DATABASE ON ENERGY RESOURCES IN TAMIL NADU

MARCH, 2020

Submitted to

The Director,

Department of Environment,

Government of Tamil Nadu, Saidapet, Chennai - 15

by

Tamil Nadu State ENVIS Hub,

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In collaboration with

Ecogeomatix

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ABBREVATIONS

BBGTPS	Basin Bridge Gas Turbine Power Station
CER	Conventional Energy Resources
CGS	Central Generating Stations
ETPS	Ennore Thermal Power Station
FRL	Full Reservoir Level
JNNSM	Jawaharlal Nehru National Solar Mission
KGTPS	Kuttalam Gas Turbine Power Station
kHa	Kilo Hectare or ,000 Ha
KKNPP	Kudankulam Nuclear Power Project
kWh/a	Kilowatt-Hour
MAPS	Madras Atomic Power Station
MAWPD	Mean Annual Wind Power Density
MAWS	Mean Average Wind Speed
MMTPA	Million Metric Tonnes Per Annum
MTPA	Metric Tonnes Per Annum
MTPS	Mettur Thermal Power Station
MU	Mega Unit
MW	Mega Watt
MWe	Mega Watt electrical
NCES	Non-Conventional Energy Resources
NCTPS	North Chennai Thermal Power Station
NLC	Neyveli Lignite Corporation
PHWR	Pressurised Heavy Water Reactor
SECI	Solar Energy Corporation of India
SEZ	Special Economic Zone
TANGEDCO	Tamil Nadu Generation and Distribution Corporation Limited
TANTRANSCO	Tamil Nadu Transmission Corporation Limited
TEDA	Tamil Nadu Energy Development Agency
TKGTPS	Thirumakottai Gas Turbine Power Station
TMTPA	Thousand Metric Tonne Per Annum
TNEB	Tamil Nadu Electricity Board
TTPS	Tuticorin Thermal Power Station
VGTPS	Valathur Gas Turbine Power Station
VVER	Water-Water Energetic Reactor
WPD	Wind Power Density

Database on Energy Resources in Tamil Nadu

1. INTRODUCTION

Energy is one of the most important building blocks in human development, and as such, acts as a key factor in determining the economic development of all the countries. In an effort to meet the demands of a developing nation, the energy sector has witnessed a rapid growth. It is important to note that non-renewable resources are significantly depleted by human use, whereas renewable resources are produced by ongoing processes that can sustain indefinite human exploitation.

Tamil Nadu is already a pioneer state in implementing 24x7 Power to all sectors. The state has already achieved 100% village electrification level.

Tamil Nadu Electricity Board (TNEB) was formed on July 1, 1957 under section 54 of the Electricity (Supply) Act 1948 in the State of Tamil Nadu as a vertically integrated utility responsible for power generation, transmission and distribution. The electricity network has since been extended to all villages and towns throughout the State. As per the provisions under the section 131 of the Electricity Act, 2003 TNEB was restructured on 1.11.2010 into TNEB Limited; Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO); and Tamil Nadu Transmission Corporation Limited (TANTRANSCO). Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO) is responsible for electricity generation and distribution within the state. Tamil Nadu Transmission Corporation Limited (TANTRANSCO) is responsible for electricity transmission of the state

To satisfy the energy needs of the State, Tamil Nadu Generation and Distribution Corporation Limited has an installed capacity of 18,747.28 MW which includes TANGEDCO owned State projects, share from the Central Generating Stations (CGS) and private producers including renewable energy generators. Other than this, the State has installations in renewable energy sources like wind mill, solar, biomass and cogeneration up to 10,479.61 MW.

TEDA is Tamil Nadu Energy Development Agency. It is an independent agency setup by Government of Tamil Nadu in the year 1984, as a registered society with a specific purpose – to create awareness and migrate the State from using fossil fuels to renewable energy.

Of the total renewable energy capacity of about 32,730MW installed all over India, TN alone has about 8326.86MW, thus about 25.44% of the total installed capacity. In the important sector of wind energy, this number is even more dominant, with Tamil Nadu having about 34.31% of the total wind energy installed capacity in India.

Tamil Nadu being the leader in Renewable Energy with an installed capacity of 12,180 MW has harnessed 12,601 million units of wind energy and 3,554 million units of solar energy during 2018-19.

This database provides an overview of Energy Resources in Tamil Nadu. It covers Conventional Energy Resources and Non-Conventional Energy Resources. Conventional Energy Resources are Thermal power plants, Hydro Power House and Nuclear Power Plants. Thermal Power Plants are mainly located along the coastal district, it provides easy access to import coal and also provides unlimited water supply for cooling purposes. There are different sources of fuel used in Thermal power plants to generated energy. The different types of fuels used are Coal, Lignite and Natural Gas. Coal are sourced from other parts of India and also imported mainly from Indonesia. Lignite is locally available in Neyveli, Cuddalore district, it is explored by Neyveli Lignite Corporation. Natural Gas is found in the Cauvery Delta areas (Nagapattinam, Thanjavur and Thiruvarur district), other areas identified are Pudukkottai and Ramanathapuram districts. Oil and Natural Gas are explored by the Oil and Natural Gas Corporation Limited (ONGC). Hydro Power Houses are mainly located along the Western Ghats districts where the river originates and flows to the plains, Important river flows in the state are Cauvery, Bhavani, Vaigai, Tamirabarani and Kodayar . The major districts in Hydro Power Houses located are Nilgiris, Coimbatore, Theni, Tirunelveli, Kanyakumari, Erode and Salem. The Hydro Power Houses are Operated and Maintained by the state owned TANGEDCO. Madras Atomic Power Station, Kalpakkam and Kudankulam Nuclear Power Stations located in the state.

Non-conventional Energy Sources are Solar, Wind, Biomass and Biogas power plants. Non-conventional Energy generation is promoted by the state owned Tamil Nadu Energy Development Agency (TEDA). Tamil Nadu has reasonably high solar insolation (5.6 -60 kWh/sq.m) with around 300 clear sunny days in a year. Average solar irradiation in Tamil Nadu state is 1266.52 W / sq.m. TEDA provides incentives to promote Roof Top Solar Photovoltaic installations, the state government scheme CM's Solar Power Green House promotes usage of Solar Photovoltaic installations. Solar Net Metering provided benefit to the consumers. Tamil Nadu is the leader in installation of wind mills, the wind potential areas are Palghat pass, Cumbam pass, Sengottah pass and Aralvoimozhi pass. Muppandal near Aralvoimozhi has the largest installation of wind mills in Tamil Nadu. TANGEDCO promotes Bio-mass power plants in Tamil Nadu with co-operation extended by the Tamil Nadu Energy Development Agency Bio-mass based Cogeneration Plants, Bagasse based Cogeneration Plants, Biomass gasification based Power Projects and Municipal Solid waste & Vegetable based Power Plant.

2. TAMIL NADU POWER SECTOR AT A GLANCE

Electricity Act, 2003

An act to consolidate the laws relating to generation, transmission, distribution, trading and use of electricity and general for taking measures conducive to development of electricity industry, promoting competition therein, protecting interest of consumers and supply of electricity to all areas, rationalisation of electricity tariff, ensuring transparent policies regarding subsides, promotion of efficient and environmentally benign policies constitution of Central Electrical Authority, Regulatory Commissions and establishment of Appellate Tribunal and for matters connected therewith or incidental thereto.

Energy Conservation Act, 2001

Considering the vast potential of energy savings and benefits of energy efficiency, the Government of India enacted the Energy Conservation Act, 2001 (52 of 2001). The Act provides for the legal framework, institutional arrangement and a regulatory mechanism at the Central and State level to embark upon energy efficiency drive in the country. Five major provisions of Energy Conservation Act relate to Designated Consumers, Standard and Labelling of Appliances, Energy Conservation Building Codes, Creation of Institutional Set up (BEE) and Establishment of Energy Conservation Fund.

The Energy Conservation Act became effective from 1st March, 2002 and Bureau of Energy Efficiency (BEE) operationalized from 1st March, 2002. Energy efficiency institutional practices and programs in India are now mainly being guided through various voluntary and mandatory provisions of the Energy Conservation Act.

Tamil Nadu Solar Energy Policy 2019

This policy includes solar net metering for consumer Solar Photo Voltaic systems. This early adoption of net metering contributed to making the state a national leader in solar energy. It promotes Solar Energy Research in Tamil Nadu; Government will facilitate and support research in the solar energy sector. TEDA, in collaboration with other Government Departments, will constitute a Solar Energy Research Fund (SERF). Solar or other renewable energy projects installed for study, research or pilot purposes may be given special priorities and exemptions by the TNERC and the distribution license on the recommendation of the Government.

Vision Tamil Nadu 2023

A Strategic Plan or Infrastructure Development in Tamil Nadu, includes energy target of 5,000 MW. More recently the MNRE proposed a solar energy target for the year 2020 of 9,000 MW for Tamil Nadu

2.1. ORGANISATION SET UP IN TAMIL NADU

2.1.1. TAMIL NADU ELECTRICITY BOARD

The main function of Tamil Nadu Electricity Board has been to perform electricity generation, transmission and distribution in an effective manner and to supply quality power to its consumers.

RESTRUCTURING OF TNEB: Electricity Act 2003 mandates restructuring of the State Electricity Boards by unbundling. TNEB has been reorganised into one Holding company and two subsidiary companies with effect from 01.11.2010 namely;

i. TNEB Limited.

ii. Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO) and

iii. Tamil Nadu Transmission Corporation Limited (TANTRANSCO)

The aforementioned companies shall be fully owned by Government.

TANGEDCO performs the Generation and Distribution Functions. **TANTRANSCO** performs the functions of Transmission of Power.

2.1.2. TAMIL NADU ENERGY DEVELOPMENT AGENCY

The Government of Tamil Nadu realized the importance and need for renewable energy, and set up a separate Agency, as registered society, called the Tamil Nadu Energy Development Agency (TEDA) as early as 1985,as per G.O.Ms.No.163, P. & D. (EC) Department, dated 29.11.1984 with the following specific objectives:-

- To promote the use of new and renewable sources of energy (NRSE) and to implement projects therefore.
- To promote energy conservation activities.
- To encourage research and development on renewable sources of energy.

Tamil Nadu Energy Development Agency has been set up with the objective of creating awareness on the potential and prospects of use of Renewable Energy, identifying and estimating the potential for Renewable Energy, evolving policies for the promotion of Renewable Energy sector, encouraging Research and Development, setting up demonstration projects etc.,

There is an ever increasing demand for energy in spite of the rising prices of oil & other fossil fuel / depletion of fossil fuels. Energy demand, in particular electricity production has resulted in creation of fossil fuel based power plants that let out substantial greenhouse gas / carbon emission into the atmosphere causing climate change and global warming.

The Government of Tamil Nadu is committed to mitigate the climate change effects by bringing out policies conducive to promote renewable energy generation in the State. The Government intends to make renewable energy a people's movement just like rain water harvesting.

The state is blessed with various forms of renewable energy sources viz., Wind, Solar, Biomass, Biogas, Small Hydro, etc. Municipal and Industrial wastes could also be useful sources of energy while ensuring safe disposal. Renewable Energy (RE) sources provide a viable option for on/off grid electrification & wide industrial applications.

2.1.3. TAMIL NADU ENERGY REGULATION COMMISSION

The Govt. of India had enacted the Electricity Regulatory Commissions Act, 1998 (No.14 of 1998) on 2nd July, 1998 with the objective of providing for the establishment of a Central Electricity Regulatory Commission and State Electricity Regulatory Commissions, rationalisation of electricity tariff, transparent policies regarding subsidies, promotion of efficient and environmentally benign policies and for matters connected therewith or incidental thereto.

2.1.4. TAMIL NADU POWER FINANCE AND INFRASTRUCTURE DEVELOPMENT CORPORATION

Tamil Nadu Power Finance and Infrastructure Development Corporation is wholly owned by Government of Tamil Nadu. Registered with RBI as a Non-Banking Finance Company vide Regn no: 700389 Classified as a Hire Purchase Finance Company. Mobilises funds through various attractive Deposit Schemes. Provides Financial Assistance to Power and Infrastructure Projects and provides funds to Tamil Nadu Generation and Distribution Corporation Ltd.

2.1.5. CENTRAL - MINISTRY OF ENERGY

The Ministry of Power started functioning independently with effect from 2nd July, 1992. Earlier it was known as the Ministry of Energy sources. Electricity is a concurrent subject at Entry 38 in List III of the seventh Schedule of the Constitution of India. The Ministry of Power is primarily responsible for the development of electrical energy in the country. The Ministry is concerned with perspective planning, policy formulation, processing of projects for investment decision, monitoring of the implementation of power projects, training and manpower development and the administration and enactment of legislation in regard to thermal, hydro power generation, transmission and distribution. The Ministry of Power is responsible for the Administration of the Electricity Act, 2003, the Energy Conservation Act , 2001 and to undertake such amendments to these Acts, as may be necessary from time to time, in conformity with the Government's policy objectives.

2.1.6. CENTRAL - MINISTRY OF NEW AND RENEWABLE ENERGY

MNRE is the nodal agency of the Government of India for all matters relating to non-conventional/renewable energy. It undertakes policy making, planning, promotion and co-ordination functions relating to all aspects of renewable energy, including fiscal and financial incentives, creation of industrial capacity, promotion of demonstration and commercial programmes, R&D and technology development, intellectual property protection, human resource development and international relations. MNRE also deals with emerging areas such as fuel cells, electrical vehicles, ocean energy and hydrogen energy.

2.1.6.1. NATIONAL INSTITUTE OF SOLAR ENERGY

National Institute of Solar Energy, an autonomous institution of Ministry of New and Renewable (MNRE), is the apex National R&D institution in the field Solar Energy. The Government of India has converted 25 year old Solar Energy Centre (SEC) under MNRE to an autonomous institution in September, 2013 to assist the Ministry in implementing the National Solar Mission and to coordinate research, technology and other related works.

2.1.6.2. SOLAR ENERGY CORPORATION OF INDIA LIMITED

"Solar Energy Corporation of India ltd" (SECI) is a CPSU under the administrative control of the Ministry of New and Renewable Energy (MNRE), set up on 20th Sept, 2011 to facilitate the implementation of JNNSM and achievement of targets set therein. It is the only CPSU dedicated to the solar energy sector. It was originally incorporated as a section-25 (not for profit) company under the Companies Act, 1956.

2.1.6.3. NATIONAL INSTITUTE OF WIND ENERGY (NIWE)

National Institute of Wind Energy has been established in Chennai in the year 1998, as an autonomous R&D institution by the Ministry of New and Renewable Energy (MNRE), Government of India. It is a knowledge-based institution of high quality and dedication, offers services and seeks to find complete solutions for the kinds of difficulties and improvements in the entire spectrum of the wind energy sector by carrying out further research.

2.1.6.4. SARDAR SWARAN SINGH NATIONAL INSTITUTE OF RENEWABLE ENERGY

Sardar Swaran Singh National Institute of Renewable Energy (SSS-NIRE), Kapurthala (Punjab) is an autonomous Institution of the Ministry of New and Renewable Energy. Govt. of India spread over a sprawling campus of about 75 acres, the Institute is marching towards development into a centre of excellence in the biomass energy. The objectives of the Institute is to carry out and facilitate research, design, development, testing, standardization & technology demonstration eventually leading to commercialization of RD&D output with a focus on bioenergy, biofuels & synthetic fuels in solid, liquid & gaseous forms for transportation, portable & stationary applications, development of hybrid / integrated energy systems, to undertake & facilitate human resource development and training in the area of bioenergy.

2.1.6.5. INDIAN RENEWABLE ENERGY DEVELOPMENT AGENCY

The Indian Renewable Energy Development Agency (IREDA) is a Non-Banking Financial Institution under the administrative control of this Ministry for providing term loans for renewable energy and energy efficiency projects.

2.1.7. CENTRAL ELECTRICITY REGULATORY COMISSION

The Commission intends to promote competition, efficiency and economy in bulk power markets, improve the quality of supply, promote investments and advise government on the removal of institutional barriers to bridge the demand supply gap and thus foster the interests of consumers. In pursuit of these objectives the Commission aims to –

- Improve the operations and management of the regional transmission systems through Indian Electricity Grid Code (IEGC), Availability Based Tariff (ABT), etc.
- Formulate an efficient tariff setting mechanism, which ensures speedy and time bound disposal of tariff petitions, promotes competition, economy and efficiency in the pricing of bulk power and transmission services and ensures least cost investments.
- Facilitate open access in inter-state transmission
- Facilitate inter-state trading
- Promote development of power market
- Improve access to information for all stakeholders.
- Facilitate technological and institutional changes required for the development of competitive markets in bulk power and transmission services.
- Advise on the removal of barriers to entry and exit for capital and management, within the limits of environmental, safety and security concerns and the existing legislative requirements, as the first step to the creation of competitive markets.

2.1.8. POWER SYSTEM OPERATION CORPORATION LTD.

- The Corporation has set the following objectives in line with its Mission for integrated operation of regional and national power system through “National Load Despatch Centre and Regional Load Despatch Centres” to discharge the following functions:
- To supervise and control all aspect concerning operations and manpower requirement of RLDCs and NLDC.
- To act as the apex organisation for human resources requirement of NLDC and RLDCs.
- To ensure planning and implementation of infrastructure required for smooth operation and development of NLDC and RLDCs.
- To coordinate the functioning of NLDC and all the RLDCs.
- To advise and assist state level Load Despatch Centres, including specialised training etc.
- To perform any other function entrusted to it by the Ministry of Power.

2.1.9. NATIONAL LOAD DESPATCH CENTRE

The National Load Despatch Centre is the apex body to ensure integrated operation of the national power system and discharge the following functions, namely:-

- Supervision over the Regional Load Despatch Centres;
- Scheduling and despatch of electricity over inter-regional links in accordance with grid standards specified by the Authority and grid code specified by Central Commission in coordination with Regional Load Despatch Centres;
- Coordination with Regional Load Despatch Centres for achieving maximum economy and efficiency in the operation of National Grid;
- Monitoring of operations and grid security of the National Grid;
- Supervision and control over the inter-regional links as may be required for ensuring stability of the power system under its control;
- Coordination with Regional Power Committees for regional outage schedule in the national perspective to ensure optimal utilization of power resources;
- Coordination with Regional Load Despatch Centres for the energy accounting of inter-regional exchange of power;
- Coordination for restoration of synchronous operation of national grid with Regional Load Despatch Centres;
- Coordination for trans-national exchange of power;
- Providing operational feedback for national grid planning to the Authority and the Central Transmission Utility;
- Levy and collection of such fee and charges from the generating companies or licensees involved in the power system, as may be specified by the Central Commission.
- Dissemination of information relating to operations of transmission system in accordance with directions or regulations issued by Central Electricity Regulatory Commission and the Central Government from time to time.

2.1.10. SOUTHERN REGIONAL LOAD DESPATCH CENTRE (SRLDC)

SRLDC is the apex body to ensure integrated operation of the power system in the Southern Region. The main responsibilities of SRLDC are to ensure the integrated operation of the power system in the Southern Region.

- Monitoring of system parameters and system security.
- Daily scheduling and operational planning.
- Facilitating bilateral and inter-regional exchanges of power.
- Analysis of tripping/disturbances and facilitating immediate remedial measures.
- System studies, planning and contingency analysis.
- Augmentation of telemetry, computing and communication facilities.
- Computation of energy despatch and drawl values using SEMs.

i) Southern regional grid is an electrical system comprising of 6,51,000 Sq. km of area with 5 States namely Andhra Pradesh, Karnataka, Kerala, Tamilnadu, Telangana and Union Territory of Pondicherry, Generating Stations at Central and State Sector, Independent Power producing stations, State DISCOMS and STUs etc.

ii) TThe Southern region has an installed capacity of 74367 MW as on 31/07/2016 with 30,347 MW in State Sector and 10490 MW in Central Sector and 33530 MW IPPs.

iii) The States are inter connected with each other through 765/400/220 kV network. Southern Region is connected to Western region through HVDC Back-to-back (2x500 MW) link at Bhadrawathi in WR and to Eastern regions through HVDC back-to-back link (2x500 MW) at Gazuwaka in SR and ±500 kV Bipolar HVDC link (2x1000 MW) from Talcher in ER to Kolar in SR as well as 765 kV 2 x Single Circuit Sholapur-Raichur Interconnector to facilitate exchange of power from surplus to deficit region / State as well as wheeling of power.

2.1.11. STATE LOAD DISTRIBUTION CENTRE

i) The SLDCs shall be the Apex Body to ensure integrated operation of the power system in a State.

ii) SLDCs shall:

- be responsible for optimum scheduling and despatch of electricity within a State in accordance with the contracts entered into with the licensees or the generating Companies operating in that State.
- monitor grid operation.
- keep accounts of the quantity of electricity transmitted through State grid.
- exercise supervision and control over the inter-State transmission system.
- be responsible for carrying out real time operation for grid control and despatch of electricity within the State through secure and economic operation of the State Grid in accordance with the Grid standards and State Grid Code.

iii) SLDCs in the Southern Region are performing the following functions.Overall supervision, monitoring and control of the integrated power system in the State on real time basis for ensuring stability, security and economy operation of the power system in the State.

Optimum scheduling and dispatch of electricity within the State. For this SLDCs estimate the demand of the State / DISCOMS, as may be the case, availability of power in the State/DISCOMS (Distribution Companies) from State generators and other sources like Central Generating stations, bilateral contracts etc, conveys the final requisition to RLDCs on the State's entitlement from the Central Generating Stations and bilateral transactions under open access, if any, and issues final dispatch schedule to the State Generators and drawal schedule to the DISCOMS.

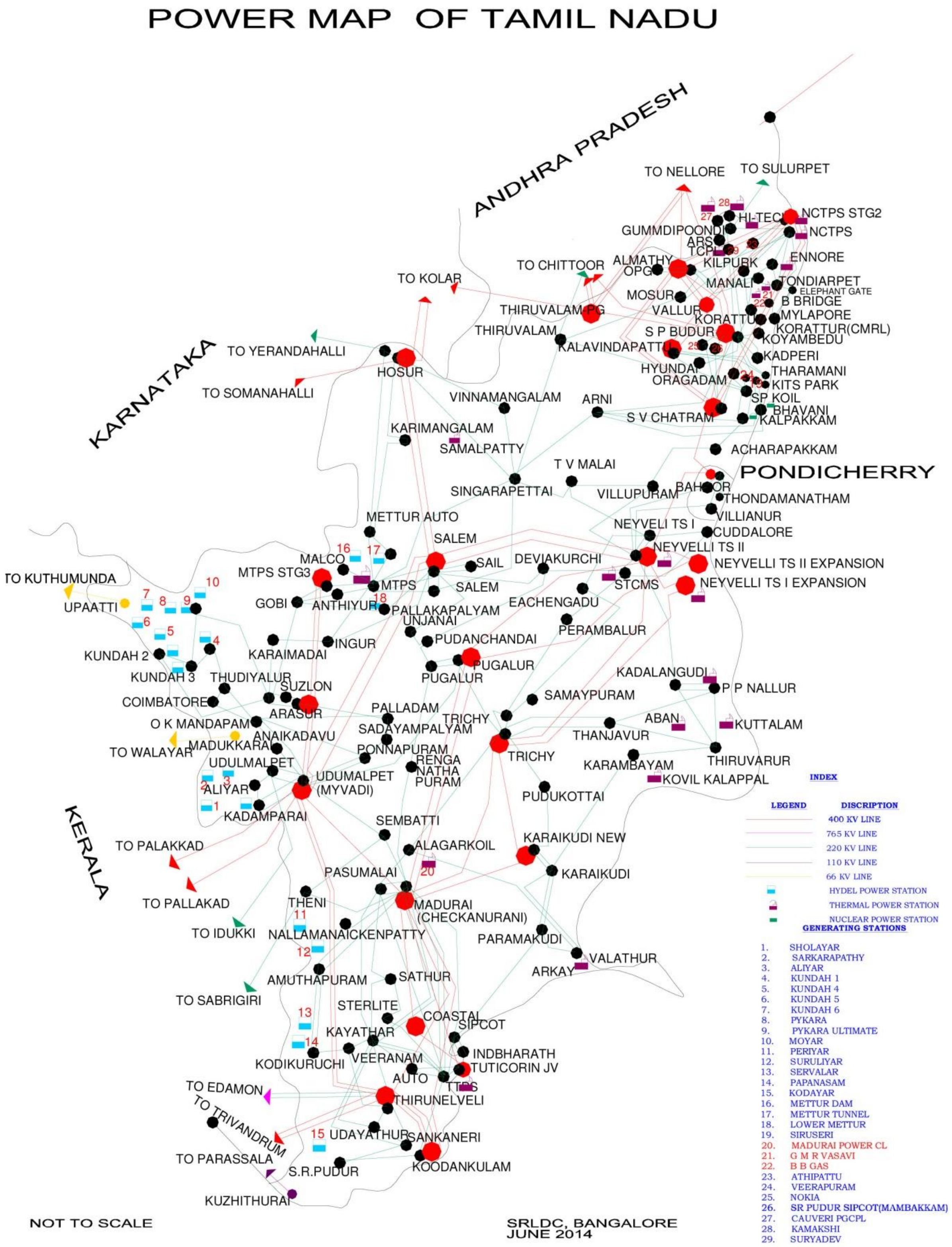


Figure 1: Power Map of Tamil Nadu, SRLDC

2.2. CONVENTIONAL ENERGY SOURCES (CES)

These sources of energy are also called non-renewable sources. These sources of energy are in limited quantity except hydro-electric power. The conventional source of energy in the State includes hydro, thermal, gas, including the share from Central sector projects (thermal and atomic), private power projects and external assistance projects.

2.2.1. THERMAL POWER GENERATION

Thermal power generation in India constitutes to about 65% of the total energy generation, the fuel resource supplied mainly from the Bengal-Bihar Belt. Modern thermal power stations operate on the thermodynamic principle of Modified Rankine Cycle.

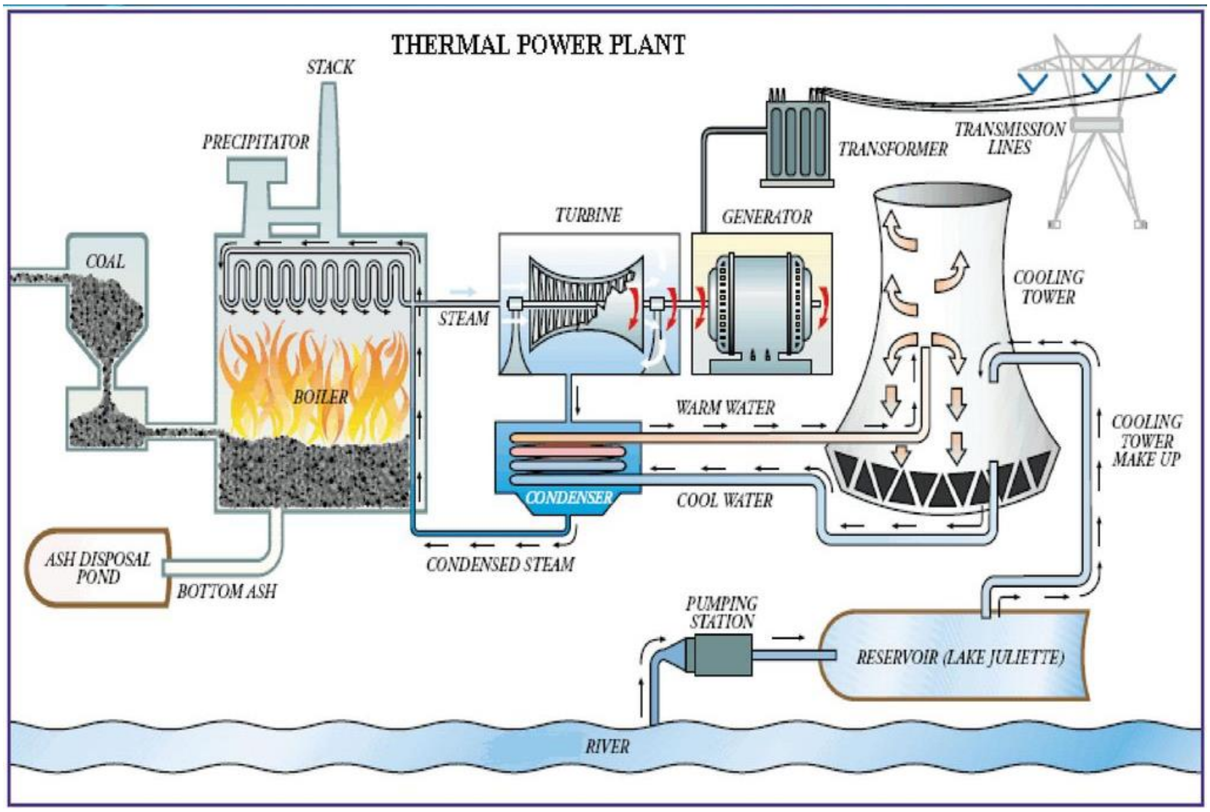


Figure 2: Process of Thermal Power Generation

Boiler: Boiler or Steam generator helps to burn the coal and transfer the heat to water, thereby generating steam at the required pressure and temperature. Coal is fed to the Raw Coal Bunkers that is sufficient to store one day requirement. Then, the coal is pulverised into a fine powder in the pulverisers or mills and carried away into the boiler by the hot air at 60 – 70°C supplied by Primary Air Fans. The fuel/air mixture is fed in the four corners of the boiler in a corner fired boiler, in four or five elevations. For complete combustion of coal in the furnace, secondary air is supplied by the Forced Draft fans. Feed water is supplied to the boiler drum situated at the top of the boiler from the economiser which makes use of the heat in flue gas to preheat the feed water to increase the boiler efficiency. Water converts into steam in the furnace area and the dry and saturated steam is collected in the top portion of the drum. The saturated steam is then superheated with help of super heaters. The superheated steam is called main steam that leaves the boiler at rated pressure and temperature.

Turbine: Turbine is a high speed rotating machine that converts the kinetic energy and pressure energy of the steam into useful work. A turbine generally has three stages viz. High Pressure, Intermediate Pressure and Low Pressure. The main steam enters into HP turbine and after expansion in the turbine the pressure and temperature fall down. The main steam is returned to the boiler for reheating in the Reheater. The Hot Reheated steam is admitted in the intermediate pressure turbine IPT after expansion in the IPT, steam enters into the Low pressure turbine. When the useful work is extracted from the steam, the pressure falls below the atmospheric pressure. Vacuum is maintained in the condenser to create steam flow by means of vacuum pump or steam jet ejectors. Cooling Water flows in the tubes of condenser to cool the steam. The condensate is pumped to the deaerator by condensate extraction pump (CEP) through Low Pressure Heaters where the temperature gain in the condensate is achieved from the heat of extraction steam from the turbine. The deaerator helps to remove the oxygen in the feed water as dissolved oxygen enhances corrosive action.

The feed water from deaerator is pumped to the boiler drum, by Boiler Feed Pump (BFP) through HP heaters and economiser. Boiler Feed Pump is the heart of a thermal power station as it supplies feed water to the boiler continuously.

Generator: Turbine is coupled with the Turbo Generator that normally spins at 3000 rpm in countries with 50 Hz supply frequency or at 3600 rpm in countries with 60 Hz supply frequency. The generated voltage is stepped up in Generator Transformer and the power is evacuated through transmission line feeders.

Fly Ash: After complete combustion of coal in the furnace, the heat in the flue gas is utilised to preheat the water in the economiser and primary and secondary air in Air Preheaters. The fly ash laden gas is evacuated through chimney by Induced Draft fans through Electro Static Precipitators (ESP). Electro Static Precipitators are devices that separate fly ash from the flue gas and thus Solid Particulate Matter in the exit gas is controlled. Apart from fly ash, bottom ash is also collected in the bottom of the furnace and is disposed off in the form of ash slurry in ash dyke.

The hot water discharge from condenser is cooled in cooling towers of Natural Draft or Induced Draft type in closed circuit cooling system. In open circuit cooling system, the hot water is discharged into sea or Perennial River in such a way that it does not affect the flora / fauna of the ecosystem. Cooling Water Pumps (CW pumps) pump the cold water stream back to the condenser.

2.2.1.1. COAL BASED POWER STATIONS

Anthracite is highest rank coal is a harder, glassy black coal with highest content of carbon and calorific value. It is best suited for combustion as fuel for power generation, the ash content is low. The Tamil Nadu Generation & Distribution Corporation Ltd. (TANGEDCO) requires 16.00 Million Tonnes of coal per annum (MTPA) for its Thermal Power Stations (Ennore Thermal Power Station 450 MW; Tuticorin Thermal Power Station 1050 MW; Mettur Thermal Power Station 840 MW; North Chennai Thermal Power Station 630 MW). (Source: TANGEDCO, 2020)

The indigenous coal is moved from various Coal fields to the load ports namely Haldia, Paradip and Vizag through Rail and then transported via ships to the discharge ports namely Ennore and Tuticorin ports. Imported coal is being procured mainly from Indonesia for delivery at Ennore and Tuticorin ports.

Coal deposits are mainly confined to eastern and south central parts of the country. The states of Jharkhand, Odisha, Chhattisgarh, West Bengal, Madhya Pradesh, Telangana and Maharashtra account for 98.20% of the total coal reserves in the country.

I. ENNORE THERMAL POWER STATION (ETPS):

Ennore Thermal Power Station is located in Thiruvallur District. ETPS total installed capacity was 450 MW comparing 2 X 60 MW and 3 X 110 MW Units, The Units was Coal based power station, Coal for ETPS is received from Mahanadi coal field (IB Valley, Talcher), Orissa and Eastern coal field Limited – Ranikanj. After more than four decades the Power Plant was shut down on 31.03. 2017 permanently and will be replaced with a single Supercritical unit of 660 MW Ennore Expansion Thermal Power Project

Ennore Thermal Power Station

Mettur Thermal Power Station

II. METTUR THERMAL POWER STATION (MTPS):

Mettur Thermal Power Station - I is situated in Salem District. This is the first inland thermal Power Station of TANGEDCO. The first stage consists of units I & II of 210 M.W at a cost of Rs.384.30 crores. The second stage consists of units III &IV of 210 M.W each at a cost of Rs.351.76 crores. All the four units are coal based, coal for MTPS is received from Mahanadi coal fields Limited (Talchar & IB Valley), Orissa, Eastern coal fields Limited, Ranikanj, West Bengal. Also imported coal is being received from Indonesia.

Mettur Thermal Power Station – II (1X 600 MW) is the first 600 MW Thermal Power Plant of Tamil Nadu by the Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO Ltd.) and second inland Thermal Power Station. The project cost of Mettur Thermal Power Station –II (1x600 MW) is Rs. 3550 Crores. The construction of Mettur Thermal Power Project – Stage – III started on 25.06.08 and the Unit was first Synchronized with Grid on 4.5.2012.

III. NORTH CHENNAI THERMAL POWER STATION (NCTPS)

North Chennai Thermal Power Station - I is situated about 25 KMs from Chennai on Northern side in Ennore – Puzhudivakkam village, Ponneri Taluk, Thiruvallur District. NCTPS has a total installed capacity of 630 M.W comprising 3 units of 210 M.W each, all the three units are coal based. Coal for NCTPS is received from Mahanadi coal fields Limited (Talchar & IB Valley), Orissa, Eastern coal fields Limited, Ranikanj, and West Bengal.

North Chennai Thermal Power Station - II has a total installed capacity of 1200 MW(2 X 600 MW units) has been located adjacent to the existing 3 x 210 MW North Chennai Thermal Power Station (NCTPS) complex on northern side. Both the Units are coal based, From Mahanadi coal fields Limited (Talchar & IB Valley), Orissa, Eastern coal fields Limited.

North Chennai Thermal Power Station

Tuticorin Thermal Power Station

IV. Tuticorin Thermal Power Station

Tuticorin Thermal Power Station is located in Thoothukudi harbour Estate, 8 Km away from Thoothukudi Town on 160 hectares of land leased from Port Trust. It is connected by Road, Rail and Seaways and Air. TTPS has 5 units having capacity of 210 MW each. The coal required for the boilers is transported from coal fields of Odisha, Bengal & Bihar. Coal is transported through rail from the coal fields to the load Ports of Haldia, Paradip and Vizag and from these Ports; coal is transported to TTPS through ships and unloaded at Tuticorin Port. The average coal consumption is around 5 million tonnes per annum.

Table 1: List of Thermal Power Plants in Tamil Nadu

Name of the Power Station	Operating Agency	No of Units	Capacity (MW)	Date of Commissioning
Ennore Thermal Power Station (ETPS)	TANGEDCO	Unit I	60	31.03.1970
	TANGEDCO	Unit II	60	14.02.1971
	TANGEDCO	Unit III	110	17.05.1972
	TANGEDCO	Unit IV	110	26.05.1973
	TANGEDCO	Unit V	110	02.12.1975
Mettur Thermal Power Station I (MTPS-I)	TANGEDCO	Unit I	210	07.01.1987
	TANGEDCO	Unit II	210	01.12..1987
	TANGEDCO	Unit III	210	22.03.1989
	TANGEDCO	Unit IV	210	27.03.1990
Mettur Thermal Power Station II (MTPS-II)	TANGEDCO	Unit I	600	12.10.2013
North Chennai Thermal Power Station I (NCTPS-I)	TANGEDCO	Unit I	210	25.10.1994
	TANGEDCO	Unit II	210	27.03.1995
	TANGEDCO	Unit III	210	24.02.1996
North Chennai Thermal Power Station II (NCTPS-II)	TANGEDCO	Unit I	600	30.06.2013
	TANGEDCO	Unit II	600	17.12.2012
Tuticorin Thermal Power Station (TTPS)	TANGEDCO	Unit I	210	09.07.1979
	TANGEDCO	Unit II	210	17.12.1980
	TANGEDCO	Unit III	210	16.04.1982
	TANGEDCO	Unit IV	210	11.02.1992
	TANGEDCO	Unit V	210	31.03.1991
TANGEDCO COAL POWER	**TOTAL**		**4,770**	

Location Map of Coal Based Thermal Power Plants in Tamil Nadu

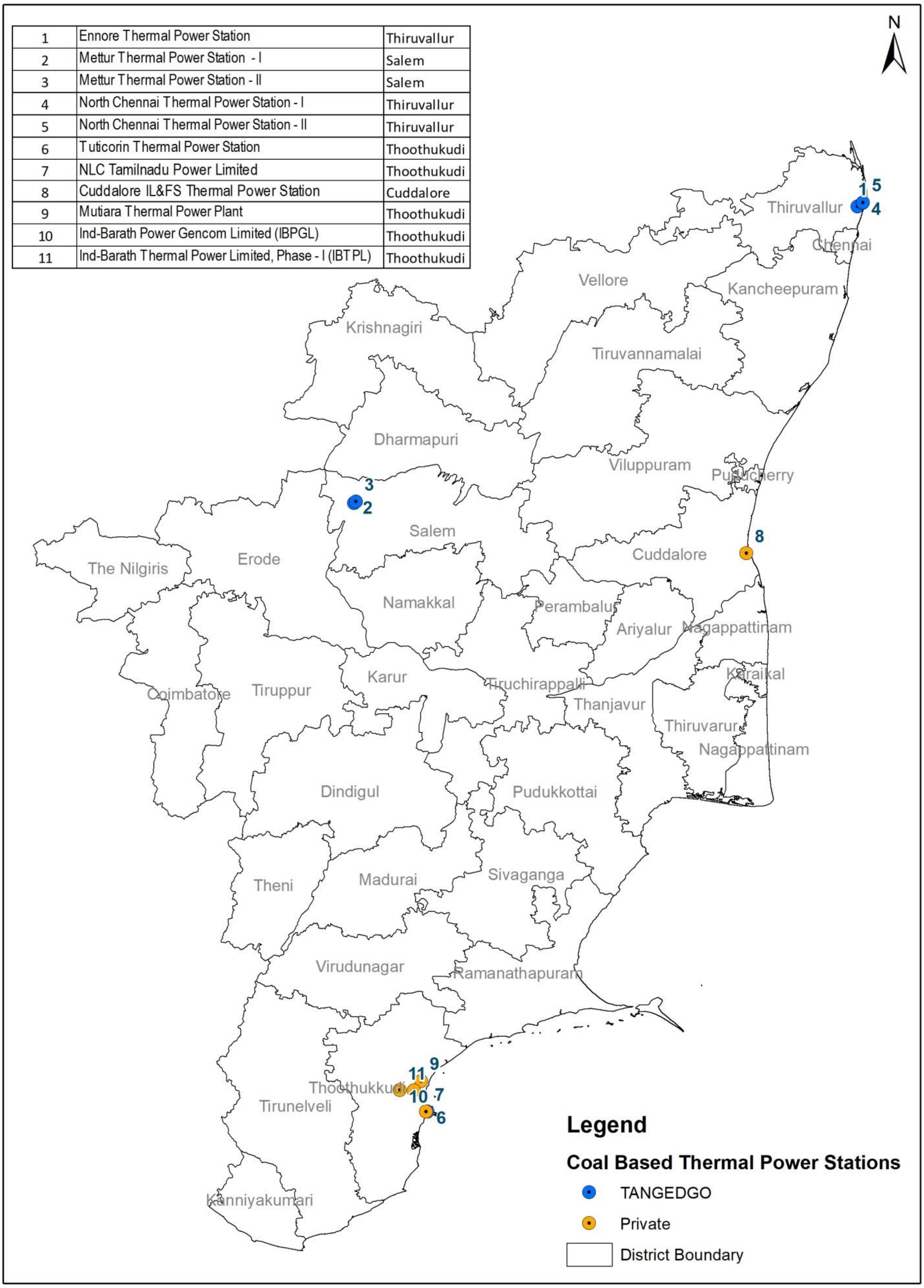


Figure 3: Location map of Coal Based Thermal Power Stations in Tamil Nadu

Table 2: List of Ongoing Thermal Power Plant Projects in Tamil Nadu

Name of the Power Station	Agency	No of Units	Capacity (MW)	Date of Commissioning
Ennore Expansion Thermal Power Project	TANGEDCO	1x660	660	--
Ennore SEZ Supercritical Power Plant	TANGEDCO	2x660	1,320	--
North Chennai Thermal Power Plant- Stage III	TANGEDCO	1x800	800	--
Uppur Thermal power project	TANGEDCO	2x800	1,600	--
Ennore Replacement Thermal Power Project	TANGEDCO	1x 660	660	--
Udangudi Thermal Power Project Stage I	TANGEDCO	2x660	1,320	--
Udangudi Thermal Power Project Stage II	TANGEDCO	2x660	1,320	--
Udangudi Thermal Power Project Stage III	TANGEDCO	2x660	1,320	--
Cheyyur Ultra Mega Power Project	TANGEDCO	5x800	4,000	--
Kadaladi Thermal Power Project	TANGEDCO	5x800	4,000	--
Total Capacity			17,000	

2.2.1.2. COAL BASED POWER STATIONS - PRIVATE

I. IND-BARATH POWER GENCOM LIMITED (IBPGL)

IBPGL is a 189 MW (3 x 63 MW) coal-based thermal power plant located at Thoothukudi, Tamil Nadu. The main generating equipment consists of three steam turbine generator sets and three CFBC boilers manufactured by Hangzhou Steam Turbine Company Limited and Hangzhou Boiler Group Company Limited, respectively. Each turbine generator set is capable of producing power up to 63 MW. The use of newer circulating fluidized bed combustion (CFBC) technology allows burning a wider range of fuel types. CFBC technology is considered to be more environment-friendly compared to other conventional technologies and is also comparatively economical to maintain. IBPGL is also equipped with air-cooled condensers which result in efficient water usage. IBPGL delivers generated power using 230 KV transmission line to TNEB Meelavittan sub-station.

Ind-Barath Power Gencom Limited (IBPGL)

Ind-Barath Thermal Power Limited, Phase - I

II. IND-BARATH THERMAL POWER LIMITED, Phase - I (IBTPL)

IBTPL is a 300 MW (2 x 150 MW) coal-based thermal power plant located at Thoothukudi, Tamil Nadu. The main generating equipment consists of two steam turbine generator sets and two CFBC boilers manufactured by Hangzhou Steam Turbine Company Limited and Hangzhou Boiler Group Company Limited, respectively. Each turbine generator set is capable of producing power up to 150 MW. The use of newer CFBC technology allows burning a wider range of fuel types. CFBC technology is considered to be more environment-friendly compared to other conventional technologies and is also comparatively economical to maintain. IBTPL is also equipped with air-cooled condensers which result in efficient water usage.

III. MUTIARA THERMAL POWER PLANT (MTPP)

Mutiara Thermal Power Plant (MTPP) is a 1200 MW (2×600 MW) coal based thermal plant located in the Tuticorin District of Tamil Nadu. It is mega project of Coastal Energen Private Limited – a flagship power generation company of The Coal and Oil Group. MTPP now supplies power to Tamil Nadu Generation and Distribution Corporation (TANGEDCO) under a 15-year Power Purchase Agreement (PPA) that was signed on 19 December 2014, besides plans to sell in the states of Telangana, Andhra, Karnataka, Kerala, etc. Unit 1 of 600 MW started operations and successfully commenced supply of power to TANGEDCO from 23 December 2014 onwards. Unit 2 of 600 MW went live on 16th Jan 2016.

Mutiara Thermal Power Plant

NLC Tamilnadu Power Limited

I. IL&FS TAMIL NADU POWER COMPANY LTD

IL&FS Tamil Nadu Power Company Limited ("ITPCL") is setting up 3180 MW thermal power plant in Kothattai, Ariyagoshti and Villianallur revenue villages of Chidambaram Taluk, Cuddalore District. The project is being implemented in Phases. Phase I of the project is for 1200 MW comprising of 2 units of 600 MW each. Second phase shall have 3 x 660 MW. Phase I, Unit 1 of 600 MW commenced commercial operation on 29th September 2015 and Unit 2 of 600 MW on 30th April 2016

2.2.1.3. COAL BASED POWER STATIONS – JOINT VENTURE

II. NLC TAMILNADU POWER LIMITED (NTPL)

NLC Tamilnadu Power Limited (NTPL) is located in Tuticorin. The coal based 2x500 MW Thermal Power Project was a dream of NLC to diversify from Lignite to Coal Based power plants and to use the exemplary knowledge gained over the years in power generation. It also fulfilled the mission of NLC to spread its wings outside Neyveli in Tamil Nadu. The search for a project location for the coal based power plant culminated in the Harbour Estate of Tuticorin Port Trust (VOCPT) and adjacent to the Tuticorin Thermal Power Station in Tamil Nadu. The project is a joint venture of TANGEDCO and NLC India Limited

The Joint venture Company “NLC Tamilnadu Power Limited” was incorporated to implement the power project at Tuticorin and the promoters (viz, NLC and TNEB/TANGEDCO) share in the equity ratio of 89:11. The Commercial Operation Declarations (CODs) were Achieved successfully for Unit-I on 18-Jun-2015 and for Unit-II on 29-Aug-2015.

Name of the Power Station	Agency	No of Units	Capacity (MW)	Date of Commissioning
NLC Tamilnadu Power Limited, Tuticorin	NLC / TANGEDCO	I	500	18.06.2015
	NLC / TANGEDCO	II	500	29.08.2015

Power Purchase Agreement (PPA) has been signed between the Company and the Southern states for sharing the power as under:

S.No	State	Power Purchase MW
1	Tamil Nadu	439.02
2	Karnataka	179.13
3	Pondicherry	10.78
4	Kerala	82.24
5	Andhra Pradesh	133.18
6	Telangana	155.65
	Total	**1000.00**

Table 3: List of Coal Thermal Power Plant Projects Owned by Private in Tamil Nadu

S.No	Power Plant	District	Units	Capacity	Date of Commissioning
1	Ind-Barath Power Gencom Limited (IBPGL)	Thoothukudi	3 x 63 MW	189 MW	-
2	Ind-Barath Thermal Power Limited, Phase - I (IBTPL)	Thoothukudi	2 x 150 MW	300 MW	-
3	Mutiara Thermal Power Plant (MTPP)	Thoothukudi	2 x 600 MW	1200 MW	Unit – I, 23.12.2014 Unit – II, 16.01.2016
4	NLC Tamilnadu Power Limited (NTPL)	Thoothukudi	2 x 500 MW	1000 MW	Unit – I, 18.06.2015 Unit – II, 29.08.2015
5	IL&FS Tamil Nadu Power Company Ltd	Cuddalore	2 x 600 MW	1200 MW	Unit – I, 29. 09. 2015 Unit – II, 30. 04. 2016

2.2.1.4. LIGNITE BASED POWER STATIONS

I. NEYVELI THERMAL POWER STATION-I:

The 600 MW Neyveli Thermal Power Station-I in which the first unit was synchronized in May'62 and the last unit in September'70 consists of six units of 50 MW each and three units of 100 MW each. The Power generated from Thermal Power Station-I after meeting NLC's requirements is fed into Tamil Nadu Electricity Board which is the sole beneficiary. Due to the aging of the equipment's / high pressure parts, Life extension programme has been approved by GOI in March 1992 and was successfully completed in March'99 thus extending the life by 15 years. In view of the high grid demand in this region, this power station is being operated after conducting Residual Life Assessment (RLA) study. GOI has sanctioned a 2x500 MW Power Project (Neyveli New Thermal Power Plant – NNTPS) in June 2011 as replacement for existing TPS-I. The Board of Directors of NLC accorded approval to keep the plant in service till the commissioning of the Neyveli New Thermal Power Plant (NNTPS).

II. NEYVELI THERMAL POWER STATION-II:

The 1,470 MW Neyveli Thermal Power Station-II consists of 7 units of 210 MW each. In February 1978, Government of India sanctioned the Second Thermal Power Station of 630 MW capacity (3 X 210 MW) and in Feb.'83, Government of India sanctioned the Second Thermal Power Station Expansion from 630 MW to 1470 MW with addition of 4 units of 210 MW each. The first 210 MW unit was synchronised in March 1986 and the last unit (Unit-VII) was synchronized in June'93. The power generated from Second Thermal Power Station after meeting the needs of Second Mine is shared by the Southern States viz., Tamil Nadu, Kerala, Karnataka, Andhra Pradesh and Union Territory of Pondicherry.

Neyveli TPS – I

Neyveli TPS - II

III. NEYVELI THERMAL POWER STATION-I EXPANSION:

Neyveli Thermal Power Station-I has been expanded using the lignite available from Mine-I Expansion. The scheme was sanctioned by Government of India in February 1996. The Unit-I was synchronised in October 2002 and Unit-II in July 2003. The power generated from this Thermal Power Station after meeting the internal requirements is shared by the Southern States viz., Tamil Nadu, Kerala, Karnataka, and Union Territory of Pondicherry.

Neyveli TPS – I Expansion

Neyveli TPS – II Expansion

IV. NEYVELI THERMAL POWER STATION-II EXPANSION

Neyveli Thermal Power Station-II Expansion is consisting of two units of 250 MW capacity each. Unit-II attained commercial operation in April 2015 and Unit-I in July 2015. The lignite requirement is met by Mine-II expansion which has already been commissioned. The steam generators of this project employ eco-friendly “Circulating Fluidised Bed Combustion” (CFBC) technology. This technology is being adopted for 250 MW Capacity units for the first time in India.

2.2.1.5. LIGNITE BASED POWER STATIONS - PRIVATE

I. TAQA NEYVELI LIGNITE THERMAL POWER PLANT

TAQA (Arabic for Energy)/The Abu Dhabi National Energy Company owns and operates a 250 MW lignite-fired power plant located in Neyveli, Tamil Nadu. TAQA is a government controlled energy holding company of Abu Dhabi, United Arab Emirates. The Tamil Nadu-based lignite-fired power plant has been in operation since 2002 and produced 1,301 GWh of power. TAQA sells the entire capacity of the Neyveli plant to TANGEDCO, the local state government-owned utility, under a 30-year power purchase agreement (PPA). TAQA is also responsible for the maintenance of the plant and related facilities.

Table 4: List of Lignite Thermal Power Plant Projects in Tamil Nadu

<table>
<tr><th>Name of the Power Station</th><th>Agency</th><th>No of Units</th><th>Capacity (MW)</th><th>Date of Commissioning</th></tr>
<tr><td rowspan="7">NLC Thermal Power Station-II 1470 (MW), Neyveli</td><td>NLC</td><td>Unit I</td><td>210</td><td>1978</td></tr>
<tr><td>NLC</td><td>Unit II</td><td>210</td><td>1978</td></tr>
<tr><td>NLC</td><td>Unit III</td><td>210</td><td>1978</td></tr>
<tr><td>NLC</td><td>Unit IV</td><td>210</td><td>1986</td></tr>
<tr><td>NLC</td><td>Unit V</td><td>210</td><td>1986</td></tr>
<tr><td>NLC</td><td>Unit VI</td><td>210</td><td>1993</td></tr>
<tr><td>NLC</td><td>Unit VII</td><td>210</td><td>1993</td></tr>
<tr><td rowspan="2">NLC Thermal Power Station I Expansion (420MW), Neyveli</td><td>NLC</td><td>Unit I</td><td>210</td><td>2002</td></tr>
<tr><td>NLC</td><td>Unit II</td><td>210</td><td>2003</td></tr>
<tr><td rowspan="2">NLC Thermal Power Station II Expansion (500MW), Neyveli</td><td>NLC</td><td>Unit I</td><td>250</td><td>2015</td></tr>
<tr><td>NLC</td><td>Unit II</td><td>250</td><td>2015</td></tr>
<tr><td>NEYVELI LIGNITE CORPPORATION</td><td colspan="2">TOTAL</td><td>2990</td><td></td></tr>
</table>

Table 5: List of Private Lignite Thermal Power Plant Projects in Tamil Nadu

<table>
<tr><th>Name of the Power Station</th><th>Agency</th><th>No of Units</th><th>Capacity (MW)</th><th>Date of Commissioning</th></tr>
<tr><td>TAQA Neyveli Lignite Thermal Power Plant</td><td>Abu Dhabi National Energy Company</td><td>I</td><td>250</td><td>2002</td></tr>
<tr><td>TOTAL LIGNITE ENERGY FROM PRIVATE</td><td colspan="2">TOTAL</td><td>250</td><td></td></tr>
</table>

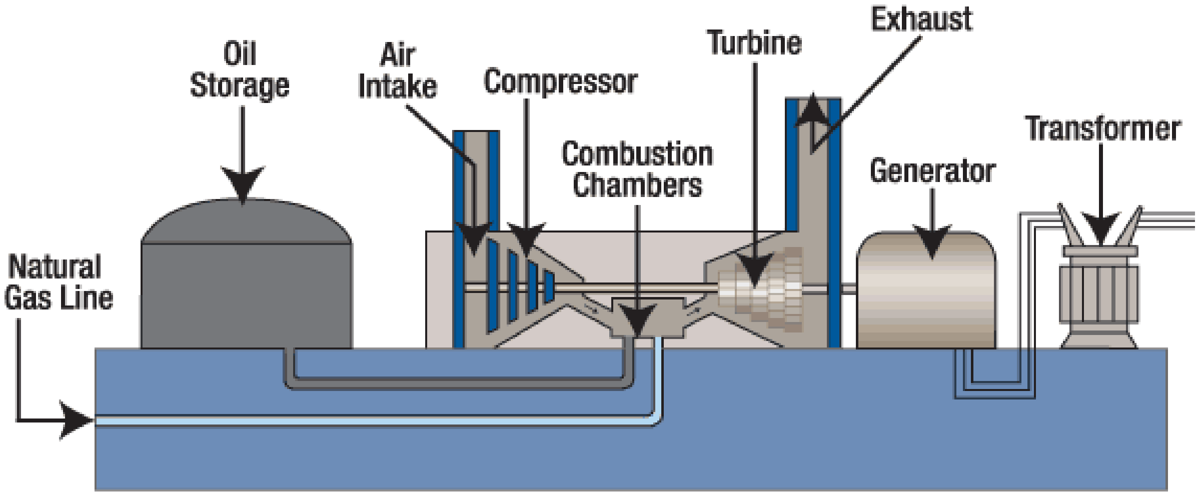
Location Map of Lignite Based Thermal Power Plants in Tamil Nadu

1	Neyveli Thermal Power Station-I	Cuddalore
2	Neyveli Thermal Power Station-II	Cuddalore
3	Neyveli Thermal Power Station -I Expansion	Cuddalore
4	Neyveli Thermal Power Station -II Expansion	Cuddalore
5	TAQA Neyveli Lignite Thermal Power Plant	Cuddalore

Figure 4: Location map of Lignite Based Thermal Power Stations in Tamil Nadu

2.2.1.6. GAS TURBINE STATION

Ambient air is compressed to 11-30 bar pressure and as a consequence its temperature rises. · Most of this warm air is used in the combustor to burn the fuel (natural gas or a liquid e.g. oil etc.). · The resulting hot gas expands through the turbine, doing work, and exits at nearly atmospheric pressure but a temperature of up to 500- 640°C. · Work extracted during the expansion is used to turn the turbine which drives the generator that produces electricity. · The hot exit gas from the turbine still has significant amounts of energy which is used to raise steam to drive a steam-turbine and another generator. This combination of gas and steam cycle gives rise to the term 'combined cycle gas turbine' (CCGT) plant. Working Principle Gas Turbine Cycle (i) Open Cycle (ii) Combined Cycle.



Advantages of Gas Turbine Plants ·

- They are more compact, since fuel is burnt directly in the small combustion Chamber in the gas turbine rather than in a bulky boiler · '
- Gas Turbine has no condenser ·
- They can be started and take more load quickly (i.e.15 - 30 min) ·
- They are simpler in design and easy to maintain ·
- They consume less metal and other materials for the same capacity ·
- They cost less
- Unlike steam turbines , they require very less water for cooling
- Gas Turbine is more suitable for power generation, where water scarcity exists or the water is more precious.

Disadvantages of Gas Turbine Plants ·

- They have a lower specific power
- They have lower efficiency at the modern state of progress

- They have a shorter service life and more sensitive to fuel quality

I. BASIN BRIDGE GAS TURBINE POWER STATION

It is located in Chennai city about 3 kms from Chennai Central & Chennai Egmore Railway Stations. The project was aided by Overseas Economic Co-operative Fund, Japan. The Units can be operated by multi fuels, such as Naphtha and Natural Gas (Dual fuel system) starting fuel used is High Speed Diesel (HSD). Due to non-availability of Natural Gas / LNG at Chennai, The Units are being operated on Naphtha fuel. From 20.01.2010 onwards, the Units are run also as synchronous condenser to supply reactive power to the Grid for better Voltage profile and system stability.

Basin Bridge Gas Turbine Power Station

Thirumakkottai Gas Turbine Power Station

II. THIRUMAKOTTAI GAS TURBINE POWER STATION

It is the foremost Gas Station under Combined Cycle in TANGEDCO. It is located at Thirumakottai, a small village situated 18 km from the town of Mannargudi in Thiruvarur District. Natural gas required for this station is sourced from ONGC wells located at a distance of about 10 km from the power plant. The power generated improves the voltage and grid stability in the neighbouring areas of Pattukottai, Mannargudi, Thiruvarur and Thanjavur. The power plant uses natural gas which is a clean gas and so pollution of the environment is minimum unlike Thermal plant which produces by-products like fly ash in large quantities.

III. VALUTHUR GAS TURBINE POWER STATION

It is located at Valuthur Village, Ramanathapuram District. Power generated in this station is distributed to R.S.Madai, Perungulam, Mandapam, Keelakarai & Valinokkam of both Ramanathapuram and Sivagangai Districts. · The Power Generated by Valuthur Gas Turbine Plant has helped very much in solving the low voltage problems in Ramanathapuram District. It will help the development of small & major industries. The growth of these industries will provide more employment opportunities to the local people.

Valuthur Gas Turbine Power Station

Kuttalam Gas Turbine Power Station

IV. KUTTALAM GAS TURBINE POWER STATION

It is located in Maruthur Village near Kuttalam which is 15Km from Mayiladuthurai in Nagapattinam District. · The power generated improves the voltage and grid stability in the neighbouring areas of Kumbakonam, Kadalangudi, Thiruvarur and Thanjavur.

Table 6: List of Gas Turbine Power Houses in Tamil Nadu

Gas Turbine Station	**Capacity MW**	**Year of commissioning**	**Fuel**	**Mode of operation**
Basin Bridge Gas Turbine Power Stations	120 MW (4 Units x30 MW)	1996	Naptha	Open Cycle
Kuttalam Gas Turbine Power Station	101 MW	2003	Natural Gas	Combined Cycle
Thirumakotai Gas Turbine Power Station (Kovilkalappal)	107.88 MW	2001	Natural Gas	Combined Cycle
Valuthur Gas Turbine Power Station	Phase I – 95 MW Phase II – 92.2 MW	2003 2008	Natural Gas	Combined Cycle

(Source: TANGEDCO, 2020)

2.2.1.7. GAS TURBINE STATION - PRIVATE

I. PPN (PILLAI PERUMAL NALLUR) POWER GENERATING COMPANY PRIVATE LIMITED

Largest Independent Power Project in the State of Tamil Nadu, supplying, under a long term Power Purchase Agreement, its entire generation, reliably and consistently for more than a decade, to Tamil Nadu Generation and Distribution Corporation (TANGEDCO - erstwhile TNEB). The company owns and operates a 330.5 MW Gas cum Naphtha fired, Combined Cycle Power Plant at Villages Pillaiperumalnallur and Manickapangu, Tharangambadi Taluk, Nagapattinam District, Tamil Nadu. The plant has been in operations since April 2001.

PPN (Pillai Perumal Nallur) Power Generating Company Private Limited

II. LANCO TANJORE POWER COMPANY

Lanco Tanjore is a Gas-based Combined Cycle Power Plant located at Karuppur village in Thiruvidaimaruthur taluk of Tanjore district, situated around 260 kms from Chennai capital of Tamil Nadu. Lanco Tanjore Power Co is a subsidiary of Lanco Infratech Ltd and it was incorporated to set up Tanjore Power Plant in 2005. The company has tied up with GAIL for long term supply of natural gas. The plant has 1 gas turbine of 67.8 MW rated capacity and another turbine with 51.2 MW rated capacity. The commercial production at the plant commenced from August 2005. LTPCL has entered into a Power Purchase Agreement (PPA) with TANGEDCO - erstwhile TNEB for selling their entire production for a period of 15 years from the date of commencement of commercial production.

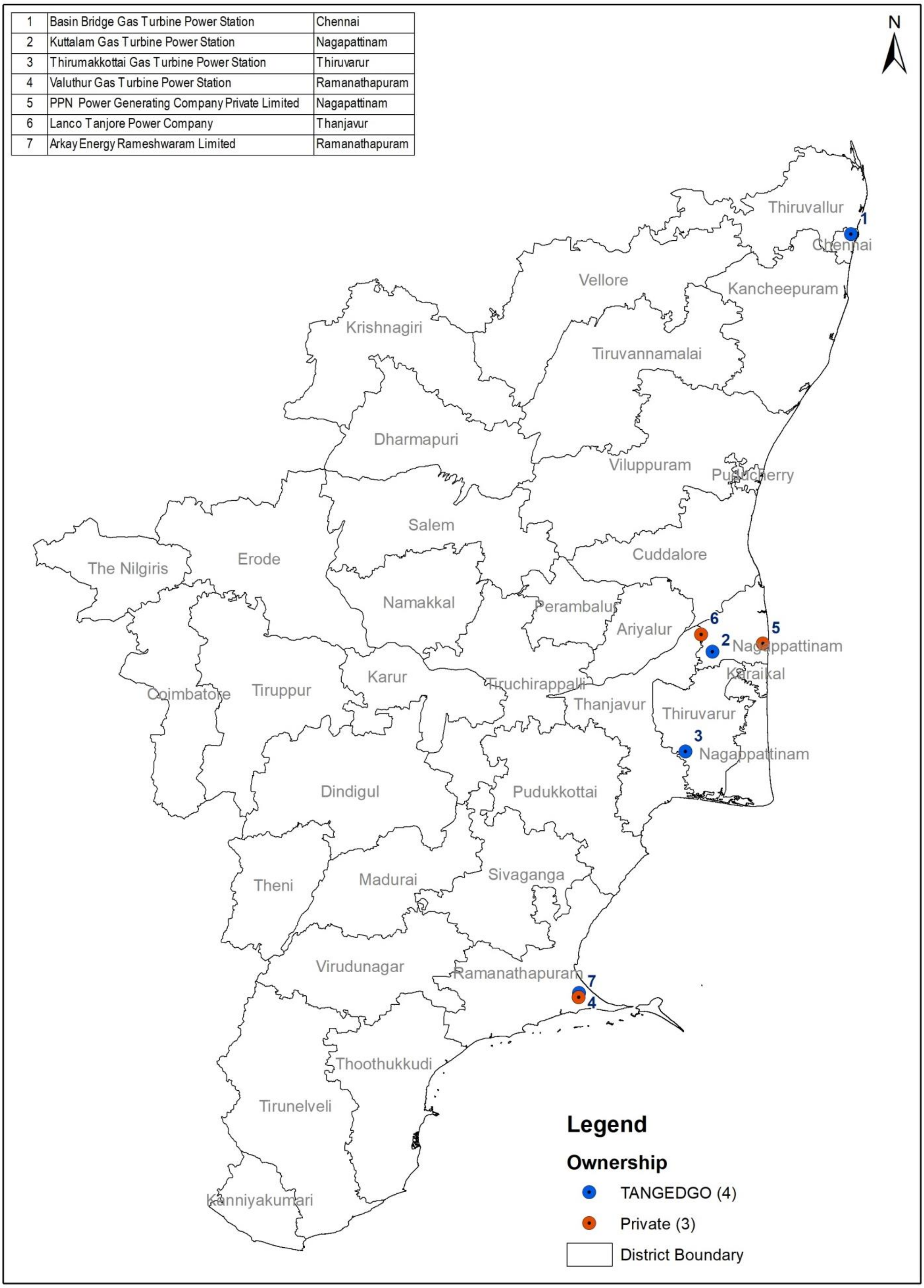
III. ARKAY ENERGY RAMESHWARAM LIMITED (AERL)

AERL is an IPP promoted by the IndBharath group of companies. The company operates a 150 MW natural gas based combined cycle power plant at Valantharavai, Ramnathapuram District, Tamil Nadu. AERL has signed an agreement with GAIL (India) Limited ("GAIL") for supply of natural gas. Further, an expansion of 35 MW is under development

Lanco Tanjore Power Company

Arkay Energy Rameshwaram Limited

Location Map of Gas Based Thermal Power Plants in Tamil Nadu



1	Basin Bridge Gas Turbine Power Station	Chennai
2	Kuttalam Gas Turbine Power Station	Nagapattinam
3	Thirumakkottai Gas Turbine Power Station	Thiruvarur
4	Valuthur Gas Turbine Power Station	Ramanathapuram
5	PPN Power Generating Company Private Limited	Nagapattinam
6	Lanco Tanjore Power Company	Thanjavur
7	Arkay Energy Rameshwaram Limited	Ramanathapuram

Figure 5: Location map of Gas Based Thermal Power Stations in Tamil Nadu

Table 7: List of Natural Gas Based Thermal Power Plant Projects by Private Companies in Tamil Nadu

Name of the Power Station	Agency	No of Units	Capacity (MW)	Date of Commissioning
PPN Power Generating Company Pvt. Ltd*	Private	1	330.50	04/2001
Lanco Tanjore Power Company ABAN	Private	1x67.8+1x51.2	119.00	08/2005
Arkay Energy Ltd.(PENNA)PIONEER	Private	-	150.00	-
TOTAL GAS BASED THERMAL POWER INSTALLED CAPACITY			**599.50**	--

2.2.2. HYDROELECTRIC POWER GENERATION

The hydroelectric power plant, also called as dam or hydropower plant, is used for generation of electricity from water on large scale basis. The dam is built across the large river that has sufficient quantity of water throughout the river. In certain cases where the river is very large, more than one dam can built across the river at different locations.

In hydroelectric power plants the potential energy of water due to its high location is converted into electrical energy. The total power generation capacity of the hydroelectric power plants depends on the head of water and volume of water flowing towards the water turbine.

It is the most widely used form of renewable energy. Once a hydroelectric complex is constructed, the project produces no direct waste, and has a considerably lower output level of the greenhouse gas carbon dioxide (CO_2) than fossil fuel powered energy plants.

Working Principle of Hydroelectric Power Plant

The water flowing in the river possesses two type of energy: the kinetic energy due to flow of water and potential energy due to the height of water. In hydroelectric power plants or dams potential energy of water is utilized to generate electricity.

The formula for total power that can be generated from water in hydroelectric power plant due to its height is given by $P = rhg$

Where: P is the total power that can be produced in watts

r- is the flow rate of water measured in cubic meters per second.

h- is called height of water measured in meters. It is also head of water. It is difference in height between the source of water (from where water is taken) and the water's outflow (where the water is used to generate electricity, it is the place near the turbines).

g- is the gravity constant 9.81 m/second square

The formula clearly shows that the total power that can be generated from the hydroelectric power plants depends on two major factors: the flow rate of water or volume of flow of water and height or head of water. More the volume of water and more the head of water more is the power produced in the hydroelectric power plant.

To obtain the high head of water the reservoir of water should as high as possible and power generation unit should be as low as possible. The maximum height of reservoir of water is fixed by natural factors like the height of river bed, the amount of water and other environmental factors. The location of the power generation unit can be adjusted as per the total amount of power that is to be generated. Usually the power generation unit is constructed at levels lower than ground level so as to get the maximum head of water.

The total flow rate of water can be adjusted through the penstock as per the requirements. If more power is to be generated more water can be allowed to flow through it.

Principle Components of Hydroelectric Power Plant

The principal components are Forebay (Reservoir), Intake Structure, Penstock, Surge Tank, Turbines, Power House, Draft tube, Tail Race.

Forebay: Enlarged body of water provided in front of penstock, provided in case of run off river plants and storage plants. Main function is to store water which is rejected by hydro power plant. Power house located closed to dam penstock directly take water from reservoir, reservoir act as forebay.

Intake Structure: Water conveyed from forebay to penstocks through intake structure, main components are trash rack and gate. Trash rack prevents entry of debris and gate to operate water flow. Intake structure consists of gated structure at the dam/barrage to control the flow of water and provided with gates along with hoisting arrangements. Normally these gates remain open and allow water to flow to the tunnel/channel as the case may be until and unless water conductor system is taken under shut down for repair and maintenance.

Waterways: Water ways are the passage through which the water is conveyed to the turbine from the dam. These may include tunnels, canals, flumes, forebays and penstocks and also surge tanks.

Surge tank: An additional storage near to turbine, usually provided in high head plants, located near the beginning of the penstock, as the load on the turbine decreases or during load rejection by the turbine, the surge tank provides space for holding water.

Surge Shaft: Surge Shaft is located at the end of the tunnel; it is a well type structure of suitable height and diameter to absorb the upcoming and lowering surges in case of tripping and starting of the machine in the power house. The surge shaft is provided with gates to stop flow of water to the penstock if repairs are to be carried out in the penstock or inlet valves.

Penstock: Penstock are the water conductor conduit of suitable size connecting surge shat to main inlet valve, it allows water to the turbine through main inlet valve. At the end of the penstock a drainage valve is provided which drains water from penstock to the draft tube. In case of long penstock and high head, butterfly valve is provided just before the penstock. It takes off from the surge shaft in addition to spherical valve at the end of the penstock acting as the main inlet valve. The thickness of penstock depends on water head and hoop stress allowed in the material.

Turbines: Turbines are used to convert the energy water of falling water into mechanical energy. Water turbines are a rotatory engine that takes energy from moving water. Flowing water is directed on to the blades of a turbine runner, creating a force on the blades. Since the runner is spinning, the force acts through a distance in this way, energy is transferred from the water low to the turbine.

Classified into two categories:

Impulse Turbine

1. Uses the velocity of water to move the runner & discharges to atmospheric pressure.
2. The water stream hits each bucket on the runner.
3. There is no suction on the down side of the turbine.
4. Water flows out the bottom of the turbine housing after hitting the runner.
5. Generally suitable for high head, low flow applications.

Reaction Turbine

1. Develops power from the combined action of pressure and moving water
2. Runner is placed directly in the water stream flowing over the blades rather than striking each individually
3. Used for sites with lower head and higher flows

Generator: Hydro generator is coupled to the turbine and converts the mechanical energy transmitted by the turbine to electrical energy. Governor is used for controlling the guide vanes by detecting turbine seed and its guide vane opening in order to keep turbine speed stable or to regulate its output. The performance of the governor dominates the controllability of the power plant and quality of electrical power produced.

Draft tube: Draft tube is a pipe or passage of gradually increasing cross sectional area, which connect to the exit to tail race. It reduced high velocity of water discharged by the turbine. Draft tube permits turbines to be installed at a higher level than the tail race level, which help the maintenance and repair of turbines.

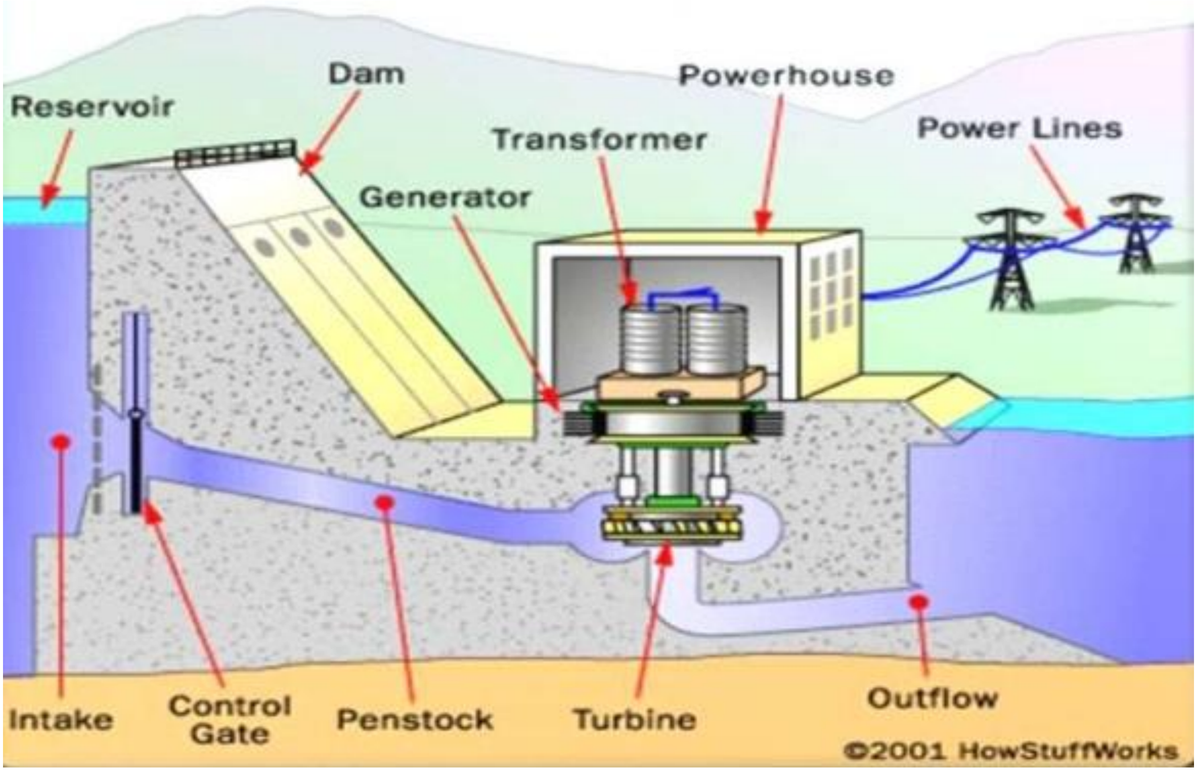


Figure 6: Schematic Representation of Major Hydro Power Houses

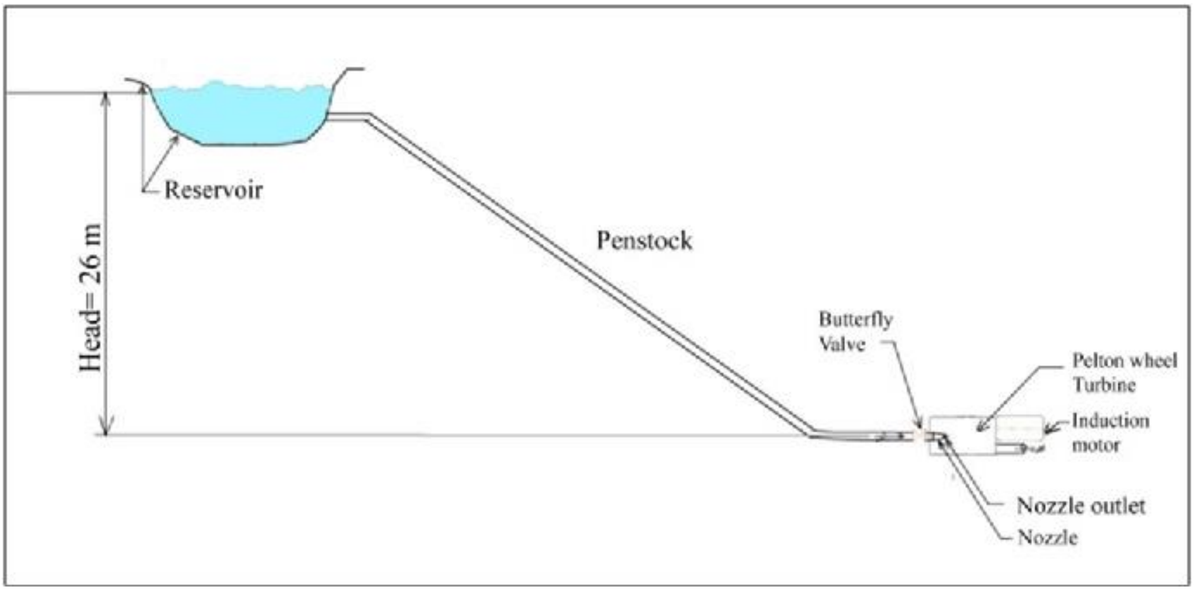


Figure 7: Schematic Representation of Micro Hydro Power Houses

TANGEDCO HYDRO POWER GENERATING CIRCLES

I. KUNDAH HYDRO CIRCLE

1. Kundah Power House 1
2. Kundah Power House 2
3. Kundah Power House 3
4. Kundah Power House 4
5. Kundah Power House 5
6. Kundah Power House 6
7. Pykara Micro Power House
8. Moyar Power House
9. Maravakandy Power House
10. Mukurthy Micro Power House
11. PUSHEP - Pykara Ultimate Stage Hydroelectric Project
12. Pykara Power House /Singara

II. KADAMPARAI HYDRO CIRCLE

1. Sholayar Power House – I
2. Sholayar Power House – II
3. Aliyar Power House
4. Aliyar Mini Power House
5. Sarkarpathy Power House
6. Kadamparai Power House (Pumped Storage Scheme)
7. Thirumurthy Mini Power House.
8. Poonachi Mini Power House
9. Amaravathi Power House

III. ERODE HYDRO CIRCLE

1. Mettur Dam Power House
2. Mettur Tunnel Power House
3. Lower Mettur Barrage Power House -1 / Chekkanur
4. Lower Mettur Barrage Power House -2 / Nerinjipettai
5. Lower Mettur Barrage Power House-3 / Kuthiraikkalmedu (Konerpatti)
6. Lower Mettur Barrage Power House -4 /Uratchikottai
7. Bhavani Kattalai Barrage - I
8. Sathanur Power House
9. Lower Bhavani -1/Micro Hydel Power House/Bhavani Sagar
10. Lower Bhavani RBC Power House
11. Bhavani Kattalai Barrage – II

IV. TIRUNELVELI HYDRO CIRCLE

1. Kodayar Power House – I
2. Kodayar Power House – II
3. Servalar Power House
4. Papanasam Power House
5. Suruliyar Power House
6. Periyar Power House
7. Vaigai Power House

ONGOING AND NEW PROJECTS

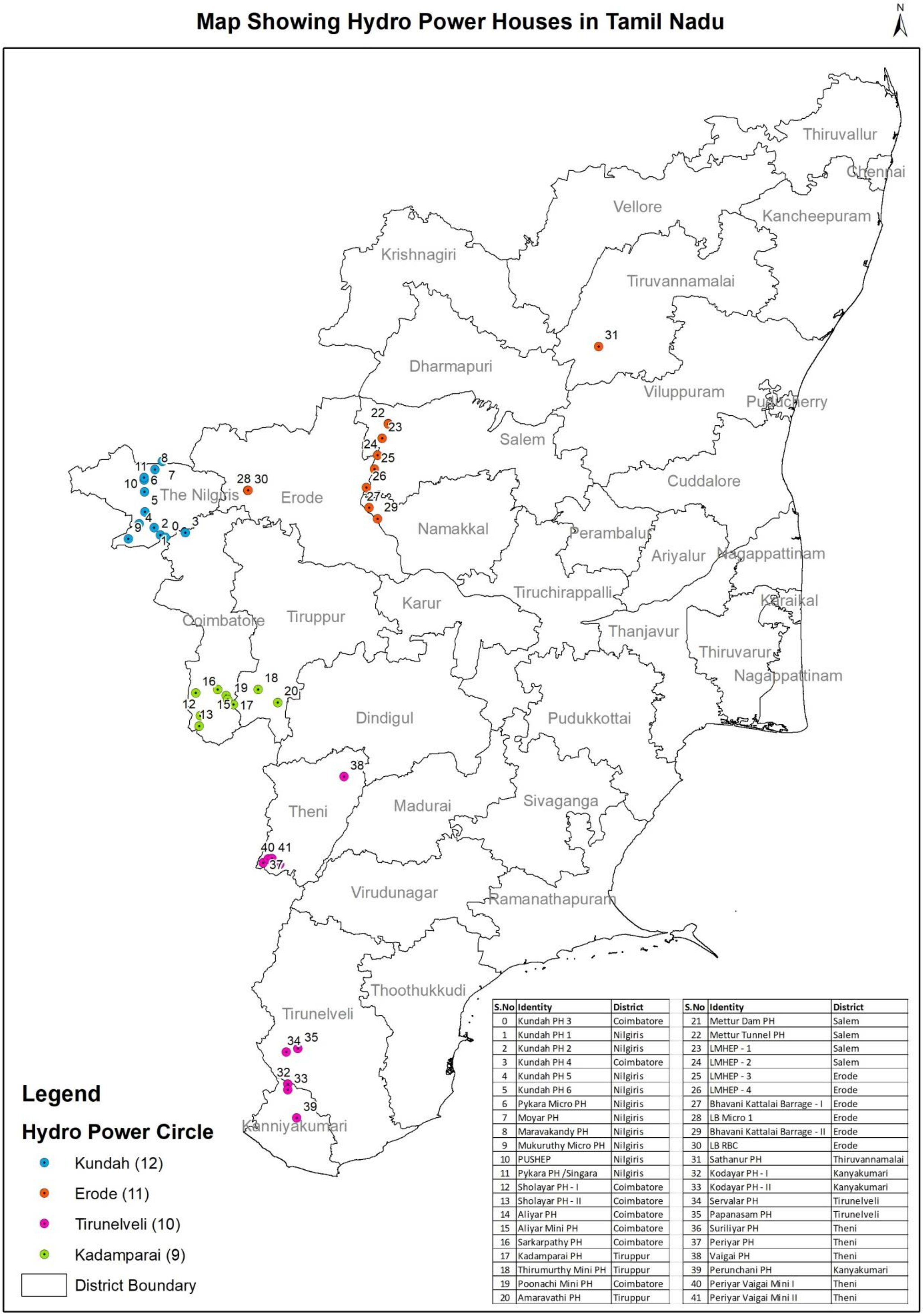
Kundah Pumped Storage Hydro-electric Project: Kundah Pumped Storage Hydro-electric Project 500 MW (4x125MW) is a Pumped Storage Scheme in Nilgiris hills of Tamil Nadu for providing peaking benefits utilizing the existing reservoir at Porthimund (live storage 20.10 Mm^3 between FRL 2220.46m and MDDL of 2207.55 m) as the upper reservoir and Avalanche-Emerald reservoir (live capacity 130.84 Mm^3 between FRL 1985.80m and MDDL 1957.98m) as lower reservoir.

Sillahalla Pumped Storage Project: The proposed Sillahalla Pumped Storage Project (PSP) area is located in the Nilgiris District. The upper reservoir is planned in Udhagamandalam & Kundah taluk and lower reservoir is planned in Kundah taluk of the Nilgiris district. The Upper dam is located on Sillahalla stream which is a tributary of Kundah River. The Sillahalla River joins Kundah River about 1.4 km upstream of Kundah Palam dam of existing Kundah Power House – I project. .

Table 8: List of Ongoing Hydro Power Plant Projects in Tamil Nadu

Name of the Hydro Power Project	Agency	No of Units	Capacity (MW)	Date of Commissioning
Kollimalai Hydro Electric Project	TANGEDCO	1x20	20	--
Kundah Pumped Storage Hydro-electric Project	TANGEDCO	4x125	500	--
Sillahallah Pumped Storage Hydro Electric Project Stage – I	TANGEDCO	4x250	1,000	--
Sillahallah Pumped Storage Hydro Electric Project Stage –II	TANGEDCO	4x250	1,000	--
		Total	2,520	

Map Showing Hydro Power Houses in Tamil Nadu



S.No	Identity	District	S.No	Identity	District
0	Kundah PH 3	Coimbatore	21	Mettur Dam PH	Salem
1	Kundah PH 1	Nilgiris	22	Mettur Tunnel PH	Salem
2	Kundah PH 2	Nilgiris	23	LMHEP - 1	Salem
3	Kundah PH 4	Coimbatore	24	LMHEP - 2	Salem
4	Kundah PH 5	Nilgiris	25	LMHEP - 3	Erode
5	Kundah PH 6	Nilgiris	26	LMHEP - 4	Erode
6	Pykara Micro PH	Nilgiris	27	Bhavani Kattalai Barrage - I	Erode
7	Moyar PH	Nilgiris	28	LB Micro 1	Erode
8	Maravakandy PH	Nilgiris	29	Bhavani Kattalai Barrage - II	Erode
9	Mukuruthy Micro PH	Nilgiris	30	LB RBC	Erode
10	PUSHEP	Nilgiris	31	Sathanur PH	Thiruvannamalai
11	Pykara PH /Singara	Nilgiris	32	Kodayar PH - I	Kanyakumari
12	Sholayar PH - I	Coimbatore	33	Kodayar PH - II	Kanyakumari
13	Sholayar PH - II	Coimbatore	34	Servalar PH	Tirunelveli
14	Aliyar PH	Coimbatore	35	Papanasam PH	Tirunelveli
15	Aliyar Mini PH	Coimbatore	36	Suriliyar PH	Theni
16	Sarkarpathy PH	Coimbatore	37	Periyar PH	Theni
17	Kadamparai PH	Tiruppur	38	Vaigai PH	Theni
18	Thirumurthy Mini PH	Tiruppur	39	Perunchani PH	Kanyakumari
19	Poonachi Mini PH	Coimbatore	40	Periyar Vaigai Mini I	Theni
20	Amaravathi PH	Tiruppur	41	Periyar Vaigai Mini II	Theni

Figure 8: Location of Hydro Power Houses in Tamil Nadu

2.2.2.1. KUNDAH HYDRO GENERATING CIRCLE POWERHOUSES AND INSTALLED CAPACITY

Table 9: List of Hydro Power Houses in Kundah Hydro Generating Circle

Name of the Hydro Power House	Source	Location	Elevation ft.	No of units	Installed capacity (MW)	Total capacity (MW)	Date of commissioning
Kundah Power House 1	Source from Avalanchi & Emerald Dam	The Nilgiris Dist. 32 Kms from Ooty 90 Kms from Coimbatore	5,353	3	3 X 20	60	UNIT.1- 08.071960 UNIT.2-22.07.1960 UNIT.3- 01.04.1964
Kundah Power House 2	Source from Kundah Forebay Dam, Tail Race Water of Power House I Forebay Capacity is 1000 Cusec.	The Nilgiris Dist. 16 Kms from Kundah 80 Kms from Coimbatore	2,876	5	5 X 35	175	UNIT.1 : 30.10.1960 UNIT.2 : 10.01.1961 UNIT.3 : 02.05.1961 UNIT.4 : 16.06.1961 UNIT.5 : 23.02.1964
Kundah Power House 3	Source from Pegumbahallah Dam, Nirali Pallam and Kattery Weir Dam Capacity is 1800 Cusec	Coimbatore Dist. 40 Kms from Kundah 80 Kms from Coimbatore	1,429	3	3 X 60	180	UNIT.1: 07.04.1965 UNIT.2 : 11.06.1965 UNIT.3 : 18.02.1978
Kundah Power House 4	Source from Pillur Dam ,Tail Race water of Power House III ,Dam Capacity is 6000 Cusec	Coimbatore dist. 6 kms. from Parali	1,193	2	2 X 50	100	UNIT.1 : 27.02.1966 UNIT.2 : 19.10.1978

Name of the Hydro Power House	Source	Location	Elevation ft.	No of units	Installed capacity (MW)	Total capacity (MW)	Date of commissioning
Kundah Power House 5	Source from Western Catchment . 1,Upper Bhavani Dam Dam Capacity is 700 Cusec	The Nilgiris Dist. 18 Kms from Kunda 10 Kms from Emerald 33 Kms from Ooty	6,527	2	2 X 20	40	UNIT.1 : 30.10.1964 UNIT.2 : 06.12.1989
Kundah Power House 6	Source from Western Catchment 2 & 3, Porthimund Dam, Parsons Valley Dam	The Nilgiris Dist.	6,519	1	1 X 30	30	UNIT 1 : 20.03.2000
Pykara Micro Power House	Source from Pykara Dam · Max. Head is 113 Feet · Min. Head is 25.23 Feet.	The Nilgiris Dist. 20 Kms from Ooty 15 Kms from Glenmorgan	6,550	2	2X1	2	09.10.1989
Moyar Power House	Source from Moyar Forebay Dam, Maravakandy Dam, Pykara Power House Tail Race	The Nilgiris Dist. 48 Kms from Ooty 11 Kms from Singara	2,000	3	3 X 12	36	UNIT.1 : 10.04.1952 UNIT.2 : 19.09.1952 UNIT.3 : 06.01.1953
Maravakandy Power House	Source from Discharge from Pykara PH.	The Nilgiris Dist. 7 Kms from Moyar 38 Kms from Ooty	2,900	1	1 X 0.75	0.75	14.10.1992

Name of the Hydro Power House	Source	Location	Elevation ft.	No of units	Installed capacity (MW)	Total capacity (MW)	Date of commissioning
Mukurthy Micro Power House	Source Discharge from Mukurthy Dam	The Nilgiris Dist. Mukurthy Dam 32 Kms from Ooty	6,800	2	2 X 350 KW	700 KW	UNIT I 27.06.2001. UNIT II 01-11-2003
PUSHEP - Pykara Ultimate Stage Hydroelectric Project	Source from Pykara Non Irrigation	Nilgiris District	4,420	3	3x50 MW	150 MW	06.09.2005
Pykara Power House /Singara	Source from Mukuruthy Pykara,Sandynallah And Glenmorgon Dam	The Nilgiris Dist. 40 Kms from Ooty 11 Kms from Moyar	3,400	7	3 X 7 MW 1 X 11 MW 2 X 13.6 MW	59.2 MW	UNIT.1 : 09.06.1933 UNIT.2 : 22.11.1932 UNIT.3 : 05.09.1932 UNIT.5 : 28.08.1939 UNIT.6 : 30.05.1954 UNIT.7: 11.06.1954

(Source: TANGEDCO, 2020)

Table 10: List of Hydro Power Houses in Kadambarai Hydro Generating Circle

2.2.2.2. KADAMBARAI HYDRO GENERATING CIRCLE POWERHOUSES AND INSTALLED CAPACITY

Name of the Power House	Source	Location	Elevation ft	No of units	Installed capacity (MW)	Total capacity (MW)	Date of commissioning
Sholayar Power House – I	Source from Sholayar Reservoir Irrigation Net Capacity at FRL (MCFT) is 4800	Manomboli	1,931	2	2 X 35	70	UNIT.1 - 22.04.1971 UNIT.2 - 04.05.1971
Sholayar Power House – II	Source from Sholayar Reservoir Capacity at FRL (in MCFT) is 4800 Irrigation - Interstate water sharing to Kerala.	Sholayar P.H. II	2,750	1	1 X 25	25	Unit.1 - 29.03.1971
Aliyar Power House	Source from Upper Aliyar Dam, Net Capacity at FRL (in MCFT) is 914.89 Non -Irrigation	Aliyar/ Coimbatore	1,083	1	1 X 60	60	21.03.1970
Aliyar Mini Power House	Source from Lower Aliyar Dam, Source from Net Capacity at FRL (in MCFT) is 3553 Irrigation	Aliyar/ Coimbatore	1,083	2	2 X 1.25	2.5	23.09.2002

Name of the Power House	Source	Location	Elevation ft	No of units	Installed capacity (MW)	Total capacity (MW)	Date of commissioning
Sarkarpathy Power House	Source from Parambikulam, Thunakadavu Net Capacity at FRL (in MCFT) is 11820 Irrigation	Sarkarpathy/ Coimbatore	1,429	1	1 X 30	30	14.08.1966
Kadamparai Power House (Pumped Storage Scheme)	Source from Kadamapari Reservoir/Upper Aliyar Dam, Net Capacity at FRL is 940.38 /737 Non Irrigation	Kadamparai/. Coimbatore	710	4	4 X 100	400	UNIT.1- 17.10.1987 UNIT.2 -26.02.1988 UNIT.3- 12.04.1989 UNIT.4- 16.12.1988
Thirumurthy Mini Power House.	Source from Thirumurthy Dam -Irrigation	Udumalpet		3	3 X 0.65	1.95	UNIT.1- 20.03.2000 UNIT.2- 20.03.2000 UNIT.3- 20.03.2000
Poonachi Mini Power House	Source from Punachi river - Run of River, Non-Irrigation	Poonachi/ Coimbatore District		2	2 X 1	2	UNIT.1- 12.11.1992 UNIT.2- 16.12.1992
Amaravathi Power House	Source from Amaravathy Source from Net Capacity at FRL(MCFT) -3749 Irrigation	Coimbatore District		2	2 X 2	4	UNIT.1- 21.09.2006 UNIT.2- 30.11.2006

(Source: TANGEDCO, 2020)

2.2.2.3. ERODE HYDRO GENERATING CIRCLE POWERHOUSES AND INSTALLED CAPACITY

Table 11: List of Hydro Power Houses in Erode Hydro Generating Circle

Name of the Hydro Power House	Source	Location	Elevation ft.	No of units	Installed capacity (MW)	Total capacity (MW)	Date of commissioning
Mettur Dam Power House	Source from Mettur Dam Irrigation	Located around 50kms from Salem	650	4	4 X 12.5	50	Unit 1 : 13.06.1937 Unit 2 : 21.08.1937 Unit 3 : 21.01.1938 Unit 4 : 28.10.1946
Mettur Tunnel Power House	Source from Mettur Dam Irrigation	Located around 50kms from Salem	726	4	4 X 50	200	Unit 1 : 16.08.1965 Unit 2 : 21.07.1966 Unit 3 : 21.07.1966 Unit 4 : 31.07.1966
Lower Mettur Barrage Power House -1 / Chekkanur	Source from lower Mettur Barrage Power House – I/Chekkanur Irrigation	Located near Chekkanur village about 8kms. from Mettur in Salem District.	626	2	2 X 15	30	Unit 1 : 12.08.1988 Unit 2 : 07.08.1988
Lower Mettur Barrage Power House -2 / Nerinjipettai	Source from Mettur Dam / Pondage of Cauvery River Net Irrigation	Located near Nerinjipettai village about 18kms. from Mettur in Salem District.	577	2	2 X 15	30	Unit 1 : 26.08.1988 Unit 2 : 04.08.1988

Name of the Hydro Power House	Source	Location	Elevation ft.	No of units	Installed capacity (MW)	Total capacity (MW)	Date of commissioning
Lower Mettur Barrage Power House-3 Kuthiraikkalmedu (Konerpatti)	Source from Mettur Dam/ Pondage of Cauvery River Irrigation	Located near Koneripatti village about 18kms. from Bhavani in Erode District.	564	2	2 X 15	30	Unit 1 : 04.01.1988 Unit 2 : 30.09.1988
Lower Mettur Barrage Power House -4 /Uratchikottai	Source from Lower Mettur Barrage Power House – 4 / Uratchikottai Irrigation	Located near Uratchikottai village about 5 kms from Bhavani in Erode District.	530	2	2 X 15	30	Unit 1 : 18.09.1989 Unit 2 : 28.12.1988
Bhavani Kattalai Barrage - I	Source from Lower Mettur Barrage Power House – 4 / Uratchikottai Irrigation	Located near Uratchikottai village about 6 kms from Bhavani in Erode District.	500	2	2 X 15	30	Unit 1 : 01.08.2006 Unit 2 : 22.09.2006
Sathanur Power House	Source from Sathanur Dam	Chengam Taluk 32 Kms from Thiruvannamalai in Thiruvannamalai	680	1	1 X 7.5	7.5	10.03.1999
Lower Bhavani -1/Micro Hydel Power House/Bhavani Sagar	Bhavani Sagar Dam	Located in Bhavani Sagar about 18 Kms from Satyamangalam	835	4	4 X 2	8	Unit 1 - 26.05.1990 Unit 2 - 17.04.1990 Unit 3 - 11.04.1990 Unit 4 - 03.04.1990

Name of the Hydro Power House	Source	Location	Elevation ft.	No of units	Installed capacity (MW)	Total capacity (MW)	Date of commissioning
Lower Bhavani RBC Power House	Bhavani Sagar Dam	Located near Bhavani Sagar about 18 Kms from Satyamangalam in Erode District	835	2	2 X 4	8	Unit 1 - 10.02.1998 Unit 2 - 28.02.1998
Bhavani Kattalai Barrage - II	Source from Bhavani Kattalai Barrage - I	Located near Erode about 3 Kms from Pallipalayam in Erode District	465	2	2 X 15	30	Unit 1 - 28.07.2011 Unit 2 - 29.09.2011

(Source: TANGEDCO, 2020)

2.2.2.4. TIRUNELVELI HYDRO GENERATING CIRCLE POWERHOUSES AND INSTALLED CAPACITY

Table 12: List of Hydro Power Houses in Tirunelveli Hydro Generating Circle

Name of the Hydro Power House	Source	Location	Elevation ft.	No of units	Installed capacity (MW)	Total capacity (MW)	Date of commissioning
Kodayar Power House – I	Source from Upper Kodayar (Kodayar Dam-I) Net Capacity at FRL is 2589.8 Irrigation	Kanyakumari district	1319.78	1	1 X 60	60	09.12.1970

Name of the Hydro Power House	Source	Location	Elevation ft.	No of units	Installed capacity (MW)	Total capacity (MW)	Date of commissioning
Kodayar Power House – II	Source from Lower Kodayar (Kodayar Dam II) Irrigation	Kanyakumari district	340.77	1	1 X 40	40	17.11.1971
Servalar Power House	Source from Servalar Dam (Interlinked with Karaiyar Dam) Net capacity at FRL is 1135 Irrigation	Tirunelveli district	205.2	1	1 X 20	20	23.03.1986
Papanasam Power House	Source from Papanasam Dam (Karaiyar Dam)	Tirunelveli district	98	4	4 X 8	32	UNIT-I - 08.07.44 UNIT-II - 12.12.44 UNIT-III - 10.06.45 UNIT-IV - 08.07.51
Suruliyar Power House	Source from Suruliyar (Tributary to Vaigai River),Water Consumption at FLG is 148 Cusec Rated Head is 979.15M	Theni district	1028.8	1	1 X 35	35	27.08.1978
Periyar Power House	Source from Periyar Stream, Rated Head is 373.38 M Water Consumption at Full Load Generation – 1600 Cusecs	Theni district	1574	4	2 X 35 2 X 42	154	I (42 MW) – 12.10.1958 II (42 MW) – 19.02.1959 III – 07.06.1959 IV – 22.12.1965

Name of the Hydro Power House	Source	Location	Elevation ft.	No of units	Installed capacity (MW)	Total capacity (MW)	Date of commissioning
Vaigai Power House	Source from Vaigai River, Rated Head is 27.54 M Water Consumption At Full Load Generation is 3 MW at 550 Cusecs with 91' level & 700 Cusecs with 49.5' level	Theni district	261.76	2	2 X 3	6	04.03.1990
Perunchani Power House	Source from Perunchani River Max Head is 27.54 M	Kanyakumari district	1574	2	2 x 650 KW	1300 KW	I – 21.12.2005 II – 22.01.2006
Periyar Vaigai Mini I	Source from Periyar Stream	Theni district	462	2	2 X 2	4	I – 02.10.2010 II – 21.01.2011
Periyar Vaigai Mini II	Source from Periyar Stream	Theni district	450	2	2 X 1.25	2.5	30.01.2012

(Source: TANGEDCO, 2020)

2.2.3. NUCLEAR POWER GENERATION

Nuclear energy is energy in the nucleus (core) of an atom. Atoms are tiny particles that make up every object in the universe. There is enormous energy in the bonds that hold atoms together. Nuclear energy can be used to make electricity. But first the energy must be released. It can be released from atoms in two ways: nuclear fusion and nuclear fission. In nuclear fusion, energy is released when atoms are combined or fused together to form a larger atom. This is how the sun produces energy. In nuclear fission, atoms are split apart to form smaller atoms, releasing energy. Nuclear power plants use nuclear fission to produce electricity.

Nuclear power is the use of nuclear reactions that release nuclear energy to generate heat, which most frequently is then used in steam turbines to produce electricity in a nuclear power plant. Nuclear power can be obtained from nuclear fission, nuclear decay and nuclear fusion reactions. Presently, the vast majority of electricity from nuclear power is produced by nuclear fission of uranium and plutonium. Nuclear decay processes are used in niche applications such as radioisotope thermoelectric generators. Generating electricity from fusion power remains at the focus of international research. This article mostly deals with nuclear fission power for electricity generation.

Pressurized heavy-water reactor

A pressurized heavy-water reactor (PHWR) is a nuclear reactor that uses heavy water (deuterium oxide D2O) as its coolant and neutron moderator. PHWRs frequently use natural uranium as fuel, sometimes very low enriched uranium. The heavy water coolant is kept under pressure to avoid boiling, allowing it to reach higher temperature (mostly) without forming steam bubbles, exactly as for pressurized water reactor. While heavy water is very expensive to isolate from ordinary water (often referred to as light water in contrast to heavy water), its low absorption of neutrons greatly increases the neutron economy of the reactor, avoiding the need for enriched fuel. The high cost of the heavy water is offset by the lowered cost of using natural uranium and/or alternative fuel cycles.

The key to maintaining a nuclear chain reaction within a nuclear reactor is to use, on average, exactly one of the neutrons released from each nuclear fission event to stimulate another nuclear fission event (in another fissionable nucleus). With careful design of the reactor's geometry, and careful control of the substances present so as to influence the reactivity, a self-sustaining chain reaction or "criticality" can be achieved and maintained.

PHWR Advantage: The use of heavy water as the moderator is the key to the PHWR (pressurized heavy water reactor) system, enabling the use of natural uranium as the fuel (in the form of ceramic UO2), which means that it can be operated without expensive uranium enrichment facilities. The mechanical arrangement of the PHWR, which places most of the moderator at lower temperatures, is particularly efficient because the resulting thermal neutrons are "more thermal" than in traditional designs, where the moderator normally is much hotter. These features mean that a PHWR can use natural uranium and other fuels, and does so more efficiently than light water reactors (LWRs).

PHWR Disadvantage: Pressurised heavy-water reactors do have some drawbacks. Heavy water generally costs hundreds of dollars per kilogram, though this is a trade-off against reduced fuel costs. The reduced energy content of natural uranium as compared to enriched uranium necessitates more frequent replacement of fuel; this is normally accomplished by use of an on-power refuelling system. The increased rate of fuel movement through the reactor also results in higher volumes of spent fuel than in LWRs employing enriched uranium. Since unenriched uranium fuel accumulates a lower density of fission products than enriched uranium fuel, however, it generates less heat, allowing more compact storage

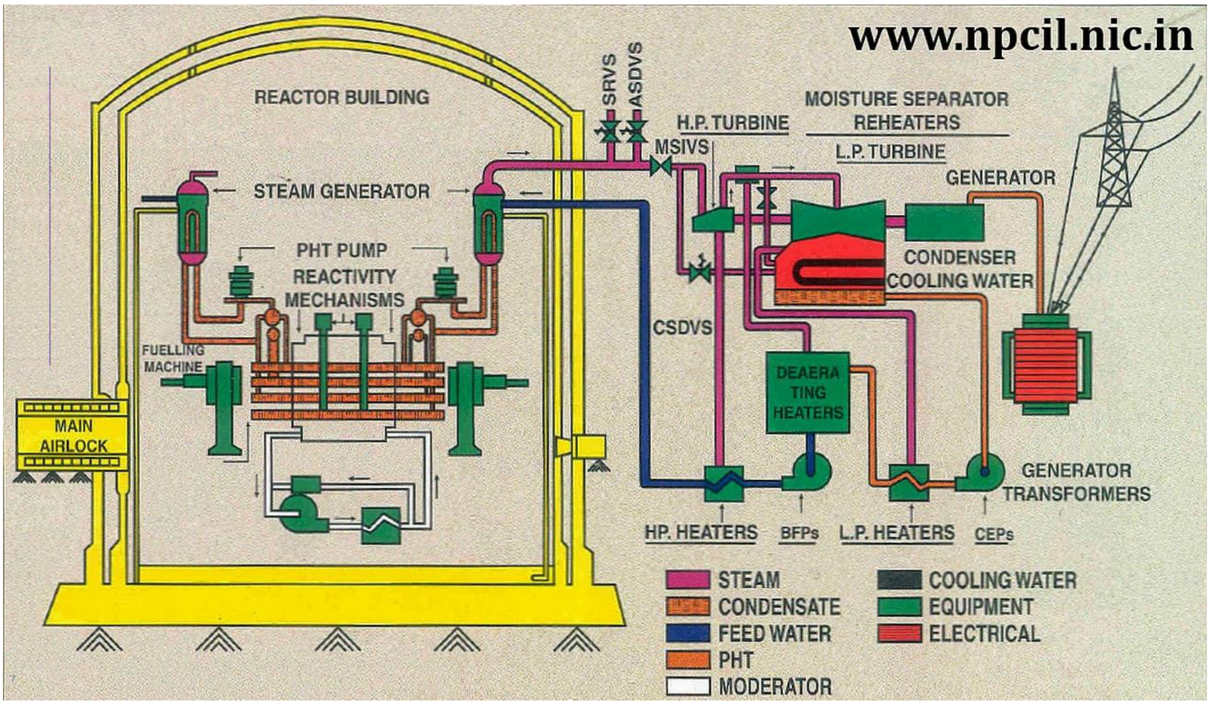


Figure 9: Schematic Representation of Pressurised Heavy Water Reactor (PHWR)

Water-water energetic reactor:

The water-water energetic reactor (WWER), or VVER (from Russian: водо-водяной энергетический реактор; transliterates as vodo-vodyanoi energetichesky reaktor; water-water power reactor) is a series of pressurised water reactor designs originally developed in the Soviet Union, and now Russia, by OKB Gidropress. The idea of a reactor was proposed at the Kurchatov Institute by Savely Moiseevich Feinberg. VVER were originally developed before the 1970s, and have been continually updated. As a result, the name VVER is associated with a wide variety of reactor designs spanning from generation I reactors to modern generation III+ designs. Power output ranges from 70 to 1300 MWe, with designs of up to 1700 MWe in development

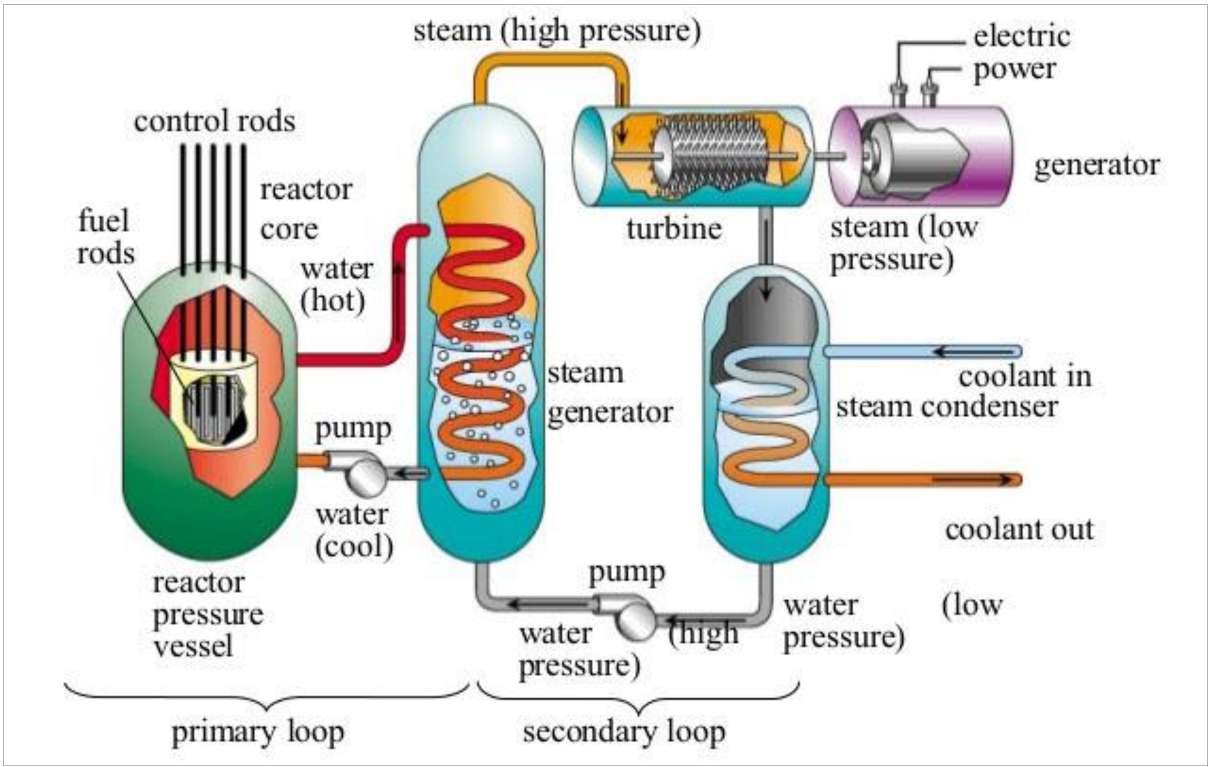


Figure 10: Schematic Representation of Pressurised Heavy Water Reactor (PWR)

2.2.3.1. MADRAS ATOMIC POWER STATION

The Madras Atomic Power Station (MAPS) is located within 80 kilometres south of Chennai City and was the first indigenously built nuclear power station in India. The Department of Atomic Energy (DAE) and the Indian engineering firm Larsen and Toubro built the power station based on experience obtained by working with the CANDU reactors at Kota. The power station consists of two units. MAPS-1 was completed in 1981, but start-up was delayed due to a shortage of heavy water. After procuring the necessary heavy water, the Madras Unit-1 went critical in 1983 and began operating at full power in January 1984. MAPS-2 obtained criticality in 1985 and began full power operations in March 1986. Two Pressurized Heavy Water Reactors (PHWR) with original capacity of 220MWe each.

Table 13: List of Units and its power generating capacities in MAPS

Unit	Reactor Type	Capacity (MWe)	Date of Commercial Operation
1	Pressurised Heavy Water Reactor(PHWR)	220	January 27,1984
2	Pressurised Heavy Water Reactor(PHWR)	220	March 21,1986

2.2.3.2. KUDANKULAM NUCLEAR POWER PROJECT ‘

Kudankulam site has two operational units (Unit 1 and Unit 2)& four more units (Unit 3, Unit 4, Unit 5 and Unit 6) of 1000 MWe capacity each are approved. Kudankulam Nuclear Power Plant (or Kudankulam NPP or KKNPP) is the largest nuclear power station in India, situated on the shore of Gulf of Mannar and is located near the South-Eastern tip of India which is 4 km south of Kudankulam village, Radhapuram Taluka, Tirunelveli District of Tamil Nadu State. KKNPP is scheduled to have six VVER-1000 reactors built in collaboration with Atomstroyexport, the Russian state company and Nuclear Power Corporation of India Limited (NPCIL), with an installed capacity of 6,000 MW of electricity. Unit 1 was synchronised with the southern power grid on 22 October 2013 and since then, has been generating electricity at its warranted limit of 1,000 MW. Unit 2 attained criticality on 10 July 2016 and was synchronised with the electricity grid on 29 August.

- Kudankulam Nuclear Power Project (KKNPP) 1 & 2 (2x 1000 MWe, VVER, Operational)
- Kudankulam Nuclear Power Project (KKNPP) 3 to 6 (4 x1000 MWe, approval is granted by Govt. of India)

Table 14: List of Units and its power generating capacities in KKNPP

Unit	Reactor Type	Capacity (MWe)	Date of Commercial Operation
KKNPP Unit -1	Water-Water Energetic Reactor VVER -1000 (PWR)	1000	December 31, 2014
KKNPP Unit -2	Water-Water Energetic Reactor VVER -1000 (PWR)	1000	March 31, 2017

Source: NPCIL, 2020

Table 15: List of New Nuclear Power Projects in Tamil Nadu

Unit	Reactor Type	Capacity (MWe)	Date of Commercial Operation
MAPS, Unit -3	Prototype Fast Breeder Reactor (PFBR)	500	--
KKNPP Unit -3	Light Water Reactor (LWR)	1000	--
KKNPP Unit -4	Light Water Reactor (LWR)	1000	--
KKNPP Unit -5	--	1000	--
KKNPP Unit -6	--	1000	--
MAPS, Unit -4	Fast Breeder Reactor (FBR)	600	--
MAPS, Unit -5	Fast Breeder Reactor (FBR)	600	--
	Total	**5,700**	

Map Showing Nuclear Power Stations in Tamil Nadu

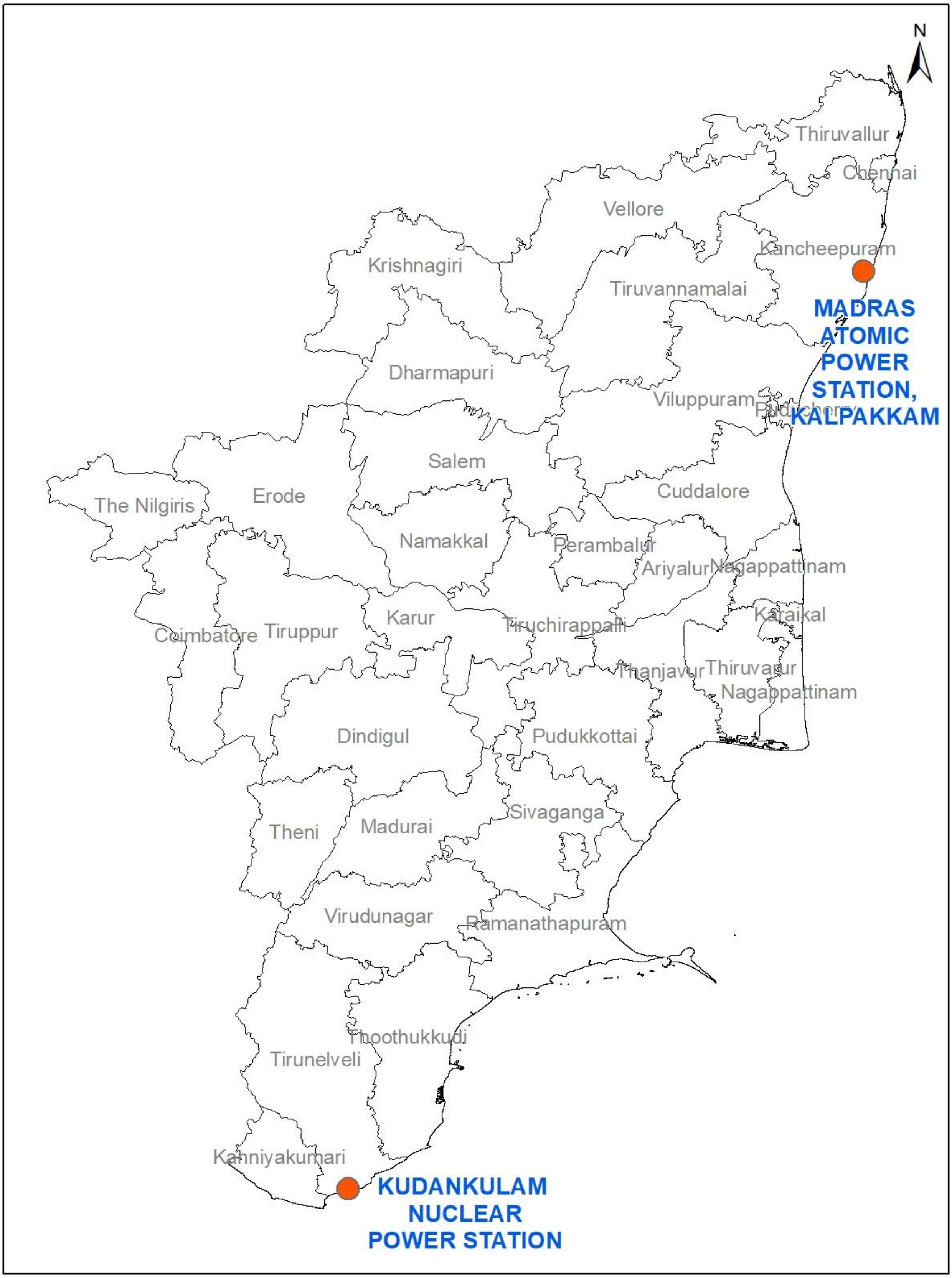


Figure 11: Location of Nuclear Power Stations in Tamil Nadu

2.3. NON-CONVENTIONAL ENERGY SOURCES (NCES)

The state of Tamil Nadu is blessed with various forms of renewable energy sources viz., Wind, Solar Biomass, Biogas, Small Hydro etc. The state has emerged as a major hub for development of renewable energy in the last few years and presently approx. 40% of the total installed capacity in the state is from Renewable Energy sources.

The Govt. of Tamil Nadu set up the Tamil Nadu Energy Development Agency (TEDA) in 1985 to promote the use of new and renewable energy sources and promote energy conservation activities in the state. The credit for such large capacity additions is attributable to the enabling policy framework promulgated by the state govt. and effective implementation of projects.

2.3.1. SOLAR PHOTOVOLTAIC POWER PLANTS

Conventional energy sources like coal, oil, natural gas, etc. are limited in quantity, and if these continue to be depleted at the present rate, these will be exhausted in the coming decades. Energy demand is resulting in the creation of fossil fuel based power plants leading to substantial greenhouse gas emissions having an adverse impact on global warming and climate change.

Solar energy offers a clean, climate-friendly, abundant and inexhaustible energy resource to mankind. The costs of solar energy have been falling rapidly and are entering new areas of competitiveness. Solar Thermal Electricity and Solar Photo Voltaic Electricity are becoming competitive against conventional electricity generation in tropical countries. Rooftop SPV in tropical countries can compete with high retail electricity prices. Solar Power installations worldwide are growing.

Tamil Nadu has reasonably high solar insolation (5.6 -60 kWh/sq.m) with around 300 clear sunny days in a year. Based on the Tamil Nadu Solar Energy Policy 2012, Solar Net Metering concept has been implemented in the state of Tamil Nadu. TANGEDCO is encouraging establishment of HT/LT grid – interactive roof top solar power plants for captive use. Solar pumps for Agriculture connections are also being implemented by TEDA and agricultural department.

The state has total RE based installed capacity of 9,687 MW which includes 1,155 MW of solar energy (including 54.97 MW of solar rooftop). The state has some ambitious schemes for promotion of RE based energy sources viz. CM's Solar Powered Green House Scheme, CM's Solar Rooftop Capital Incentive Scheme, Wind Solar Hybrid System and small hydro/micro hydel projects. Under the state's REC scheme, 66 Solar Plants having total capacity of 120.152 MW have been commissioned so far. Under the state preferential tariff scheme, solar PV projects are allowed to be set up at a tariff of Rs. 7.01 (without AD) and Rs. 6.28/kWh (with AD) during the control period. Similarly solar thermal projects shall attract a tariff of Rs. 11.03/kWh (without AD) and Rs.9.88/kWh (with AD). It was observed that the entire solar capacity in the various districts is privately owned.

Jawaharlal Nehru National Solar Mission: The Jawaharlal Nehru National Solar Mission was launched on the 11th January, 2010. The Mission has set the ambitious target of deploying 20,000 MW of grid connected solar power by 2022 and aims at reducing the cost of solar power generation in the country through (i) long term policy; (ii) large scale deployment goals; (iii) aggressive R&D; and (iv) domestic production of critical raw materials, components and products. It has been envisaged to achieve grid tariff parity by 2022. Revision of cumulative targets under National Solar Mission from 20,000 MW by 2021-22 to 1,00,000 MW was approved in the Union Cabinet chaired by the Prime Minister, Shri Narendra Modi, for stepping up of India's solar power capacity target under the JNNSM by five times. The target will principally comprise of 40 GW Rooftop and 60 GW through Large and Medium Scale Grid Connected Solar Power Projects. With this ambitious target, India will become one of the largest Green Energy producers in the world, surpassing several developed countries.

Solar Photovoltaic (SPV) cells convert solar radiation into electricity. A Solar cell is a semi-conducting device made of silicon materials which, when exposed to sunlight, generated electricity. Solar cells are connected in series and parallel combinations to form modules that provide the require power. PV modules are manufactured by assembling the solar cells after stringing, tabbing and providing other inter connections.

Traditional solar cells are made from silicon, and are generally the most efficient. Thin-film solar cells made from amorphous silicon or non-silicon materials such as cadmium telluride are the second-generation solar cells, and are gaining a greater share in overall installations.

Third-generation solar cells use a variety of new materials and nanotechnology etc. for designing high efficiency PV materials. These systems are expected to rapidly become cost effective for use by utilities and industry.

Table 16: Types of SPV technologies

Cell Type	**Efficiency of Cell**	**Land per MW**
Mono Crystalline Silicon	Around 18 -24%	3-4 Acres
Poly / Multi Crystalline Silicon	Around 14-18%	4-5 Acres
Thin film (Different Types)	Amorphous silicon 6-10% Cadmium Telluride 10-11% Copper Indium Gallium Diselenide 12-14%	7.5 – 9 Acres

Large scale PV plants are used for electricity generation that is fed into the grid. Such systems typically consist of one or more photovoltaic (PV) panels, a DC/AC power converter/inverter, racks, mounting fixtures, and electrical interconnections. Additionally, such systems could also include maximum power point trackers (MPPT), battery systems and chargers, solar trackers, software for energy management, solar concentrators etc. The electricity generated is either stored, used directly for self-consumption, or is fed into large electricity grids.

Grid connected projects may be either i) Ground Mounted PV or ii) Rooftop PV

2.3.1.1. GROUND MOUNTED PHOTOVOLTAIC

I. SOLAR PARKS & ULTRA MEGA SOLAR POWER PROJECTS

Solar Park is a concentrated zone of development of solar power generation projects, by providing to developers an area that is well characterized, properly infra-structured and where the risk of the projects can be minimized as well as the facilitation of the permitting process.

Figure 12: World's largest solar power plant 648 MW at Kamudhi, Tamil Nadu

2.3.1.2. ROOFTOP PHOTOVOLTAIC

Roof-top solar PV installations are becoming a popular green energy option for not only meeting own electricity load but also injecting surplus generation into the grid. Schools, hospitals, storehouses, bus stations, railway stations etc. provide ample spaces to set up PV projects. There is a high possibility of natural load-generation balance if roof-top PV solar systems are installed.

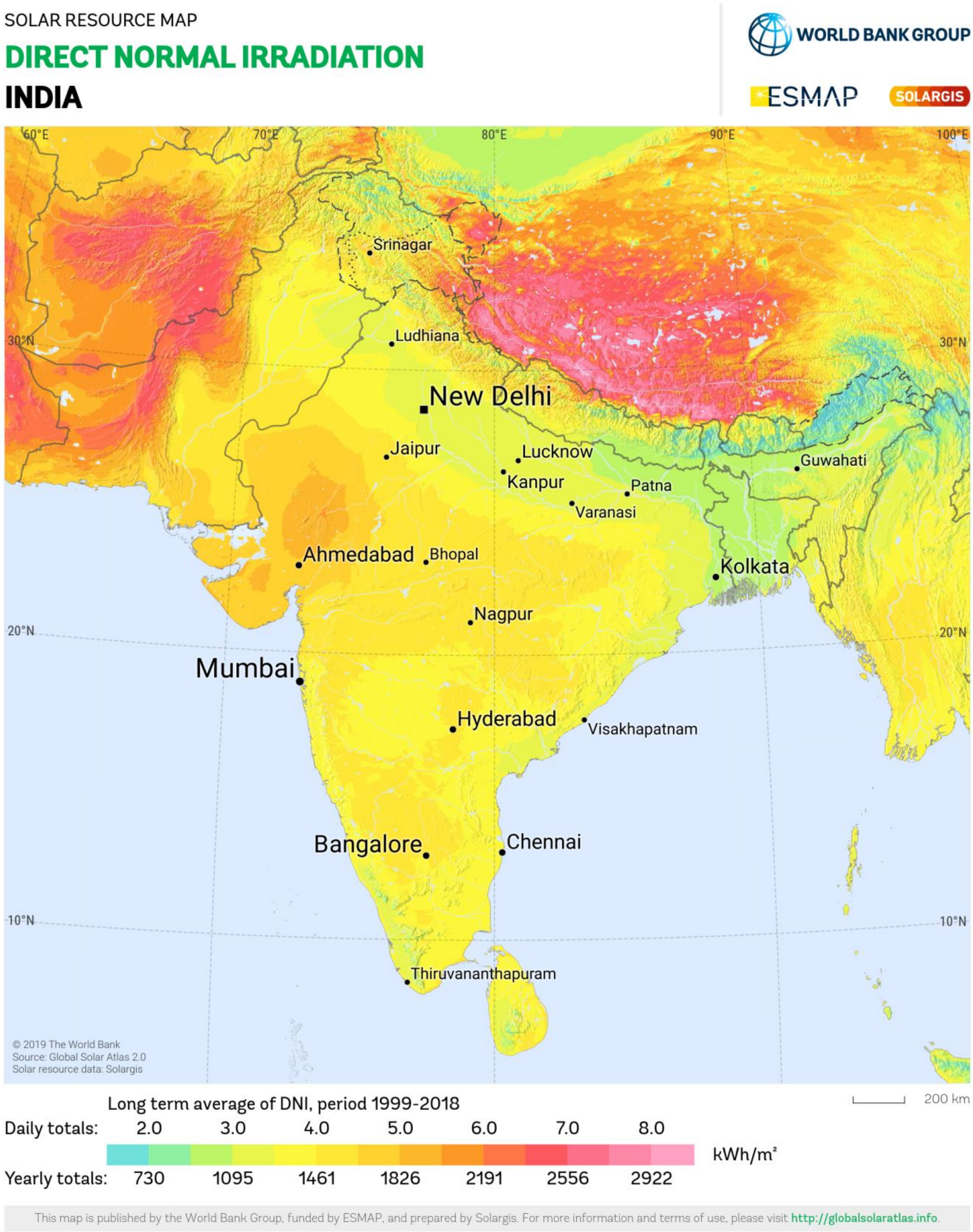


Figure 13: Map showing long term average of Daily Normal Irradiance (DNI)

Table 17: List of Solar Power Units and their capacities, TEDA

S.No	Name and Location of SPV Power Plant	Capacity (KW)
1.	SSN College of Engineering, Kalavakkam	10.5
2.	Softeon Industrial Chennai	25
3.	Velammal School Ladanendal	60
4.	Sri Balaganapathy Mills, Srivilliputhur	10
5.	Loyola Industrial School, Ranipet	1.8
6.	D.G. Vaishanav College ,Chennai	10
7.	SSN Engineering College , Kancheepuram	10.5
8.	Yadava College, Madurai	3P.P.29 Nos. S.L.
9.	Einstein College of Engineering ,Seethaparpanallur ,Tirunelveli	100
10.	Thiru. P. Sivaji Poosari ,Madurai	1
11.	Aditya Gramam Ultratech Cement Ltd.,Reddipalayam, Ariyalur District.	100
12.	Loyola Industrial School,1/107 4A, South Railway Station, P.B.No.6, Palar Road,Ranipet – 632 401. Vellore.	3
13.	M/s. Rajendran Associates, New # 43,Gandhi Nagar 4th Main Road, Adayar, Chennai-20	10.08
14.	M/s. Zigma Marketing (India) Pvt. Ltd., Plot #62,Door # 13,Thirumangaiamman street, Sundaram Colony, East Tambaram, Chennai- 600 059	2.04
15.	PSG College of Technology, Peelamedu, Coimbatore Dist.	10
16.	Metecno India (P) Ltd., Mambakkam, Kancheepuram Dist.	5.5
17.	Grundfos Pumps India (P) Ltd., Chennai	30.5
18.	Menon Eternity Building Chennai	20
19.	Wings Trust, Madurai.	2
20.	TRP Engineering College, Trichy.	24
21.	Wipro Ltd., Sholinganallur, Chennai	100
22.	Anna University, MIT Campus, Chrompet, Chennai	1
23.	Harish Matriculation School, Rajapalayam Virudhunagar	1
24.	RVS College of Engineering and Technology, Coimbatore	100

25.	RVS Siddha Medical College, Coimbatore	100
26.	RVS Homeopathic Medical College, Coimbatore	100
27.	RVS Polytechnic College, Coimbatore	100
28.	RVS Industrial Training Institute, Coimbatore	100
29.	RVS College of Arts and Science, Coimbatore	100
30.	AVO Carbon India Private Ltd. Ambatore, Chennai	90
31.	Dr.N. Thangavelu Kumaran Hospital, Virudhunagar District	4
32.	Mahindra World city Developers Ltd Chennai.	75
33.	M/s. Sethu Institute of Technology, Pullor, Kariapatti 626 106,Virudhunagar District.	25
34.	M/s. Cape Institute of Technology, Levengipuram, Rajakrishnapuram P.O., Tirunelveli District 627 114.	10
35.	M/s. Rega Auto DistributorsR.S.125/B, Madurai-Dindigul Road,(Opp. Fatima College, Madurai 625 018.	3
36.	M/s. SPGC Metal Industries P.Ltd., P.O.Box, 78/1, Goods Shed Road, Virudhunagar 626 001.	5
37.	Kumaran HospitalNo.36B, Sedankinathu St. Thiruthangal (PO) Sivakasi , Viruthunagar District– 626 130	2
38.	Sri Krishna Hospital2/364, Balaji Garden Vembakottai (PO) Sivakasi – 626 131 Virudhunagar District	4
39.	M/s. Maharajaa Farm, 178, 11th Main, 5th Cross Saraswathipuram Mysore 570009	3
40.	PENGUIN APPARELS(P) LTD., Unit IV. R.S. No. 419/2P1&2, Astinapati Road Karadikal, Thirumangalam Taluk	13.3
41.	M/s. Balaji Enterprises, Old No. 34, New No. 8,Hyder Garden 2nd Street Perambur, Chennai 600 012	3.22
42.	M/s. Balaji Electricals, No.1 Chinnathambi Street, Kosapet, Chennai 600012	3.22
43.	M/s. Avant Grade Engineers and Consultants (P) Ltd., Old No.67A, New No.37 Kundrathur High Road, Porur, Chennai	10.71

(Source: TEDA, 2020)

I. CM'S SOLAR POWERED GREEN HOUSE SCHEME

Government of Tamil Nadu has launched solar powered Green House Scheme. Under this scheme 3 lakh houses will be constructed with solar powered lighting systems over a period of 5 years from 2011-12 to 2015-16 for the benefit of poor in rural areas.

For the year 2011-12, 60,000 Houses have been taken up and solar powers lighting systems are provided at an estimated cost of Rs.180 Cr. Out of 180 Cr the eligible subsidy from Ministry of New and Renewable Energy, GOI will be appx Rs.42.6 Cr

For the year 2012-13, 60,000 Houses have been taken up and are being provided with 49650 CFL based, 10,350 LED based solar power lighting system at an estimated cost of Rs 180 Cr. With approximately Rs 39.42 Cr subsidy from MNRE.

Figure 14: House constructed under CM's Solar Powered Green Houses Scheme fitted with solar panel

The solar lighting system consists of 5 no's CFLs/ LEDs one each in Living room, Bed room, Kitchen, Toilet & Veranda. These CFLs/ LEDs can be operated for 5 hrs a day. The solar home lighting system has grid backup with following innovative features:

1. Smart power conditioning unit to charge the battery from grid only in rainy or cloudy days when solar power is insufficient.

2. MNRE design of solar system is with 3 day autonomy. i.e., even if it is raining for 3 days the system will work as the required energy for 3 days is generated by the panel & stored in the battery. Provision

of grid back up avoids requirement of autonomy for more than a day. Hence additional capacity of battery and SPV panel required for more autonomy is reduced, resulting in huge capital saving.

3. Direct EB supply to lights in case of failure of Battery/Inverter

4. Comprehensive maintenance of the systems by the supplier for 5 years

5. Call Centre is established for addressing the grievance of beneficiaries.

II. CM'S SOLAR ROOFTOP CAPITAL INCENTIVE SCHEME

Under this scheme, the Tamil Nadu Government provides a capital subsidy of Rs. 20,000 per kilowatt for grid-connected domestic solar PV systems in addition to the 30% subsidy scheme (National Clean Energy Fund) of the Ministry of New and Renewable Energy (MNRE) of the Government of India. For individual homes / flats, the solar system capacity shall be 1 kW. For the residential flats solar system capacity of 5 kW, 10 kW and multiples thereof can be applied for common usage as group application. For every 1 KW installed, the typical solar PV system generation in Tamil Nadu is about 1,500 kWh (units) per annum. Actual energy generation depends on the efficiency of solar, tilt angle of the solar panel, weather, grid availability and cleanness of the solar panels.

A grid-connected photovoltaic power system will reduce the power bill due to the import and export of power through net metering provision. Illustration: someone imports (consumes) 1,000 kWh from the grid and exports 600 kWh to the grid in a billing cycle. The energy bill will be for 400 kWh (1000 kWh – 600 kWh) accounted by Net meter.

- Grid-connected PV systems do not require batteries. Batteries are costly require periodic maintenance and also lead to wastage of 15 – 20 % energy in storage and retrieval.
- Grid-connected PV systems are much easier to operate and maintain.
- Segregation of load is not required.

A. SOLAR NET METERING

Solar net-metering was announced in the Tamil Nadu Solar Energy Policy 2012 and forms an integral part of that policy. Consumers who plan to install grid-connected solar PV systems can apply for solar net-metering.

In grid-connected solar PV systems the solar energy produced by the solar panels is converted to AC (alternating current) by a solar grid inverter. The output of the solar grid inverter is connected to the distribution board switch board of the building. The electrical energy flows to the loads of the buildings (lights, fans, appliances etc.). If the solar energy produced is more than what the building loads consume, the surplus energy will automatically be exported to the TANGEDCO distribution network (the grid). If there is less solar energy than what the loads of the building require, the shortfall will be drawn from the grid (energy import).

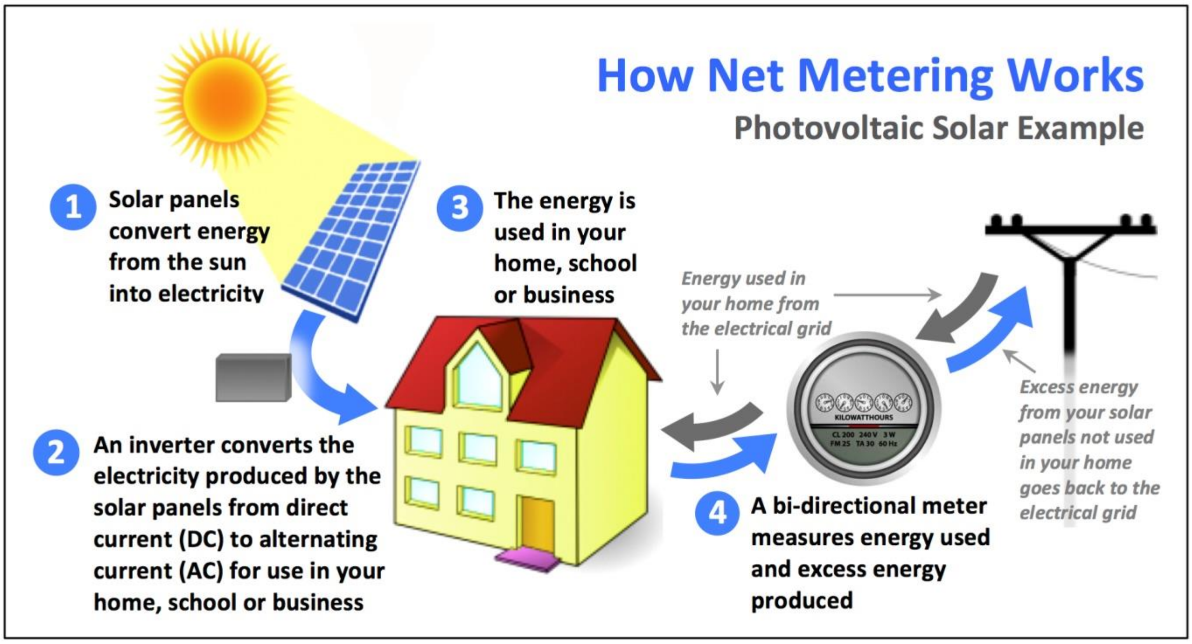


Figure 15: Solar Net Metering Concept

For solar net-metering to be implemented the existing TANGEDCO service connection meter needs to be replaced with a meter that can measure both energy import (from the grid to the consumer) and energy export (from the consumer to the grid). These meters are known as bidirectional energy meters or import-export energy meters.

With solar net-metering the Consumer pays for the difference between import and export energy (the net-metered energy). Example: a Consumer imports during a billing cycle 900 kWh (units) and exports 500 kWh. The electricity bill will be for 400 kWh. If the export energy exceeds the import energy, the excess of import kWh will be carried over to the next billing cycle. During a 12 months period (the Settlement Period) the maximum of energy export that will be credited by TANGEDCO is 90% of the energy import.

Example**:** During the settlement period there is a total import of 5,000 kWh and a total export of 6,000 kWh. Of the 6,000 kWh exported 4,500 kWh is eligible for adjustment with the import kWh (90% of 5,000 kWh).

2.3.1.3. OFF-GRID PHOTOVOLTAIC

Lack of access to modern forms of energy in the rural areas is a major barrier to inclusive growth of the country. Large numbers of households use kerosene for cooking and lighting requirements. JNNSM Phase II has envisaged giving a major thrust to off-grid solar power applications in areas where grid has not reached, or the areas where electricity supply is poor. Solar Energy Corporation of India (SECI) plans to focus on Solar off grid generating systems, solar home lighting systems and various other forms of solar based heating/cooling/thermal applications in domestic, commercial and industrial segments

- 25,068 Solar domestic lighting systems installed in Tamil Nadu with assistance from Government.
- 6,095 Solar street lights installed in public places/streets mostly in village panchayats with Government assistance and active support and involvement of Rural Development Department.
- Solar water and air heating/drying systems installed for a collector area of 28,791 sq.m.

I. LOW COST SOLAR LANTERNS

Solar lanterns are increasingly finding applications in the rural areas for lighting purpose with key features such as LEDs, mobile charging, battery back-up etc. However, the prices of such lanterns continue to be prohibitively high for the rural population and thus out of their reach. Solar lanterns can be immensely useful, particularly for children's study besides household and other economic activities. They have a huge potential to replace current use of kerosene lamps, thus can contribute towards significant reduction in subsidy burden on this account. Solar lanterns are pollution-free and environment-friendly.

With a view to safeguard customers from spurious and unreliable products flooding the market and to have competitive pressure on high prices so as to achieve large scale rapid diffusion of solar lanterns in the rural areas across the country, SECI has embarked on development of 6 Lakh robust and efficient solar lanterns for distribution in the rural areas of the country. The Lanterns are currently being manufactured.

II. SOLAR STREET LIGHTS

Solar Street Lighting Systems are solar powered photovoltaic modules that convert sunlight directly into electricity in the day time, which is stored in a battery and is used for the purpose of street-lighting during the night.

Government of Tamil Nadu has decided to energise 1 lakh street lights in village panchayats through solar power over a period of 5 years up to 2016. For the year 2011-12, 20,000 street lights have been taken up at an estimated cost of Rs. 50.5 Cr out of which Ministry of New and Renewable Energy, GOI provides the subsidy of Rs. 8.1Cr.

For the year 2012-13, 20,000 street lights have been taken up at an estimated cost of Rs. 50.5 Cr out of which Ministry of New and Renewable Energy, GOI provides the subsidy of Rs. 8.1Cr

The street lights are energised through solar power in three categories.

1. Per year 18000 existing street lights with 40W incandescent bulbs or tube lights are replaced with 20W LED lights and powered in clusters from centralised Solar Photo Voltaic(SPV) power plants

through the existing distribution line of TANGEDCO, with grid backup.

2. Per year 1000 new LED based street lights are powered in clusters from centralised SPV power plants.

3. Per year 1000new LED based Standalone Street lights are powered by SPV.

LED lights are used as its life is around 50,000 hrs, which is 5-8 times that of CFL and consumes only half of the energy consumed by CFL.

This is first of its kind in the country, as the existing street lights so far powered from grid supply are now being powered with solar energy with provision for grid backup. i.e., Battery charges from EB supply only during Cloudy/Rainy days.

The solar street lighting system has following innovative features:

1. Remote monitoring unit is provided to monitor the performance of the street lighting systems from anywhere. A daily fault report will be generated & given to the installer for rectification within 48 Hrs. Tampering of Panel, battery & inverter housing is also monitored.

2. Automatic ON/OFF control of the lights from 6am to 6 pm

3. Automatic dimming of lights to one third during off peak hours. The LED lights glow with full brightness during the peak hours (Evening 6.00pm-10.00pm & Morning 5.00am – 6.00am) and one third of full brightness during remaining period. This reduces the capacity of SPV panel, Battery and other accessories resulting in huge reduction in investment, while going for large scale implementation.

4. Smart power conditioning unit to charge the battery from grid only in only during rainy or cloudy days when solar power is insufficient.

5. MNRE design of solar system is with 3 day autonomy. i.e., even if it is raining for 3 days the system will work as the required energy for 3 days is generated by the panel & stored in the battery. Provision of grid back up avoids requirement of autonomy for more than a day. Hence additional capacity of battery and SPV panel required for more autonomy is reduced, resulting in huge capital saving.

6. Direct EB supply to lights in case of failure of Battery/Inverter

7. Comprehensive maintenance of the systems by the supplier for 5 years.

III. MICRO/MINI GRID FOR REMOTE HABITATIONS

Micro grids are modern, small-scale versions of the centralized electricity system. They are very effective for achievement of community-level electrification in remote areas, using renewable energy sources and have a low carbon footprint. Micro grids generate, distribute, and regulate the flow of electricity to consumers locally. Micro grids are an ideal way to integrate various renewable resources and allow for community participation in the electricity enterprise. In remote/forest area habitations where the conventional mode of electrification is not possible, TANGEDCO has electrified the households in these areas through Solar Roof Top System.

IV. SOLAR STEAM COOKING SYSTEM

The dish antennas concentrate solar rays on a giant reflector, which transfers the heat to generate steam with temperatures ranging between 550 and 600°C. With an automated sun tracking system, the dishes rotate continuously along with the sun's movement, harnessing the solar rays on the receivers. However, they have to be manually rotated back to the east to await the rising sun next morning. As the solar system is hooked to the boilers, it works for a while even without the sun. Sathyabama University inaugurated the Solar Steam Cooking System on 1st of July, 2009 in the campus, 110 concentrator dishes with an area of 1100 m^2 makes it the largest installation in terms of the number of dishes and square metres of the reflecting concentrator dishes. A solar-powered kitchen consumes lesser power and time than a conventional kitchen and ensures that a meal is cooked in half-an-hour, whereas it may take one-and-a-half hour to cook the same using LPG. Unlike the LPG model, solar steam cooking system helps to keep the kitchen clean and hygienic.

Table 18: List of Institution Installed with Solar Steam Cooking System

S.No	Name of the institution with address	Area
1.	Sathyabama Engineering College, Chennai	1100 m^2
2.	National Engineering. College, K.R.Nagar, Kovilpatti	160 m^2
3.	SRM University Kattankulathur	592 m^2
4.	M/s. L & T Plastics Machinery Ltd., Chennai 600 123	64 m^2
5.	Titan Industries, Hosur	464m^2

Figure 16: Roof Top Installation of Solar Concentrator Dishes at an Educational Institute

2.3.2. WIND ENERGY

Growing concern for the environmental degradation has led to the world's interest in renewable energy resources. Wind is commercially and operationally the most viable renewable energy resource and accordingly, emerging as one of the largest source in terms of the renewable energy sector. Wind is the natural movement of air across the land or sea. Wind is caused by uneven heating and cooling of the earth's surface and by the earth's rotation. Land and water areas absorb and release different amount of heat received from the sun. As warm air rises, cooler air rushes in to take its place, causing local winds. The rotation of the earth changes the direction of the flow of air. Wind electric generator converts kinetic energy available in wind to electrical energy by using rotor, gearbox and generator. The wind turns the blades of a windmill-like machine. The rotating blades turn the shaft to which they are attached. The turning shaft typically can either power a pump or turn a generator, which produces electricity. The amount of energy produced by a wind machine depends upon the wind speed and the size of the blades in the machine. In general, when the wind speed doubles, the power produced increases eight times. Larger blades capture more wind. As the diameter of the circle formed by the blades doubles, the power increases four times.

2.3.2.1. WIND (POTENTIAL ZONES/ WIND PASSES)

Under National Wind Resource Assessment programme, Ministry through National Institute of Wind Energy, Chennai (erstwhile Centre for Wind Energy Technology (C-WET)) and State Nodal Agencies had installed and monitored 794 dedicated Wind Monitoring Stations (WMS) of height ranging from 20 m to 120 m (20m, 25m, 50m, 80m, 100m & 120m) throughout the country as on 31.12.2014. Initially the wind monitoring was carried out only in known windy areas. Now it is extended to new/ uncovered areas which are not explored in earlier projects to complete the Indian Wind resource mapping. Further hundreds of private winds monitoring stations are also operational in the country. Based on the analysis on the data collected from these 700 plus WMS, it is found that 237 stations have economically preferable wind power potential greater than 200 W/m2.

2.3.2.2. INDIAN WIND ATLAS

NIWE has assessed India's wind power potential at 100m hub height with scientific rigor and based on authentic latest available data-sets of wind as well as land geologically spread across India. This information is essential for the Policy makers, Private players, Government Agencies and other stakeholders of the industry to move towards achieving the ambitious goal of 60,000 MW of wind power by 2022 as envisaged by the government. NIWE (formerly C-WET) had already performed the potential estimation study corroborating meso-scale derived wind maps and micro-scale measurements and released Indian Wind Atlas at 50m and indicative values at 80m hub heights with 5km resolution in April

2010 in collaboration with RISO-DTU, Denmark.

- NIWE has chosen advanced modelling techniques and revisited this study as per the guidance and directives of MNRE / Govt. of India, with realistic and practical assumptions and estimated the wind power potential at 100m height as 302 GW. The present potential assessment has been carried out at a very high (10 times finer than 5km) spatial resolution of 500m, using the advanced meso-micro coupled numerical wind flow model, and with the corroboration of almost 1300 actual measurements spread all over India, which can be stated as first of its kind. In addition, the study has been performed with actual land availability estimation using NRSC 56m resolution Land Use Land Cover (LULC) Data (AWiFS) 1:250K scale and with consideration of 6MW / Sq.Km. Land features which are not suitable for wind farming has been excluded from the potential map with appropriate buffer/set-off. In addition, other developments such as roads, railways, Protected Areas, Airports, etc., have been excluded. Land area with elevation more than 1500m and slope more than 20 degree have also been excluded. The suitable land features have been grouped into 3 ranks (Rank I: Wasteland, Rank II: Cultivable Land and Rank III: Forest Land) and considerable weightage of 80% to Rank I, 30% to Rank II and 5% to Rank III has been assumed for the estimation. The map has been prepared in Capacity Utilization Factor (%CUF) scale and % CUF more than 20% has been considered for potential estimation.

Table 19: List of area potential for Wind Farms

State	Rank I*	Rank II*	Rank III*	Total
Andaman & Nicobar	4.12	3.43	0.88	8.43
Andhra Pradesh	22525.50	20538.10	1165.00	44228.60
Chhattisgarh	3.24	57.03	16.31	76.59
Goa	0.00	0.08	0.76	0.84
Gujarat	52287.59	32037.83	105.09	84431.33
Karnataka	15202.36	39802.59	852.40	55857.36
Kerala	332.63	1102.56	264.38	1699.56
Lakshadweep	3.50	3.40	0.77	7.67
Madhya Pradesh	2216.39	8258.55	8.93	10483.88
Maharashtra	31154.76	13747.43	492.15	45394.34
Odisha	1666.20	1267.06	160.22	3093.47
Puducherry	69.43	79.00	4.40	152.83
Rajasthan	15414.91	3342.62	12.96	18770.49

State	Rank I*	Rank II*	Rank III*	Total
Tamil Nadu	11251.48	22153.34	394.82	33799.65
Telangana	887.43	3347.52	9.34	4244.29
West Bengal	0.03	2.04	0.01	2.08
Total in MW	**153019.59**	**145742.59**	**3489.31**	**302251.49**
Total in GW	**153**	**146**	**3**	**302**

* Rank I – NRSC Level-II Classification Values: 12, 13, 15, 19

* Rank II – NRSC Level-II Classification Values: 2, 3, 4, 5, 6, 10, 18

* Rank III – NRSC Level-II Classification Values: 7, 8, 9

2.3.2.3. WIND PASSES IN TAMIL NADU

Aralvaimozhi Pass: Aralvaimozhi is an important mountain passes through the Western Ghats which leads to the West, Muppandal wind farms in along the pass; it has the largest wind farm area in Asia. It is well known for being the greatest source of wind energy in Asia. Aralvaimozhi pass wind flows through Kanyakumari and Tirunelveli district (Radhapuram Taluka).

Sengottah Pass: Sengottah Pass is located in the southern Western Ghats in Tirunelveli district. Wind in the region passes through (Kayathar area) Tirunelveli and Thoothukudi Districts. Sengottah mountain pass connect Sengottah, Tamil Nadu and Punalur, Kerala.

Aralvoimozhi Wind Pass

Sengottah Wind Pass (Kayathar)

Cumbam Pass (Theni)

Palghat Wind Pass (Udumalaipet)

Palghat Pass: It is a low mountain pass in the Western Ghats between Coimbatore in Tamil Nadu and Palakkad in Kerala. The Palakkad Gap funnels the winds blowing from the west on to Coimbatore and Tirupur districts in Tamil Nadu making the region one of the major wind power generation areas. Large windmill farms can be seen in and around Udumalaipettai and Kadathur.

Cumbam Pass: Cumbum Pass is a low mountain pass which connects Tamil Nadu and Central Kerala. Wind in the region passes through Theni and Dindigul Districts

Table 20: List of Wind Pass and Districts covered

S.No	Name of the Wind Pass	District Covered
1	Aralvaimozhi	Kanyakumari, Tirunelveli
2	Senkottah	Tirunelveli, Thoothukudi
3	Cumbam	Dindigul, Theni
4	Palghat	Coimbatore, Tirupur, Erode

Table 21: District wise number of wind monitoring locations

S.No	District	No of Monitoring Locations
1	Chennai	1
2	Coimbatore	11
3	Dharmapuri	3
4	Dindigul	6
5	Erode	3
6	Kancheepuram	1
7	Kanyakumari	8
8	Karur	2
9	Krishnagiri	1
10	Madurai	1
11	Nagapattinam	3
12	Nilgiris	2
13	Pudukottai	7
14	Ramanathapuram	3
15	Salem	1
16	Sivagangai	1
17	Theni	3
18	Thiruvannamalai	1
19	Tirunelveli	23
20	Tiruvallur	1
21	Tiruchirappalli	2
22	Tuticorin	10
23	Virudhunagar	2

Map Showing Wind Passes and Wind Potential Sites in Tamil Nadu

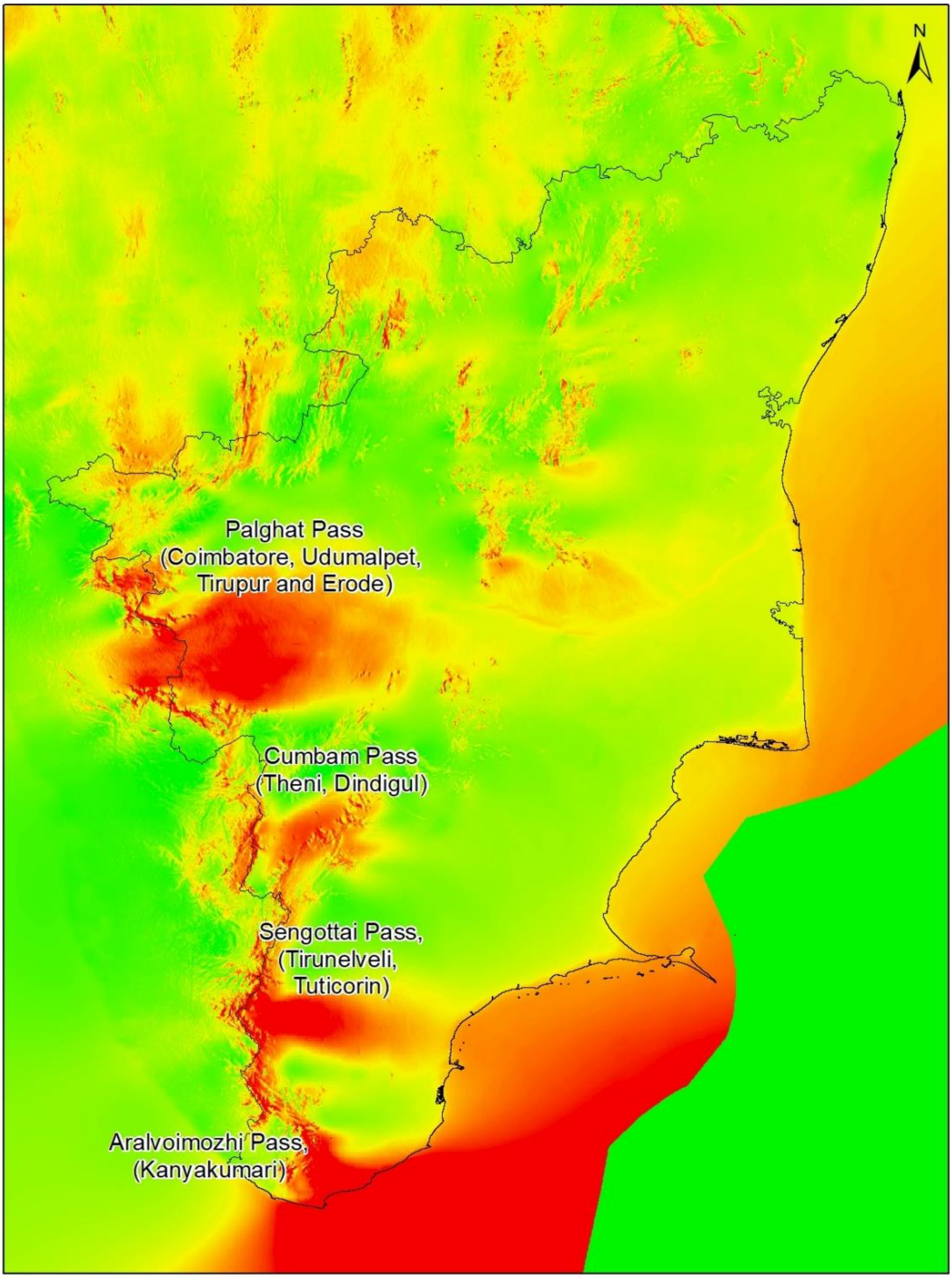


Figure 17: Map Showing Wind Passes and Wind Potential Sites in Tamil Nadu

Table 22: Installed Capacity of Wind Energy Generators in Tamil Nadu

S.No	Year	Installed Capacity in MW during the year	Cumulative Installed Capacity in MW	TANGEDCO Generation MU	Private Generation MU	Total Generation MU
1	Upto 1997	0	676.155	19.489	659.646	679.135
2	1997-1998	31.14	707.295	18.822	747.032	765.854
3	1998-1999	17.765	725.06	23.273	905.592	928.865
4	1999-2000	45.675	770.735	27.228	1129.365	1156.593
5	2000-2001	41.895	812.63	17.608	1076.567	1094.175
6	2001-2002	44.035	856.665	17.899	1239.211	1257.11
7	2002-2003	133.6	990.265	19.456	1286.247	1305.703
8	2003-2004	371.225	1361.49	24.346	1690.129	1714.475
9	2004-2005	678.735	2040.225	18.036	2242.696	2260.732
10	2005-2006	857.555	2897.78	14.581	3429.7	3444.281
11	2006-2007	577.91	3475.69	17.591	5251.391	5268.982
12	2007-2008	381.075	3856.765	12.058	6054.588	6066.646
13	2008-2009	430.975	4287.74	10.285	6644.865	6655.15
14	2009-2010	602.025	4889.765	11.092	8134.415	8145.508
15	2010-2011	997.4	5887.165	12.675	8707.37	8720.046
16	2011-2012	1083.46	6970.625	12.148	9750.9	9763.048
17	2012-2013	166.05	7136.675	12.66	12935.58	12948.24
18	2013-2014	107.38	7252.605	12.584	10917.65	10930.24
19	2014-2015	186.25	7438.855	7.805	10139.76	10147.56
20	2015-2016 (Apr)	7.3	7446.155	0.046	207.281	207.327

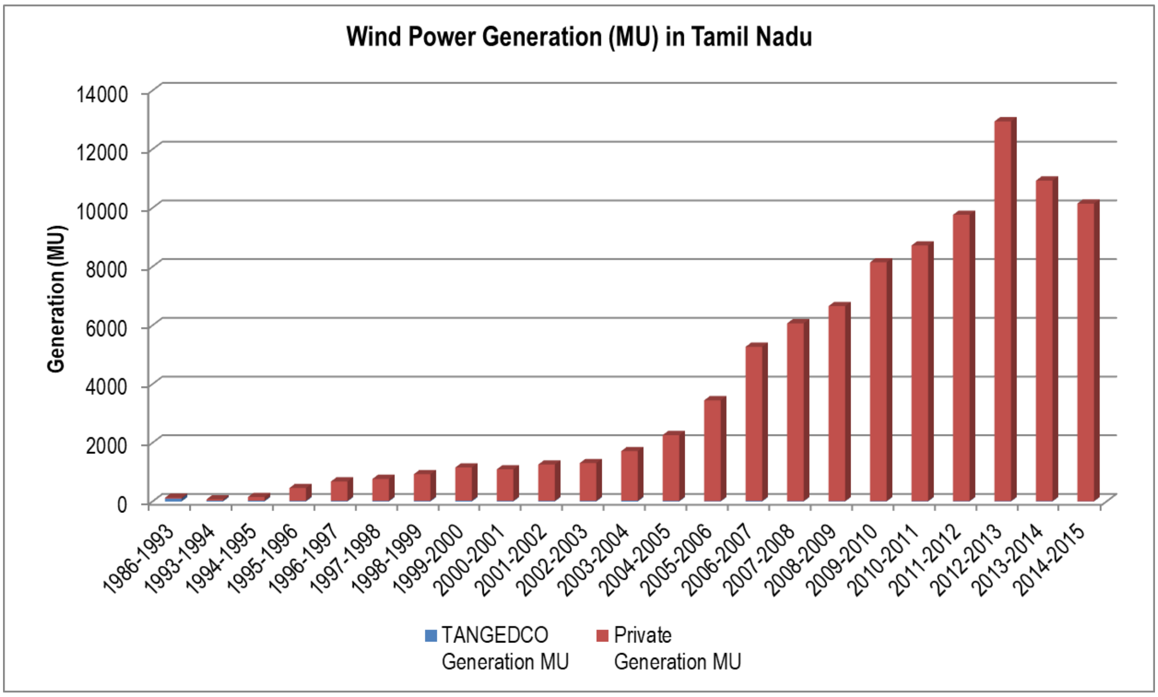


Figure 18: Wind Power Generation in Tamil Nadu

2.3.2.4. WIND MONITORING SITES IN TAMIL NADU

The National Institute of Wind Energy under its Wind Resource Assessment & Offshore Project locates wind rich sites in the country through field measurements for the development of wind energy utilization. The data generated from all parts of the country is consolidated for the preparation of a National wind resource atlas. Apart from this all wind resource related studies on–land and off-shore using other techniques like models and satellite information are used for the exploitation of wind energy.

The National Wind Resource Assessment Programme was designed for the selection of windy sites, procurement of suitable instruments, design and fabrication of 20 m tall masts, their installation at the selected sites and collection & processing of the data's. Nodal agency of each state also actively participated in the implementation of the programme. After the establishment of the National Institute of Wind Energy (formerly, C-WET) in Chennai, the National Wind Resource Assessment Programme has been transferred to NIWE and the activities of FRU-IITM was terminated. Since 2001 the National Wind Resource Assessment Programme is being executed by NIWE on behalf of MNRE. Under the programme, NIWE has commissioned 50m, 80m, 100m and 120m height masts to collect dedicated wind resource data at multi-level.

All the states and the major union territories are covered under this programme. More stations are being added every year so that more uncovered areas in states are studied scientifically. The data collected also serves as data bank for the preparation of national wind potential maps and other research purposes. Under the programme, cumulatively 877 stations have been established as on December 2018. The Ministry is continuing this project through NIWE in association with State Nodal Agencies. There are 95 stations in Tamil Nadu, the location of the monitoring station map has been provided below.

Map Showing Locations of Wind Monitoring in Tamil Nadu

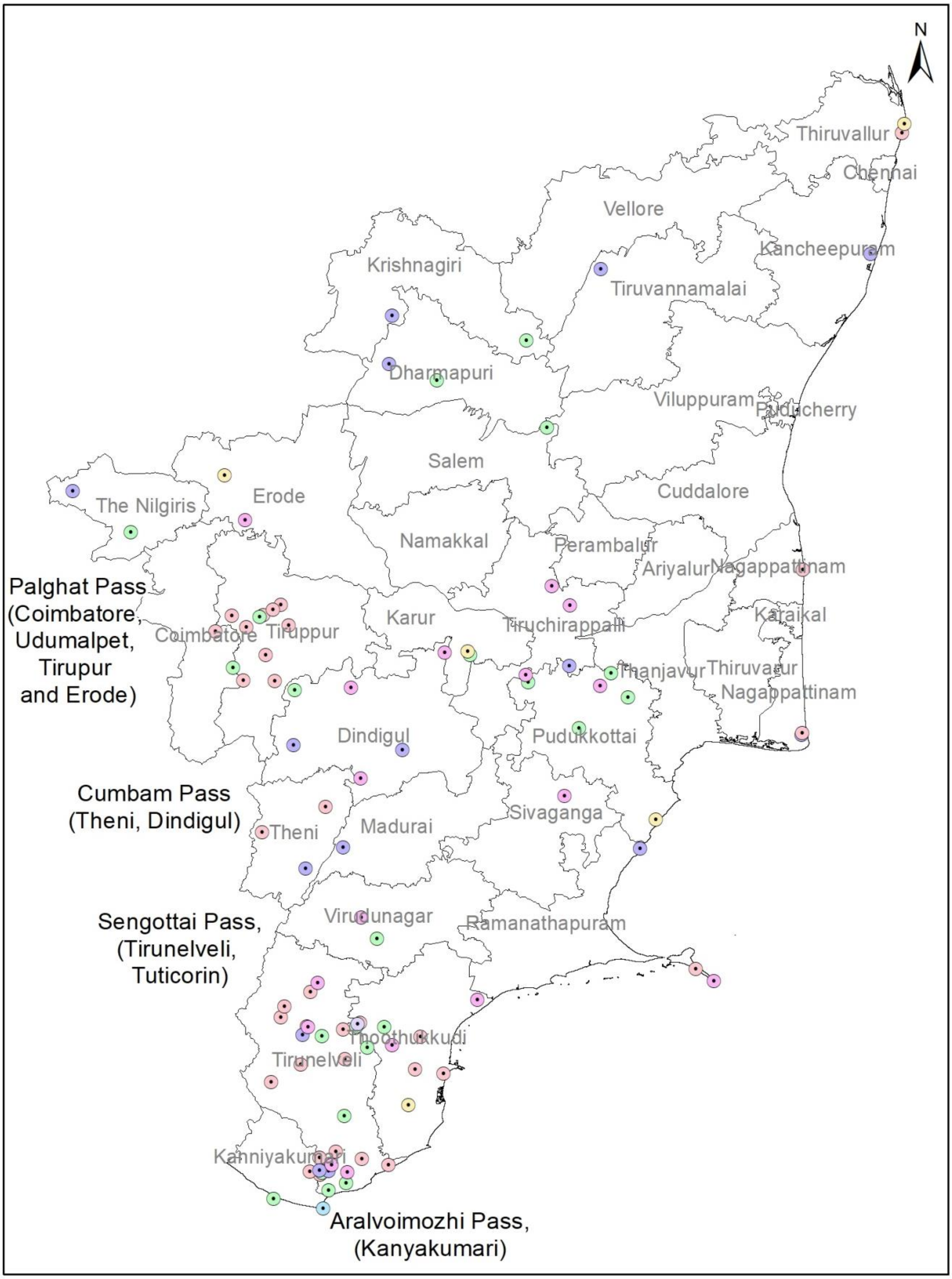


Figure 19: Map Showing Wind Monitoring Locations in Tamil Nadu

Table 23: List of Wind Monitoring Station, Mean annual wind power density (MAWPD), Mean Annual Wind Speed (MAWS), Wind Power Density (WPD)

S.NO	Station	District	Mast Height (m)	Elevation	MAWS	MAWPD	WPD
1	ACHANKUTTAM	TIRUNELVELI	20	139	5.17	270	397
2	AGASTHIANPALLI	NAGAPATTINAM	50	5	5.76	157	157
3	ALAGIYAPANDIYAPURAM	TIRUNELVELI	20	106	5.81	301	442
4	ANDHIYUR	COIMBATORE	20	380	5.31	177	271
5	ANDIPATTI	THENI	20	298	5.28	266	346
6	ARASAMPALAYAM	COIMBATORE	20	370	5.69	195	291
7	AYIKUDY	TIRUNELVELI	20	179	5.94	305	448
8	EDAYARPALAYAM	COIMBATORE	20	444	6.22	273	398
9	EMERALD	NILGIRIS	25	2055	3.5	103	113
10	ENNORE	TIRUVALLUR	20	1	5.36	139	243
11	GANDARVAKOTTAI	PUDUKOTTAI	25	118	3.26	42	70
12	GANGAIKONDAN	TIRUNELVELI	25	40	5.11	246	338
13	KAINANKARAI	PUDUKOTTAI	50	100	5.02	132	132
14	KALUGUR	PUDUKOTTAI	25	160	3.56	87	116
15	KALUNIRKULAM#	TIRUNELVELI	50	119	6.6	390	390
16	KANNANKULAM	KANYAKUMARI	25	20	5.92	238	375
17	KANYAKUMARI#	KANYAKUMARI	30	5	7.32	352	436
18	KARUMANTHURAI	SALEM	25	750	2.94	33	61
19	KATTADIMALAI	KANYAKUMARI	20	90	6.58	312	458
20	KAYATTAR I	TUTICORIN	20	94	5.64	294	413
21	KAYATTAR	TUTICORIN	25	105	5.37	285	356
22	KETHANUR 1	COIMBATORE	20	439	5.86	259	376
22	KETHANUR 2	COIMBATORE	25	403	5.47	189	345
23	KILLUKOTTAI	PUDUKOTTAI	25	130	3.78	76	102
24	KUMARAPURAM	TIRUNELVELI	25	80	6.11	288	385
25	MANGALAPURAM	TIRUNELVELI	20	182	6.19	312	423
26	MARUKALKURICHI	TIRUNELVELI	25	101	4	97	144
27	MEENAKSHIPURAM	THENI	20	464	4.56	224	334
28	METTUKADAI	ERODE	20	350	5	184	281
29	MUPPANDAL -1	KANYAKUMARI	20	105	7.08	406	597

S.NO	Station	District	Mast Height (m)	Elevation	MAWS	MAWPD	WPD
29	MUPPANDAL 2	KANYAKUMARI	25	103	6.19	243	410
30	MUTTOM	KANYAKUMARI	25	70	4.75	116	203
31	MYLAMPATTI	KARUR	25	200	4.74	145	177
32	MYVADI	COIMBATORE	20	341	5.44	251	376
33	NADUVAKKURICHI	TIRUNELVELI	20	163	4.67	157	244
34	NALLAMPALLY	DHARMAPURI	25	490	3.28	40	53
35	NETTUR	TIRUNELVELI	25	100	5.53	338	419
36	ONAMKULAM	TUTICORIN	25	100	5.53	247	292
37	OTTAPIDARAM	TUTICORIN	20	57	5.14	221	378
38	OVARI	TIRUNELVELI	20	21	5.08	160	221
39	PANAKUDI	TIRUNELVELI	20	140	6.36	366	469
40	PONGALUR	COIMBATORE	20	388	5.31	213	309
41	POOLAVADI	COIMBATORE	20	321	5.89	283	416
42	POOMPUHAR	NAGAPATTINAM	20	1	4.77	121	149
43	POOSARIPATTI	COIMBATORE	25	380	5.36	168	254
44	PULIYAMKULAM	TIRUNELVELI	20	35	5.26	188	343
45	PUSHPATHUR	DINDIGUL	25	363	4.47	128	201
46	RAMESWARAM	RAMANATHAPURAM	20	4	6.64	290	426
47	SANKANERI	TIRUNELVELI	25	30	6.28	258	388
48	SEMBAGARAMANPUDUR	KANYAKUMARI	20	40	6.03	300	441
49	SERVALLAR HILLS	TIRUNELVELI	20	312	4.78	207	313
50	SULTANPET	COIMBATORE	20	380	5.28	203	206
51	TALAYATHU	TIRUNELVELI	20	105	5.69	324	422
52	THANNIRPANDAL	COIMBATORE	20	400	5.06	216	317
53	THAYILPATTI	VIRUDHUNAGAR	25	107	3	40	65
54	THUPPAKUDI	TIRUNELVELI	20	80	3.22	78	87
55	TUTICORIN	TUTICORIN	20	3	4.89	148	245
56	UTHANGARAI	DHARMAPURI	25	350	3.22	50	88
57	VAKAIKULAM	TUTICORIN	20	32	4.61	167	256
58	VEDARANYAM	NAGAPATTINAM	20	3	3.78	83	101
59	VINAYAKAPURAM	TIRUNELVELI	20	80	4.33	114	194

S.NO	Station	District	Mast Height (m)	Elevation	MAWS	MAWPD	WPD
60	VIRALIMALAI	PUDUKOTTAI	25	167	3.27	49	85
61	PUDUPUDUR	DINDIGUL	50	1860	3.16	42	42
62	UPPATTY	NILGIRIS	50	957	3.1	32	32
63	KALIANAGARI	RAMANATHAPURAM	50	7	5.56	157	157
64	MADAM	DHARMAPURI	50	530	4.81	105	105
65	CHINNASHANTIPURAM	THENI	50	580	3.26	56	56
66	M.S.PURAM	MADURAI	50	253	5.57	343	343
67	KAMAGIRI	KRISHNAGIRI	50	1178	6.27	215	215
68	JAMNAMARTHUR	THIRUVANNAMALAI	50	743	4.87	106	106
69	ITTARAI	ERODE	80	1313	6.05	202	160
70	VELLAMADAM	TUTICORIN	80	23	5.63	184	137
71	KAYATHAR	TUTICORIN	120	89	6.29	319	196
72	MAMARATHUPATTI	KARUR	80	225	6.11	271	188
73	NALLUR	ERODE	100	280	4.18	81	47
74	DHANUSKODI	RAMANADHAPURAM	100	1			
75	KALIMANDAYAM*	DINDIGUL	100	302	5.92	279	188
76	KARUNGAL / PALAYAM	DINDIGUL	100	210	6.34	293	200
77	SRIVILLIPUTHUR	VIRUDHUNAGAR	100	146	4.22	87	59
78	AKKANAYAKANPATTI*	TUTICORIN	100	72	7.42	468	274
79	MELAMANDAI	TUTICORIN	100	7	6.35	230	159
80	KEERANIPATTI	SIVAGANGAI	100	104	4.7	97	52
81	ENNORE PORT#	CHENNAI	80	5			
82	UDAYALIPATTI	PUDUKOTTAI	100	110	5.59	160	94
83	SANKARANKOVIL	TIRUNELVELI	100	151	5.25	174	119
84	PALAYAVATHALAKUNDU	DINDIGUL	100	270	4.87	133	78
85	SUBRAMANIYA PURAM*	TRICHY	100	145	5.86	203	203
86	VIRALIMALAI	PUDUKOTTAI	100	150	5.78	219	147
87	GANDHIGRAM RURAL INSTITUTE#	DINDIGUL	50	315			
88	AARUPADAI VEEDU INSTITTUTE OF TECHNOLOGY#	KANCHEEPURAM	50	15			

S.NO	Station	District	Mast Height (m)	Elevation	MAWS	MAWPD	WPD
89	TNPL PERUNGUDI#	TIRUNELVELI	50	45			
90	KELAYAMBAL#	PUDUKOTTAI	80	7			
91	DEVIMANGALAM*	TRICHY	100	91	5.69	178	178
92	DALMIA(MUPPANDAL)	KANYAKUMARI	50	121			
93	KAVALKINARU (ABAN 1)	TIRUNELVELI	100	72			
94	VEERANAM	TIRUNELVELI	100	122			
95	RADHAPURAM (ABAN 2)	TIRUNELVELI	100	49			

2.3.3. CAPTIVE GENERATION PLANTS / CO GEN PLANTS / GENERATORS

A captive power plant is an electricity generation facility used and managed by an industrial or commercial energy user for own energy consumption. Captive power plants can operate off-grid or they can be connected to the electric grid to exchange excess generation.

A cogeneration facility is defined as one which simultaneously produces two or more forms of useful energy such as electric power and steam, electric power and shaft (mechanical) power etc. Cogeneration facilities, due to their ability to utilize the available energy in more than one form, use significantly less fuel input to produce electricity, steam, shaft power or other forms of energy than would be needed to produce them separately. Thus by achieving higher efficiency, cogeneration facilities can make a significant contribution to energy conservation.

Two basic cogeneration cycles:

Topping Cycle: Any facility that uses fuel input for power generation and also utilizes for useful heat for other industrial activities. In any facility with a supplementary firing facility, it would be required that the useful heat, to be utilized in the industrial activities, is more than the heat to be supplied to the system through the supplementary firing by at least 20%.

Bottoming Cycle: Any facility that uses waste industrial heat for power generation by supplementing heat from any fossil fuel.

Table 24: List of Captive Generation Plants / Co Gen Plants / Generators in Tamil Nadu with details of Capacity and Fuels Used (33 Kv And Below)

Sl. No.	Name of the Captive Generation Plant	Installed Capacity in MW	Fuel	Date of Synchronization	EDC/ Voltage level
1	M/s. SEDCO , **Captive Co-gen** Thiruvarur District	7.98 MW (2x2.74+ 1x2.5)	Natural gas	14.12.98	Thiruvarur EDC/33 KV
2	M/s. MMS Steel & Power Pvt. Ltd. (Koilkalappai) **MP*** Nagapattinam District.	6.12 (2x3.06)	Natural gas	19.9.06	Thiruvarur EDC/33 KV
3	M/s. Sabari Industries **Captive Co-gen** Pudukottai District	6.0	Waste heat	2.10.05	Pudukottai EDC/11 KV
4	M/s Jagannath Textile Company Ltd **MP*** Tiruppr District	5.4 (2x2.7)	Diesel / HFO	01.12.06	Coimbatore / South EDC/ 33 KV
5	M/s Noble Tech Industries Pvt. Ltd., **Captive Co- gen** Kancheepuram District	8.0	Waste heat	07.05.07	Kanchipuram EDC/33 KV
6	M/s Loyal Textile Mills ltd, **MP*** Thoothukudi District	4.1	HFO	30.04.10	Tuticorin EDC 11 KV
7	M/s Thiagraja Mills Ltd, **MP*** Madurai District	3.08	Diesel / FO	28.06.99	Madurai/ Metro/MEDC 11 KV
8	M/s Sun paper Mill ltd, **MP*** Tirunelveli District	6	Lignite & Biomass	1998	Tirunelveli EDC/11 KV
9	M/s Basudha Udyog Pvt ltd , **MP*** Thiruvallur District	10.0	Waste Heat	03/2012	Chennai/ North/CEDC 33 KV
10	M/S OPG Renewable Energy Pvt Ltd, **Generator MP*** Thiruvallur District	10.0	Waste Heat	26.08.08	Chennai/ North/CEDC 33 KV
	Total	66.68			

Note:- * MP - Mere Parallel, No export of power to grid CGP: Captive Generating Plant

Map Showing Captive Co-generation Power Plants in Tamil Nadu

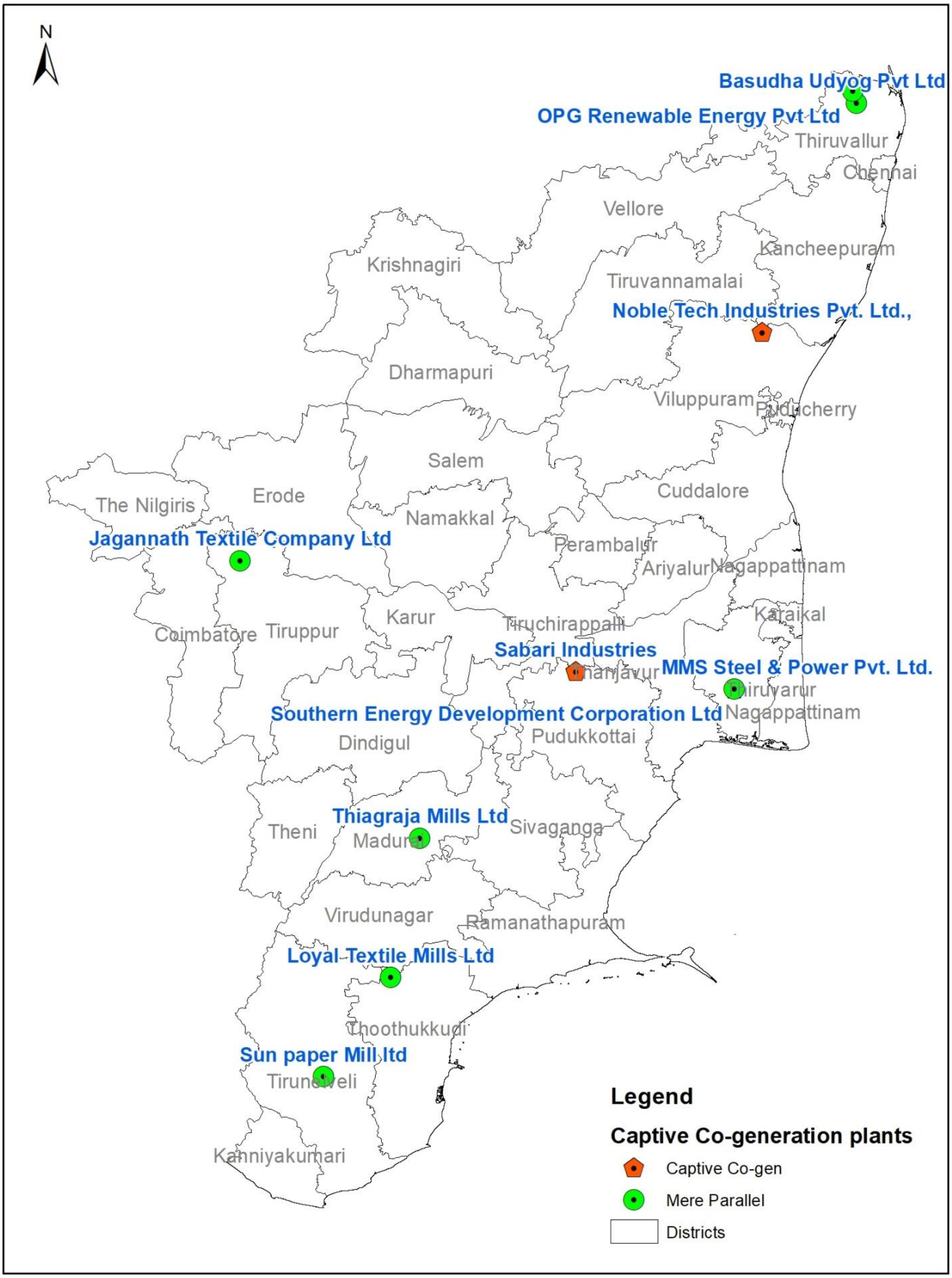


Figure 20: Map Showing CCPower Plants connected to TANGEDCO (<33 Kv EDC/Voltage level)

2.3.4. BIOMASS ENERGY:

Biomass is a renewable and widely available resource for generating electricity. Since it is carbon-neutral, it is considered an eco-friendly energy source. TANGEDCO promotes Bio-mass power plants in Tamil Nadu with co-operation extended by the Tamil Nadu Energy Development Agency.

- Bio-mass based Cogeneration Plants
- Bagasse based Cogeneration Plants
- Biomass gasification based Power Projects
- Municipal Solid waste & Vegetable based Power Plant

Biomass has always been an important energy source for the country considering the benefits it offers. It is renewable, widely available, carbon-neutral and has the potential to provide significant employment in the rural areas. Biomass is capable of providing firm energy. About 32% of the total primary energy use in the country is still derived from biomass. Ministry of New and Renewable Energy has initiated a number of programmes for promotion of efficient technologies for its use in various sectors to ensure derivation of maximum benefits .

For efficient utilization of biomass, bagasse based cogeneration in sugar mills and biomass power generation / co-generation in industries have been taken up under biomass power and cogeneration programme.

Biomass power & cogeneration programme is implemented with the main objective of promoting technologies for optimum use of country's biomass resources for grid power generation and captive power production. Biomass materials used for power generation include juliflora, bagasse, rice husk, straw, cotton stalk, coconut shells, soya husk, de-oiled cakes, coffee waste, jute wastes, groundnut shells, saw dust etc.

It is thermo-chemical conversion of solid biomass into a combustible gas mixture (producer gas) through a partial combustion route with air supply restricted to less than that theoretically required for full combustion. The newest method for generating electricity is gasification. This method captures 65-70% of the energy present in solid fuels by converting it first to combustible gases. These gases are then burnt as we currently burn natural gas, and create energy. The technologies for this synthetic fuel are still new and therefore not quite ready for commercial production.

Composition of Producer gas:

Hydrogen	- 15%-20%
Methane	- 1%-5%
Carbon Dioxide	- 9%-12%
Nitrogen	- 45%-55%
Calorific value	- 1000 – 1200 kcal/m^3

Table 25: District wise Biomass potential from Agro-residue

District	Area (kHa)	Crop Production (kT/Yr)	Biomass Generation (kT/Yr)	Biomass Surplus (kT/Yr)*	Power Potential (MWe)*
Chennai	-	-	-	-	-
Coimbatore	257.7	903.7	829.3	372.4	51.0
Cuddalore	227.7	4673.4	1320.2	457.6	59.3
Dharmapuri	125.4	476.6	451.2	208.3	27.1
Dindigul	157.6	351.6	856.4	321.7	42.4
Erode	122.4	1799.8	791.0	359.5	47.4
Kancheepuram	150.7	701.1	485.3	118.0	15.0
Kanniyakumari	74.7	443.2	870.3	457.7	60.5
Karur	79.3	335.3	395.4	171.7	22.3
Krishnagiri	119.8	529.2	477.8	232.5	30.2
Madurai	80.6	544.5	574.4	220.8	28.9
Nagapattinam	190	537.2	581.3	132.5	16.3
Namakkal	113.9	2317.9	1065.9	563.6	73.4
Nilgiris	11.4	22.0	80.4	46.5	6.3
Perambalur	169.4	1058.9	514.9	135.9	17.6
Pudukkottai	119.5	990.9	948.4	379.4	49.1
Ramanathapuram	159.5	96.6	111.0	42.6	5.7
Salem	139.4	1478.5	1124.8	610.7	79.8
Sivaganga	103.9	463.7	308.6	124.2	16.4
Thanjavur	294.0	1813.2	1339.2	456.1	58.6
Theni	77.8	927.0	595.1	238.4	31.3
Thiruvarur	158.8	392.0	395.1	93.2	11.6
Tiruchchirappalli	124.8	743.2	1543	718.9	93.2
Tirunelveli	100.2	734.6	1095.3	426.5	55.1
Tiruvallur	114.5	686.5	495.0	138.8	17.7
Tiruvanamalai	205.0	1021.4	801.7	198.9	25.0
Tuticorin	109.3	522.3	1464.1	666.1	86.6
Vellore	171.8	1555.5	1144.6	327.9	42.6
Villupuram	309.3	3852.6	1441.3	538.9	70.7
Virudhunagar	96.9	442.8	406.9	140.6	18.7
Total	4165.3	30415.2	22507.9	8899.9	1159.8

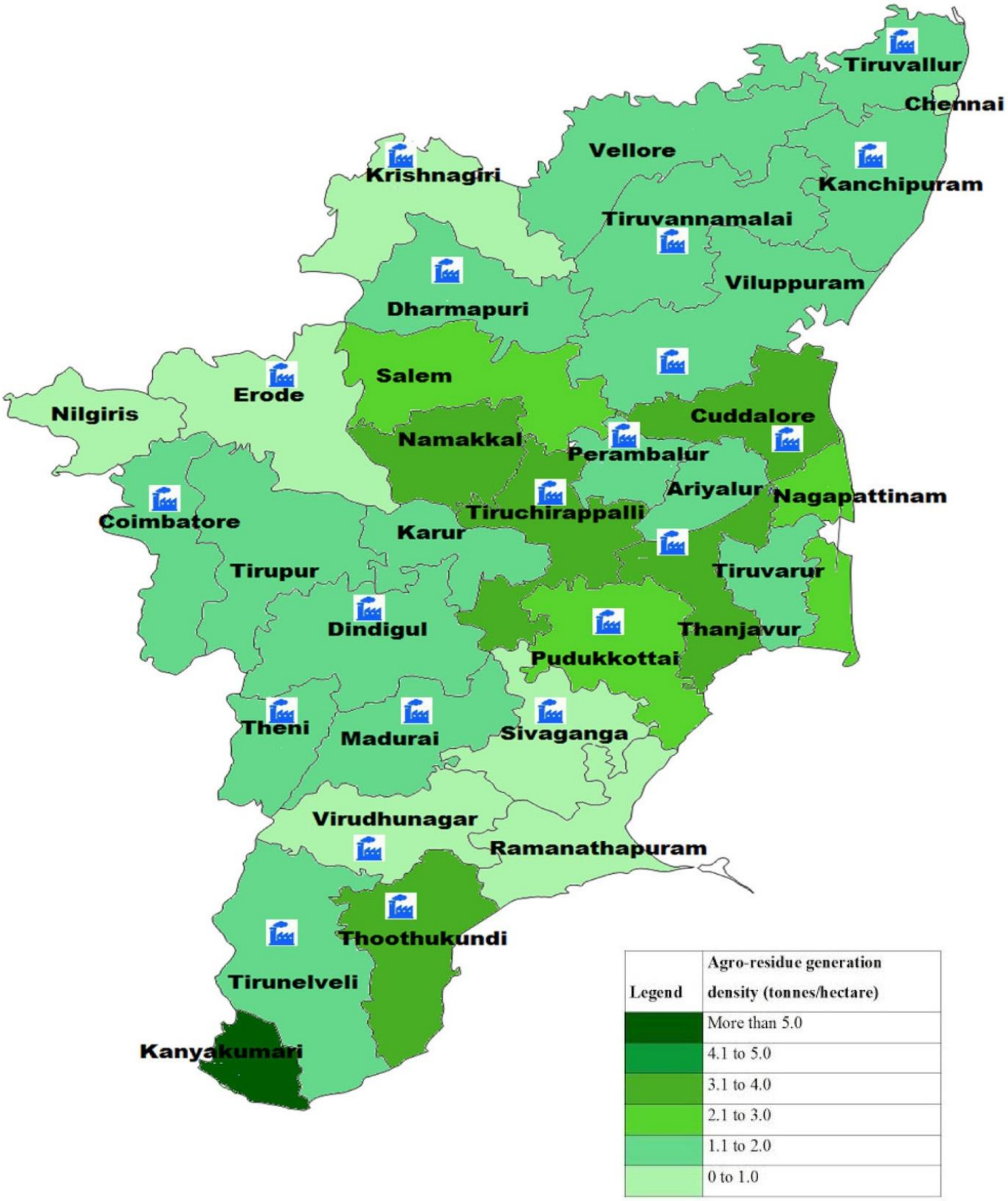
Source: (MNRE, Biomass Portal, 2020)

Table 26: District wise Biomass potential from Forest and Wasteland

District	Area (kHa)	Biomass Generation (kT/Yr)	Biomass Surplus (kT/Yr)*	Power Potential (MWe)*
Chennai	2.0	2.4	1.6	0.2
Coimbatore	200.8	2.4	1.6	0.2
Cuddalore	69.1	103.7	68.5	9.6
Dharmapuri	207.6	323.0	213.2	29.8
Dindigul	224.4	321.0	211.8	29.7
Erode	251.0	420.4	277.5	38.8
Kancheepuram	39.2	61.2	40.4	5.7
Kanniyakumari	80.8	138.8	91.6	12.8
Karur	24.4	44.0	29.1	4.1
Krishnagiri	133.3	172.5	113.9	15.9
Madurai	92.1	138.0	91.1	12.8
Nagapattinam	18.7	28.2	18.6	2.6
Namakkal	93.3	118.2	78.0	10.9
Nilgiris	181.8	237.5	156.8	21.9
Perambalur	91.0	133.5	88.1	12.3
Pudukkottai	54.5	84.2	55.6	7.8
Ramanathapuram	33.0	53.7	35.4	5.0
Salem	163.5	219.1	144.6	20.2
Sivaganga	24.5	40.0	26.4	3.7
Thanjavur	26.7	37.7	24.9	3.5
Theni	175.2	227.9	150.4	21.1
Thiruvarur	13.5	21.0	13.8	1.9
Tiruchchirappalli	65.1	98.5	65.0	9.1
Tirunelveli	162.8	211.2	139.4	19.5
Tiruvallur	45.6	72.4	47.8	6.7
Tiruvanamalai	205.0	320.8	211.7	29.6
Tuticorin	37.2	59.4	39.2	5.5
Vellore	335.3	335.3	221.3	31.0
Villupuram	252.8	252.8	166.8	23.4
Virudhunagar	67.6	89.6	59.1	8.3
Total	3371.8	4652.4	3070.6	429.9

Source: (MNRE, Biomass Portal, 2020)

2.3.4.1. BIO-MASS BASED CO-GEN PLANTS IN TAMIL NADU



Source: (MNRE, Biomass Portal, 2020)

Figure 21: Map Showing Districts with Biomass based Co-generation Power Plants and density of agricultural residue generation in Tamil Nadu

Table 27: District wise Biomass based Co-Gen Plants in Tamil Nadu

District	Developer	Capacity (MW)	Date of Commissioning
Coimbatore	Venkesteshwar Paper Mill	2.5	96-97/97-98
Coimbatore	Orient Green Power Co. Ltd	10.0	04.07.11
Dindigul.	Shriram Power Gen Ltd	7.5	02.11.07
Kancheepuram	Nandha Energy Ltd, C/o. M/s. Mohan Breweries Distilleries Ltd	18.0	31.03.97
Krishnagiri	Synergy Shakthi Renewable Energy Ltd	10.0	22.02.10
Madurai	Servall Engineering Industries Ltd	2.5	95-96/96-97
Madurai	Auro Mira Bio Energy Madurai Ltd	10.0	04.02.09
Madurai	Astro Energy and Biom Systems Ltd	10.0	
Pudukkottai	Empee Distilleries Ltd	10.0	17.04.08
Pudukottai	Chitra Bio Energy Ltd	7.5	22.03.06
Ramanathapuram	Raghu Rama renewable Energy Ltd	18.0	
Sivagangai	Aurobindo Energy Pvt Ltd	15.0	05.09.06
Sivagangai	TCP Limited	9.0	24.11.06
Thanjavur	G.B. Engineering Pvt Ltd	6.0	2008
Thanjavur	Shriram Non-Conventional Energy Ltd	7.5	04.02.09
Theni	Shri Renuga Textiles Ltd	4.5	25.10.08
Thiruvannamalai	Southern Power Tech Equipment's Pvt Ltd	6.0	
Thoothukudi	Ind-Barath Energies Ltd	20.0	22.03.06
Thoothukudi	Rajkumar Impex Pvt Ltd	6.0	12.04.12
Thoothukudi	Spic Electric Power Corporation Ltd	7.0	
Tirunelveli	Prathyusha Power Pvt Ltd	10.0	03.08.07
Tirunelveli	Auro Mira Bio Power India Pvt Ltd	15.0	06.07.11
Thiruvallur	Manali Petro Chemicals Ltd	4.7	15.11.08
Thiruvallur	Cetex Energy Generation Pvt Ltd	12.0	
Thiruvannamalai	Global Power Tech Equipment's Ltd	7.5	04.02.10
Tuticorin	Continental Warehousing Corporation Ltd	6.0	
Virudhunagar	ETA Powergen Pvt Ltd	10.0	22.05.09
Virudhunagar	Sripathi Paper and Boards Pvt Ltd	4.9	09.03.11
	Total	**164.6**	

Source: (MNRE, Biomass Portal, 2020)

MNRE/GoI provides subsidy for the following

- Biomass Gasifier based Distributed / Off-grid power programme for Rural Areas.
- Biomass Gasifier based Grid Connected Power Programme
- Biomass gasifier based programmes in Rice Mills

2.3.4.2. BAGASSE BASED COGENERATION POWER PLANTS IN SERVICE

Table 28: List of Bagasse based Co-Gen Power Plants in Tamil Nadu

District	**Bagasse based Co-Gen Power Plants**	Capacity (MW)	Year of commissioning
Cuddalore	M.R.K Coop. Sugar Mills Ltd	3.5	1992
Cuddalore	Eid (Parry) India Ltd	14.0	1997
Cuddalore	Supreme Renewable Energy Ltd	24.0	
Cuddalore	Eid (Parry) India Ltd	12.0	
Dharampuri	Subramaniya Siva Coop. Sugar Mills Ltd	2.0	1998
Erode	Bannari Amman Sugar Ltd	13.5	
Erode	Shakti Sugars,	18.0	
Erode	Shakti Sugars	18.0	
Kancheepuram	S.V. Sugars,	2.5	1997
Madurai	Rajashree Sugars and Chemicals Ltd	8.0	1996
Madurai	Astro Energy and Biom Systems Ltd	10.0	2009
Perambalur	Kothori Sugars and Chemicals Ltd	12.0	
Perambalur	Mahalakshmi Srinivasan Sugar Mills	15.0	
Pudukottai	Eid (Parry) India Ltd	10.0	
Sivaganga	Sakthi sugar Ltd,	2.0	2002
Thanjavur	Thiruarooran Sugars Ltd	9.0	1996
Thanjavur	Thiruarooran Sugars Ltd	8.0	1998
Thanjavur	Auro Energy Ltd	7.0	
Thiruvannamalai	Arunachalam Sugar	8.0	2002
Thiruvannamalai	Cheyyar Coop. Sugar Mills Ltd	3.5	1993
Tiruchirapalli	Eid (Parry) India Ltd	15.0	2002
Tiruchirapalli	Eid (Parry) India Ltd	2.0	2009
Tiruchirapalli	Kothari Sugars and Chemicals	8.5	1996
Tirunelveli	Thirru Arooran Sugars Ltd	13.0	1997
Tirunelveli	M/s. Prathyusha Power Pvt Ltd	10.0	
Tirunelveli	Empee Sugars and Chemicals Ltd	18.0	
Tirunelveli	Dharani Sugars and Chemicals Ltd	9.5	1996
Villupuram	Rajshree Sugars and Chemicals Ltd	15.0	
Villupuram	M/s Rajshree Sugars and Chemicals Ltd	15.0	2008
	Total	**306.0**	

Source: TANGEDCO, 2020

Table 29: List of Co-Gen Plants Selling Power to TANGEDCO

District	Name of the Company & address	Sale to TNEB in MW	Rate of power purchase	Installed Capacity MW/Fuel	Agreement period
Thiruvallur	M/s.CPCL Manali, Chennai- 600 068.	3.0 MW (infirm)	U.I (Rs.2.10 to 4.08), 90% of UI for Infirm power	129.9/ Naptha	31.03.16 to 30.03.19 (3 years)
Thiruvallur	K16, Phase II, Sipcot Industrial complex, P.O, Gummidipoondi, Thirvallur dist,-601201	2.0 MW(firm)	U.I (Rs2.10 to 4.08) with 10% premium	33.7/ Waste heat	29.06.15 to 28.06.18 (3 years)
Salem	M/s. JSW Steel Ltd P.O.Pottaneri Mecheri Mettur –Tk, Salem	15.0 MW (Infirm)	U.I (Rs 2.10 to 4.08)	60/ Coal	26.12.15 to 25.12.18 (3 years)
Tiruchirapalli	M/s. TNPL MondipattyVillage, Manaparai Taluk, Trichy District.	8.0 MW (Infirm)	U.I (Rs 2.10 to 4.08)	30/ Coal	13.11.15 to 12.11.18 (3 years)
		Infirm 26.00 MW Firm 02.00 MW			
	Total	28.00 MW			

Data as on 29.05.2018

Source: TANGEDCO/Non-Conventional, 2020

2.3.4.3. BIOMASS GASIFICATION:

Biomass gasification is a mature technology pathway that uses a controlled process involving heat, steam, and oxygen to convert biomass to hydrogen and other products, without combustion. Because growing biomass removes carbon dioxide from the atmosphere, the net carbon emissions of this method can be low, especially if coupled with carbon capture, utilization, and storage in the long term.

Biomass, a renewable organic resource, includes agriculture crop residues (Sugarcane, Paddy straw, and Cashew nut shell), forest residues, wood chips, rice husk, and other plants such as *Prosopis juliflora.* This renewable resource can be used to produce hydrogen, along with other by-products, by gasification.

Gasification is a process that converts organic or fossil-based carbonaceous materials at high temperatures (>700°C), without combustion, with a controlled amount of oxygen and/or steam into carbon monoxide, hydrogen, and carbon dioxide. The carbon monoxide then reacts with water to form carbon dioxide and more hydrogen via a water-gas shift reaction. Adsorbers or special membranes can separate the hydrogen from this gas stream.

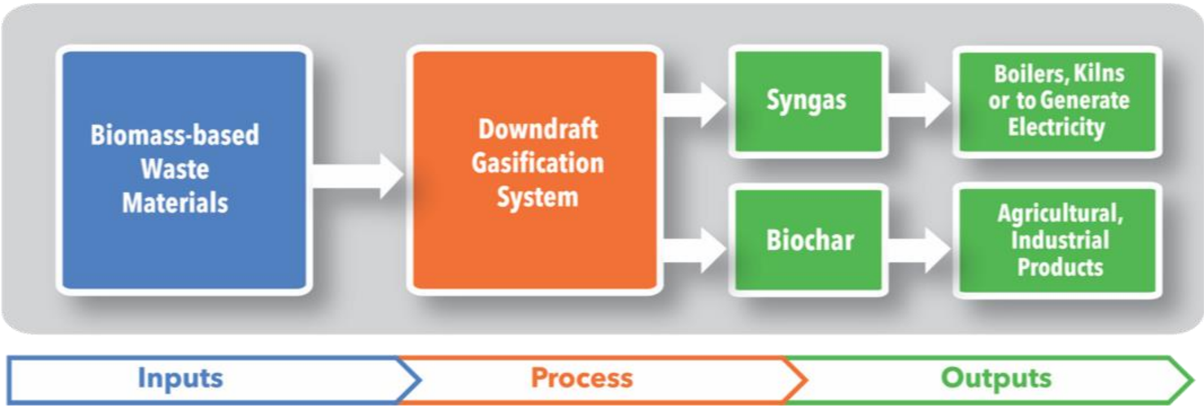


Figure 22: Process flow of Bio gasifier plant

Bio-mass gasifiers at Local Panchayats: Three bio-mass gasifiers at Odanthurai Panchayat, 9 KW capacity, Nellithurai Panchayat 9 KW and Kadachanallur Panchayat 40 KW are now in operation.

i. ODANTHURAI PANCHAYAT, COIMBATORE DISTRICT

Odanthurai Panchayat installed a 9kW biomass gasifier power generation system to substitute the grid electricity usage for pumping of drinking water supply system. The biomass gasifier system saves about 70% of pumping cost compare to using grid electricity. This panchayat also has other renewable energy projects such as solar street lighting and biogas using human and domestic animal excrement. The biogas system is connected to each house for cooking purpose. People do not use firewood. Panchayat is purchasing waste wood from a saw mill in the village at very low price of Rs. 0.3/kg for the fuel of the gasifier. No demand of waste wood for cooking purpose might contribute the very low price. Total energy planning rather than just electrification can improve the efficiency.

ii. NELLITHURAI PANCHAYAT, COIMBATORE DISTRICT

This is almost same installation with Odanthurai Panchayat. The difference is that Nellithurai Panchayat operate the gasifier during the night to supply power for 90 street lights to maximize the plant capacity factor. There were street light connected to grid electricity but the panchayat stopped using them and installed new street lights connected to the gasifier system. Electricity Board (EB) does not allow small IPP (< 1 MW) to supply electricity in the area connected to grid therefore the idea of street lighting is adopted. The cost for water pumping and street lights used to be about Rs. 20,000 per month but the cost reduced to Rs. 6,000 per month after installation of biomass gasifier system.

iii. PALLIPALAYAM PANCHAYAT, ERODE DISTRICT

Pallipalayam Panchayat has installed 40 kW gasifier systems for water supply system. The system is almost same as other two installations shown above except the plant capacity. They purchase fuel wood from village people. The species are mainly wild grown *Prosopis juliflora*. No planting activities have been conducted.

2.3.4.4. BIOMETHANATION PLANT

A combustible gas (composed primarily of methane) produced when Organic waste, sewage or manure is fermented in the absence of oxygen. The solid material that remains in the digester after fermentation can be used as an organic fertilizer.

Biogas – a gas mixture of methane, carbon dioxide and small quantities of hydrogen and hydrogen sulphide – is created under air exclusion through the fermentation of organic substances with microorganism assistance. Biogas is a gas mixture, consisting of approximately 40 to 75 % methane (CH_4), 25 to 60 % carbon dioxide (CO_2), and approx. 2 % of other gases (hydrogen, hydrogen sulphide and carbon monoxide).

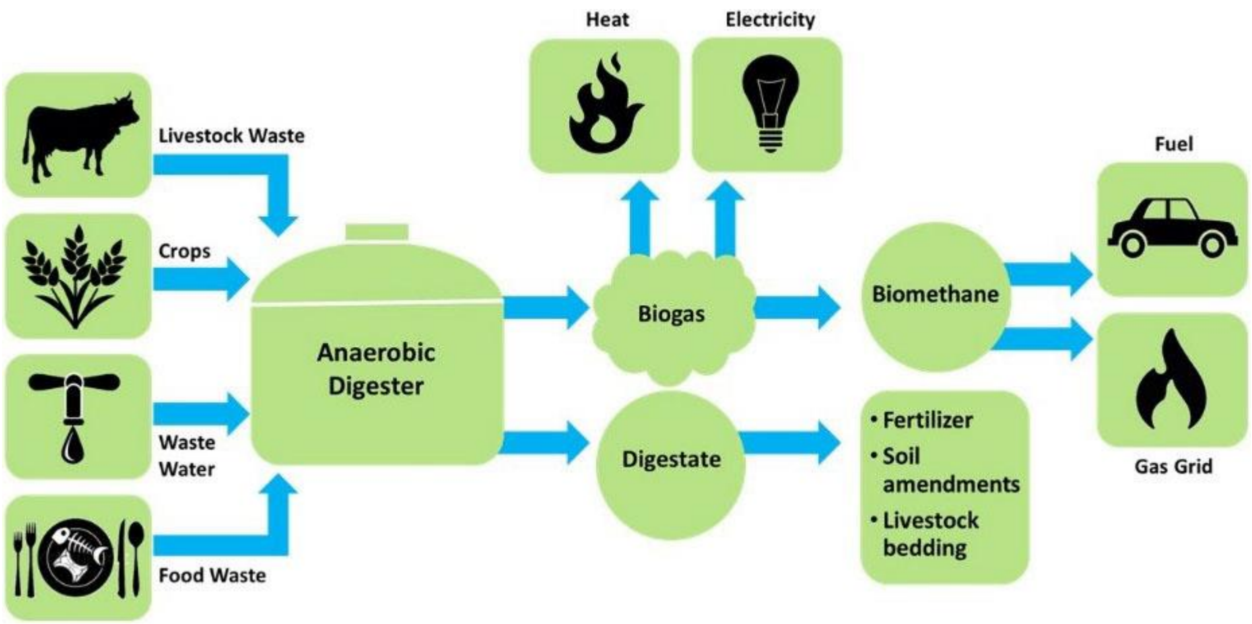


Figure 23: Process flow of Biomethanation plant

Biomethanation means a process which entails enzymatic decomposition of organic matter by microbial action to produce methane rich biogas. It is the process of creating energy in the form of electricity or heat from the incineration (the combustion of organic material such as waste) of waste source. Waste to energy is a form of energy recovery. Most Waste to energy processes produce electricity directly through combustion or produce a combustible fuel commodity such as methane, methanol, ethanol or synthetic fuels.

Municipal Solid Waste consists of 50-60% of bio-degradable matter and the rest is recyclables and inerts. Of the total biodegradable waste generated, approximately 20%–25% of waste comes from bulk waste generators viz., Hotels, Restaurants, Marriage Halls, Vegetable Markets, Slaughter Houses etc., Chennai Metropolitan Development Agency (CMDA) has installed a 250 KW Vegetable Waste based power plant at Koyambedu Whole sale Vegetable Market in Chennai.

ADVANTAGES OF BIOGAS

- No smoke , Clean Fuel
- Produces organic manure for a sustainable agriculture
- It reduces fossils fuels Dependency

Table 30: Major Biogas Plants in Tamil Nadu connected to TANGEDCO

S.No	Name of the Biogas plant	Capacity MW	Fuel Used
1	M/s.C.M.D.A., Koyambedu Veg. Market Bio-metharation plant, Chennai	0.25	Vegetable waste (Biogas generated from Biomethanation of veg. waste)
2	M/s. IOT Mabagas Ltd., Namakkal	2.4	Chicken litter, Sugar, Starch Industrial waste, Cow Dung
3	M/s. Shubashree Bio Energy Pvt Ltd	4	Poultry waste
4	M/s. G.K.Bio Energy Pvt Ltd	1.5	Poultry waste
	TOTAL CAPACITY	**8.15**	

C.M.D.A., KOYAMBEDU VEG. MARKET BIO-METHANATION PLANT: The Koyambedu Wholesale Market Complex was made by CDMA to decongest the central business district of Chennai city and to facilitate trading of perishables items like vegetables, fruits and flowers. It has developed over an area of 60 acres with good infrastructural facilities to attract traders and consumers. This Market Complex being one of the largest in Asia generates large quantity of organic wastes. The plant is located in Koyambedu vegetable market, Chennai. Organic wastes from Koyambedu market is converted in biogas, the gas is used to generates power for bio gas. The plant was commissioned late in 2005. About 30 tonnes of green waste daily is sufficient to produce 0.25 MW. Some 40 per cent of this power is used to keep the plant running and the remainder be exported to the TANGEDCO grid.

GK BIO-ENERGY PVT LTD : GK Bio-Energy Pvt Ltd is located in Namakkal district, Generated biogas form poultry waste. Biogas is used for power production of 1.5 MW and organic waste is converted in to organic manure.

IOT MABAGAS (IOTM): IOT Mabagas (IOTM) currently operates a 2.4 MW biogas to power plant in Namakkal. The plant is based on mixed feed stock like chicken litter, sugar and starch industry wastes and cow dung. The plant also produces high nutrient compost as a bi-product which is marketed as **Aishwaryam**, an organic fertilizer.

SUBHASHRI BIO ENERGIES (P) LTD. (SBEL): Subhashri Bio Energies (P) Ltd is a division of the Subhashri group of companies, Tiruchengode, India had metamorphosed into a knowledge leader in organic regeneration and energy independence arena. With the commissioning of its 4 MW power generation plant cum organic agri-inputs production facility, developed indigenously, SBEL presents urban and rural societies with a bi-noble services such as Bio-gas as primary fuel for power and **PAVEL** Processed Organic Manure that is weed seeds free, pathogens free, to which is added organic additives to give a world class organic manure product

Figure 24: Biomethanation plant at Koyambedu Vegetable Market, Chennai

Advantages

1. The quantity of wastes is reduced by nearly 60%-90%, depending upon the waste composition and technology adopted
2. With less wastes to dispose of the demand of landfills is reduced, thereby saving land, which is already scarce in cities
3. Environmental pollution is reduced
4. Energy is obtained from the waste.
5. The slurry produced by biomethanation technology serves as a good fertilizer.

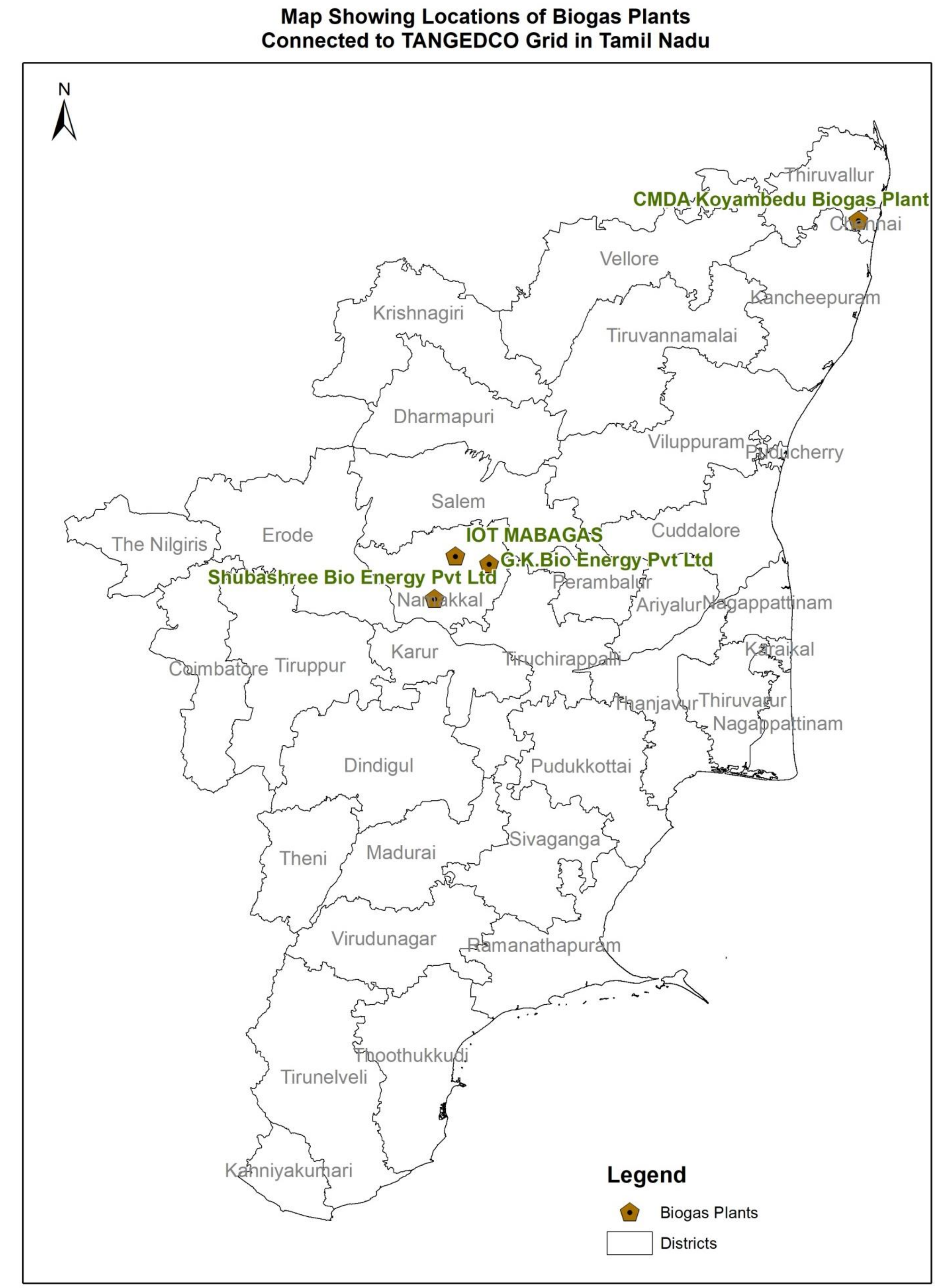


Figure 25: Map Showing BioGas/Biomethanation Power Plants connected to TANGEDCO Grid

Table 31: Other Biogas Plants in Tamil Nadu

S.No	Name of the Developer	Location	Fuel Used	Biogas generated m3/ day	Capacity (MWeq.)
1	M/s Sri Velmuragan Sago Factory,	Malaiyalapatty, Perambalu	Tapioca starch industry waste	2,600	0.22
2	M/s Palaniandavar Sago Factory,	Paithur, Attur Tk, Salem	Tapioca starch industry waste	3,177	0.26
3	M/s Sri Krishna Industrial Starch Factory,	Gangavalley, TK, Salem	Tapioca starch industry waste	5,068	0.42
4	M/s R.S. Sago Factory R. Selraj & Co.	Siteri, Attur, TK, Salem	Tapioca starch industry waste	3,755	0.31
5	M/s Mappilai Sago Factory,	Siteri, Attur, TK, Salem	Tapioca starch industry waste	2,020	0.17
6	M/s Varalakshmi Company	Kommapalayam, Rasipuram, Namakkal	Sago starch industry waste	20,160	1.68
7	M/s SPAC Starch Products (India) Ltd	Poonachi Village, Anthiyur Tk, Erode District	Starch Industry Effluent	7,200	0.60
8	Biogas generation project using tannery flushing and sludge	Melvisaram,	Tannery fleshings and sludge.	300	0.03
9	M/s Varalakshmi Starch Industries Ltd.	Salem,	Tapioca processing industry waste water	6,000	0.50
10	M/s Tamil Nadu Newsprints and Papers Ltd.	Karur	Paper mill effluents.	15,000	
11	M/s Varalakshmi Starch Industries Ltd.	Salem	Starch industry waste	12,000	1.00
12	M/s Varalakshmi Company	Mallur, Salem, Distt. Namakkal,	Starch industry waste	9,000	0.75
13	M/s Spac Tapioca Products (India) Ltd.	Poonachi Bhavani TK , Erode,	Tapioca starch industry waste	12,000	1.00
14	M/s Anbu Rice, Oil & Sago Factory	Ammampalayam P.O., Attur Tk., Salem.	Tapioca starch industry waste	2,890	0.24
15	M/s Sri Velmurugan Sago Factory	Oduvankurichi Post, Rasipuram Taluk, Namakkal	Tapioca starch industry waste	2,890	0.24
16	M/s Sri Senthil Kumar Sago Factory	Thimmanaickenpatty, Rasipuram Taluk, Namakkal.	Tapioca starch industry waste	2,890	0.24
17	M/s Vetrivel Sago Products	Vellakkalpatti Post, Rasipuram Taluk, Namakkal.	Tapioca starch industry waste	2,890	0.24

S.No	Name of the Developer	Location	Fuel Used	Biogas generated m3/ day	Capacity (MWeq.)
18	M/s Sri Thirumalaivasan Sago & Starch Products	Toppapatty, Rasipuram Taluk, Namakkal	Tapioca starch industry waste	2,890	0.24
19	M/s Sri Venkateswara Sago & Starch Products	O. Jedarpalayam Post, Rasipuram Taluk, Namakkal	Tapioca starch industry waste	2,890	0.24
20	M/s M.R. Samy Sago Factory	Tammapatty Gangavalli Tk., Salem	Starch industry waste	2,890	0.24
21	M/s Murugan Sago Factory,	K. Palanivel Gounder & Co., Ulipuram, Gangavalli Tk., Salem	Starch industry waste	3,396	0.283
22	M/s Vetrivel Sago Factory,	Ulipuram Pudur, Gangavalli Tk., Salem	Starch industry waste	1,992	0.166
23	M/s Annai Sago Factory	Ulipuram, Gangavalli Tk., Salem	Starch industry waste	1,992	0.166
24	M/s Sri Soorya Sago Factory	Echampatty, Attur Tk., Salem	Starch industry waste	1,992	0.166
25	M/s Jayamurugan Sago Factory,	Kopampatty, Thuraiyur Tk., Namakkal,	Starch industry waste	288	0.24
26	M/s Ganesa Samy Sago Factory,	Ariyagoundampatty Namgiripet, Rasipuram Tk., Namakkal,	Starch industry waste	3,960	0.33
27	M/s Sri Venkateswara Sago Factory	Namgiripet, Rasipuram Tk Namakkal	Starch industry waste	2,496	0.208
28	M/s Varalakshmi Starch Industries Ltd.	Salem.	Starch industry waste	13,000	3.28
29	M/s Varalakshmi Starch Industries Ltd.	Varalakshmi Starch Industry Ltd., allur,Salem, Tamilnadu	Waste water treatment plant at Sago manufacturing	--	0.20
30	M/s Trichi Distillers & Chemicals Ltd.	Senthannipuram, Tiruchirapalli	Distillery waste	--	1.40

GOI, Ministry of Energy, 2018

3. POWER SUPPLY POSITION OF THE STATE

The State Government owned TANGEDCO generates from Coal and Natural Gas based thermal power plants, Hydel power stations. TEDA promotes renewable energy generation through installation of wind mills, solar plants, Biomass and Biogas plants. Apart from their own capacity, TANGEDCO purchased energy from private power companies to meet the demand. Tamil Nadu also receives an assigned share of the installed capacity of Central sector power projects in Tamil Nadu as well as in neighbouring States. The thermal stations viz., Neyveli – and II, Ramagundam (Andhra Pradesh), Talcher Stage II, Simhadiri II, Vallur and the two nuclear projects viz., Madras Atomic Power Project and Kaiga (Karnataka).

Table 32: Year wise installed capacity and TANGEDCO Power Generation capacity, Power Purchase and Per capita consumption

S.No	Year	Installed capacity (MW)	TANGEDCO Generation (MU)	Purchases (MU)	Per Capita Consumption (KWH)
1	2003-04	9319	24114	25599	780
2	2004-05	9531	26450	25895	815
3	2005-06	10031	26915	29812	860
4	2006-07	10098	29481	34208	960
5	2007-08	10122	29241	37608	1000
6	2008-09	10214	28983	38093	1000
7	2009-10	10214	27860	45027	1080
8	2010-11	10237	25639	50433	1040
9	2011-12	10364	27942	48592	1065
10	2012-13	10515	25301	49571	1011
11	2013-14	11884	31276	58518	1196
12	2014-15	13231	34569	59559	1228
13	2015-16	17976	34709	64982	1280
14	2016-17	18733	29223	76505	1340

(Source: DES, GoTN, 2008-2018)

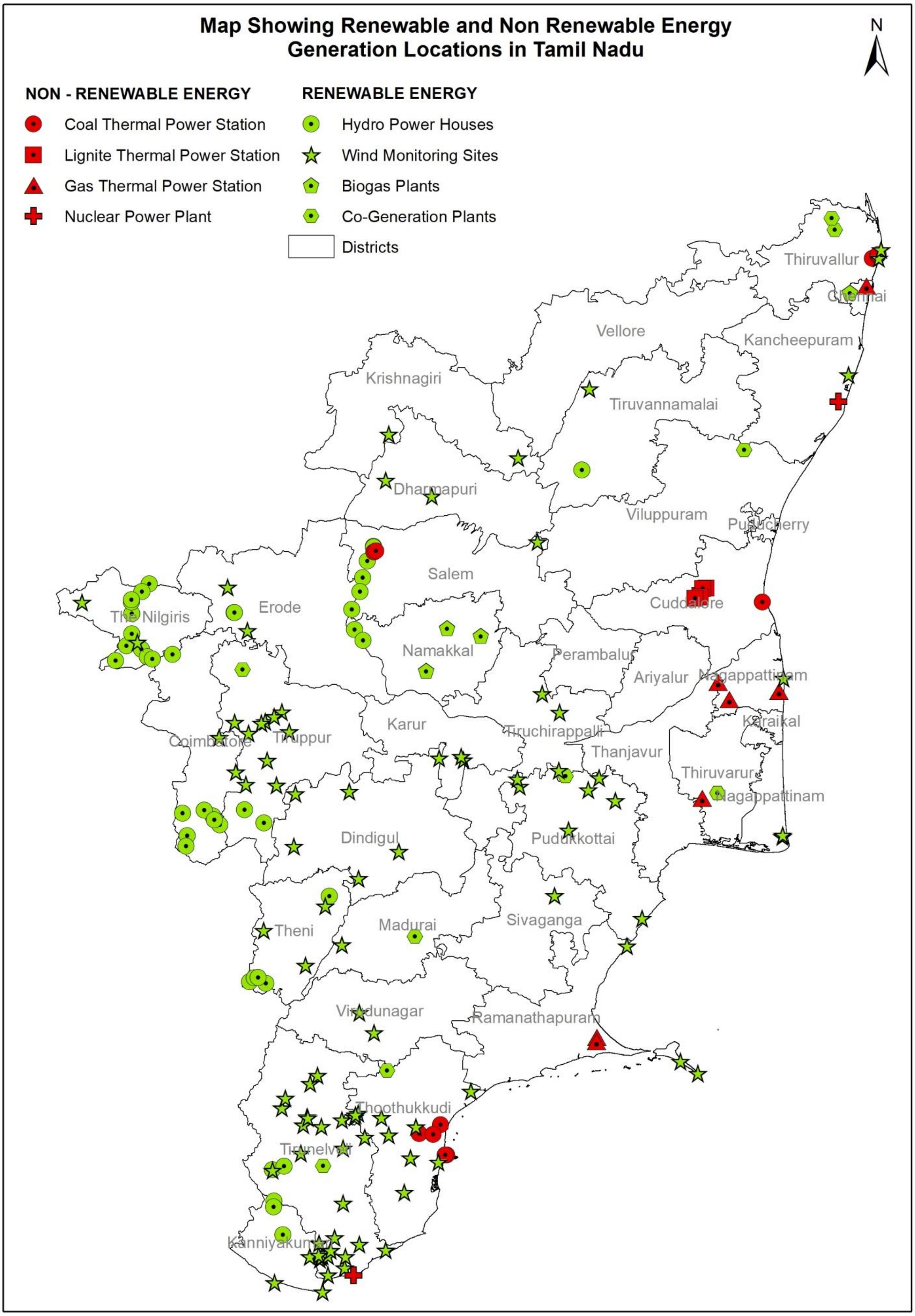


Figure 26: Location Map Showing Renewable and Non-Renewable Energy Generation in Tamil Nadu

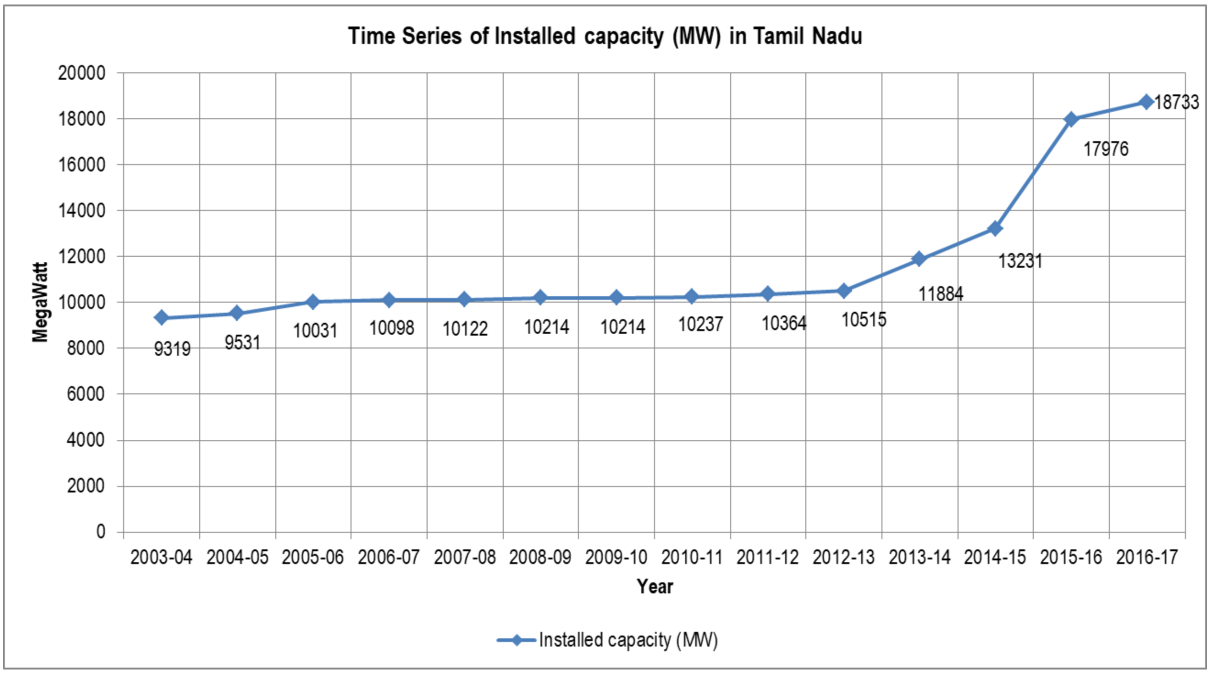


Figure 27: Graph shows the trend of installed capacity in Tamil Nadu

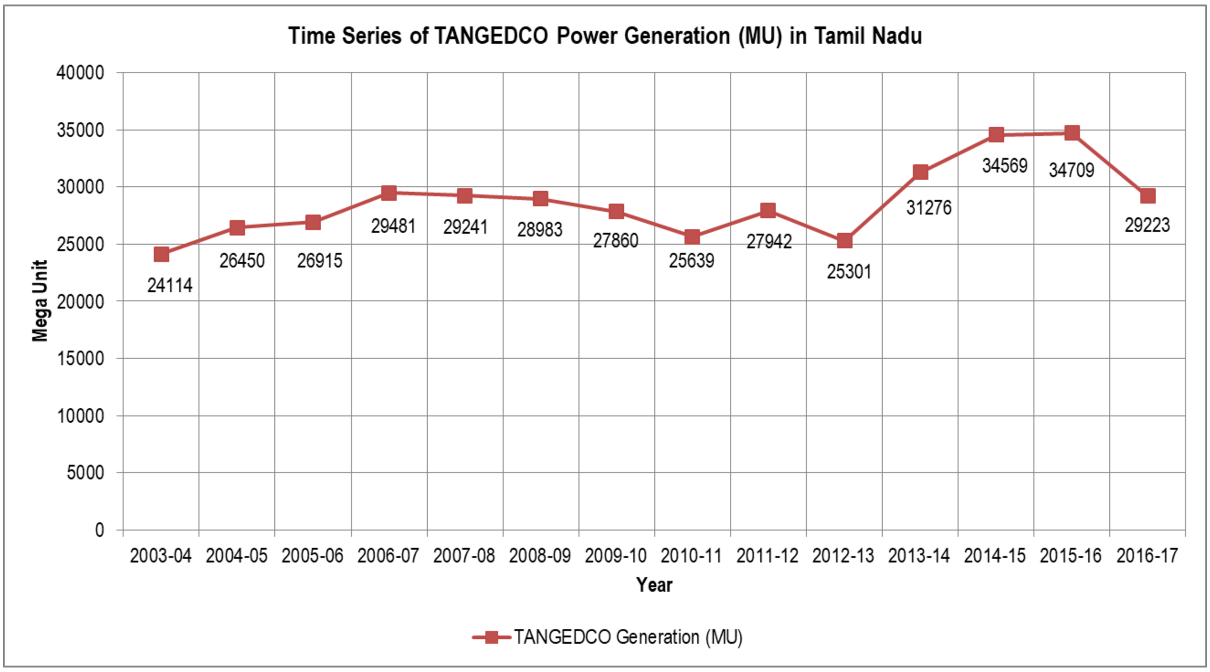


Figure 28: Graph shows Power Generation capacity in Tamil Nadu

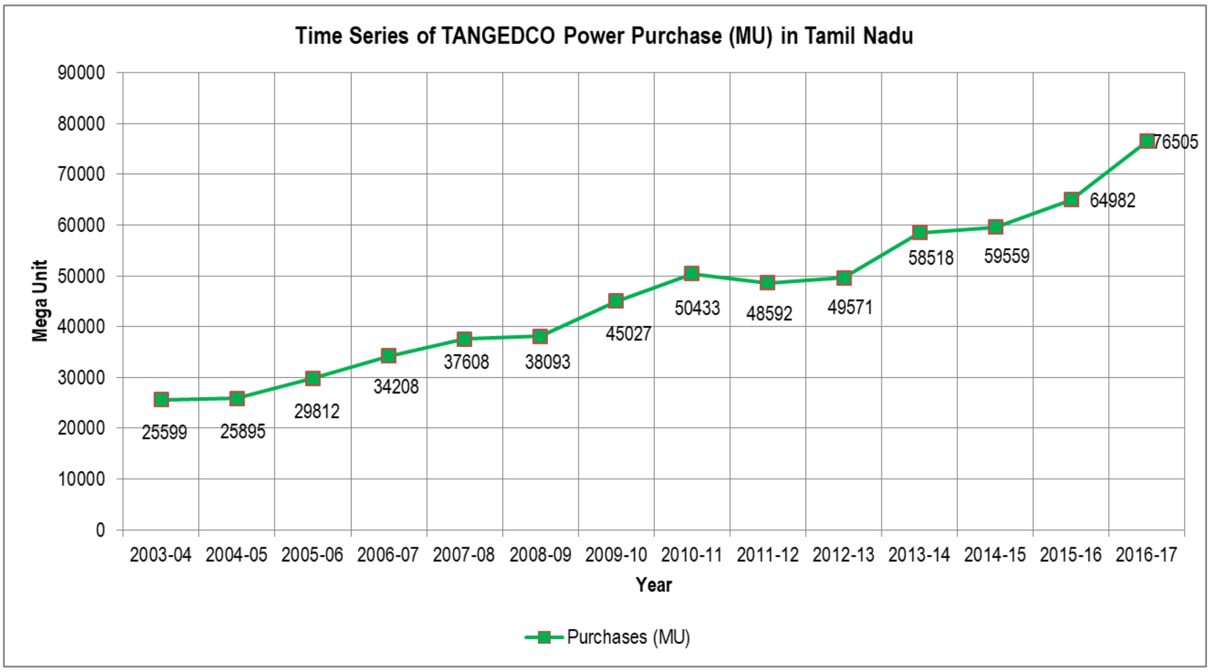


Figure 29: Graph shows Power Purchased from private companies

Table 33: Plant wise allocation from Central Generation Scheme

Name of the Plant	State	Plant Type	Installed Capacity (MW)	Allocated Capacity (MW)	Percentage Share to Tamil Nadu
Ramagundam Station I, II and III	Andhra Pradesh	Thermal	2,600	663	26
Talcher Station II	Odisha	Thermal	2,000	490	25
Simhadri STPS St II, Unit – I and II	Andhra Pradesh	Thermal	1,000	223	22
NLC TPS - I	Tamil Nadu	Thermal	600	473	79
NLC TPS – II, Unit I	Tamil Nadu	Thermal	630	190	30
NLC TPS – I, Unit II	Tamil Nadu	Thermal	840	284	34
NLC TPS – I Expansion	Tamil Nadu	Thermal	420	228	54
NLC TPS – II Expansion Unit – I and II	Tamil Nadu	Thermal	500	271	54
Vallur STPS Unit – I, II and III	Tamil Nadu	Thermal	1,500	1,067	71
NTPL Tuticorin Unit I and II	Tamil Nadu	Thermal	1,000	415	42
Madra Atomic Power Station	Tamil Nadu	Nuclear	440	331	75
Kaiga Atomic Power Station	Karnataka	Nuclear	440	228	52
Kudankulam Nuclear Power Project	Tamil Nadu	Nuclear	1,000	563	56
ER plants		Thermal		35	
		Total	**12,970**	**5,463**	**42.12**

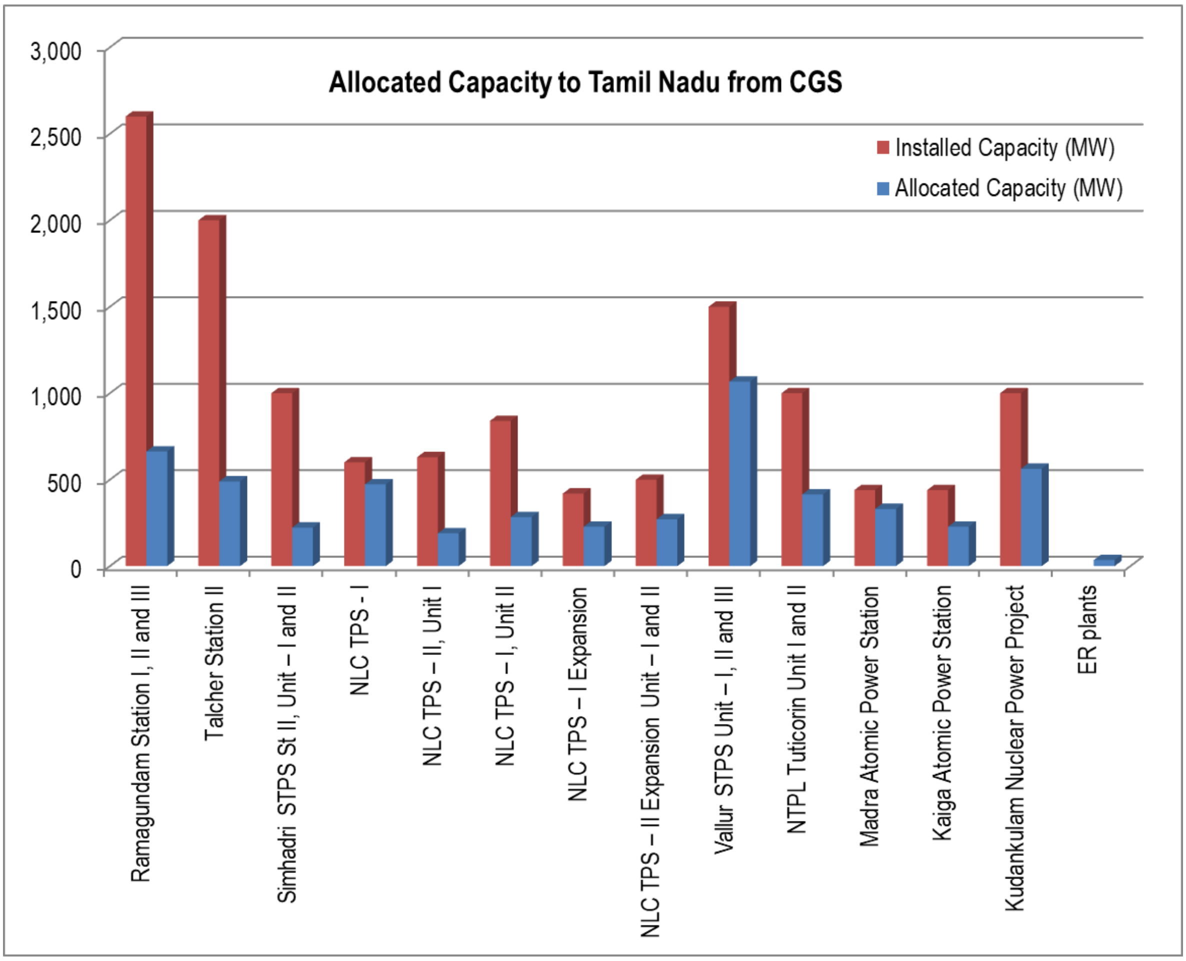


Figure 30: Graph shows Allocation of energy from installed capacity from Central Generation Scheme

4. NON-RENEWABLE ENERGY SECTOR SCENARIO IN DISTRICT WISE

Non-renewable energy sources such as Coal, Lignite, Gas, Oil and Nuclear are used generate electricity in Tamil Nadu. The coal based thermal power plants are located in the coastal districts such as Thiruvallur and Thoothukudi. The important reasons are location of major ports to import coal from other countries and also requires huge amount of water for cooling purpose. The only inland coal power plant in Tamil Nadu is located in Mettur, Salem District. Ennore and North Chennai Thermal Power Plans are Located in Thiruvallur District. Thoothukudi Thermal Power Plant Station is located in Thoothukudi District. Neyveli Thermal Power Station – I, Neyveli Thermal Power Station – II, Neyveli Thermal Power Station – I Expansion and Neyveli Thermal Power Station – II Expansion are lignite based power plants are located at Neyveli, Cuddalore district; the plants are located close to lignite mines in Neyveli. There are four natural gas based power stations operated by TANGEDCO are located in Tamil Nadu. Natural Gas based power plants are located in Cauvery Delta Region district Nagapattinam, Thanjavur and Thiruvarur and other potential locations for natural gas are Pudukkottai and Ramanathapuram. There are two nuclear power plants in located in Tamil Nadu, MAPS in Kalpakkam, Kancheepuram district and KKNPP in Kudankulam, Tirunelveli District.

The amount of electricity generated from Non –renewable energy resources are addressed in the chapter.

Table 34: Non-renewable energy generated by TANGEDCO and NPCIL

Year	Coal based Thermal Power Net Generation in MU	Gas based Thermal Power Net Generation in MU	Nuclear Power Generation in MWe
2007-2008	19480.884	1335.992	1064.119
2008-2009	19180.672	2415.49	903
2009-2010	18040.669	2178.03	1259.166
2010-2011	17357.122	1343.214	1398.218
2011-2012	18586.617	2099.308	1604.076
2012-2013	18548.677	1602.395	1774.498
2013-2014	NA	NA	NA
2014-2015*	25079.75	1840.313	3743.624
2015-2016	26072.576	1562.357	3129.536
2016-2017	22964.357	1335.992	6433.453

* Additional generation in nuclear power from KKNPP

NA – Data Not Available

4.1. COAL POWER GENERATION AND INSTALLED CAPACITY

Table 35: District wise Coal Power Energy Generated in Tamil Nadu

District	**Thiruvallur**						**Thoothukudi**		**Salem**				**Net Generation (MU)**
Thermal Power Station	**Ennore TPS**		**NCTPS**		**NCTPS Stage II**		**TTPS**		**MTPS**		**MTPS Stage II**		
Year of Operation	1970		1994		2013		1979-1991		1990		2013		
	Installed Capacity	Generation MU	Installed Capacity	Generation MU	Installed Capacity	Generation MU	Installed Capacity	Generation MU	Installed Capacity	Generation MU	Installed Capacity	Generation MU	
2007-2008	450 MW	1754.629	630MW	4242.644	-	-	1050MW	7336.422	840MW	6147.189	-	-	19480.884
2008-2009	450 MW	7567.85	630MW	1524.279	-	-	1050MW	5835.771	840MW	4252.772	-	-	19180.672
2009-2010	450 MW	1217.937	630MW	4411.067	-	-	1050MW	6543.42	840MW	5868.245	-	-	18040.669
2010-2011	450 MW	1175.988	630MW	4109.999	-	-	1050MW	6522.577	840MW	5548.558	-	-	17357.122
2011-2012	450 MW	744.147	630 MW	4300.947	-	-	1050 MW	7261.89	840MW	6279.633	-	-	18586.617
2012-2013	450 MW	610.232	630 MW	4633.506	-	-	1050 MW	7620.485	840MW	5684.454	-	-	18548.677
2013-2014	340 MW	NA	630 MW	NA	600MW	NA	1050 MW	NA	840MW	NA	600MW	NA	NA
2014-2015	340 MW	485.136	630 MW	3864.434	1200MW	5187.079	1050 MW	7043.332	840MW	5697.399	600MW	2802.37	25079.75
2015-2016	340 MW	347.36	630 MW	4046.394	1200MW	6031.957	1050 MW	6501.373	840MW	5471.328	600MW	3674.164	26072.576
2016-2017	340 MW	144.158	630 MW	3365.746	1200MW	5912.396	1050 MW	5089.655	840MW	5239.703	600MW	3212.699	22964.357

4.2. GAS TURBINE GENERATION AND INSTALLED CAPACITY

Table 36: District wise Gas Power Energy Installed Capacity and Net Generation by TANGEDCO

District	Gas Power Station	Installed Capacity	Year of Operation	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2016-2017
Chennai	BBGTPS	120	1996	60.9914	176.56	79.16	49.534	26.973	-2.1702	NA	2.0175	10.469
Thiruvarur	TKGTPS (Kovilkalapal)	107.880	2001	640.2768	660.94	487.2	605.037	663.277	678.372	NA	372.6797	308.967
Ramanathapuram	VGTPS	95	2003	571.6437	897.12	1008.89	529.853	618.344	421.6841	NA	658.0663	647.254
Ramanathapuram	VGTPS Phase II	92	2008	NA	NA	NA	0	408.299	455.0372	NA	355.0041	259.74
Nagapattinam	KGTPS	101	2004	63.0801	680.87	602.78	158.79	382.415	49.472	NA	452.545	335.927
Total				**1335.992**	**2415.49**	**2178.03**	**1343.214**	**2099.308**	**1602.3951**	**NA**	**1840.3126**	**1562.357**

Table 37: District wise Gas Power Energy Installed Capacity by Private Companies

District	Name of the Power Station	Agency	No of Units	Capacity (MW)	Date of Commissioning
Nagapattinam	PPN Power Generating Company Pvt. Ltd	Private	1	330.50	04/2001
Thanjavur	Lanco Tanjore Power Company ABAN	Private	1x67.8 + 1x51.2	119.00	08/2005
Ramanathapuram	Arkay Energy Ltd.(PENNA)Pioneer	Private	-	150.00	-
			Total	**599.50**	--

Table 38: District wise Gas Power Energy Installed Capacities of Captive Co-generation Plants

District	Name of the Captive Co-Generation Generation Plant	Installed Capacity in MW	Fuel	Date of Synchronization	EDC/ Voltage level
Thiruvarur	M/s. SEDCO	7.98 MW (2x2.74+ 1x2.5)	Natural gas	14.12.98	Thiruvarur EDC/33 KV
Nagapattinam	M/s. MMS Steel & Power Pvt. Ltd. (Koilkalappai)	6.12 (2x3.06)	Natural gas	19.9.06	Thiruvarur EDC/33 KV
	Total	14.1			

4.3. OIL BASED POWER GENERATION

Table 39: District wise Oil based Power Energy Installed Capacities of Captive Co-generation Plants

District	Name of the Captive Co-Generation Plant	Installed Capacity in MW	Fuel	Date of Synchronization	EDC/ Voltage level
Tiruppur	M/s Jagannath Textile Company Ltd	5.4 (2x2.7)	Diesel / HFO	01.12.06	Coimbatore / South EDC/ 33 KV
Viruthunagar	M/s Loyal Textile Mills ltd,	4.1	HFO	30.04.10	Tuticorin EDC 11 KV
Madurai	M/s Thiagraja Mills Ltd	3.08	Diesel / FO	28.06.99	Madurai/ Metro/MEDC 11 KV
	Total	12.58			

4.4. ATOMIC POWER GENERATION AND INSTALLED CAPACITY

Tamil Nadu Ranks First with Total Installed capacity of 2440 MWe of Nuclear power plants. The table below indicates the India's total nuclear power capacity installed.

Table 40: State wise Atomic Power Generation Statistics

State	Name of the Nuclear Power Station	Number of Units	Capacity (MWe)
Tamil Nadu	Kudankulam Nuclear Power Station (KKNPS)	2	2,000
	Madras Atomic Power Station (MAPS),	2	440
Maharashtra	Tarapur Atomic Power Station (TAPS)	4	1,400
Rajasthan	Rajasthan Atomic Power Station (RAPS)	6	1,180
Karnataka	Kaiga Generating Station (KGS)	4	880
Gujarat	Kakrapar Atomic Power Station (KAPS)	2	440
Uttar Pradesh	Narora Atomic Power Station (NAPS)	2	440
Grand Total		**22**	**6,780**

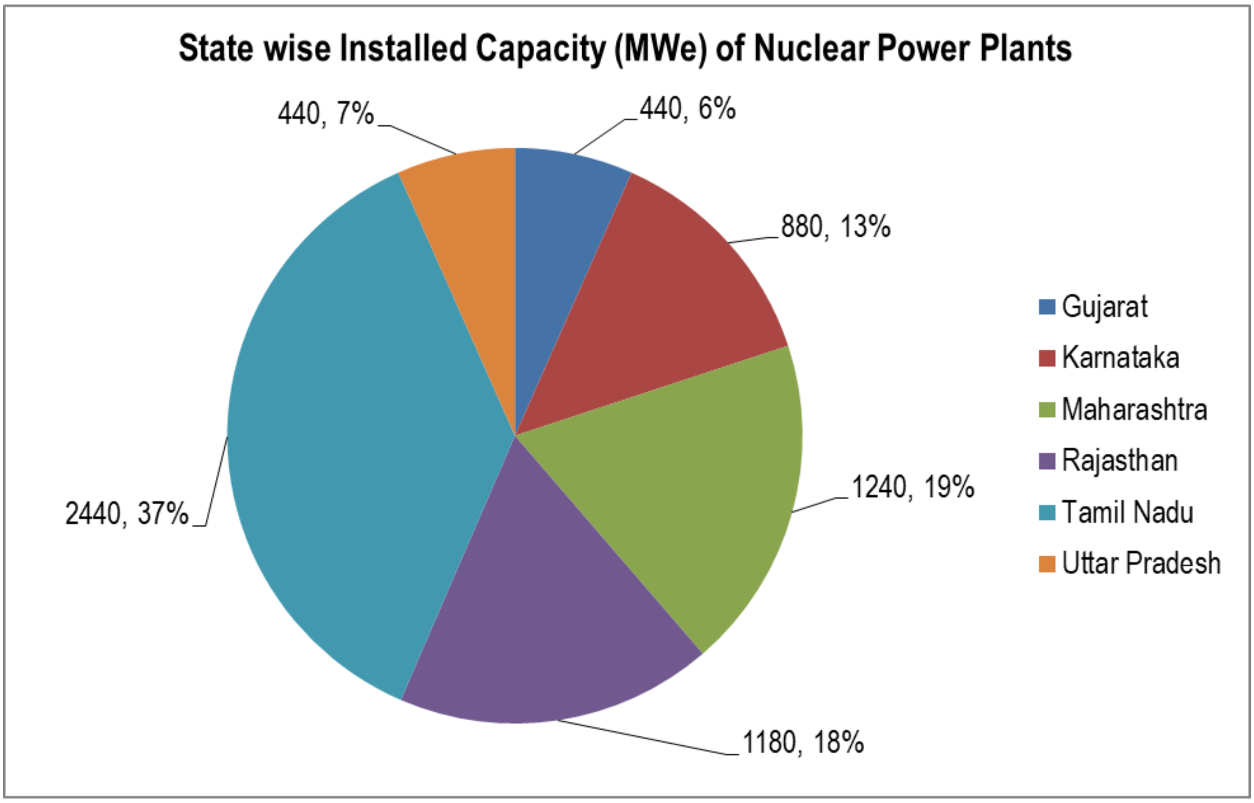


Figure 31: Graph shows State wise share of Installed capacity of Nuclear power plants

Table 41: District wise Atomic Power Generation Statistics

District	Kancheepuram	Tirunelveli
Nuclear Power Stations	Madras Atomic Power Station	Kudankulam Nuclear Power Project
Installed Capacity	440	2000
2007-2008	1064.119	NA
2008-2009	903	NA
2009-2010	1259.166	NA
2010-2011	1398.218	NA
2011-2012	1604.076	NA
2012-2013	1774.498	NA
2013-2014	NA	NA
2014-2015	1672.288	2071.336
2015-2016	2092.262	1037.274
2016-2017	2059.197	4374.256

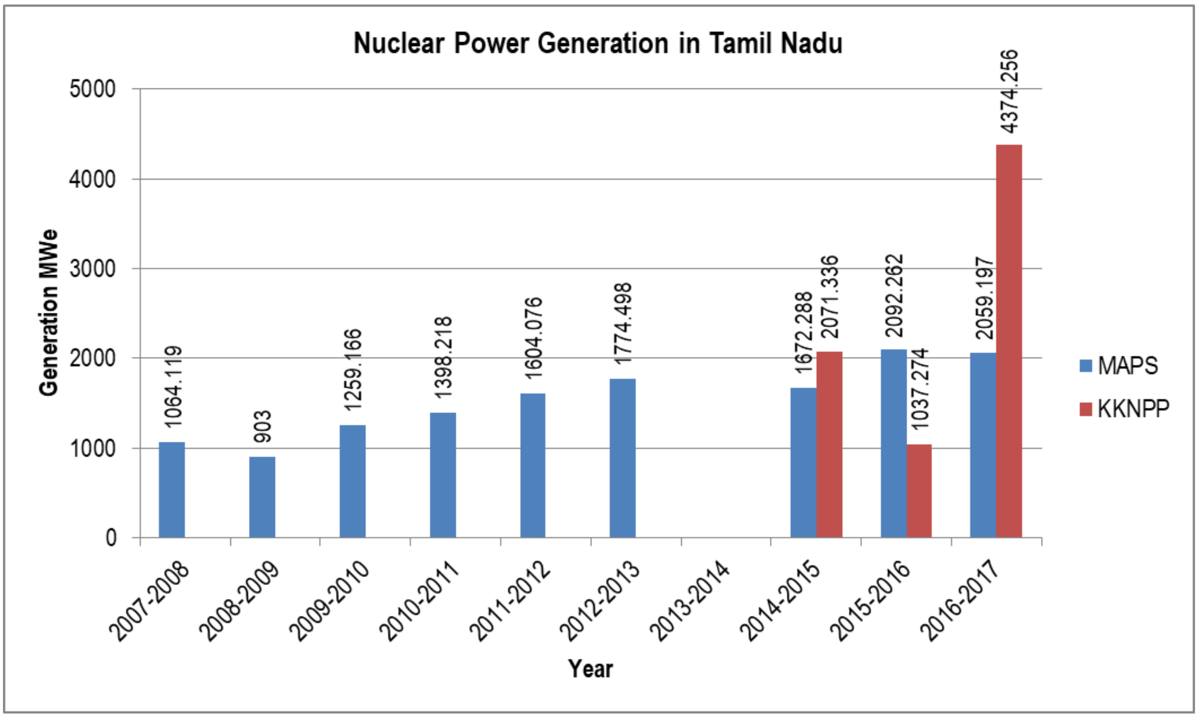


Figure 32: Comparison of Power Generation from Nuclear power plants in Tamil Nadu

5. RENEWABLE ENERGY SECTOR SCENARIO IN DISTRICT WISE

A 2018 report lists Tamil Nadu as one of the top nine renewable energy markets in the world. Today, 14.3 per cent of all the energy demand in the state is met by renewable energy, primarily solar and wind.

There is an ever increasing demand for energy in spite of the rising prices of oil & other fossil fuel / depletion of fossil fuels. Energy demand, in particular electricity production has resulted in creation of fossil fuel based power plants that let out substantial greenhouse gas / carbon emission into the atmosphere causing climate change and global warming.

The Government of Tamil Nadu is committed to mitigate the climate change effects by bringing out policies conducive to promote renewable energy generation in the State. The Government intends to make renewable energy a people's movement just like rain water harvesting.

The state is blessed with various forms of renewable energy sources viz., Wind, Solar, Biomass, Biogas, Small Hydro, etc. Municipal and Industrial wastes could also be useful sources of energy while ensuring safe disposal.

Renewable Energy (RE) sources provide a viable option for on/off grid electrification & wide industrial applications.

Table 42: Cumulative achievement of renewable energy up to 01.04.2019 (MW), TEDA

Renewable Energy Programme/ Systems	Cumulative achievement up to 01.04.2019 (MW)
Wind Power	8468.11 MW
Bagasse Cogeneration	721.40 MW
Biomass Power	265.59 MW
Solar Power (SPV)	2724.55 MW
Total	12179.65 MW

5.1. HYDRO POWER GENERATION AND INSTALLED CAPACITY

Table 43: District wise Hydel power Installed Capacity and Generation of Electricity

District	Name of Power House	Year of Operation	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
Nilgiris	Pykara Power House	1954	159.118	59.66	63.921	28.661	39.188	39.617	39.27	NA	38.452	56.153	12.498
Nilgiris	Pykara Micro Hydel	1989	9.875	5.92	9.61	5.467	5.827	3.691	3.617	NA	7.225	5.438	3.301
Nilgiris	PUSHEP	2005	471.268	388.84	557.302	428.72	354.187	195.094	193.409	NA	365.832	279.237	191.753
Nilgiris	Moyar	1953	179.514	131.79	210.967	154.911	131.116	78.017	77.468	NA	144.185	115.642	48.973
Nilgiris	Maravakandi Micro Hydel	1992	1.7	0.41	1.206	1.982	0.751	0.756	0.692	NA	0.539	0.971	0.321
Nilgiris	Kundah – 6 Parsons Valley	2000	53.04	40.98	65.136	39.18	35.704	30.172	30.012	NA	34.656	25.498	23.986
Nilgiris	Kundah 1	1964	346.071	284.1	278.018	255.092	217.451	181.296	180.589	NA	257.291	229.645	156.81
Nilgiris	Kundah 2	1964	903.016	753.07	733.422	655.977	577.02	453.954	453.174	NA	652.903	619.67	406.077
Coimbatore	Kundah 3	1978	547.769	437.52	435.921	387.923	348.08	264.472	262.836	NA	388.15	364.173	213.42
Coimbatore	Kundah 4	1978	225.389	137.58	166.705	136.84	156.401	71.097	70.831	NA	156.608	117.325	47.171

District	Name of Power House	Year of Operation	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
Nilgiris	Kundah 5	1988	92.968	67.59	84.981	60.416	52.941	43.129	42.719	NA	93.212	37.607	43.215
Salem	Mettur Dam	1946	151.845	90.25	82.26	94.637	153.204	83.313	83.051	NA	106.742	92.138	44.162
Salem	Mettur Tunnel	1966	592.407	452.62	388.628	265.371	470.726	120.242	119.77	NA	335.189	245.864	80.35
Salem	LMHEP Barrage 1	1987	94.001	102.6	80.066	70.981	107.585	46.64	45.877	NA	68.257	40.44	21.868
Salem	LMHEP Barrage 2	1988	94.026	101.82	75.79	65.978	101.612	41.082	40.366	NA	69.489	62.221	23.593
Erode	LMHEP Barrage 3	1987	91.487	103.39	76.443	66.531	105.481	40.75	39.69	NA	69.292	63.394	25.115
Erode	LMHEP Barrage 4	1988	72.832	87	62.456	56.162	83.949	30.851	30.098	NA	55.91	53.858	19.486
Erode	Bhavani Kattalai PH-1	2006	90.947	98.41	74.496	71.225	97.15	70.915	70.139	NA			
Erode	Bhavani Kattalai PH-2	2011	NA	NA	NA	NA	NA	NA	NA	NA	193.486	164.438	58.472
Erode	Bhavani Kattalai PH-3	2013	NA	NA	NA	NA	NA	NA	NA	NA			
Erode	Bhavani Barrage 2 PH	2012	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.42

District	Name of Power House	Year of Operation	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
Erode	Bhavanisagar RBC	1998	36.648	33.09	26.752	20.709	23.743	0.064	0.057	NA	18.897	7.164	-0.003
Erode	Bhavanisagar Micro Hydel	1990	46.248	44.74	36.629	32.98	41.442	16.178	16.067	NA	31.394	30.008	18.192
Coimbatore	Poonachi Micro	1992	1.501	0.189	3.376	4.496	1.444	1.696	1.662	NA	3.231	3.199	1.722
Tiruvannamalai	Sathanur Micro	1999	5.15	12.87	6.508	10.189	10.725	5.081	5.04	NA	0.987	10.705	0.41
Nilgiris	Mukuruthy Micro	2000	1.884	1.68	2.177	1.443	1.478	1.147	1.12	NA	1.825	0.289	0.262
Tiruppur	Thirumoorthi Micro	2000	6.065	5.92	3.131	3.799	3.208	1.964	1.938	NA	1.721	1.163	1.359
Coimbatore	Lower Aliyar	2002	10.766	10.91	7.779	8.533	8.638	4.022	3.975	NA	6.238	8.005	-0.013
Coimbatore	Amaravathy	2006	9.456	7.34	10.164	8.691	6.648	2.282	2.225	NA	6.104	4.845	0.77
Kanyakumari	Perunchani	2006	1.149	2.45	2.342	2.677	0.933	0.244	0.237	NA	-0.003	1.255	-0.013
Theni	Periyar	1965	290.242	451.96	394.754	428.739	533.254	179.084	177.928	NA	515.721	503.076	93.091
Theni	Vaigai Micro Hydel	1990	26.685	23.77	10.373	15.135	23.544	3.201	3.116	NA	15.434	17.935	1.654

District	Name of Power House	Year of Operation	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
Theni	Periyar Vaigai Micro I, II and III	2010	NA	NA	NA	1.039	7.867	1.862	1.807	NA	17.225	18.767	1.877
Theni	Suruliyar	1986	121.164	99.89	98.631	97.747	115.18	49.361	49.081	NA	102.916	92.035	41.918
Tirunelveli	Papanasam	1951	136.371	136.88	129.196	136.778	121.599	63.248	62.641	NA	117.374	115.745	65.709
Tirunelveli	Servalar	1987	47.166	34.51	26.047	38.84	27.099	9.604	9.546	NA	38.544	38.925	11.862
Coimbatore	Sakarapathy	1966	153.402	128.63	121.08	134.795	109.459	83.68	83.589	NA	134.139	79.113	63.188
Coimbatore	Aliyar	1970	183.201	152.22	165.692	162.921	173.908	76.68	76.231	NA	153.842	152.409	61.221
Tiruppur	Kadamparai	1988	453.928	291.77	496.719	568.952	506.532	302.063	297.304	NA	499.129	411.058	286.74
Coimbatore	Sholayar - 1	1971	374.615	235.08	287.043	355.208	216.967	145.446	145.081	NA	195.967	206.633	183.806
Coimbatore	Sholayar - 2	1971	63.936	65.55	63.524	56.962	60.96	56.529	56.358	NA	64.854	56.56	42.577
Kanyakumari	Kodayar - 1	1971	200.762	191.03	195.912	80.864	214.471	74.983	74.733	NA	135.601	192.269	126.797
Kanyakumari	Kodayar - 2	1971	83.774	89.48	83.168	64.172	81.255	31.436	31.289	NA	65.677	85.547	42.011
	Total Hydro Power Net Generation (MU)		**6431.386**	**5363.509**	**5618.325**	**5081.723**	**5328.727**	**2904.943**	**2884.633**	**NA**	**5164.235**	**4632.825**	**4632.825**

5.2. WINDMILL POWER GENERATION AND INSTALLED CAPACITY

Indian government has already set an ambitious target to achieve 175 gigawatt (GW) of renewable energy capacity by 2022. Keeping the target in mind, states have already started ramping up their installed solar and wind powered capacity. Tamil Nadu tops the list of states with the largest installed wind power generation capacity in the country. The state's total wind capacity at the end of 2018 stood at 8,631 Mw while its total installed electricity generation capacity stood at 30,447 Mw at the end of 2018, with wind sector's share at 28.34 per cent.

Table 44: District wise Wind Energy Installed Capacity in Tamil Nadu

S.No	District	Capacity (MW)
1	Tirunelveli	3,700
2	Thoothukudi	245.97
3	Kanyakumari	118.81
4	Ramanathapuram	2.15
5	Coimbatore	355.25
6	Tirupur	2,264.98
7	Dindigul	420.00
8	Theni	534.70
9	Chennai	0.22
	Total	**7642.09**

Solar Energy: The government of India has already set an ambitious target to achieve 100 gigawatt (GW) by 2022. Tamil Nadu ranks the fifth-highest installed solar power generation capacity in the country. The state's solar capacity at the end of 2018 stood at 2,055 MW. Tamil Nadu's total installed electricity generation capacity stood 30,447 MW at the end of 2018, with solar sector's share at 6.74 per cent. Karnataka (5,328 MW), Telangana (3,501 MW), Rajasthan (3,081 MW) and Andhra Pradesh (2,829 MW) ahead of Tamil Nadu in Solar power installation capacity.

Table 45: List of district wise Solar Power Installed Capacity in Tamil Nadu

S.No	District	Installed Capacity (MW)	Ownership
1	Sivagangai	11.55	Private
2	Nagapattinam	1.00	Private
3	Madurai	1.00	Private
4	Thoothukudi	28.00	Private
5	Coimbatore	7.00	Private
6	Tirupur	37.26	Private

7	Erode	4.00	Private
8	Viruthunagar	199.40	Private
9	Dindigul	59.6	Private
10	Tirunelveli	9.36	Private
11	Tiruchirappalli	166.00	Private
12	Vellore	5.00	Private
13	Karur	151.49	Private
14	Krishnagiri	0.75	Private
15	Ramanathapuram	348.00	Private
16	Perambalur	10.00	Private
17	Cuddalore	10.00	Private
18	Thiruvannamalai	30.00	Private
19	Pudukkottai	20.00	Private
20	Kanyakumari	1.00	Private
		1100.412	

Table 46: List of district wise Biogas Power Plant Capacity connected to TANGEDCO grid

District	Agency	Type	Capacity MW
Chennai	Chennai Metropolitan Development Agency	Bio gas from Vegetable waste	0.25
Namakkal	IOT MABAGAS	Chicken litter, Sugar, Starch, Industrial Waste	2.4
Namakkal	M/s. Shubashree Bio Energy Pvt Ltd	Poultry waste	4
Namakkal	M/s. G.K.Bio Energy Pvt Ltd	Poultry waste	1.5
		Total	**8.15**

6. ELECTRICITY CONSUMPTION

TANGEDCO has a consumer base of about 20 million consumers. 100% rural electrification has been achieved. The per capita consumption of Tamil Nadu is 1000 units.

Percentage of electricity consumptions by various sectors were calculated based on the times series data

- Industries (including Traction) - 37%
- Agriculture – 18%
- Domestic – 28%
- Commercial – 10%
- Public Lighting & Water Works – 2%
- Sale to other states-1%
- Miscellaneous – 4%

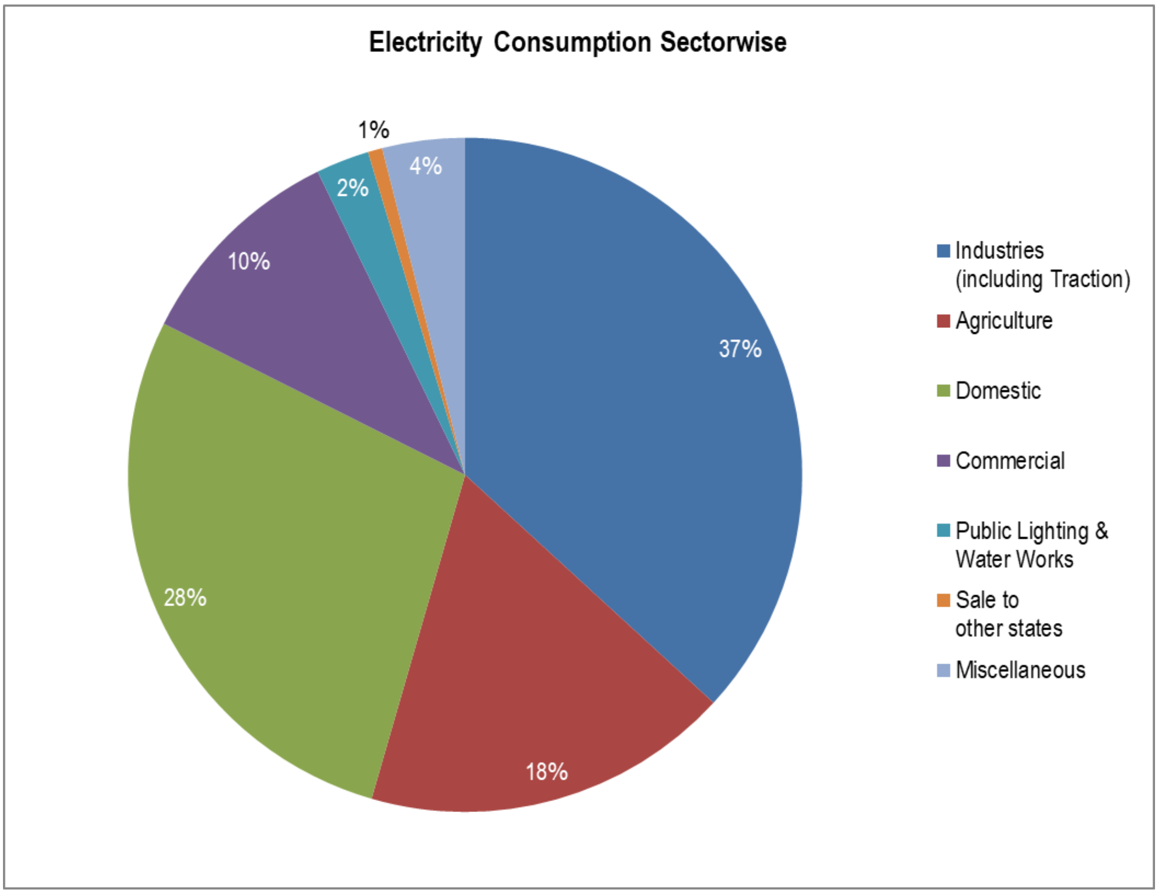


Figure 33: Sector wise Electricity Consumption in Tamil Nadu

Details of installed capacities of electricity generation in Tamil Nadu, year wise consumption of electricity, sector wise electricity consumptions are provided in the chapter

Table 47: Installed Electricity Generation Capacity in Tamil Nadu

Year	Installed Capacity MW	Annual gross generation MU	Purchase MU	Per capita consumption KwH
2007-08	10122	66848	37607	1000
2008-09	10214	66966	37984	1000
2009-10	10214	27860	45027	1080
2010-11	10237	25639	49351	1040
2011-12	10364	27942	49877	1065
2012-13	10515	25301	49571	1011
2013-14	11884	31276	58518	1196
2014-15	13231	34569	59559	_
2015-16	17976	34709	64982	_

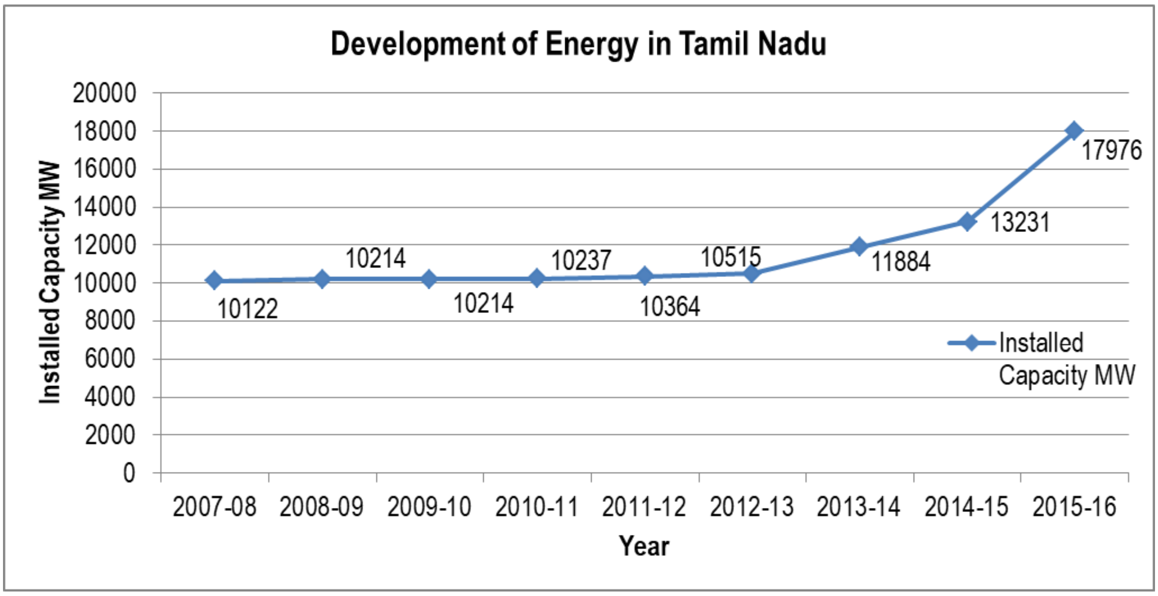


Figure 34: Time series graph shows Installed Electricity capacity in Tamil Nadu

Table 48: Sector wise consumption of electricity in Tamil Nadu

Year	Industries (including Traction)	Agri-culture	Domestic	Commercial	Public Lighting & Water Works	Sale to other states	Miscell-aneous	Total
2007-08	21100	10922	12997	5024	1331	521	1475	53370
2008-09	21029	10528	13294	5068	1353	712	1522	53506
2009-10	22790	11940	13709	5686	1043	420	1712	57300
2010-11	25622	12625	16312	4586	1592	429	731	61897
2011-12	22663	10425	16249	6498	1597	423	1897	59752
2012-13	19238	10091	18231	6851	1711	188	2500	58810
2013-14	15,606	12,301	20,201	7,123	1,917	_	3,717	60865
2014-15	28,790	12,406	21,990	8,394	2,110	_	3,138	79,464
2015-16	29,939	11,542	23,489	8,860	2,232	_	3,402	79,464
2016-17	31,872	11,733	24,530	9,300	-	_	5,585	83,020

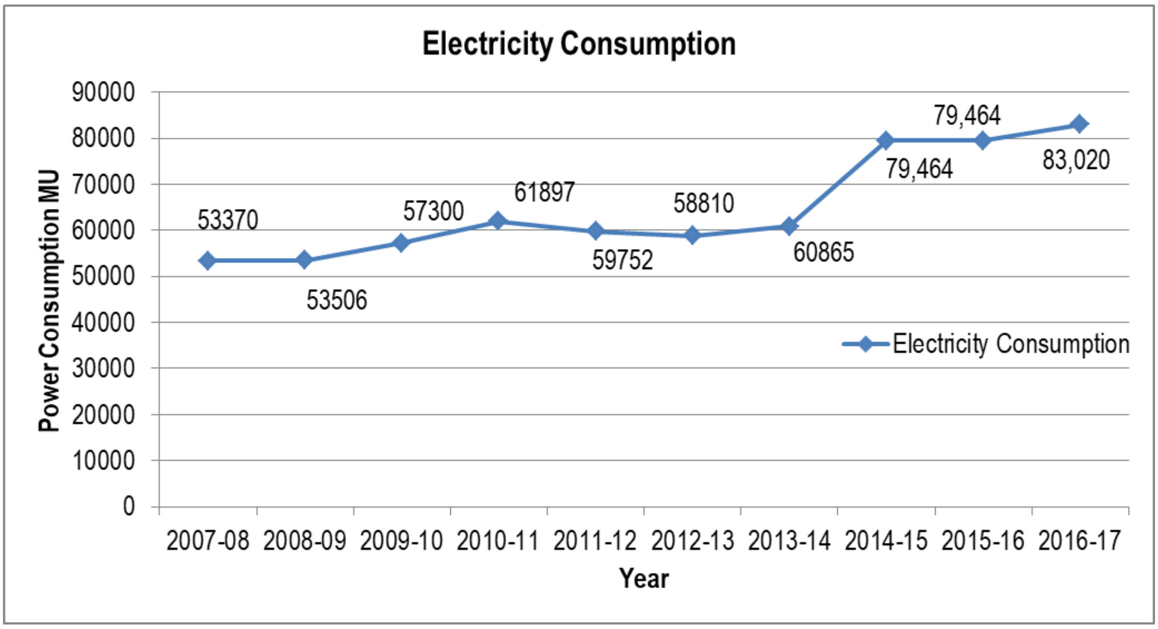


Figure 35: Time series graph shows Electricity Consumption in Tamil Nadu

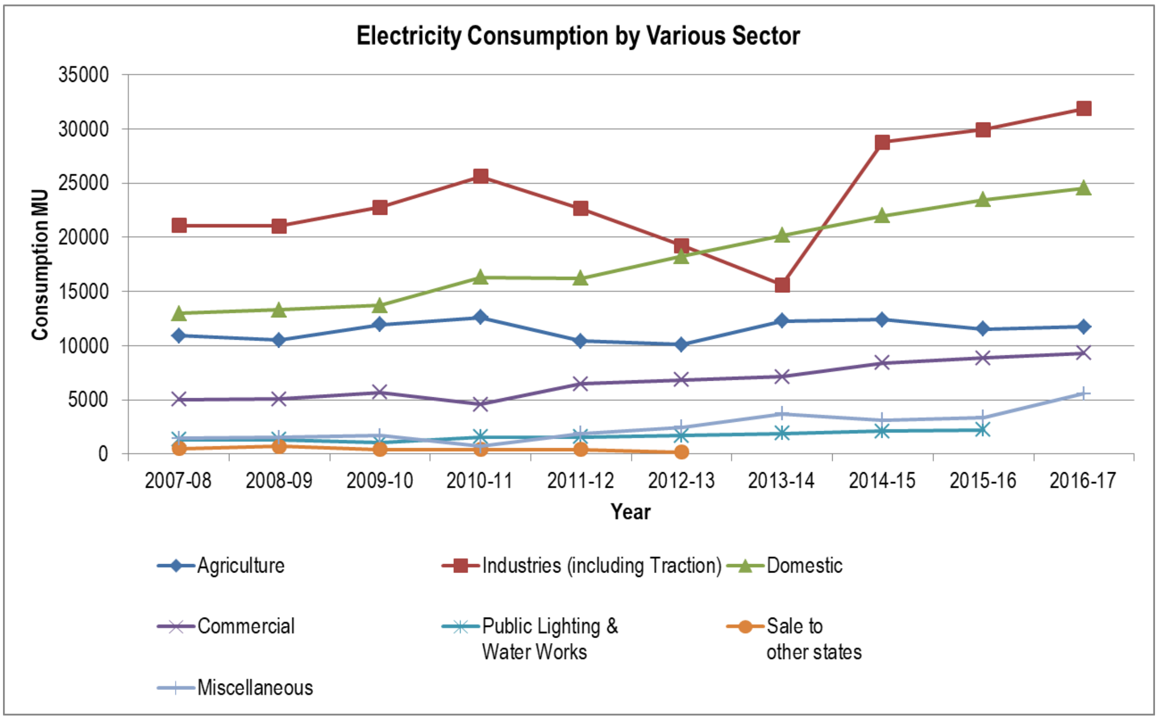


Figure 36: Time series graph shows Electricity Consumption by various sectors in Tamil Nadu

6.1. POWER GENERATION AND POWER CONSUMPTION

Table 49: Installed Capacity, Power Generation, Power Purchased and Power Consumption

S.No	Years	TANGECO Installed capacity (MW)	TANGEDCO Generation (MU)	Purchases (MU)	Total Power Available (MU)	Power Consumption (MU)
1	2007-08	10,122	29,241	37,608	66,849	53,370
2	2008-09	10,214	28,983	38,093	67,076	53,506
3	2009-10	10,214	27,860	45,027	72,887	57,300
4	2010-11	10,237	25,639	50,433	76,072	61,897
5	2011-12	10,364	27,942	48,592	76,534	59,752
6	2012-13	10,515	25,301	49,571	74,872	58,810
7	2013-14	11,884	31,276	58,518	89,794	60,865
8	2014-15	13,231	34,569	59,559	94,128	79,464
9	2015-16	17,976	34,709	64,982	99,691	79,464
10	2016-17	18,733	29,223	76,505	1,05,728	83,020

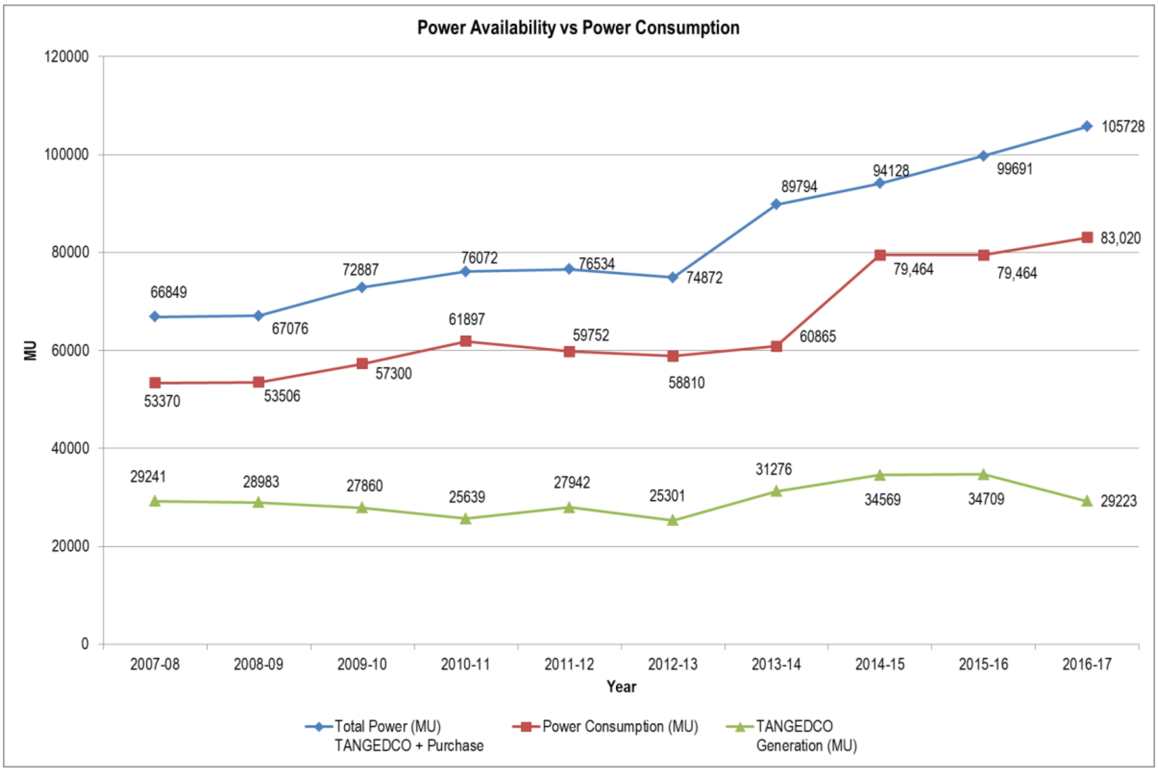


Figure 37: Power availability with TANGEDCO generation, TANGEDCO and Power purchase

ADDITIONAL PROJECTS TO MEET THE DEMAND

Table 50: Comparison of Installed Power Generation Capacity in Tamil Nadu

S.No	Power Station	Responsibility	Existing Capacity	Capacity (MW)
1	Thermal Power Stations	TANGEDCO	4320#	17,000
2	Hydro Power Projects	TANGEDCO	2307.9	2,520
3	Nuclear Power Stations	NCPIL	2,440	5,700
4	Solar Photovoltaic*	TEDA/TANGEDCO	2724.55	6,000
5	Wind Energy	TEDA/TANGEDCO	8468.11	-
	Total		20,260.56	**31,220**

#Ennore Thermal Power Plant is Completely under Shutdown 31.03.2017.

*The target for Solar Photovoltaic power generation for Tamil Nadu is fixed as 9000 MW by the Ministry of New and Renewable Energy, earlier the vision 2023 document planned

Table 51: List of Upcoming Power Projects in Tamil Nadu and its Capacity

Name of the Power Station	Agency	No of Units	Capacity (MW)	Date of Commissioning
Ennore Expansion Thermal Power Project	TANGEDCO	1x660	660	--
Ennore SEZ Supercritical Power Plant	TANGEDCO	2x660	1,320	--
North Chennai Thermal Power Plant- Stage III	TANGEDCO	1x800	800	--
Uppur Thermal power project	TANGEDCO	2x800	1,600	--
Ennore Replacement Thermal Power Project	TANGEDCO	1x 660	660	--
Udangudi Thermal Power Project Stage I	TANGEDCO	2x660	1,320	--
Udangudi Thermal Power Project Stage II	TANGEDCO	2x660	1,320	--
Udangudi Thermal Power Project Stage III	TANGEDCO	2x660	1,320	--
Cheyyur Ultra Mega Power Project	TANGEDCO	5x800	4,000	--
Kadaladi Thermal Power Project	TANGEDCO	5x800	4,000	--
Thermal Power Total Capacity			**17,000**	
Name of the Hydro Power Project	**Agency**	**No of Units**	**Capacity (MW)**	**Date of Commissioning**
Kollimalai Hydro Electric Project	TANGEDCO	1x20	20	--
Kundah Pumped Storage Hydro-electric Project	TANGEDCO	4x125	500	--
Sillahallah Pumped Storage Hydro Electric Project Stage – I	TANGEDCO	4X250	1,000	--
Sillahallah Pumped Storage Hydro Electric Project Stage –II	TANGEDCO	4X250	1,000	--
Hydel Power Total Capacity			**2,520**	
Nuclear Power Stations		**Unit**	**Capacity (MWe)**	**Date of Commissioning**
MAPS, Prototype Fast Breeder Reactor (PFBR)	NPCIL	Unit -3	500	--
KKNPP Light Water Reactor (LWR)	NPCIL	Unit -3	1000	--
KKNPP Light Water Reactor (LWR)	NPCIL	Unit -4	1000	--
KKNPP --	NPCIL	Unit -5	1000	--
KKNPP --	NPCIL	Unit -6	1000	--
MAPS Fast Breeder Reactor (FBR)	NPCIL	Unit -4	600	--
MAPS Fast Breeder Reactor (FBR)	NPCIL	Unit -5	600	--
Nuclear Power Total Capacity			**5,700**	

Solar Power Generation Plan: Vision Tamil Nadu 2023, a Strategic Plan for Infrastructure Development in Tamil Nadu, includes a solar energy target of 5,000 MW. More recently the Ministry of New and Renewable Energy proposed a solar target for the year 2022 of 9,000 MW for Tamil Nadu.

Power Tariff and Subsidy

The Government of Tamil Nadu (GoTN) had issued policy directions under sub-section (1) of section 108 of the Electricity Act, 2003, for extension of free supply / concessional tariff to different categories of consumers like Hut consumers, Agricultural consumers, Domestic consumers, Actual Places of Public Worship, Powerloom Consumers, Handloom Consumers and Lift Irrigation Co-operative Societies for Agriculture from 2004 onwards. The Government has also committed to provide subsidy to meet the shortfall in revenue to TANGEDCO u/s 65 of the Electricity Act, 2003.

Table 52: Consumer electricity subsidy provided by GoTN for TANGEDCO

S.No	Categories of consumer	Subsidy (Rs. in Crores)
1	Domestic (Free supply/Reduction in tariff)	3279.30
2	Agricultural consumers under normal category (Free supply)	3261.49
3	Agricultural consumers under SFS category (Free supply)	910.94
4	Hut consumers (Free supply)	195.09
5	Actual Place of Public Worship (Reduction in tariff)	16.30
6	Power loom weavers (Free Supply / Reduction in tariff)	374.72
7	Hand Loom Weavers (Free supply)	6.06
8	Lift Irrigation Co-operative Societies (Free supply)	9.21
	FY 2019-20 (Total)	**8053.11**

Table 53: Tariff rates for I - High Tension supply

Tariff	Category of Consumers and Slabs	Tariff fixed by TNERC		Tariff Payable by the Consumer	
		Energy Charges (Rs/unit)	Demand Charges (Rs/kVA/ month)	Energy Charges after Govt's subsidy (Rs/unit)	Demand Charges after Govt's subsidy (Rs/kVA/ month)
I- A	Industries, Registered factories, Textiles, Tea estates, IT services, start up power provided to generators.etc.,	6.35	350	6.35	350
I-B	Railway Traction	6.35	300	6.35	300
	Govt. and Govt. aided Educational	6.35	350	6.35	350

Tariff	Category of Consumers and Slabs	Tariff fixed by TNERC		Tariff Payable by the Consumer	
		Energy Charges (Rs/unit)	Demand Charges (Rs/kVA/ month)	Energy Charges after Govt's subsidy (Rs/unit)	Demand Charges after Govt's subsidy (Rs/kVA/ month)
II-A	Institutions and hostels, Government Hospitals, Public Lighting and Water supply, Actual places of public worship etc.,				
II-B	Private Educational Institutions & Hostels	6.35	350	6.35	350
III	All other categories of consumers not covered under HT-I-A, I-B, II-A, II-B, IV and V	8.00	350	8.00	350
IV*	Lift Irrigation societies for Agriculture registered under Co-op Societies or under any other Act. (Fully subsidised by the Govt.)	6.35	0	0	0
V	HT Temporary Supply for construction and other temporary purposes	11.00	350	11.00	350

**Category of Consumers Fully subsidised by the Government, #Category of Consumers Partly subsidised by the Government*

The Handloom consumers are categorized under Domestic category. All the Handloom weavers are to be extended with free electricity of 200 units (bi-monthly) in addition to reduction in tariff rate applicable to domestic consumers. The Government has committed to provide tariff subsidy for the consumption of first 200 units at entire tariff rate in respective slabs by Handloom weavers. The Government also has committed to provide tariff subsidy of Rs.10 per service/month towards fixed charges for the handloom weavers who consume up to 200 units/bimonthly only.

Table 54: Tariff rates for II - Low Tension supply

Tariff	Category of Consumers and Slabs	Tariff fixed by TNERC		Tariff Payable by the Consumer	
		Energy Charges (Rs/unit)	Demand Charges (Rs/kVA/ month)	Energy Charges after Govt's subsidy (Rs/unit)	Demand Charges after Govt's subsidy (Rs/kVA/ month)
I- A#	Domestic , Handloom, Old age homes, Consulting rooms, Nutritious Meals Centres etc.				
	Consumption upto 100 units bi-monthly				
	(100 units free scheme) 0-100 units	2.50	30/Service	0	0
	Consumption above 100 units and upto 200 units bi-monthly	2.50	30/Service	0	20/Service
	(100 units free scheme) 0-100 units			1.50	
	Consumption above 200 units and upto 500 units bi-monthly				
	(100 units free scheme) 0-100 units	2.50	40/Service	0	30/Service
	101-200 units			2.00	
	201 to 500 units	3.00		3.00	
	Consumption above 500 units bi-monthly				
	(100 units free scheme) 0-100 units	2.50	50/Service	0	50/Service
	101-200 units	3.50		3.50	
	201 to 500 units	4.60		4.60	
	above 500 unit	6.60		6.60	
	For Handlooms in residence, 0 to 200 units bimonthly is free. (Above 200 units bi-monthly, the corresponding slab in the domestic tariff is applicable)				

I- B*	Huts in village panchayats,TAHDCO:- Till installation of meters (Fully subsidised by the Govt.)	0	290/ Service	0	0
	On installation of meters (Fully subsided by the Govt.)	4.95	0	0	0
I-C	L.T. Bulk supply to residential Colonies of Railway, Defence , Police quarters etc.	4.60	120/ Service	4.60	120/ Service
II-A	Public lighting by Govt./Local bodies, Public water supply, Sewerage etc.,	6.35	120/kW	6.35	120/kW
II-B (1)	Govt and Govt. aided Educational Institutions, Govt. Hospitals and Research labs, etc	.75	120/kW	.75	120/kW
II-B (2)	Private Educational Institutions & Hostels	7.50	120/kW	7.50	120/kW
II-C#	Actual Places of Public worship(Bi-monthly) 0-120 units	5.75	120/kW	2.85	120/kW
	Above 120 units	5.75	120/kW	5.75	120/kW
III-A(1)	Cottage and Tiny Industries, Agricultural and allied activities, Sericulture, Floriculture, Horticulture and Fish/Prawn culture etc. (contracted load shall not exceed 12 kW) (Bi-monthly)				
	upto 500 units	4.00	40/kW	4.00	40/kW
	above 500 units	4.60		4.60	
III-A(2)#	Power Looms (contracted load shall not exceed 12 kW) incl. Winding etc.(Bi-monthly)				
	(750 units bimonthly is free) upto 500 units	5.20	120/kW	0	0
	501-750 units	5.75	120/kW	0	0
	751-1000 units	5.75	120/kW	2.30	70/kW
	1001-1500 units	5.75	120/kW	3.45	70/kW
	above 1500 units	5.75	120/kW	4.60	70/kW
III-B	Industries(Not covered under LT-III-A(1) & III-A(2)) , If the connected load of all industries in LT-III-A(1) & III-	6.35		6.35	70/k/W

	A(2)connected load exceeds 12 kW, welding sets and IT				
IV*	Agricultural, sericulture, floriculture, horticulture and fish/prawn culture etc., - Till installation of meters (Fully subsidised by the Govt.)	0	Rs. 2875/HP /Annum	0	0
	On installation of meters (Fully subsidised by the Govt.)	3.22	0	0	0
V	Commercial (Not covered under LT-I-A, I-B, I-C, II-A, II-B(1), II-B(2), II-C, III-A(1), III-A(2), III-B, IV and VI)				
	consumption upto 100 units bi-monthly 0-100 units	5.00	140/kW	5.00	140/kW
	consumption above 100 units bi monthly (for all units)	8.05	140/kW	8.05	140/kW
VI	For temporary activities, construction of buildings and Lavish illumination, additional construction of beyond 2000 square feet in the premises of an existing consumer.	12.00	690/kW	12.00	690/kW
	Lavish illuminations	12.00	690/kW	12.00	690/kW

**Category of Consumers Fully subsidised by the Government, #Category of Consumers Partly subsidised by the Government*

Table 55: List of district wise electrification of rural and Adi Dravidar colonies in Tamil Nadu

S.No	Name of the District	Existing Habitations (in Nos)	Electrified Habitations (in Nos)	Un-Electrified Habitations (in Nos)	Adi Dravidar Colonies Electrified Habitations (in Nos)	Huts Electrified as on 31.03.2017 (in Nos)
1	Ariyalur	710	710	0	NA	114
2	Chennai	NA	NA	0	0	0
3	Coimbatore	1200	1181	19	2997	25414
4	Cuddalore	2403	2403	0	2358	98298
5	Dharmapuri	2835	2832	3	1049	17323
6	Dindigul	3083	3076	7	NA	31747
7	Erode	3199	3196	3	NA	28014
8	Kancheepuram	3512	3512	0	2201	42027
9	Kanyakumari	1155	1150	5	388	4037
10	Karur	2179	2179	0	NA	22808
11	Krishnagiri	3983	3983	0	NA	20504
12	Madurai	1946	1945	1	1734	23853
13	Nagapattinam	2054	2054	0	NA	52896
14	Namakkal	2520	2520	0	NA	32211
15	Perambalur	314	314	0	NA	57728
16	Pudukkottai	4062	4062	0	1062	51462

S.No	Name of the District	Existing Habitations (in Nos)	Electrified Habitations (in Nos)	Un-Electrified Habitations (in Nos)	Adi Dravidar Colonies Electrified Habitations (in Nos)	Huts Electrified as on 31.03.2017 (in Nos)
17	Ramanathapuram	2306	2306	0	1518	8486
18	Salem	5109	5094	15	1521	45078
19	Sivagangai	2723	2723	0	NA	14625
20	Thanjavur	2260	2260	0	6671	70883
21	The Nilgiris	1282	1269	13	87	10795
22	Theni	607	575	32	NA	4660
23	Thiruvallur	3862	3862	0	NA	41048
24	Thiruvarur	1704	1704	0	NA	40970
25	Thoothukkudi	1761	1761	0	1378	6651
26	Tiruchirappalli	2210	2210	0	2004	43366
27	Tirunelveli	2337	2332	5	NA	8103
28	Tiruppur	2455	2444	11	NA	30578
29	Tiruvannamalai	4267	4267	0	NA	64608
30	Vellore	6109	6108	1	1796	72503
31	Villupuram	3487	3487	0	NA	141843
32	Virudhunagar	1760	1760	0	NA	12849
Total	Districts Total	79394	79279	115	26764	1125482

Table 56: List of district wise Agricultural Pump Sets Electrification in Tamil Nadu

S.No	District	Cummulative Number of Agricultural Pumpsets Energised									
		2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
1	Ariyalur	_	530	530	13632	14651	14899	15322	15441	15520	15681
2	Chennai	1	1	1	0	2	2	1	1	1	1
3	Coimbatore	119444	121223	124348	83758	86044	86530	74864	73760	74442	74643
4	Cuddalore	65456	66567	67602	67806	69570	70519	72151	72631	73162	73898
5	Dharmapuri	101328	103560	105313	72139	76652	77321	68017	67134	68193	68887
6	Dindigul	86025	87630	89296	90045	92518	93051	93202	93371	93674	94170
7	Erode	128586	129968	131007	90105	93164	94033	96190	96627	97618	98925
8	Kancheepuram	69001	69881	71557	69766	72255	72741	70567	69920	69960	70062
9	Kanniyakumari	6855	6997	7177	7214	7516	7622	7690	7755	7927	7951
10	Karur	41999	42498	43067	42973	44854	44975	43846	43979	44295	44617
11	Krishnagiri	4514	6859	6859	42467	47330	47913	53135	53821	54794	55657
12	Madurai	47984	48634	49316	50286	51581	51989	51565	51858	52136	52319
13	Nagapattinam	24809	25108	25507	25065	25775	26163	27757	27875	27927	27961
14	Namakkal	76213	77217	78007	77397	81921	82467	82874	83197	83922	84710
15	The Nilgiris	1188	1221	1245	1280	1297	1327	1331	1342	1352	1356
16	Perambalur	49851	50410	50410	36204	38188	38453	39225	39301	39399	
17	Pudukkottai	50216	51089	52110	59907	62502	62885	63094	63228	63799	63973

S.No	District	Cummulative Number of Agricultural Pumpsets Energised									
		2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
18	Ramanathapuram	8083	8189	8288	8348	8745	8866	8933	9020	9047	9073
19	Salem	115670	117756	119531	127435	132889	134280	127130	127595	128231	128927
20	Sivagangai	20999	21679	22279	24315	25416	26062	25690	25780	26043	26185
21	Thanjavur	56658	57428	58069	59111	59911	60194	62425	62533	62748	62918
22	Theni	34118	34580	35169	35991	36792	37057	36765	36824	36882	36917
23	Thiruvallur	45228	45989	45989	37945	40009	40991	49071	50384	50676	50865
24	Tiruvannamalai	160753	164180	166472	170560	179681	180086	181267	181961	183464	184620
25	Thiruvaur	20376	20622	20622	24573	24886	24980	29346	21160	21211	
26	Tirunelveli	73634	75254	76869	78384	81555	81852	82633	83118	83506	83625
27	Tiruppur	_	_	_	83256	86920	87140	99879	101838	101817	102493
28	Tiruchirappalli	79496	80625	82657	85880	88611	89171	88227	88458	88825	89336
29	Thoothukkudi	28794	29073	29372	29608	30409	31627	30707	30869	30993	31020
30	Vellore	128078	129788	131585	132192	137864	138942	140396	140807	141189	142050
31	Villupuram	157899	161964	164490	170102	180544	183840	185458	186213	189070	190368
32	Virudhunagar	35985	36214	36630	35576	36272	36411	38416	38516	38622	38658
Total	Districts Total	**1839241**	**1872734**	**1901374**	**1933320**	**2016324**	**2034389**	**2047174**	**2046317**	**2060445**	**2011866**

7. ENERGY CONSUMPTION

The petroleum products such as LPG, Naptha, Motor Spirit, Superior Kerosene Oil, High Speed Diesel Oil, Light Diesel Oil, Furnace oil/Low Sulphur Heavy Stock, Lubes/Greases, Bitumen, Aviation Turbine Fuel are obtained by fractional distillation of crude oil

Fractional distillation of crude oil: Fractional distillation separates a mixture into a number of different parts, called fractions. A tall fractionating column is fitted above the mixture, with several condensers coming off at different heights. The column is hot at the bottom and cool at the top. Substances with high boiling points condense at the bottom and substances with lower boiling points condense on the way to the top. Crude oil is a mixture of hydrocarbons. The crude oil is evaporated and its vapours condense at different temperatures in the fractionating column. Each fraction contains hydrocarbon molecules with a similar number of carbon atoms and a similar range of boiling points.

Oil fractions: The following figure below summarises the main fractions from crude oil and their uses, and the trends in properties. Note that the gases leave at the top of the column, the liquids condense in the middle and the solids stay at the bottom.

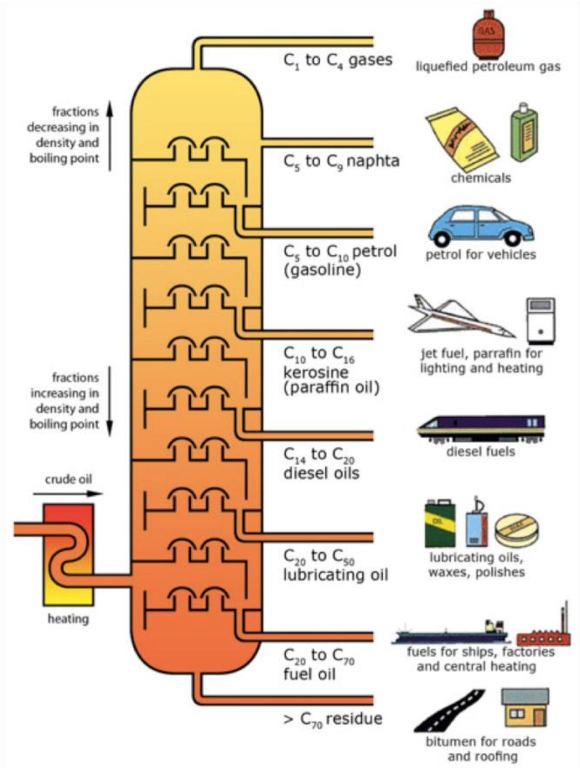


Figure 38: Fractional distillation of crude oil

Table 57: Major End Use of Petroleum Products

Product	Major End Use
Liquefied Petroleum Gas	Domestic fuel. Also for industrial application where technically essential. Now permitted as auto fuel.
NAPTHA / NGL	Feedstock/ fuel for Fertilizer Units, feedstock for petro-chemical sector and fuel for Power Plants.
Motor Sprit (Petrol)	Fuel for passenger cars, taxies, two & three wheelers
ATF	Fuel for aircrafts.
Superior Kerosene Oil	Fuel for cooking & lighting.
High Speed Diesel	Fuel for transport sector (Railways/Road), agriculture (tractors pump sets, threshers, etc.) and captive power generation.
Low Diesel Oil	Fuel for agricultural pump sets, small industrial units, start up fuel for power generation
Fuel Oil/Low Sulphur Heavy Stock	Secondary fuel for Thermal Power Plants, Fuel/feedstock for fertilizer plants, industrial units.
Bitumen	Surfacing of roads.
Lubes	Lubrication for automotive and industrial applications

Liquefied petroleum gas: Liquefied petroleum gas or liquid petroleum gas (LPG or LP gas), is a flammable mixture of hydrocarbon gases used as fuel in heating appliances, cooking equipment, and vehicles.

Naptha: Petroleum naphtha is an intermediate hydrocarbon liquid stream derived from the refining of crude oil. It is most usually desulfurized and then catalytically reformed, which rearranges or restructures the hydrocarbon molecules in the naphtha as well as breaking some of the molecules into smaller molecules to produce a high-octane component of gasoline (or petrol). Naphtha is generally used as fertilizer feed stock and as fuel in fertilizer plants' gas turbines and various other applications. The limited use of Naphtha in our country has necessitated export of balance quantity of this Naphtha.

Motor Spirit: Motor spirit, Petrol and Gasoline are different nomenclatures for the same product. Motor spirit is of British origin while Gasoline is of American origin. By motor gasoline is meant a mixture of the lighter fractions of petroleum composed of hydrocarbons having boiling points in the range approximately 30°C to 215°C. Straight fluidize run stream from Crude Distillation Unit (CDU) and cracked stream from

Fluidize Catalytic Cracker Unit (FCCU) with the above boiling range are blended to obtain required quality Motor Gasoline. It may contain small quantities of chemical e.g. tetraethyl lead, etc. added to improve its performance.

Superior Kerosene Oil: Kerosene are distillate fractions of crude oil in the boiling range of 150-250°C. They are treated mainly for reducing aromatic content to increase their smoke point (height of a smokeless flame) and hydrofining to reduce sulphur content and to improve odour, colour & burning qualities (char value).Kerosene is used as a domestic fuel for heating / lighting and also for manufacture of insecticides/herbicides/fungicides to control pest, weeds and fungi.

High Speed Diesel Oil: Two main grade of diesel fuel are marketed in India. High Speed Diesel and Light Diesel. High speed diesel is a 100% distillate fuel. It is normally used as a fuel for high speed diesel engines operating above 750 rpm i.e buses, Lorries, generating sets, locomotives, pumping sets etc. Gas turbine requires distillate duel normally make used of HSD as fuel.

Light Diesel Oil: Light diesel is blend of distillate fuel with a small proportion of residual fuel. Light diesel oil is used for diesel engines, generally of the stationery type operating below 70 rpm.

Furnace oil: Furnace oil is a dark, viscous residual fuel oil which is obtained by blending residual products from various refining processes with suitable diluents usually middle distillates to obtain the required fuel oil grades. It is used as fuel for Power Generation in DG Sets, fuel for Boilers/ Furnaces/ Air preheater/ Any other Heaters, Fuel for Bunkering, Fuel/ Feedstock in Fertilizer Plants

Low Sulphur Heavy Stock: LSHS is a residual fuels produced after processing of indigenous crudes. These have high pour points and require special handling arrangements. LSHS has special advantage of having low Sulphur content and high calorific value. These are used in lieu of furnace oil in the same applications where furnace oil is suitable

Lubes/Greases: Lubricating oil, sometimes simply called lubricant/lube, is a class of oils used to reduce the friction, heat, and wear between mechanical components that are in contact with each other. Lubricating oil is used in motorized vehicles, where it is known specifically as motor oil and transmission fluid. There are two basic categories of lubricating oil: mineral and synthetic. Mineral oils are lubricating oils refined from naturally occurring crude oil. Synthetic oils are lubricating oils that are manufactured. The use of lubricating oils in vehicles is vital to their operation. When an engine is properly lubricated, it needs to put less work into moving pistons as the pistons glide easily. In the long run, this means that the car is able to operate while using less fuel and run at a lower temperature.

Greases: Greases are lubricating oils to which thickening agents are added.

Bitumen: Bitumen is a sticky, black, and highly viscous liquid or semi-solid form of petroleum. It may be found in natural deposits or may be a refined product; it is primarily used for road construction.

Aviation Turbine Fuel: Jet fuel is a colourless, combustible, straight-run petroleum distillate liquid. Its principal uses are as jet engine fuel. The most common jet fuel worldwide is a kerosene-based fuel classified as JET A-1.

7.1. OIL REFINERY IN TAMIL NADU

2.2.2. CPCL MANALI

CPCL is the largest refinery in South India with a total refining capacity of 11.5 MMTPA. It was first refinery at Chennai with a capacity of 10.5 MMTPA and the Second refinery at Cauvery Basin with a capacity of 1.0 MMTPA.

2.2.3. CPCL CAUVERY BASIN REFINERY

CPCL second refinery is located at Cauvery Basin at Nagapattinam. The initial unit was setup in Nagapattinam with a capacity of 0.5 MMTPA in 1993 and later on its capacity was enhanced to 1.0 MMTPA. The main products of the refinery are LPG, Naptha, Superior Kerosene, High Speed Diesel, and Low Sulphur Heavy Stock (LSHS).

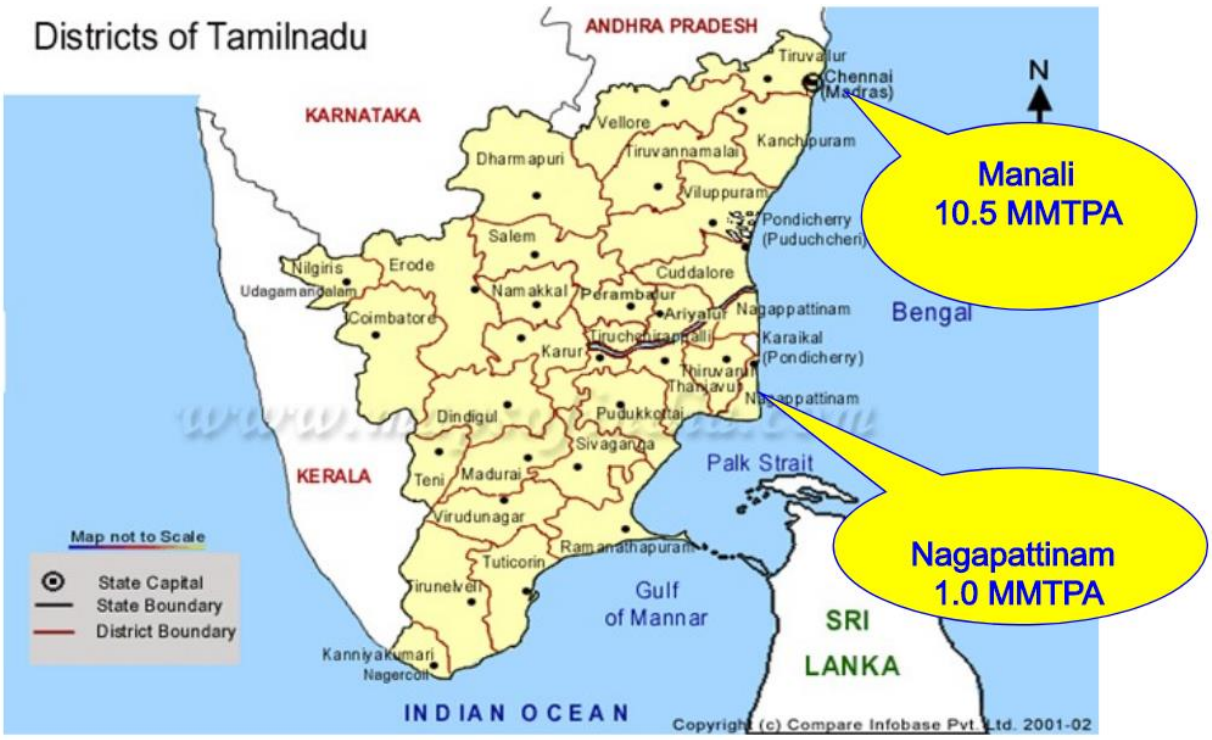


Figure 39: Location Map Showing CPCL Refineries in Tamil Nadu

Table 58: Consumption of petroleum products in Tamil Nadu

Petroleum Products (MT)	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
LPG	978455	1075995	1123652	1234726	1362462	1419540	1486875	1583326	1680298	1818574
Naptha	640400	298875	571383	488282	452015	63963	610606	488151	368160	206866
Motor Spirit	829800	957213	105190	1203539	1345977	1469902	1582582	1695753	1848928	2052049
Superior Kerosene Oil	614600	602045	590768	599303	542757	467338	400814	304489	308654	304659
High Speed Diesel Oil	3374000	4007265	4597678	4979122	5479420	5985417	6961569	6187920	5959060	6309592
Light Diesel Oil	15800	13815	10011	3814	5131	7877	10929	5210	8392	7886
Furnace oil/ Low Sulphur Heavy Stock	1671600	1619381	1620235	1566545	1389863	1170096	1057656	977796	812222	693677
Lubes/Greases	98800	120155	92222	111130	113403	112880	117106	106588	96309	107160
Bitumen	288000	375152	479973	420355	404165	359703	414825	459052	356518	475908
Aviation Turbine Fuel	360540	406744	377510	411188	456751	493105	464599	468535	442691	415489
Total MT	**8871995**	**9476640**	**9568622**	**11018004**	**11551944**	**11549821**	**13107561**	**12276820**	**11881232**	**12391860**

Source: DES, GoTN,2008-2018

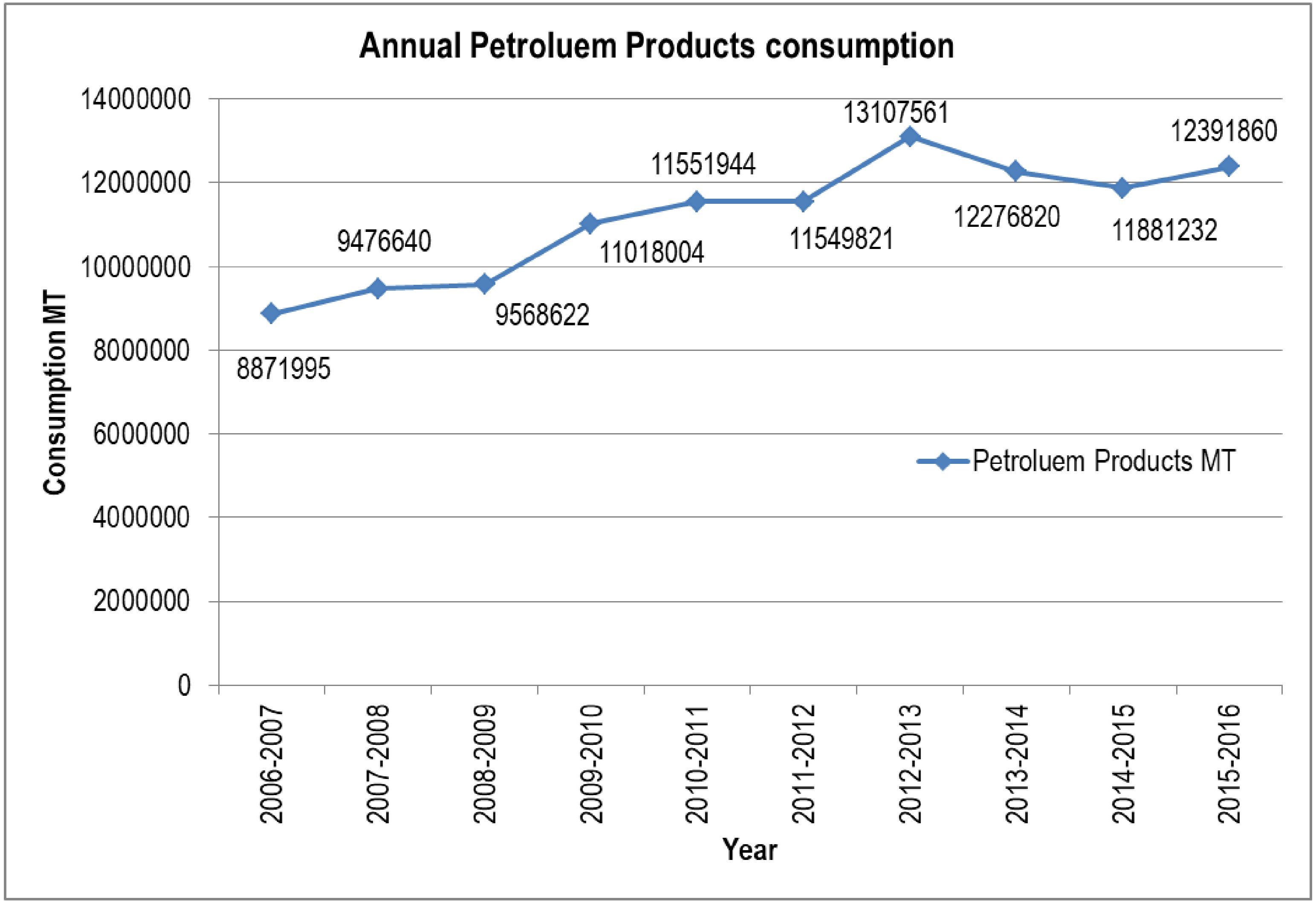


Figure 40: Petroleum product consumption in MT

Natural gas is the cleanest fossil fuels among the available fossil fuels. It is used as a feedstock in the manufacture of fertilizers, plastics and other commercially important organic chemicals as well as used as a fuel for electricity generation, heating purpose in industrial and commercial units. Natural gas is also used for cooking in domestic households and a transportation fuel for vehicles.

Domestic Gas Sources: The domestic gas in the country is being supplied from the oil & gas fields located at western and southeastern areas viz. Hazira basin, Mumbai offshore & KG basin as well as North East Region (Assam & Tripura). It is being supplied and distributed in terms of the guidelines related to pricing and utilization policies issued by the Government from time to time. In FY 2018-19, total domestic gas production was about 90.05 MMSCMD.

Import of Liquefied Natural Gas (LNG): In order to meet the gas demand, Liquefied Natural Gas (LNG) is imported through Open General License (OGL) in the country and it is imported by the gas marketer under various Long Term, Medium Term and Spot contracts. The price and utilization of imported LNG is mutually decided by buyers and sellers. At present, country is having six (6) operational LNG regasification terminals operational with capacity of about 38.8 MMTPA (~ 140 MMSCMD). One of the terminal is located in Ennore Port, Thiruvallur District.

District	Location	Owner & Operator	Regas capacity (MMTPA)
Thiruvallur	Ennore Port	Indian Oil	5

Liquified Petroleum Gas is supplied by public sector agencies such as Indian Oil Corporation Limited, Hindustan Petroleum Corporation Limited, and Bharath Petroleum Corporation Limited. 58% of the supply of the domestic supply is from Indane, 26% from Bharat Gas and 16 % from HP Gas. Number of consumers in Tamil Nadu and Locations of bottling plants are provided in the following tables.

Table 59: Number consumers and public sector supplier in Tamil Nadu, As on March 2016 and 2017

Name of the Supplier	No of Consumers (March 2016)	No of Consumers (March 2017)
Indane Gas (IOCL)	10765323	11334762
HP Gas (HPCL)	2860711	3077104
Bharat Gas (BPCL)	4684011	5025868
Total	18310045	19437734

There are 17 bottling plants operated by PSU (IOCL, BPCL, and HPCL) 1402 thousand metric tonne per annum, 1518 distributors spread across Tamil Nadu. There are 20,321,000 household were estimated during 2019, based on growth rate during the decade 2001-2011 as per census 2011. The number of LPG connection during 2019 was 20.753,000. 97.9% households were covered with LPG connection.

Table 60: Number of retail outlets of Public Sector Enterprises and Others in Tamil Nadu

Retail Outlets	IOCL	HPCL	BPCL	Other	Total Retails
March 2016	1991	1158	1317	236	4702
March 2017	2059	1211	1384	384	5039

Table 61: Number of Public Sector Enterprises LPG dealers in Tamil Nadu

LPG Dealers	IOCL	HPCL	BPCL	Total LPG Dealers
March 2016	620	216	294	1130
March 2017	679	238	328	1245

Table 62: Number of Public Sector Enterprises LDO/SKO dealers in Tamil Nadu

LPG Dealers	IOCL	HPCL	BPCL	Total LPG Dealers
March 2016	268	139	59	466
March 2017	268	139	59	466

Table 63: Crude oil and Natural Gas Production in Tamil Nadu

Year	Crude Oil Production – Onshore (TMT)	Natural Gas Production (MMSCM)
2007	353	1113
2008	298	1150
2009	265	1230
2010	239	1161
2011	233	1104.14
2012	247	1274.72
2013	238	1197.75
2014	226	1296.88
2015	240	1173.16
2016	255	988.07
2017	284	960.88
2018	345	1178.73

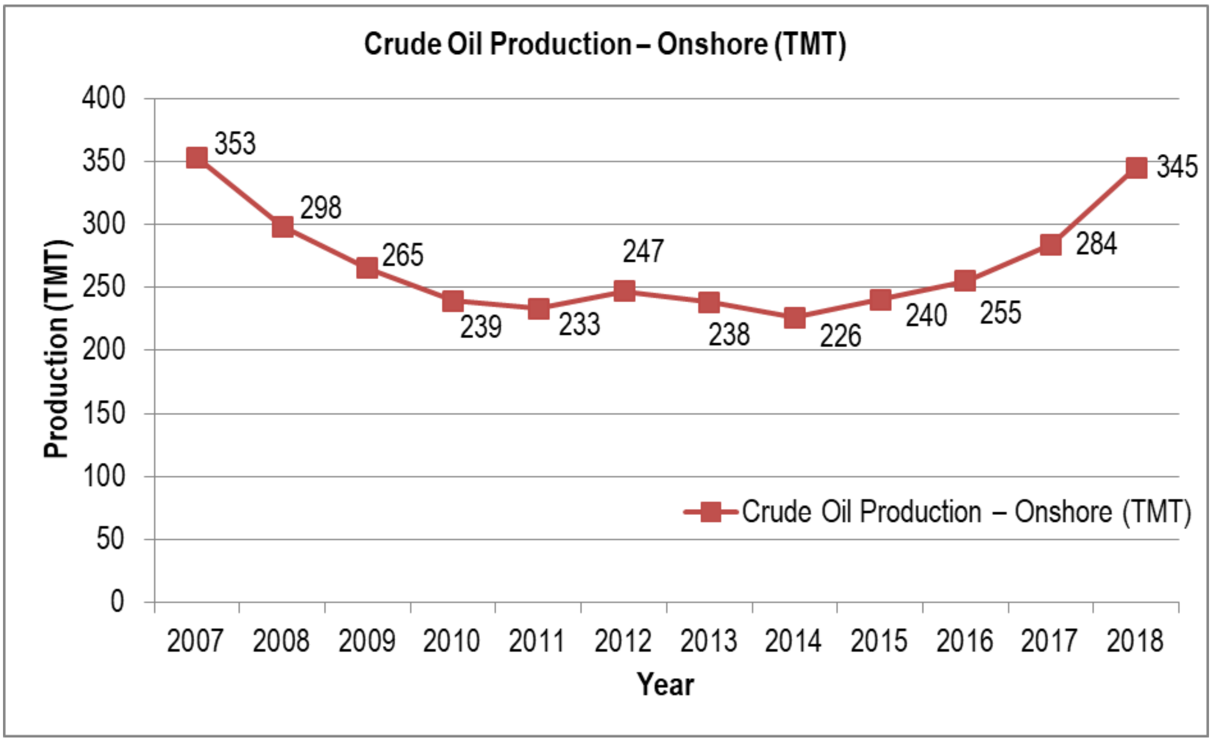


Figure 41: Crude oil production in TMT

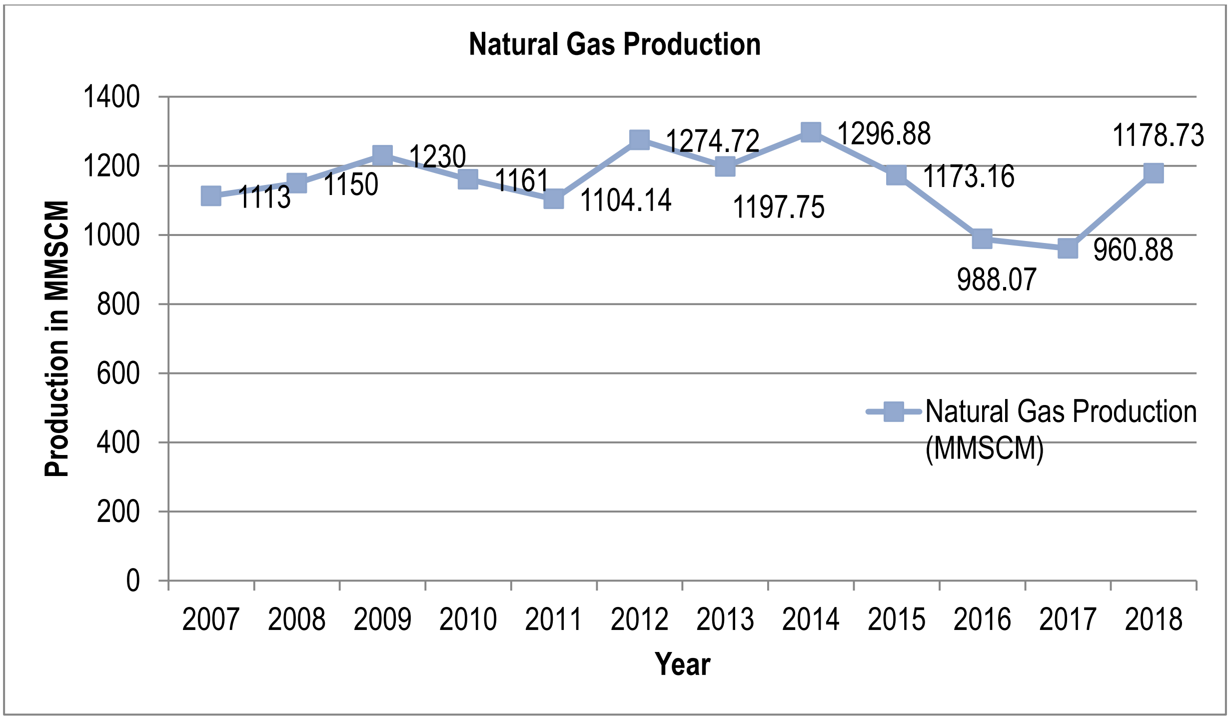


Figure 42: Natural Gas production in MMSCM

Table 64: Consumption of Diesel, Petrol and LPG customers in Tamil Nadu

Year	Diesel Consumption	Petrol Consumption	LPG Number of Domestic Customers
2007	3283	803	8798.134
2008	3896	908	9996.535
2009	4600	1051	10614.795
2010	4983	1204	11737.026
2011	5483	1346	13051.403
2012	5989	1470	13636.787
2013	6964	1583	15294.690
2014	6195	1696	16363.832
2015	5962	1849	17044.036
2016	6312	2052	18310.045
2017	6468	2255	17170.554
2018	6450	2421	18428.977

Source: Ministry of Petroleum and Natural Gas 2015, 2016, 2017, 2018

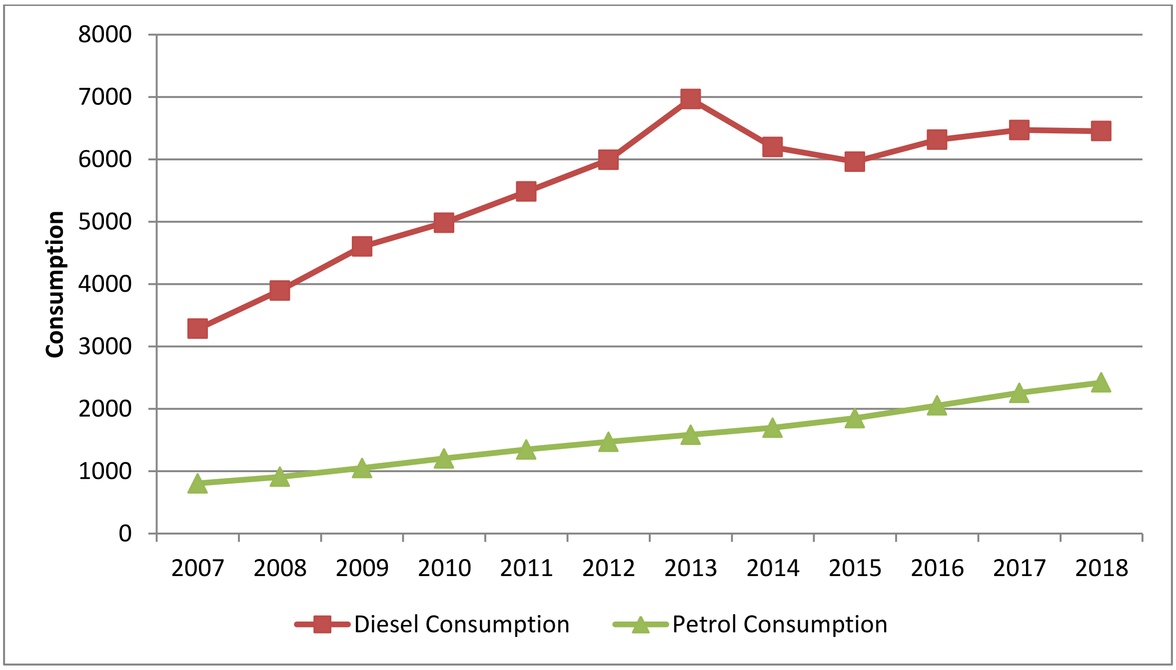


Figure 43: Consumption of Diesel and Petroleum in Tamil Nadu

Table 65: Locations of bottling plant of public sector supplier in Tamil Nadu

District	LPG Bottling Plant	Name of the Agency	Storage capacity (KL)	Capacity (in TMT/ year)	Capacity in cylinders/ day
Thiruvallur	Ennore Bottling Plant	IOCL	900	180	50,704
Thiruvallur	HPCL LPG Bottling Plant, Gummidipoondi	HPCL	NA	NA	NA
Thiruvallur	Chennai LPG Territory, Gummidipoondi	BPCL	NA	NA	NA
Kancheepuram	Chengalpattu Bottling plant	IOCL	1,800	120	33,802
Madurai	Madurai Bottling Plant	IOCL	900	60	16,901
Madurai	Madurai LPG Territory	BPCL	NA	NA	NA
Madurai	HPCL LPG Bottling Plant, Madurai	HPCL	NA	NA	NA
Coimbatore	Coimbatore Bottling Plant	IOCL	1,800	120	33,802
Coimbatore	Coimbatore LPC Territory	BPCL	NA	NA	NA
Tiruchirappalli	Trichy Bottling Plant	IOCL	100	120	33,802
Salem	Salem Bottling Plant	IOCL	1,200	45	12,676
Tirunelveli	Tirunelveli Bottling Plant	IOCL	1,800	60	16,901
Erode	Erode Bottling Plant	IOCL	1,850	60	16,901
Nagapattinam	Mayiladuthurai Bottling Plant	IOCL	99	11	3,098
Thiruvarur	Mannargudi Bottling Plant	IOCL	99	11	3,098
Thanjavur	Thanjavur LPG Territory	BPCL	NA	NA	NA
Sivagangai	Ilayangudi Bottling Plant	IOCL	450	30	8,450

ANNEXURE – I SOLAR ENERGY BENEFITS

SOLAR ENERGY POTENTIAL

Tamil Nadu has high solar insolation (5.6 to 6.0 kWh/sq mt) with more than 300 clear sunny days in a year. With substantial solar insolation and declining solar power costs there is a remarkable opportunity in the solar energy domain.

Both the Central Government as well as TEDA offer subsidy schemes to the people for installing rooftop Photo Voltaic (PV) systems. This encourages people to exploit renewable energy and to cut their electricity bill. Though the upfront cost of installation of a rooftop PV system is high, it is inexpensive in the long run when compared to electric generators. Once rooftop PV systems are installed, they don't need any other expenses as they use solar energy instead of fossil fuels.

SWITCH TO ROOFTOP SOLAR (30% CENTRAL GOVT. SUBSIDY PER INSTALLATION)

As per the MNRE notifications Residential, Institutional and Social Sectors are eligible for availing 30% of Subsidy as Central Financial Assistance. Tamil Nadu Energy Development Agency will facilitate the willing Residential, Institutional and Social Sectors who come forward to Install Solar Rooftop installations in their premises for availing MNRE Subsidy.

According to the Ministry of New and Renewable Energy, the Central Government pays 30% of the benchmarked installation cost for rooftop PV systems.

Installing a 1KW plant would cost Rs 60,000 and the end user has to pay 42000 after subsidy. The estimated cost saved from energy bills for a plant of 1 KW would be Rs.14, 700 a year. The Beneficiary would be able to get back their investment in under three and half years. In this scheme, the beneficiary need not invest in battery which would be otherwise be an expensive affair as it has to be replaced every three to four years.

INCENTIVE FOR DOMESTIC SOLAR ROOFTOPS INSTALLATIONS

1. For individual applicant only 1 kWp plants for residential purpose will be considered for a Tamil Nadu Government subsidy of Rs. 20,000/- per kWp

2. The subsidy can be availed only by domestic consumers with a TANGEDO service connection under tariff LA-1A.

In residential apartments having swimming pool with TANGEDCO service connection for common purpose other than LA-1A tariff shall also be considered for this subsidy scheme.

3. The subsidy scheme applies only to grid-connected rooftop solar PV systems comprising solar PV modules, rooftop support structure, solar grid inverter, cabling and protective devices. Grid-Tie system only will be considered.

4. Solar power that is not consumed in the residential building can be exported to the TANGEDCO grid and

will be eligible for solar net-metering. In solar net-metering the consumer pays for the net energy imported from the TANGEDCO grid (= energy imported from the grid minus energy exported to the grid). Exported energy will be credited up to a limit of 90% of the imported energy during a 12 months settlement period. To avail of solar net-metering the consumer needs to apply to TANGEDCO.

SPECIFICATIONS OF ROOFTOP PV SYSTEM FOR THE SUBSIDY SCHEME

- Approximately 100 square feet of space is required for the installation of the rooftop PV system.
- The average cost of installation of rooftop PV system without subsidy is around Rs 60,000 - 70,000.
- After leveraging 30% subsidy, people just have to pay Rs 42,000 - 49,000 for installing a rooftop PV system.
- In order to avail generation-based incentive, the customer should generate 1100 kWh - 1500 kWh per year.
- Under the scheme, a customer can earn up to Rs 2000 to 3000 per annum as generation-based incentive.

1 KW of Solar Plant	**No of Units (or) kWh***
No of Units Generated per Day	4 – 5
No of Units Generated Per Month (4-5 Units/day*30 days)	120 – 150
No of Units Generated Per Year (120-150 units/month * 10 months) (No of Sunny days = 300 days in a year, i.e approximately 10 months in a year	1200 -1500

*1 **kWh** is equal to 1 **Unit**

COMPARISON OF RENEWABLE AND NON-RENEWABLE ENERGY IN DAY TO DAY ACTIVITIES OF A HOUSEHOLD WITH DATA AND COST BENEFIT ANALYSIS

Residential Building with Solar Power Plant and Solar Net Metering:

Electrical and Electronic Appliances	Watts	Hours / Day	Nos	Watts/Day	Watts/Month	kW/h (or) Unit
LED Bulbs	10	8	5	400	12000	12
Fan	70	8	5	2800	84000	84
LED TV 43 Inch	75	8	1	600	18000	18
Double Door Fridge 310 Litre	28.4	24	1	681.6	20448	20.45
6.5 Kg Washing Machine	2000	2	1	4000	120000	120
1.5 ton Non-Inventor 5 Star AC	1130	4	2	9040	271200	271.20
2 HP Water Pump Motor	1500	2	1	3000	90000	90
Water Heater	2000	1	1	2000	60000	60
Hair Dryer	1200	0.15	1	180	5400	5.4
Iron Box	1100	0.5	1	550	16500	16.5
Induction Stove	1900	0.5	1	950	28500	28.5
Laptop 13 Inch	65	4	1	260	7800	7.8
Other Miscellaneous (Phone, Camera, Trimmer and Others)						16.15
						750.00

Considering a Residential building consuming 750 kW/h for bi-monthly the approximate bill amount is Rs. 3,380/-

Tarrif Slab (LA-1A) Consumption above 500 units bi-monthly	Rate per kW/h	Total Rate
0-100	2.5	0
100-200	3.5	350
200-500	4.6	1380
500 – 750 (Above 500)	6.6	1,650
Total Payable By Consumer		**3,380**

Average Rate per kW/h = Total Amount Payable / No of kW/h

= Rs. 3,380 / 750 = Rs. 4.50/-

Annual power requirement = 750kW/h x 12 Months /2 (bimonthly) = 4,500 kW/h

No of Units consumed per day = Total kW/h consumed bimonthly/60 days

= 750kW/h/60= 12.5 **kW/h**

As per the below table on comparison the cost of renewable generating a unit electricity is calculated as ₹0.45/kW/h.

Daily Savings Cost	
Cost of TANGEDCO energy payable per day	= Daily Units x Average unit Rate per kW/h = 12.5 kW/h x ₹4.5 = ₹56.25
Cost of renewable energy payable per day 10%	= Daily Units 10% import x cost of renewable energy per kW/h = 1.25kW/h x ₹4.5 = ₹5.625
Cost of renewable energy saving per day 90%	= Daily Units 90% exported x Cost of renewable energy per kW/h = 11.25 kW/h x ₹4.5 = ₹50.625
Daily Saving	= (Cost of renewable energy saving per day 90% – Cost of renewable energy payable per day 10%) = ₹50.625 – ₹5.625 = ₹45 Rupees.

By Installing Solar Roof Top Plant, a consumer can save approximately ₹45 per day.

Bimonthly Saving Cost	
Bimonthly Cost TANGEDCO	= (Number of Units consumed x Avg. unit cost of TANGEDCO energy) = 750 kW/h*₹4.5 = ₹3375
Bimonthly Cost Renewable	= Number of Units consumed x unit cost of renewable energy) = 750 kW/h* ₹0.45 = ₹337.5
Bimonthly Payable for 10%	= 75kW/h x ₹4.5 = 337.5 Rs.
Bimonthly Saving for 90%	= 675 kW/h x ₹4.5 = 3037.5 Rs.
Bimonthly Saving Cost	= (Bimonthly Saving for 90% - Bimonthly Payable for 10%) = ₹3037.5 - ₹337.5 = ₹2700

By Installing Solar Roof Top Plant, a consumer can save approximately ₹2,700 bimonthly

Annual	
Annual Saving	= Bimonthly Saving Cost x Total No of Months Payable (Bimonthly bill payment)
	= ₹2,700 x 6 Months
	= ₹16,200

By Installing Solar Roof Top Plant, a consumer can save approximately ₹16,200 Annually

Lifetime (25 years)	
Lifetime Saving	= Annual Saving x 25 Years
	= ₹16,200 x 25 years
	= ₹4,05,000

By Installing Solar Roof Top Plant, a consumer can save approximately ₹4,05,000 during lifetime

SOLAR POWER GENERATION CAPACITY IN TAMIL NADU

1. Average solar irradiation in Tamil Nadu state is 1266.52 W / sq.m
2. 1kWp solar rooftop plant will generate on an average over the year 5.0 kWh of electricity per day (considering 5.5 sunshine hours)
3. Annual (kW/h) calculated considering 300 Sunny Days in Tamil Nadu

CAPACITY OF SOLAR POWER PLANT REQUIRED FOR GENERATING ELECTRICITY OF 4,500 kW/h

In a day, 1 kW/p can generate 5.0 kW/h; for annual 5.0 kW/h x 300 (Sunny Days) = 1500 kW/h

Required Capacity = 4500 kW/h
= 4500 kW/h /1500 kW/h
= 3 kW/p

3 kW/p of solar power unit can generate 15.0 kW/h in a day.

For Annual 15.0 kW/h (Generated by 3kW/p in a day) x 300 (Sunny days) = **4,500 kW/h**

IMPORT AND EXPORT OF ENERGY

In case of a net import bill, the Consumer shall settle the same as per existing norms and the applicable service connections tariff. If in any billing cycle energy exported exceeds energy imported, the surplus of export Kwh over import Kwh shall be carried over to the next billing cycle for adjustment against the import Kwh of that billing cycle.

Electricity generated from a Solar P.V. System and injected into the TANGEDCO grid shall be capped commercially at 90% of the electricity consumption (Import Kwh) by the eligible Consumer at the end of each settlement period. Excess energy exported to the grid beyond the 90% Cap during a particular settlement year shall be treated as lapsed.

Table 66: Cost Comparison of TANGEDCO Supply and Roof Top Solar Plant

Category of Consumers and Slabs	**Consumption above 500 units bi-monthly**	**Solar Power Plant**	**Amount of Rs Payable for 10%**	**Total Benefit 90% Export**
Tariff Category	I - A	-	-	-
No of kW/h required	**750**	-	-	-
1. Size of Power Plant (kW)	-	3	-	-
2. Cost of the Plant :	-	-	-	-
MNRE current Benchmark Cost : Rs/kW	-	60,000	-	-
Without subsidy (Based on current MNRE benchmark) :	-	1,80,000	-	-
With subsidy 30% (Based on current MNRE benchmark) :	-	**1,26,000**	-	-
State Government Subsidy (-₹ 20,000)		**1,06,000**		
3. Total Electricity Generation from Solar Plant :	-	4,500	-	-
Annual (kW/h):	4500	4,500	-	-
Annual Energy (90%) eligible for export to TANGEDCO grid through solar net-metering.	-	4,050	-	-
Amount of Energy (kW/h) Payable per Annum	-	450	-	-
Life-Time (25 years) kW/h	1,12,500	11,250	-	-
4) Financial Savings : **a) Tariff @ Rs.4.50/ kWh (Average of different slabs up to 750 units including 100 free units) - No increase assumed over 25 years :**	-	Amount of Rs. Saved for 450 units per annum	-	-
Average of different slabs up to 750 units including 100 free units	4.5	4.5	4.5	
Bimonthly (Bimonthly No of Units x Average Rate of different slab)	3375	3037.50	337.5	2,700
Annually : (Annual No of Units x Average Rate of different slab)	20,250	18,225	2025	16,200
Life-Time (25 years) :	5,06,250	4,55,625	50,625	**4,05,000**
Calculated Per unit renewable cost compared to TANGEDCO (Life Time payable for 10% / Life-Time (25 years) kW/h)			**0.45**	
Payback period (Years) (Installation Cost/Annual Financial Saving after deducting 10% payable cost)				6 Years and 7 Months
Climate change mitigation				
Carbon dioxide emissions mitigated (Tonnes) 3 KWp		92		
This installation will be equivalent to planting number of Teak trees over the life time.		**148**		

THE KEY BENEFITS AND ADVANTAGES OF ROOFTOP SOLAR SYSTEMS ARE:

- Large numbers of solar rooftop installations pave way for Distributed Power Generation.
- Photovoltaic rooftop installations at the tail-end of the grid can enhance grid stability and reduce T&D losses as power is consumed at the point of generation.
- Potential for rooftop systems in small towns/rural areas offer local employment.
- Solar rooftop systems saves the land requirement, reduces need for additional transmission infrastructure. They are environment friendly and help in reducing GHG emissions. One GWhr of solar generation eliminates 820 metric tons of CO_2 emissions.
- The solar power is a long term reliable power source.

ANNEXURE – II RENEWABLE BENEFICIERY SCHEMES

CHIEF MINISTER'S SOLAR POWERED GREEN HOUSE SCHEME

The Chief Minister's Solar Powered Green House Scheme (CMSPGHS) Introduction: The Chief Minister's Solar Powered Green House Scheme (CMSPGHS) was launched during the year 2011-12. It is a flagship scheme of Government of Nadu, which fulfils the Housing requirement of the rural poor people along with Solar Powered Home Lighting Systems and thereby promoting green energy. Nowhere else in the country such a free housing scheme for the construction of houses with an area of 300 sq.ft with solar powered lighting is implemented.

The Commissioner of Rural Development & Panchayat Raj is authorized to draw the annual allocation for CMSPGHS in two half-yearly instalments. The fund in turn will be released to the districts at the rate of Rs.1,50,000/- per house. The balance amount at the rate of Rs.30,000/- per house shall be deposited with Chairman & Managing Director, TEDA for the purchase and installation of materials relating to Solar Powered Lighting System. Rs.30,000/- per house subsidy amount is eligible for the solar lighting system shall be claimed by Rural Development and Panchayat Raj Department from Ministry of New and Renewable Energy (MNRE), GOI and remitted to Government of Tamil Nadu account. TEDA will facilitate claim of the subsidy from MNRE. The DRDA shall release the funds directly to the respective Village Panchayats. The funds should not be routed through the Blocks.

Salient features of the Scheme.

- The poor people living in rural areas are eligible to be beneficiaries of the CMSPGHS.
- Each house shall consist of a living room, bed room, kitchen, toilet and verandah apart from the provision of harvesting rain water Both the construction of houses and installation of solar lights shall be taken up by the Rural Development and Panchayat Raj Department.
- The Green Houses shall be constructed on the land owned by the beneficiary.
- People with patta for their house sites are only eligible under this scheme.

Type design and unit cost :

- The construction of houses should not exceed the permissible limit of 300 sq.ft.
- To ensure uniformity in the design, no change of type design in normally permitted. However, changes in type design, such as

Eligibility of the Beneficiaries:

The beneficiary should :

- Be a resident of the Village Panchayat concerned.
- Own a site of not less than 300 sq.ft area.
- Have clear patta for the site/house in the name of the head of the family or any other member of the household.
- Do not own any other pucca concrete house in the or elsewhere.
- Should not have been benefited under any other housing scheme of the Government.

Mode of Selection of Beneficiaries:

- The beneficiaries should be selected from the poor people living in the Village Panchayat and the list of such beneficiaries shall be approved by the Gram Sabha.
- Out of the total allocation shall be allotted to Scheduled Tribes and the remaining 70% shall be allotted to others.
- 3% of the District differently abled persons.
- While preparing the list of beneficiaries, priority should be given to the following persons women, women headed families, Ex-Paramilitary forces, families having severely malnourished children transgender, HIV/AIDS/TB affected persons.
- Priority shall also be given to households having a mentally challenged person in the family and victims of natural calamities such as fire, flood, etc.,

CHIEF MINISTER'S SOLAR ROOFTOP CAPITAL INCENTIVE SCHEME

Under this scheme, the Tamil Nadu Government provides a capital subsidy of Rs. 20,000 per kilowatt for grid-connected domestic solar PV systems in addition to the 30% subsidy scheme* of the Ministry of New and Renewable Energy (MNRE) of the Government of India. For individual homes / flats, the solar system capacity shall be 1 kW. For the residential flats solar system capacity of 5 kW, 10 kW and multiples thereof can be applied for common usage as group application.

** limited to 30% of MNRE bench mark cost or 30% of the project cost, whichever is less*

The Chief Minister's Solar Rooftop Capital Incentive Scheme applies to grid-connected solar PV systems. This capital subsidy scheme is for the Grid-tie system only.

For every 1 KW installed, the typical solar PV system generation in Tamil Nadu is about 1,500 kWh (units) per annum. Actual energy generation depends on the efficiency of solar, tilt angle of the solar panel, weather, grid availability and cleanness of the solar panels.

Solar PV systems must be installed only by the qualified Solar Installers empanelled by the Tamil Nadu Energy Development Agency through a tendering system under this scheme.

ADVANTAGES OF A GRID CONNECTED SOLAR SYSTEM

A grid-connected photovoltaic power system will reduce the power bill due to the import and export of power through net metering provision. Illustration: someone imports (consumes) 1,000 kWh from the grid and exports 600 kWh to the grid in a billing cycle. The energy bill will be for 400 kWh (1000 kWh – 600 kWh) accounted by Netmeter.

- Grid-connected PV systems do not require batteries. Batteries are costly require periodic maintenance and also lead to wastage of 15 – 20 % energy in storage and retrieval.
- Grid-connected PV systemsare much easier to operate and maintain.
- Segregation of load is not required.

APPLICATION FOR THE SCHEME

The application format may be downloaded from the weblink www.teda.in/CIS for two different categories as follows.

a. Single Applicant of Individual house comes under category Individual www.teda.in/pdf/CIS_Individual.pdf

b. Combined Group of Flat owners comes under category Group www.teda.in/pdf/CIS_Group.pdf

Or the same may be obtained from Office of TEDA /Chennai *(TAMILNADU ENERGY DEVELOPMENT AGENCY,5th Floor, E.V.K. Sampath Maaligai, No. 68. College Road, Chennai, Pin Code: 600006.)*

SMALL HYDRO / MICRO HYDEL PROJECTS / WATERMILLS

While efforts are being made to make renewable energy available for everyone in Tamil Nadu, there are parts of the state that would be slow for adoption for practical reasons. Thanks to Micro Hydel projects which bridges this inconvenience. As the name suggests, Micro hydel is basically really small hydel installations enough to generate power for, let's say, a tea garden. Many tea garden owners have found much help from it and have adopted already.

Local organizations such as the Water Mill Associations, cooperative societies, registered NGOs, local bodies are being encouraged to install watermills in their areas. A number of NGOs are now propagating water mills for electricity generation to meet small scale electrical requirements of villages. The water mills cost approximately 2 lakhs/KW.

SUBSIDY FOR WATERMILLS AND MICRO HYDEL PROJECTS:

(a) Watermills:

1. Mechanical output only – Rs. 35,000/- per Watermill
2. Electrical output (up to 5 kW) – Rs. 1,10,000/- per Watermill
3. Both mechanical & electrical output (up to 5 kW) – Rs. 1,10,000/- per Watermill
4. Micro Hydel Projects up to 100 kW Capacity – Rs.40,000/- per KW

BATTERY OPERATED VEHICLES

Battery Operated Vehicles (BOV). They are clean, less burdensome to our planet, doesn't pollute our air, almost never contributes to the noise pollution and most importantly for you, doesn't cost you thousands on fuel. Many advancement in technology is making battery operated vehicles perform as much as the traditional ones. BOVs can be operated as public transport vehicles — BOVs are available as passenger cars, 10 seater auto rickshaws and 12 seater vans. MNRE even provides subsidy for the same. **Subsidy of Rs.4000/- & Rs.5000/- for low & high speed vehicle are provided respectively.**

HERE ARE SOME REASONS YOU SHOULD CONSIDER BOV:

1. They have zero emissions and do not pollute the atmosphere.
2. They cost about Rs.25,000/- to Rs.40,000/- and consume only about 1.5 KWhr of electricity to travel 60 km.
3. They can go about 30–50 km on a single charge. This capability meets the needs of an average, two wheeler-riders.
4. Most are used during the day and can be charged late at night, which is advantageous in balancing the electric power load.

5. Electric bikes reduce human exertion. They are structurally simple, convenient to charge, and easy to operate. Users do not need a driver's license to operate them.

6. They are compatible with city roads.

7. They will reduce traffic congestion in the cities.

8. They will help reduce energy consumption. Their annual operating cost is about 15% of that of motorcycles.

Implementation of Alternate Fuels for Surface Transportation Programme (AFSTP) for the remaining period of 11th Plan for the years 2010-2011 and 2011-12 Administrative Approval http://www.mnre.gov.in/adm-approvals/newtechnology-afstp-12112010.pdf

SOLAR POWERED PUMPING SYSTEM

Solar powered pumping system up to capacity of 10 HP with 90% subsidy assistance was proposed to be provided to the farmers who are willing to withdraw their applications for free power connection with Tamil Nadu Generation and Distribution Corporation Limited or to relinquish the existing free agricultural connection.

Funding Pattern for provision of Solar Powered Pumping Programme is as follows

MNRE	–	20%
State's share	–	40%
State DISCOM (TANGEDCO)	–	30%
Farmers Share	–	10%
Total	**–**	**100%**

ANNEXURE – III TAMIL NADU SOLAR ENERGY POLICY – 2019

TAMIL NADU SOLAR ENERGY POLICY 2019

GOVERNMENT OF TAMIL NADU

TAMIL NADU SOLAR ENERGY POLICY

TAMIL NADU SOLAR ENERGY POLICY - 2019

GOVERNMENT OF TAMIL NADU

Energy Department

1.0 Introduction

1.1. The Special Report on Global Warming (SR 15, October 2018) by the Intergovernmental Panel for Climate Change (IPCC) estimates the impact of global warming of 1.5 °C above pre-industrial levels. One of the key messages that comes out strongly from this report is that the world is already seeing the consequences of 1°C of global warming through more extreme weather, rising sea levels and diminishing Arctic sea ice, among other changes. The report states that under emissions in line with current pledges under the Paris Agreement (known as Nationally-Determined Contributions or NDCs), global warming is expected to surpass 1.5°C, even if they are supplemented with very challenging increases in the scale and ambition of mitigation after 2030.

1.2. The report also states that limiting warming to 1.5°C implies reaching net zero CO_2 emissions globally around 2050 and concurrent deep reductions in emissions of non-CO_2 climate forcers, particularly methane. Risks to natural and human systems are lower at 1.5°C than at 2°C.

1.3. Drastically de-carbonising existing energy system by investing in renewable energy systems, including solar, at an unprecedented scale and pace is required to address global warming. IPCC highlights that social justice and equity are core aspects of climate-resilient development pathways that aim to limit global warming to 1.5°C and that the poor and underprivileged communities need to be included in the solutions addressing climate mitigation. With the ratification of the Paris Agreement COP21, India has committed to reduce the emissions intensity of its GDP by 33%–35% by 2030 from 2005 levels by increasing the share of non-fossil-based energy resources to 40% of installed electric power capacity by 2030 and by creating additional (cumulative) carbon sinks of 2.5–3 GtCO2e through additional forest and tree cover by 2030.

1.4. The Government of India and the Government of Tamil Nadu have put in place various policies and mechanisms to promote solar energy, including financial incentives for certain categories of users. The Government of India has set a target of 100,000 MW of solar energy capacity for 2022 of which 40% (40,000 MW) is to come from the consumer category in the form of rooftop and similar small scale solar energy systems.

1.5. The Government of Tamil Nadu had notified the Tamil Nadu Solar Energy Policy, 2012 in October 2012. This exemplary Solar Energy Policy included solar net metering for consumer Solar Photo Voltaic systems. This early adoption of net metering contributed to making the State a national leader in solar energy. Many other Indian States followed suit in adopting solar energy policies similar to the Tamil Nadu policy.

1.6. Vision Tamil Nadu 2023, a Strategic Plan for Infrastructure Development in Tamil Nadu, includes a solar energy target of 5,000 MW. More recently the Ministry of New and Renewable Energy (MNRE) proposed a solar energy target for the year 2022 of 9,000 MW for Tamil Nadu. To meet the Vision Tamil Nadu 2023 and MNRE 2022 targets substantial solar energy capacity addition is required. Achieving the solar energy target for 2023 requires new policy instruments and solar energy programs, especially so for the consumer category. Enhanced grid penetration of solar energy requires smart grid management and energy storage solutions.

1.7. With the experience gained from implementation of the Tamil Nadu Solar Energy Policy, 2012 and with a view of accelerating the transition to a sustainable energy future, this Tamil Nadu Solar Energy Policy, 2019 provides an inclusive policy framework that promotes both utility category and consumer category solar energy generation through various enabling mechanisms.

2.0 Preamble

2.1. Government of Tamil Nadu has an unwavering commitment to the Directive Principle of the State Policy enshrined in Article 48.A of the Constitution, which stipulates that "the State shall endeavour to protect and improve the environment". It was out of this commitment that the Government issued the Tamil Nadu Solar Policy 2012, which was the first comprehensive solar energy policy in the country.

2.2. Government's commitment to people's welfare is equally resolute. Access to affordable, reliable, quality electricity supply for all is a welfare enabler.

2.3. With these twin policy objectives of protecting the environment and the welfare of its people, Tamil Nadu is committed to a sustainable and equitable energy future.

2.4. Energy is one of the key driving forces of socio-economic development and change. Long-term energy security is therefore an essential element of sustainable development. The rapid depletion of non-renewable energy sources and the adverse effects caused to the globe by the process of extracting energy from fossil fuels call for urgent solutions while demand for energy will keep increasing. The universally accepted view is that only energy from renewable sources offer a solution for a sustainable energy future. Renewable energy targets will have to be set to align with the nation's commitment of its greenhouse gas emissions.

2.5. The Government of India has launched the Jawaharlal Nehru National Solar Mission (JNNSM) under the National Action Plan for Climate Change (NAPCC) to promote ecologically sustainable growth while addressing India's energy security challenges. The objective of the National Solar Mission is to establish India as a global leader in solar energy by creating the policy conditions for its diffusion across the country as quickly as possible. Tamil Nadu will make a significant contribution to the National Solar Mission.

2.6. Tamil Nadu is one of the most urbanized and industrial states of India. A continuous increase in energy demand from all sectors is expected in the years to come. To meet the increasing energy demand in a sustainable manner, it is essential that the Government of Tamil Nadu formulates and implements energy policies that are driven by a clear vision and implemented through the participation of all stakeholders.

2.7. This Tamil Nadu Solar Energy Policy 2019 intends to create a framework that enables an accelerated development of solar energy in the State.

3.0 Tamil Nadu Solar Energy Vision

3.1. Solar energy will be a major contributor to a sustainable energy future for Tamil Nadu.

3.2. Solar energy development will be part of an overall energy strategy that includes demand side management, energy conservation, energy efficiency initiatives, distributed renewable energy generation, electric mobility and smart grids.

3.3. Solar energy development will provide green jobs to a significant number of the State's workforce.

3.4. Solar energy will become available, accessible and affordable to all citizens of Tamil Nadu.

3.5. Solar energy generation will significantly contribute to reducing the carbon and water footprint of the State's energy sector.

3.6. Tamil Nadu will be an international climate leader for emerging economies by 2023.

4.0 Solar Energy Policy Objectives

4.1. Define clear and transparent policy governance.

4.2. Establish an eco-system that translates the solar energy vision into enabling policy systems and processes.

4.3. Use regulatory mechanisms to ensure that Tamil Nadu will achieve, or exceed, the solar energy portfolio obligations as may be determined by the Tamil Nadu Electricity Regulatory Commission (TNERC) from time to time.

4.4. In accordance with regulations, facilitate open access to the public electricity grid and thereby create opportunities for grid-connected distributed generation of solar power.

4.5. Encourage and incentivise electricity consumers to set up solar energy systems.

4.6. Establish a 'Single Window System' for technical support, funding support and project clearance through cooperation between the concerned Government departments.

4.7. Encourage public-private partnerships and joint ventures to mobilize investments in solar energy projects, manufacturing facilities, research, and technology development.

4.8. Facilitate 'Ease of Doing Business' in the solar energy sector.

4.9. Create an investment-friendly environment that provides opportunities for private individuals, companies, local bodies, government departments and others to contribute to and participate in the generation of solar energy, particularly for the electricity consumer to become a "prosumer" (a producer-consumer).

4.10. Create a win-win situation for all stakeholders.

4.11. Create a road map to achieve the objectives of the "National Renewable Energy Policy" to be issued by the Central government.

5.0 Scope of Solar Energy Policy

5.1. This policy will be applicable to projects, programs and installations relating to solar photovoltaic energy (solar PV) and solar thermal energy and to both utility and consumer category systems.

5.2. This policy uses the terms "utility category systems" and "consumer category systems", which are defined as follows:

5.2.1. Utility category systems: where the objective is sales of solar energy to a distribution licensee or a third party or self consumption at a remote location (wheeling). For these systems the grid connection is through a dedicated gross metering interface.

5.2.2. Consumer category systems: where the objective is self-consumption of solar energy and export of surplus energy to the grid. For these systems the grid connection is through a consumer service connection of a distribution licensee.

6.0 Solar Energy Targets

6.1. Tamil Nadu will have an installed solar energy generation capacity of 9,000 MW by 2023. Of this target, 40% will be earmarked for consumer category solar energy systems.

6.2. Targets for subsequent years will be set by the Government of Tamil Nadu through notifications under this policy.

7.0 Legislative Framework for Policy

7.1. The legislative framework for this solar energy policy includes the following provisions; namely:-

7.1.1. The Electricity Act, 2003 (Central Act 36 of 2003) (the "Act") mandates that the Electricity Regulatory Commissions and the Governments shall take necessary steps to promote Renewable Energy. The preamble to the Electricity Act, 2003 recognizes the significance and importance of promotion of efficient and environmentally benign policies.

7.1.2. Section 61(h) of the Act provides that while specifying the terms and conditions of determination of tariff, State Regulatory Commissions shall be guided, inter-alia, by the promotion of cogeneration and generation of electricity from renewable sources of energy.

7.1.3. The National Electricity Policy (NEP) and Tariff Policy notified by the Central Government under the provisions of section 3(1) of the Act have also addressed the issues of untapped potential of energy from non-conventional and renewable energy sources.

7.1.4. Section 86(1)(e) of the Act specifies that one of the functions of the State Electricity Regulatory Commissions is to promote cogeneration and generation of electricity from renewable sources of energy by providing suitable measures for connectivity with the grid and to promote sale of such power to any person. The Regulatory Commission is also required to stipulate that a certain percentage of the total consumption of electricity in the area of a distribution licensee shall be obtained from renewable energy source (Renewable Energy Purchase Obligation, or RPO).

7.1.5. Section 86(1)(e) of the Act mandates State Electricity Regulatory Commissions (SERCs) to notify RPOs, ensure RPO compliance and invoke penal provisions against defaulting entities.

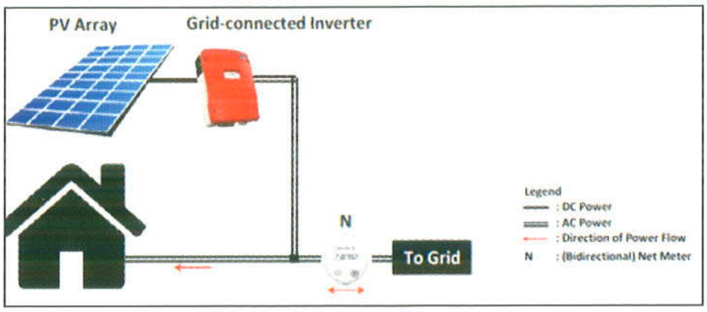
8.0 Solar Energy grid feed-in

8.1. Solar energy grid feed-in mechanisms will include, but may not be limited to the following:

8.1.1. Solar energy gross feed-in (utility category):

The solar energy is fed into the grid for energy sales to the distribution licensee or a third party under the open access facility or for captive consumption under open access. In the case of distribution licensees, the solar energy fed into the grid will be purchased by the distribution licensee at the prevailing solar energy tariffs as determined by the TNERC or a tariff determined by a bidding process. Utility category solar energy gross feed-in will be permitted at all voltage levels, subject to applicable wheeling and other applicable charges and conditions for various voltage levels as may be determined by TNERC. However, no wheeling facility is permitted at LT voltage level. Wheeling of Energy will be permitted only, during the generation of electricity and will be adjusted slot/ block to slot/ block and excess energy fed into the grid shall be treated as infirm power under sale to Discom category only. The excess energy will be paid at the rate as determined by TNERC from time to time.

8.1.2. Solar energy net feed-in (consumer category):



The solar energy is used for self-consumption with the surplus, if any, being exported to the grid. A bidirectional service connection energy meter will be installed by the distribution licensee to record the imported and exported energy. The imported energy is debited at the applicable consumer tariff while the exported energy is credited on the basis of a consumer solar energy tariff to be determined by TNERC. The consumer pays the difference between the debit and credit amounts. If the cumulative credit amount exceeds the debit amount during any billing cycle, the net credit is carried over to the next billing cycle. At the end of a 12-month settlement period as may be determined by TNERC, the net credit, if any, the consumer has the option to receive payment of the net credit balance. Solar energy net feed-in will be available to all low tension (LT) electricity consumer categories subject to TNERC regulations as may be determined from time to time.

9.0 Solar Energy feed-in tariffs

9.1. Solar energy gross feed-in at utility sale tariff will be based on competitive bidding subject to approval of TNERC and net feed-in tariffs will be determined by TNERC.

9.2. TNERC may introduce time-of-the-day (TOD) solar energy feed-in tariffs to encourage solar energy producers and solar energy storage operators to feed energy into the grid when energy demand is high.

10.0 Solar Energy implementation models

10.1. Solar energy systems may be implemented with the following models:

10.1.1. Upfront ownership: The purchaser of the solar system pays the supplier for the capital cost and takes ownership of the solar system.

10.1.2. Deferred ownership: The solar system is installed and operated by the supplier. The purchaser makes system performance-based payments to the supplier or leases the system from the supplier. System ownership is transferred to the purchaser on a mutually agreed date or is triggered by a mutually agreed event.

11.0 Solar energy mandates and programs

11.1. Building by-laws and ECBC (Energy Conservation Building Code) compliance: Any building type that requires ECBC compliance will follow ECBC compliance guidelines for the installation of solar PV and solar thermal energy systems. The Directorate of Town and Country Planning in collaboration with local bodies and Chennai Metropolitan Development Authority shall amend their building by-laws to mandate ECBC. The Electrical Inspectorate or other entity as determined by the Government will be responsible for compliance monitoring on an annual basis.

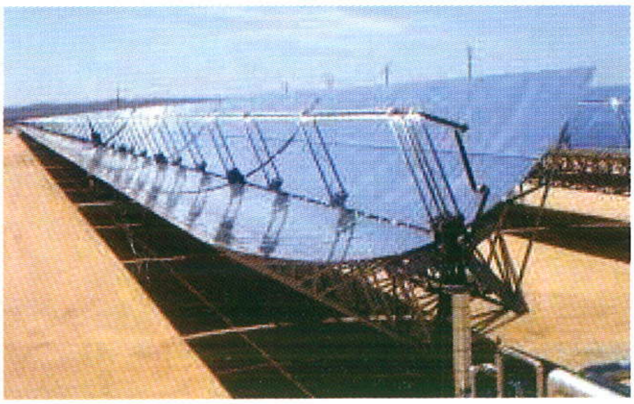
11.2. The Government will introduce a policy to promote electric vehicles, and solar energy powered charging facilities.

11.3. All public buildings, defined as per Tamil Nadu Public Buildings (Licensing) Act, will be encouraged to install solar energy systems, both photovoltaic and thermal.

11.4. Corporations, municipalities and local urban bodies will be encouraged to use solar PV energy based street lights and water supply installations.

11.5. Solar thermal for the residential, institutional and commercial segments will be promoted.

11.6. Solar thermal applications for industrial use, including concentrated solar power (CSP) will be promoted.



12.0 Incentives

12.1. Consumer category solar energy will be exempted from electricity tax for two years from the date of this policy.

12.2. Suitable incentive schemes will be designed to promote solar energy generation in the agricultural sector. This may include incentives to farmers.

12.3. Solar energy injected into the grid of the distribution licensee by solar energy producers who have no renewable energy purchase obligations (non-obligated entities), including the solar energy export by non-obligated electricity consumers, can be claimed by the distribution licensee towards fulfilment of their Renewable Energy Purchase Obligations (RPO).

12.4. The Government of Tamil Nadu will promote the manufacture of solar energy components including solar cells, inverters, mounting structures and batteries etc. in the State. Lands will be provided for the development of solar system component manufacturing. A single window process for all departmental approvals, including a set time limit for each approval will be designed and managed by TEDA.

12.5. A suitable incentive scheme will be designed to promote the co-utilization of land for solar energy projects, crop cultivation and water conservation.

13.0 Grid Connectivity and Energy Evacuation

13.1. For consumer category solar PV systems, the system capacity at the service connection point shall not exceed 100% of the sanctioned load of the service connection.

13.2. The maximum cumulative solar PV capacity at distribution transformer level may be reviewed and determined by TNERC from time to time to enable optimal solar energy penetration.

13.3. All new service connection meters in Tamil Nadu shall be configured for bidirectional energy recording and display so that all new service connections and existing service connections for which the meters are replaced in the normal course of maintenance are ready for effecting solar energy net feed-in metering at any time in the future.

13.4. For consumer category solar systems, the distribution licensee will install the required energy meters and commission the solar metering facility within three weeks from the date of application by the consumer.

13.5. The distribution licensee will enhance and update its billing system such that relevant details pertaining to solar gross feed-in and net feed-in are included in the electricity consumers' bills. Distribution licensees will make available online the billing data for each consumer, along with a sample bill explaining the various billing components above.

13.6. The distribution licensee shall implement online applications for solar energy metering. Distribution licensees shall also display online the status of all solar energy metering applications received, whether online or offline. Distribution licensees will maintain a section-wise database of solar gross and net feed-in metering application requests, approval status, installation and commissioning data, which will be submitted to the Government on a periodical basis.

13.7. Distribution licensees shall update the status of the cumulative solar capacity connected at each distribution transformer on their website.

13.8. For all grid connected solar energy systems the distribution licensee will make use of the existing distribution network to the maximum extent possible so that utilisation of such infrastructure is optimised.

13.9. For high tension consumers, open access regulations of TNERC will apply, subject to the conditions imposed by SLDC. However wheeling for less than 1 MW shall not be allowed.

13.10. To manage the integration of increasing quantities of renewable energy in the Tamil Nadu grid, flexible supply side generation capacity such as pumped hydro storage, gas turbines, flexible thermal coal power generation and energy storage systems will have to be added by TANGEDCO and the private sector. The Government will develop suitable strategies to rapidly enhance flexible power generation and energy storage capacity in consultation with TNERC and TANGEDCO.

14.0 Awareness Creation, Education and Capacity Building

14.1. All public and private schools are encouraged to introduce a curriculum on energy and environment into their syllabus.

14.2. State Government Departments and State Public Sector Undertakings (PSUs) will be encouraged to participate in annual solar energy and energy conservation training programs organized by TEDA and other agencies.

14.3. All higher education institutions are encouraged to host an annual energy and environment day to create awareness about climate change and the benefits of renewable energy as a climate change mitigation strategy.

15.0 Solar Energy Research

15.1. Tamil Nadu will facilitate and support research in the solar energy sector. TEDA, in collaboration with other Government Departments, will constitute a Solar Energy Research Fund (SERF).

15.2. Tamil Nadu will closely collaborate with multi-lateral agencies to advance solar energy research and deployment in the State.

15.3. Solar or other renewable energy projects installed for study, research or pilot purposes may be given special priorities and exemptions by the TNERC and the distribution licensee on the recommendation of the Government.

16.0 Monitoring and Evaluation

16.1. An inter-departmental monitoring and coordination committee for new and renewable energy sources, including solar energy (the "Renewable Energy Committee") shall be constituted under Principal Secretary, Energy for monitoring the implementation of this policy and to ensure that policy objectives and targets are achieved.

17.0 Role of the State Agencies

17.1. TEDA shall take the lead in launching this Solar Energy Policy with the use of media, public relations, billboards, advertisements, websites, and more. It will also communicate amendments, if any, to this policy to major stake holders via its website and/or other means.

17.2. TEDA will lead a comprehensive information and awareness creation effort in order to promote solar energy in the State.

17.3. TEDA / TANGEDCO will network and coordinate with national and international institutions that are leaders in the solar energy sector in order to promote and enhance collaboration and joint R&D projects.

17.4. TANGEDCO will design and facilitate the development of innovative solar energy projects in various modes including public, private, public-private partnership and build-own-operate-transfer (BOOT) modes. TEDA will advise TANGEDCO on these projects.

TANGEDCO will also initiate Energy Storage Projects / Solar Parks / Floating Solar Parks either on its own or as Joint Venture(JV) initiatives in collaboration with Solar Energy Corporation of India (SECI).

17.5. Statutory clearances that may be required for the development and commissioning of solar energy projects will be facilitated by TEDA with the concerned Government departments and agencies through a single window and time-bound process.

17.6. TEDA will facilitate and expedite access to various concessions and incentives provided by the Ministry of New And Renewable Energy, Government of India including capital cost subsidies, where applicable.

17.7. TEDA will provide project development and technical advice and assistance for the implementation of solar energy projects.

17.8. TEDA will provide advisory and consulting services to corporations, municipalities and local urban bodies on financing instruments for solar energy projects.

17.9. TEDA will undertake periodical review of progress of solar energy projects under development and facilitate speedy clearances and approvals if necessary.

17.10. The Chief Electrical Inspector to Government shall notify and coordinate with the Directorate of Town and Country Planning to obtain necessary amendments in the building bylaws, as outlined in this policy to facilitate extensive adoption of solar plants.

17.11. TEDA shall notify and coordinate with State Government Departments and Public Sector Undertakings to facilitate extensive adaptation of solar energy plants as outlined in this policy.

18.0 Operative Period

This policy shall come into effect on **04.02.2019** and shall remain valid until superseded or modified by another policy. The Government will review the implementation of this policy annually to evaluate the actual results against policy objectives.

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