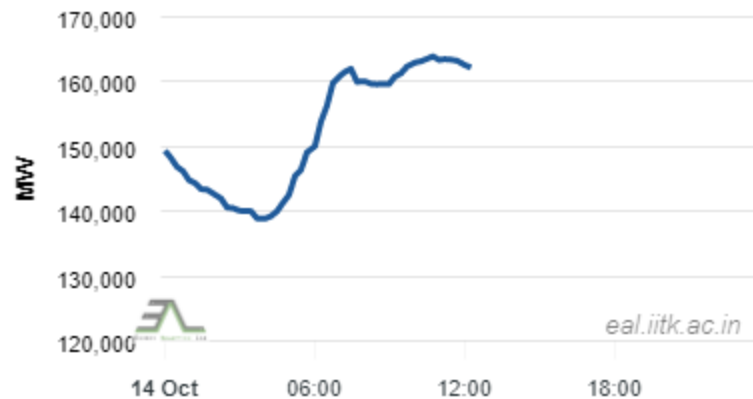
SR

ER

NER

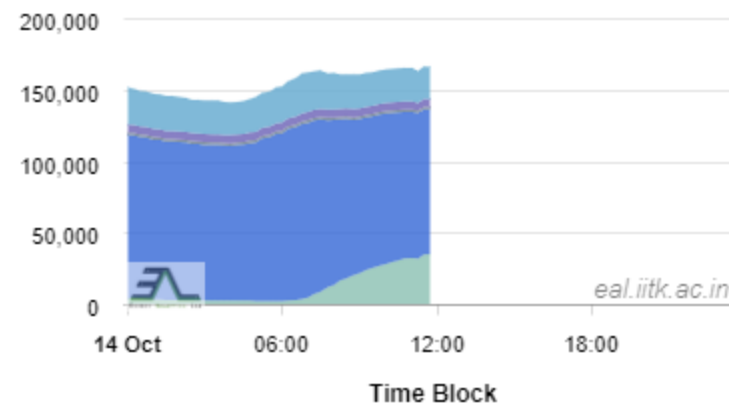
Today Max.: 163915 MW

All India Demand Met (MW)

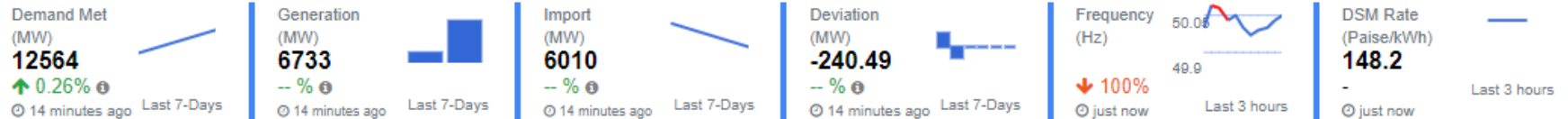


All India Generation (MW)

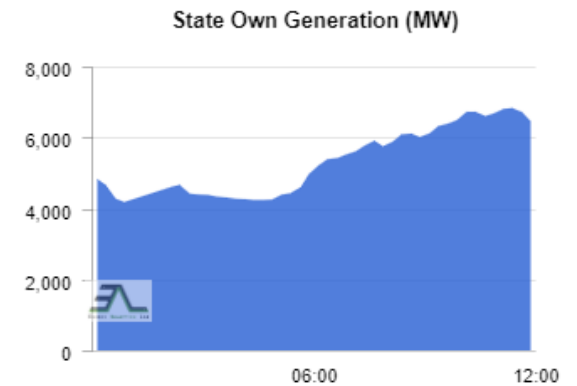
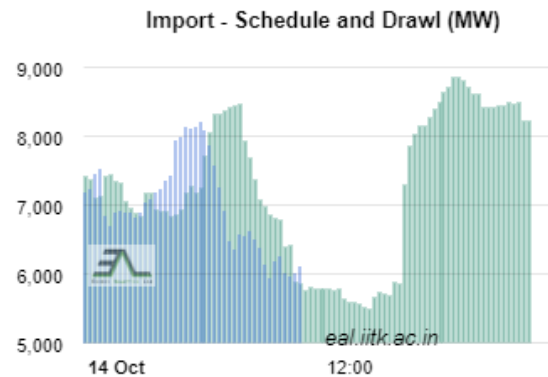
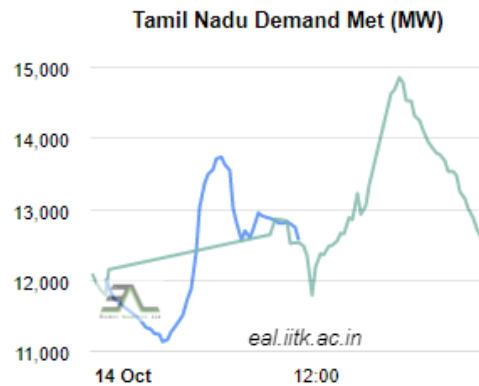
- ✓ Renewable:
- ✓ Thermal:
- ✓ Gas:
- ✓ Nuclear:
- ✓ Hydro:



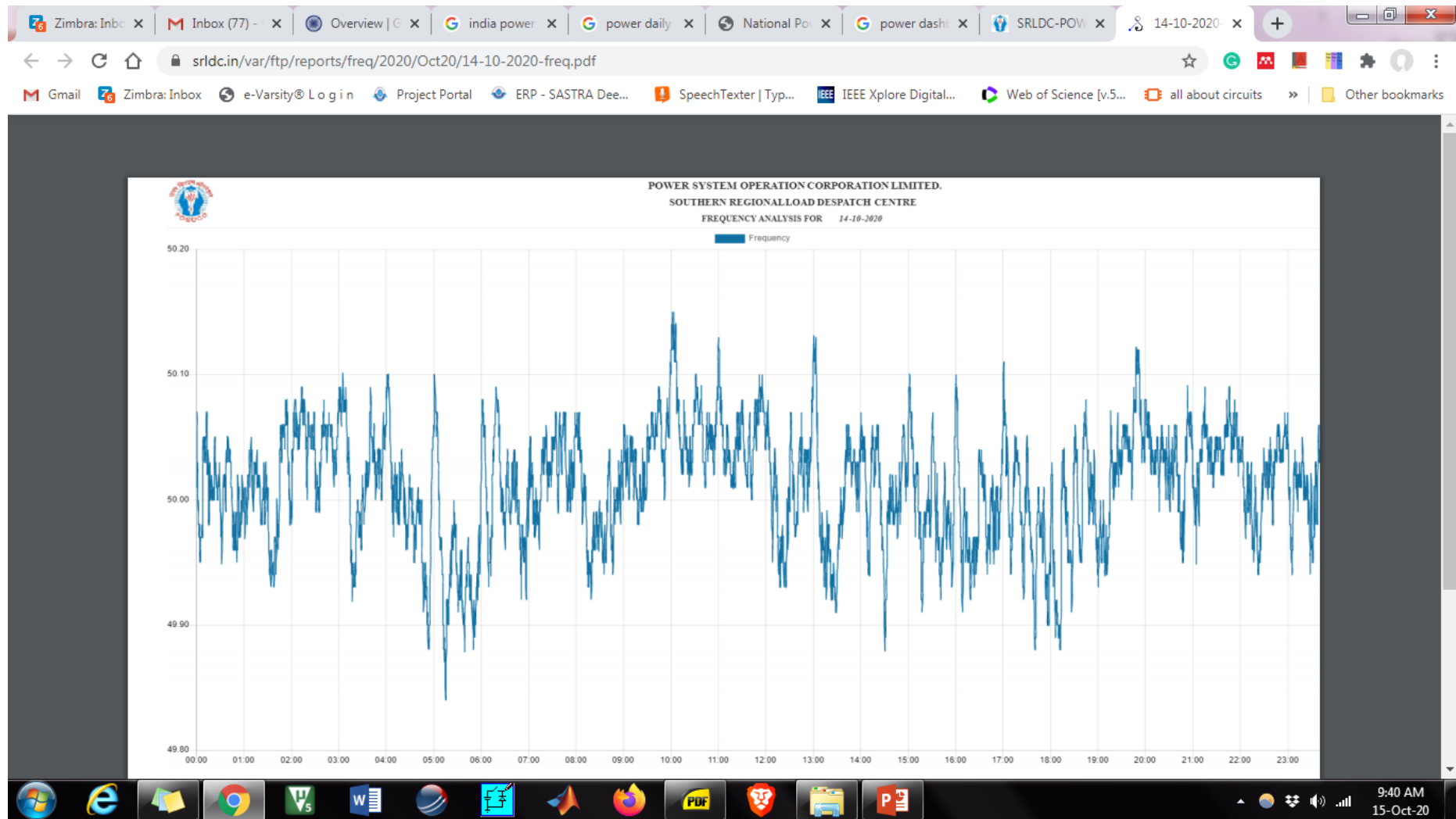
State Demand



Realtime/Today's Data

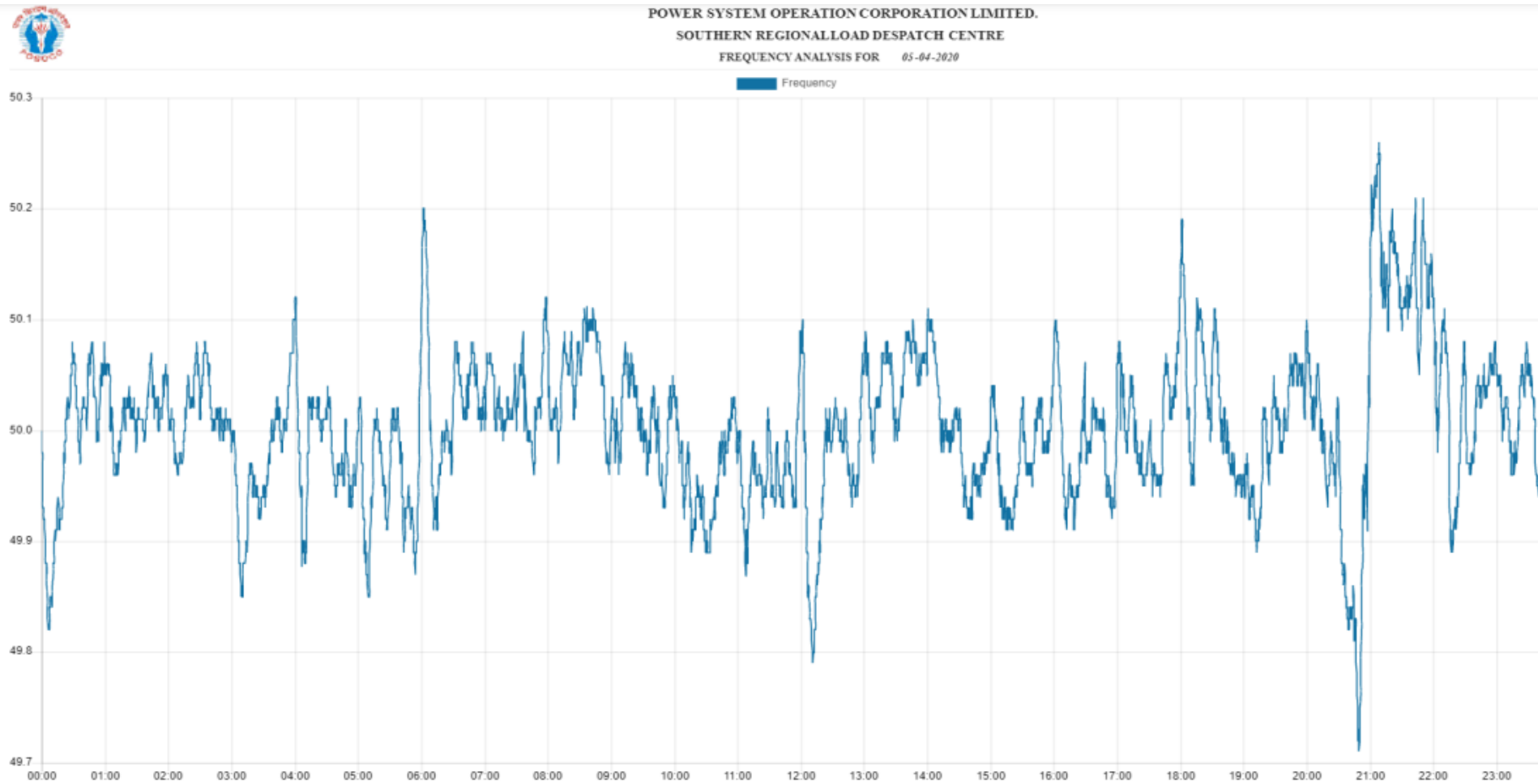


Frequency Yesterday



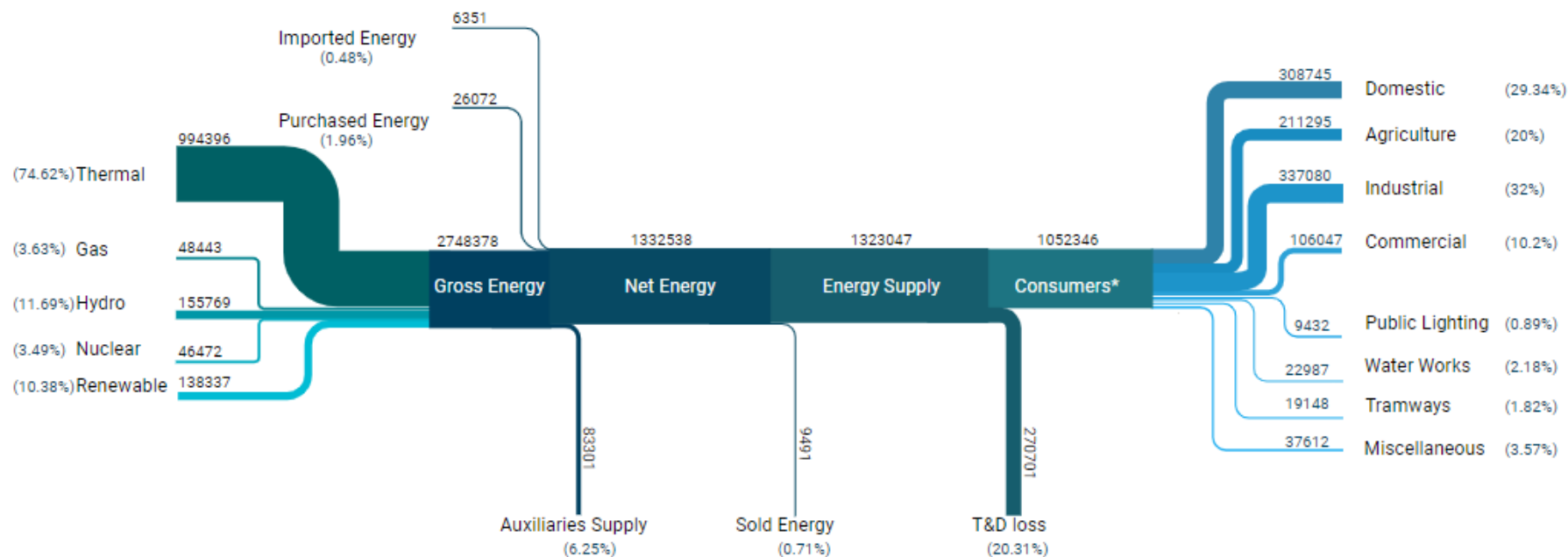
<https://www.srldc.in/Daily-Reports>

Frequency Variations(05 April 2020)



<https://www.srlcdc.in/var/ftp/reports/freq/2020/Apr20/05-04-2020-freq.pdf>

All India Utilities - Electrical Energy Generated, Purchased, Sold and T&D Loss (GWh)



Note: * Includes metered and assessed supply to agricultural consumers.

Summary