A Study on Power Scenario in Tamil Nadu

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Foreword

The energy sector is emerging as a vital sector in the Indian economy and in the next few years is likely to see a significant growth in power generation capacity in the country. This is likely to happen through a combination of Public Private Partnerships, private sector investments as well as through Government investment in the Public Sector. The growth would be across a wide spectrum of technologies, with significant capacity addition expected in both hydro as well as coal based thermal sectors. With the civil nuclear co-operation deal a reality, there would be capacity additions in the nuclear energy sector. New initiatives on gas based power plants are expected. Most importantly, new and renewable energy, including wind power, bio-mass and solar power would play an important part.

As a result, the power scenario in different states is likely to change significantly. This study attempts to look at the power situation in Tamil Nadu, and to examine the demand supply gap to look at alternative opportunities. In particular, it examines the significant progress Tamil Nadu has made in wind power generation. There has been an attempt at painstaking data collection from Governmental sources in this enterprise, and this study is likely to be useful for practitioners and academics alike.

Jayabalan is a young researcher at the Center for Asia Studies, Chennai, and this is his maiden effort, for which he deserves to be commended.

Dr. S. Narayan
President
Center for Asia Studies

Preface

The current century has been named the Asian century. The two major Asian powers China and India are competing to ensure that they are in a position to add to their economic might. Even during the recent recession, India was able to sustain a healthy positive GDP growth. India's sustained economic growth is dependent on continuous availability of power. Many innovative measures are required if the gap between supply and demand is to be bridged.

In this paper, I have made an attempt to study the present power situation in Tamil Nadu, a state that has attracted plenty of FDI in power critical industries. Presently, the environment is conducive for big companies to invest in Tamil Nadu. However, there are many challenges to ensure that the requirements are met both for domestic and industrial application. The study examines the current scenario and provides detailed inputs on the various means for providing power.

The Tamil Nadu Electricity Board is a statutory body corporate constituted under the Electricity (supply) Act, 1948. In addition to using new concepts and technologies, it has a challenging role to think 'out of the box' to remain as a leading state of India. Only then can it continue to attract investments there by providing employment, revenue and increase the GDP of the state.

The Author wants to place on record his gratitude to Dr. S. Narayan, President of Center for Asia Studies, Commodore RS Vasan, Head Strategic and Security Studies, Prof. V. Suryanarayan, Senior Research Fellow, Mr. Jacob Bonofer, Research Fellow, Miss. Deepa Karthykeyan, Research Fellow, Mrs. Pramila, Administrative Officer and Mr. D. Sivasakthivel. Who have assisted me in my efforts to bring out this study report.

I also acknowledge the help rendered by Mr. R. Krishnamoorthi and Mr. N. Panneerselvam who were part of the center till last year.

My special thanks are due to Mr. Ravichandran, Executive Engineer TNEB who helped me with statistics from relevant sources.

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Abbreviation

1.	MW	-	Mega Watt
2.	MU	-	Million Units
3.	TNEB	-	Tamil Nadu Electricity Board
4.	MHRD	-	Ministry of Human Resource Development
5.	T&D	-	Transmission and Distribution
6.	EHT	-	Extra High Tension
7.	PLF	-	Plant Load Factor
8.	AT&C	-	Aggregate Technical and Commercial
9.	CEA	-	Central Electricity Authority
10.	SLC	-	Standing Linkage Committee
11.	ECL	-	Eastern Coalfields Limited
12.	MCL	-	Mahanadi Coalfields Limied
13.	PSC	-	Poompuhar Shipping Corporation
14.	ETPS	-	Ennore Thermal Power Station
15.	TTPS	-	Tuticorin Thermal Power Station
16.	MTPS	-	Metture Thermal Power Station
17.	NCTPS	-	North Chennai Thermal Power Station
18.	CCGT	-	Combined Cycle Gas Turbine

19.	ONGC	-	Oil and Natural Gas Corporation Limited
20.	NPCIL	-	Nuclear Power Corporation of India Limited
21.	KAPS	-	Kakrapar Atomic Power Station
22.	KGS	-	Kaiga Generation Station
23.	RAPS	-	Rajasthan Atomic Power Station
24.	TAPS	-	Tarapur Atomic Power Station
25.	MAPS	-	Madras Atomic Power Station
26.	FBRs	-	Fast Breeder Reactors
27.	ISF	-	Interim Storage Facility
28.	CANDU	-	Canada Deuterium Uranium
29.	PHWRs	-	Pressurised Heavy Water Reactors
30.	VVER	-	Vodo - Vodyanoi Energetichesky Reactor
31.	USSR	-	Union of Soviet Socialist Republics
32.	TEDA	-	Tamil Nadu Energy Development Agency
33.	MNRE	-	Ministry of New and Renewable Energy
34.	DNES	-	Department of Non-Conventional Energy Sources
35.	SERC	-	Structural Engineering Research Centre
36.	WPD	-	Wind Power Density
37.	C-WET	-	Centre for Wind Energy Technology
38.	TNERC	-	Tamil Nadu Electricity Regulatory Commission
39.	EPA	-	Energy Purchase Agreement
40.	SPV	-	Solar Photo-Voltaic

Introduction

Tamil Nadu is the eleventh largest state in India with an area of 130,058 km^2 [50,216 sq mi] and the seventh most populous state with a population of 66,396,000. It is the fourth largest contributor to India's GDP and the most urbanised state in India. The state has the highest number (10.56%) of business enterprises in India compared to its population share of about 6%. Tamil Nadu lately emerged as the most literate state in India as announced by Ministry of Human Resource Development (MHRD). The top 13 cities in Tamil Nadu are Chennai, Coimbatore, Madurai, Trichy, Salem, Erode, Tirunelveli, Tirupur, Vellore, Tuticorin, Thanjavur, Nagercoil and Dindigul. These cities are built-up with the presence of large and small industries that use electricity as a main source of energy for manufacturing their products the demand for power in these cities are growing.

With agriculture emerging as the largest consumer of power in the state, Tamil Nadu holds the distinction of being one of the first states to undertake massive rural electrification programme. Currently the Tamil Nadu Electricity Board (TNEB), a state sector enterprise, is the main energy provider and distributor.

The TNEB is a statutory body corporate constituted under the Electricity (Supply) Act, 1948 (Central Act 54 of 1948) and authorised to function as the State Transmission Utility and a Licensee by the notification issued by the Government of Tamil Nadu under clause (a) of Section 172 of the Electricity Act, 2003.

Power Position in Tamil Nadu

Electricity is a primary source of energy. Hence availability of electricity to all segments of society at reasonable price and at adequate level at all times is very important for development of the economy in the state. The demand for power is mainly due to population and economic growth, which reflects growth process – taking place in the primary, secondary, and tertiary sectors. Power development is one of the key inputs for the overall economic development of a state.

It has been estimated by the World Bank that the demand for power will grow by nearly twice the rate at which the economy grows. Therefore adequate provisions have to be made for augmenting power supply to bridge the gap between demand and supply as well as to meet the increasing future demand.

Customers for electricity are classified as Domestic, Agriculture, Commercial, Industrial, and Others. There is a major government initiative to provide free supply of electricity to the agriculture sector as well as for SC/ST households. Table 1 gives us the growth pattern of different consumers served in the state from the years 2004–2009.

Table 1 : Tamil Nadu Consumer Growth Pattern (2004–2009)

Description	Year-wise Consumers Growth				
	2004–2005	2005–2006	2006–2007	2007–2008	2008–2009
Domestic	1,14,59,503	1,19,74,293	1,25,28,391	1,30,64,075	1,36,61,431
Agriculture	17,36,946	17,68,052	18,01,972	18,39,241	18,80,450
Commercial	19,92,868	21,22,967	22,26,580	23,43,407	24,93,310
Industrial	4,05,827	4,30,248	4,45,110	4,64,609	4,63,463
Others	14,33,409	15,01,907	15,73,994	17,15,954	18,23,411
Total	1,70,28,553	1,77,97,467	1,85,76,047	1,94,27,286	2,03,22,065

Source: TNEB, Statistics at a Glance-2008 Annual Report

Establishment of new industries and also migration of work force from other places into Tamil Nadu, has increased the demand for power over the years. When compared to 2007–2008 commercial consumer has increased by 0.2% and others (free electricity provided by the government) have increased by 0.1% in 2008–2009. To meet the demand TNEB also increased generating capacity every year from all sources.

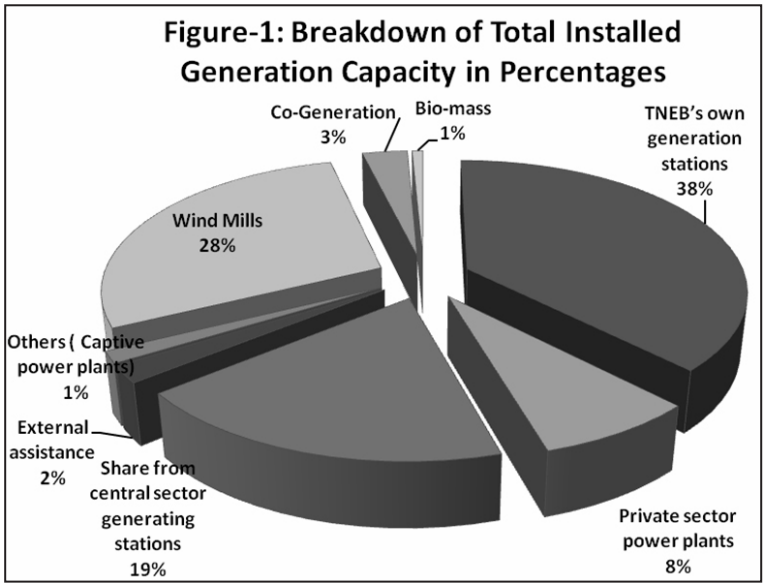
The total installed generation capacity of Tamil Nadu is 15,100 Mega Watts till 2009, the break-up of which is given in table 2 and the pie chart generated from it.

Table 2 : Breakdown of Total Installed Generation Capacity in Tamil Nadu

S. no.	Sector wise	Generation in Mega Watts
1	TNEB's own generation stations (Hydel, Thermal, Gas, and Wind)	5,690
2	Private sector power plants	1,180
3	Share from central sector generating stations	2,825
4	External assistance	305
5	Others (Captive power plants)	214
Renewable or Non-Conventional Energy Sources		
6	Wind Mills	4310.615
7	Co-Generation	466.100
8	Biomass	109.550

Source: TNEB Policy Note -2009

As per recent reports published by Government of Tamil Nadu, TNEB occupies the second rank in the list of top three State Electricity Boards in the country along with Maharashtra, Gujarat, in terms of size of its operation gauged by the generating capacity at its command, the amount of energy sold, and the number of consumers serviced. Tamil Nadu ranks sixth in terms of per capita electricity consumption among the other states.



Source: TNEB Policy Note - 2009

Transmission and Distribution

The main objective of the Transmission and Distribution (T&D) networks are as follows:

- To ensure quality of power to the consumers.
- To reduce T&D losses.
- To establish stable network for supply of power.
- To fully meet the load growth.

Under T&D network there are 90 new stations of various voltage categories, and 1,500 circuit km of Extra High Tension (EHT) lines will be added during 2009–2010. The T&D losses in TNEB

as a whole have been estimated as 18% for the year 2007–2008 considering the unit generated, units sold out, and by computing the consumption of agriculture and hut services. The technical performance/efficiencies of TNEB measured by the Plant Load Factor (PLF) and the T&D losses have normally been below the all India average and place Tamil Nadu among the top five to six State Electricity Boards in terms of performance. The Aggregate Technical and Commercial (AT&C) losses in TNEB have been estimated as 19.71% for the year 2007–2008, considering the units generated, the units sold, and the revenue realized.

Thermal Power Projects

A thermal power station is a power plant in which the prime mover is steam driven. The greatest variation in the design of thermal power stations is due to the different fuel sources. Some prefer to use the term energy centre because such facilities convert forms of heat energy into electrical energy. There are four thermal energy fuels—coal, natural gas, wood waste, and geo-thermal. Strictly speaking, nuclear power is also thermal energy fuel, but it is set aside in a class of its own because of its unique traits.

Fossil fuels such as gas and coal were created millions of years ago from layers of animals and plant matter. When coal is burnt it produces heat, this heat can be used to create steam. The steam drives the steam turbine, after it passes through the turbine connected to a generator; the steam is condensed in a condenser and recycled to where it was heated. This is known as a Rankine cycle. The energy produced by the generator is passed through a transformer into the National Grid transmission line which delivers electricity throughout Tamil Nadu. Natural gas can provide energy as well. Burning natural gas fuels heating and cooking, but it can also be used to fuel an electricity turbine. Table 3 lists the thermal power plants in the state.

Table 3 : Thermal Power Plants in Tamil Nadu

Power Plants	Owners	Location	Fuel	Total Capacity (MW)
Neyveli	Neyveli Lignite Corp. Ltd.	Neyveli	Coal	2280
Tuticorin	Tamil Nadu SEB	Tuticorin	Coal	1550
Mettur	Tamil Nadu SEB	Mettur	Coal	840
North Chennai	Tamil Nadu SEB	Chennai	Coal	630
Ennore	Tamil Nadu SEB	Chennai	Coal	450
Neyveli Zero	CMS India Ltd.	Neyveli	Coal	250
Chennai Vasavi	CMS India Ltd.	Chennai	Oil	200
Samayanallur	Balaji Power Corp. Ltd	Samayanallur	Oil	106
Samalpatti	Samalpatti Power Corp. Ltd	Samalpatti	Oil	105
Kovilkalappal	Tamil Nadu SEB	Nagaiguaid-E. Milloth Dist.	Oil	108
Perungulam	Tamil Nadu SEB	Perungulam	Natural Gas	105
Basin Bridge	GMR Group	Chennai	Naphtha	124

Source: TNEB, Statistics at a Glance-2008 Annual Report

The requirement of coal on a quarterly basis is furnished to the Central Electricity Authority (CEA) for their recommendation to the Standing Linkage Committee (SLC) for quarterly linkage allotment. The Standing Linkage Committee allots coal to TNEB Power Stations from Eastern Coalfields Limited (ECL) and Mahanadi Coalfields Limited (MCL).

The coal from the mines Talchar and IB Valley of Mahanadi Coalfields Limited (MCL) and Raniganj and Mugma of Eastern Coalfields Limited (ECL) is transported to the load ports of Paradip (Orissa), Vizag (Andhra Pradesh), and Haldia (West Bengal) respectively through rail. Thereafter the coal is transported to the discharge ports of Ennore and Tuticorin by ships. From Ennore Port the coal is transported again through rail to Ennore Thermal Power Station and Mettur Thermal Power Station. For North Chennai Thermal Power Station the coal is transported by belt

conveyor from the ship directly. At Tuticorin the coal received is fed to Tuticorin thermal power station directly through a belt conveyor system available at port. Handling contractors are being engaged for handling of coal at load ports (Haldia, Paradip, and Vizag) and discharge ports (Ennore and Tuticorin).

TNEB needs about **15 Million Tonnes** of coal annually for generating power from its four thermal power stations of TNEB with a total installed capacity of 2970 MW. The maximum daily requirement when all the units in all four stations work to the full capacity will be around 50,000 MTs. However, out of this only about **13 Million Tonnes** is being supplied by Government of India. Therefore, as advised by Government of India to meet the shortfall in supply, about 2 Million Tonnes of coal per annum had to be imported. In addition, as a permanent measure to meet the ever-existing shortfall in supply of indigenous coal, it was felt necessary to go in for acquisition of captive coal mines to have assured supply of coal. Accordingly, a request was made to Government of India and TNEB has been allotted two coal blocks viz., **Gare pelma sector II coal block** in the state of Chhattisgarh along with Maharashtra State Mining Corporation and **Mandakini B coal block** in the state of Orissa along with Orissa State Mining Corporation and Assam and Megalaya State Mining Corporations. TNEB's share from the above mentioned coal blocks would be about **5 Million Tonnes and 3.5 Million Tonnes** per annum respectively. The coal to be mined from these captive coal blocks is expected to meet the shortfall in supply of the indigenous coal supplied by Coal India Limited.

This coastal coal transportation from the three load ports to the two discharge ports is being arranged by M/s. Poompuhar Shipping Corporation (PSC), a Government of Tamil Nadu Enterprise which was specially created to assist TNEB coastal coal movement. M/s. PSC owns three specially designed coal vessels viz. *Tamil Anna, Tamil Periyar,* and *Tamil Kamaraj* suitable for the Haldia-Tuticorin sector. Also M/s. PSC charters vessels for TNEB depending upon coal requirement and monitors the movement of the vessels.

Installed Capacity of Thermal Power Stations

Ennore Thermal Power Station

Ennore Thermal Power Station (ETPS) has an installed capacity of 450 MW comprising of 2×60 MW (31 March 1970 and 14 February 1971) and 3×110 MW (17 May 1972, 26 May 1973, and 2 December 1975) units. The total cost of the project was 270 crores. The units are coal based. Coal for ETPS is received from MCL (Talchar and Ib Valley), Orissa and ECL, Raniganj, West Bengal. ETPS has completed more than 30 years. The generations from all the five units are supplied to TNEB. The PLF for the year 2008–2009 is 49.17%.

Tuticorin Thermal Power Station

Tuticorin Thermal Power Station (TTPS) is situated near the port of Tuticorin on the Bay of Bengal and spread over an area of 160 Hectares. TTPS has a total installed capacity of 1050 MW comprising five units of 210 MW each. The station was erected in three stages. The first stage consists of unit 1 and 2 of 210 MW (9 July1979 and 17 December1980) each at a total cost of Rs. 178 crores. The second stage consists of 210 MW (16 April 1982) in unit 3 at a cost of Rs. 89 crores. The third stage consists of units 4 and 5 of 210 MW (31 January1991 and 11 February1992) each at a total cost of Rs. 804 crores. The units are coal based. Coal is transported by sea through ships from Haldia, Paradip, Vizag ports to TTPS. The PLF for the year 2008–2009 is 85.35%.

Mettur Thermal Power Station

Mettur Thermal Power Station (MTPS) is situated in Salem District. This is the first inland thermal power station in TNEB. The first stage consists of unit 1 and 2 of 210 MW (7 January1987 and 1 December 1987) at a total cost of Rs. 384.30 crores. The second stage consists of units 3 and 4 with the capacity of 210 MW each (22 March 1989 and 27 March 1990) with the total cost of Rs. 351.76 crores. All the four units are coal based. Coal for

MTPS is received from MCL (Talchar and Ib Valley), Orissa and ECL, Raniganj, West Bengal. The PLF for the year 2008–2009 is 87.78%. MTPS has the responsibilities to generate and transmit electricity for the whole Tamil Nadu. Most of the power produced is consumed by the companies near it.

North Chennai Thermal Power Station

North Chennai Thermal Power Station (NCTPS) is situated about 25 km from Chennai on the North side. NCTPS has a total installed capacity of 630 MW comprising of three units with 210 MW in (25 October 1994, 27 March 1995, and 24 February 1996) each. All the three units are coal based. Coal for NCTPS is received from MCL (Talchar and Ib Valley), Orissa and ECL, Raniganj, West Bengal. The PLF for the year 2008–2009 is 86.52%.

Table 4 : Performance of Ennore Thermal Power Station

Particulars	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08
Units Generated (MU)	753	1149	1742	1264	1223	601	1428	2032
Auxiliary Consumption (MU)	115	179	224	176	181	97	198	278
Percentage	15.3	15.6	12.86	13.9	14.8	16.2	13.9	13.7
Service Hours	2519	4185	5548	3996	3975	2155	4296	6408
Planned Maintenance Hours	5624	1471	1009	2016	1508	2127	1387	278
Forced outage Hours	617	3104	2203	2772	3277	4478	3078	2098
Outage rate (%)	71.2	52.2	36.7	54.5	54.6	75.4	51	27.1
Availability factor (%)	28.8	47.8	63.3	45.5	45.4	24.6	49	72.9
Plant Load Factor (PLF) (%)	19.1	29.2	44.19	32	31	15.23	36.2	51.42
KWH/KW	1673	2553	3871	2809	2718	1335	3173	4516

Source: TNEB, Statistics at a Glance- 2008 Annual Report

Table 5 : Performance of Tuticorin Thermal Power Station

Particulars	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08
Units Generated (MU)	7934	8105	8193	8083	8178	7674	8083	7974
Auxiliary Consumption (MU)	606	620	625	631	639	618	637	638
Percentage	7.6	7.65	7.63	7.8	7.8	8.06	7.88	8
Service Hours	7699	7808	7863	7676	7896	7574	7961	7918
Planned Maintenance Hours	787	657	505	677	547	701	465	576
Forced outage Hours	274	295	379	431	259	251	285	270
Reserved shut down Hours			13		58	234	49	20
Outage rate (%)	12.1	10.9	10.24	12.6	9.9	13.5	9.12	9.86
Availability factor (%)	87.9	89.1	89.76	87.4	90.1	86.5	90.88	90.14
Plant Load Factor (PLF) (%)	86.3	88.12	89.07	87.63	88.9	83.42	87.9	86.5
KWH/KW	7556	7720	7803	7698	7789	7309	7698	7594

Source: TNEB, Statistics at a Glance - 2008 Annual Report

Table 6 : Performance of North Chennai Thermal Power Station

Particulars	2003–04	2004–05	2005–06	2006–07	2007–08
Units Generated (M.U)	4348	3918	4001	4904	4657
Auxiliary Consumption (M.U)	397	358	377	437	414
Percentage	9.14	9.14	9.42	8.91	8.89
Service Hours	7568	6586	6637	7897	7478
Planned Maintenance Hours	658	873	684	686	1147
Forced outage Hours	550	1234	1438	177	159

Reserved shut down Hours	8	66	—	—	—
Outage rate (%)	13.84	24.81	24.23	9.85	14.87
Availability factor (%)	86.16	75.19	75.77	90.15	85.13
Plant Load Factor (PLF) (%)	78.57	71	72.5	88.87	84.2
KWH/KW	6902	6220	6351	7785	7392

Source: TNEB, Statistics at a Glance - 2008 Annual Report

Table 7 : Performance of Mettur Thermal Power Station

Particulars	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08
Units Generated (MU)	6396	6738	6735	6685	6519	6813	6692
Auxiliary Consumption (MU)	512	530	528	557	546	559	545
Percentage	8.01	7.87	7.8	8.3	8.38	8.21	8.14
Service Hours	7955	8134	7993	8126	7917	8184	8101
Planned Maintenance Hours	654	463	544	410	585	372	490
Forced outage Hours	128	163	247	176	79	161	189
Reserved shut down Hours	23	—	—	48	178	43	4
Outage rate (%)	9.19	7.15	9	7.23	9.62	6.57	7.78
Availability factor (%)	90.81	92.85	91	92.77	90.38	93.43	92.22
Plant Load Factor (PLF) (%)	86.92	91.56	91.28	90.85	88.59	92.59	90.7
KWH/KW	7614	8021	8018	7958	7761	8111	7967

Source: TNEB, Statistics at a Glance - 2008 Annual Report

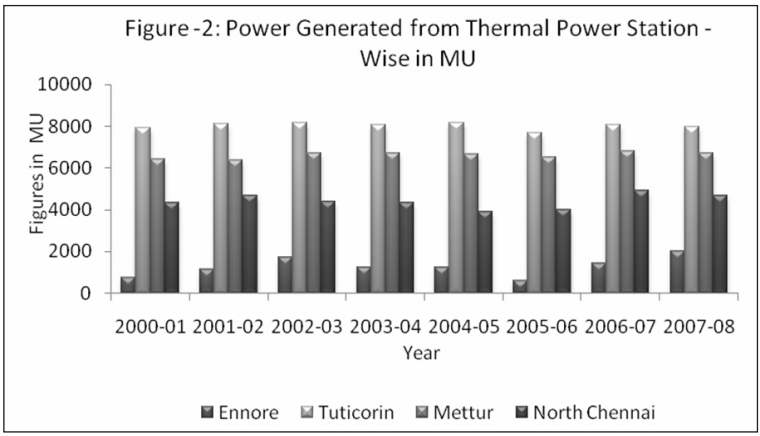
Table 8 and the bar graph constructed from the data give the year-wise generation from each thermal power station using coal from the year 2000–2001 to 2007–2008.

Table 8 : Thermal Power Generation, 2000–2001 to 2007–2008

(Units in MU)

Station	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08
Ennore	753	1149	1742	1264	1223	601	1428	2032
Tuticorin	7934	8105	8193	8083	8178	7674	8083	7974
Mettur	6422	6396	6738	6735	6685	6519	6813	6692
North Chennai	4355	4675	4407	4348	3918	4001	4904	4657
Total	19464	20325	21080	20430	20004	18795	21228	21355

Source: TNEB, Statistics at a Glance, 2008 Annual Report



Conclusion

As seen in the bar graph TTPS generates more when compared to MTPS this is predominantly on account of the higher installed capacity of the Tuticorin Thermal Power Station when compared with MTPS. The North Chennai unit generate power uniformly with its installed capacity. In 2007–2008 ETPS was the only thermal station that generated 2032 MU while all other stations had to reduce their generation capacity due to lack of coal and other reasons. While analysing the PLF of all the thermal plants, the ETPS generating only 50% of its installed capacity and ranked last. This is mainly because of the aged plant.

Gas Turbine Power Projects

Ambient air when compressed to 11–30 bar pressure causes a temperature rise. Most of this warm air is used in the combustor to burn the fuel (natural gas or a liquid, e.g., oil etc.). The hot gas produced expands through the turbine, doing work, and exits at nearly atmospheric pressure but with 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 in that there are two mode of generation of electricity one is Open Cycle and another one is Combined Cycle.

Thirumakotai Gas Turbine Power Station (Kovilkalappal)

Thirumakotai gas turbine power station is situated in Mannargudi town 18 km from Thirumakotai in Thiruvarur District. This station is the foremost gas station under combined cycle in TNEB. The fuel used for this plant to generate electricity is natural gas obtained from Oil and Natural Gas Corporation limited (ONGC) wells located at a distance of about 10 km from the plant. The

plant uses natural gas which is a clean gas hence pollution of the environment is at minimum unlike thermal plants which produces by-products such as fly ash in large quantities. The power generated improves the voltage and grid stability in the neighbouring areas of Pattukottai, Mannargudi, Thiruvarur, and Thanjavur. Commissioned in 2001the total installed capacity of the plant is 107.88 MW. The cost of generation per unit is Rs. 1.73.

Basin Bridge Gas Turbine Power Station (Chennai)

The cost of the Basin Bridge gas turbine power station (Chennai) project is Rs. 490.23 crores. Commissioned in 1996, this project was aided by Overseas Economic Co-operative Fund from Japan. The main fuel used for generating electricity is Naphtha. Natural gas can also be used for the generation purpose. Naphtha fuel linkage per year is estimated to be 50,000 tones. The installed capacity of the gas turbine power station is 120 MW. There are four units each having a capacity of 30 MW. All the four units are fuel based. The cost of generation per unit is Rs. 9.72. The mode of operation for generating the electricity is Open Cycle.

Kuttalam Gas Turbine Power Station

Kuttalam gas turbine power station, commissioned in 2004, is located in Maruthur Village near Kuttalam which is 15 km from Mayiladuthurai in Nagapattinam District. The power generated improves the voltage and grid stability in the neighbouring areas of Kumbakonam, Kadalangudi, Thiruvarur, and Thanjavur. The total installed capacity of the Kuttalam gas turbine power station is 100 MW. The main fuel used for generation is natural gas. Cost of generation per unit of electricity is Rs. 1.84. The mode of operation to generate electricity is Combined Cycle.

Valuthur Gas Turbine Power Station

Valuthur gas turbine power station is located in Valuthur Village, Ramanathapuram District. Power generated in this station is distributed to R.S. Madai, Perungulam, Mandapam, Keelakarai,

and Valinokkam of both Ramanathapuram and Sivagangai districts. The power generated by Valuthur gas turbine plant has helped solve the low voltage problems in Ramanathapuram District. It also helps in the development of small and major industries. The growth of these industries will provide more employment opportunities to the local people.

Valuthur gas turbine power station has a total installed capacity of 95 MW and it was commissioned in 2003. The fuel used for generating electricity is natural gas. The cost of generation a single unit is Rs. 1.95. The mode used for the generation of power is Combined Cycle.

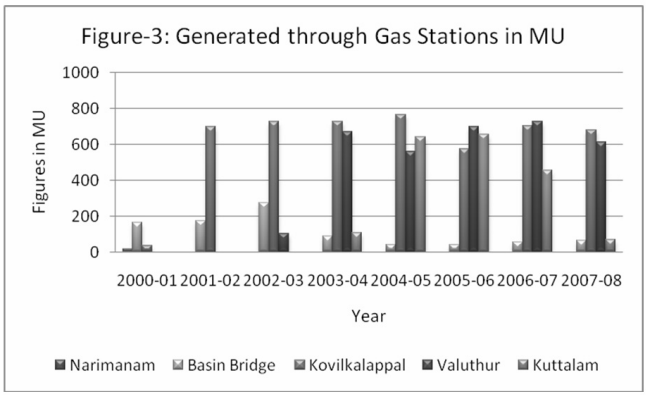
Another Unit of capacity 92.2 MW was commissioned on 17 February 2009, the capacities added to meet the demand.

Table 9 and the bar graph constructed from the data give year-wise generation from gas power stations from 2000–2001 to 2007–2008.

Table 9 : Generation through Gas Stations (Units in MU)

Station	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08
Narimanam	15	-	-	-	-	-	-	-
Basin Bridge	164	173	276	89	41	40	57	63
Kovilkalappal	36	697	727	724	763	573	704	677
Valuthur	-	-	104	671	558	697	728	611
Kuttalam	-	-	-	108	641	654	455	68

Source: TNEB, Statistics at a Glance - 2008 Annual Report



Conclusion

Comparing the two heat based power generation, gas based power generation has a much cheaper cost of production than the coal based plants. Since 2001, the Narimanam plant has stopped power generation. Being a small plant with a capacity of only 120MW Basin Bridge station generates very little energy and for the past few years, production has been at a slow pace. This power plant is operated only four hours in a day. The cost of generation is Rs.10 per unit and it is very expensive because of the fuel used. Naphtha is a costly fuel and the mode of operation is open cycle. In the Open cycle mode heat that is used to operate the generator is released after being used the first time. Currently there is a proposal to replace the open cycle mode of operation with the closed cycle mode at the Basin Bridge plant so as to reduce the cost of production by 50-60%. The Kovilkalappal power plant with its installed capacity of 108 MW has a satisfactory generation, but does not belong to TNEB. The TNEB purchases power from them. Valuthur power plant started in 2001–2002, has gradually increased power generation like Kovilkalappal power plant. Since its commissioning in 2003, power generation in Kuttalam power plant was on the raise, but from 2006-2007, there has been a decline and in 2007-2008 it produced only 68MU. Investments in gas power plants to modernise generators and also expansion of gas stations would not only help in increasing the productivity but also has an added advantage of being environment friendly.

Nuclear Power Projects

Nuclear Power Corporation of India Limited is a public sector enterprise under the administrative control of the Department of Atomic Energy (DAE), Government of India. The company was registered as a public limited company under the companies Act, 1956 in September 1987 with the objective of operating the atomic power stations and implementing the atomic power projects for generation electricity in pursuance of the schemes and programme of the Government of India under Atomic Energy Act, 1962.

The Mission of the Company is 'To develop nuclear power technology and to produce nuclear power as a safe, environmentally benign and economically viable source of electrical energy to meet the increasing electricity needs of the country.' The motto of the NPCIL is '**Safety First and Production Next**.'

The company is currently operating 17 nuclear power units at six locations and is implementing construction of five reactors at three locations. With the total installed capacity of 4120 MW, and five reactors under construction totalling of 2660 MW capacity. Three units of Nuclear Power Corporation of India Limited (NPCIL) namely Kakrapar Atomic Power Station (KAPS-1), Kaiga Generation Station (KGS-2), and Rajasthan Atomic Power Station (RAPS-4) recorded non-stop continuous run of more than a year. In the year 2002–2003, NPCIL recorded an impressive overall

capacity factor of 90% for its operating units. NPCIL completed its new units namely Tarapur Atomic Power Station (TAPS-3&4) and KGS-3 with gestation periods matching international levels. NPCIL is also proud of its equity participation in BHAVINI, an organization formed for implementation for Fast Breeder Reactors programme in the country.

Madras Atomic Power Station

Madras Atomic Power Station (MAPS) located at Kalpakkam about 80 km south of Chennai, India, is a comprehensive nuclear power production, fuel reprocessing, and waste treatment facility that includes plutonium fuel fabrication for Fast Breeder Reactors [FBRs]. It is also India's first fully indigenously constructed nuclear power station. It has two units of 220 MW capacities each. The first and second units of the station commissioned on 27 January 1984 and 21 March 1986. The station has reactors housed in a reactor building with double shell containment ensuring total protection even in the remotest possibility of loss of coolant accident. An Interim Storage Facility [ISF] is also located in Kalpakkam. The two facility houses indigenously built Canada Deuterium Uranium (CANDU) type Pressurised Heavy Water Reactors (PHWRs) called Madras Automic Power Station [MAPS-1 and MAPS-2]. 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 MAPS-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.

Table 10 : Power Generated from both the Reactor till June 2009

Unit	Cumulative Generation(MUs)
1	23085
2	23547

Kudankulam Atomic Power Station

Kudankulam NPP with two Vodo - Vodyanoi Energetichesky Reactor (i.e., water – Water Energetic Reactor) (VVER-1000), reactor plants of 2000 MW total capacity is the basic object of the Russian-Indian cooperation in the field of nuclear engineering. The construction of Kudankulam NPP in India is stipulated by the agreement between the former Union of Soviet Socialist

Republics (USSR) and the Republic of India dated 20 November 1988, and also by the supplement to this agreement signed on 21 June 1998. This project is expected to commission in December 2009. VVER-1 and VVER-2 expected to commission on September 2010.Table 11 shows the installed capacity of nuclear power reactors year–wise.

Table 11 : Installed Capacity (at the command of TNEB)

Year Ending march	Total Installed Capacity (MW)	Nuclear (MW)	% to Total
2000–01	7513	364	5
2001–02	7924	372	5
2002–03	8268	492	6
2003–04	9319	531	6
2004–05	9531	531	6
2005–06	10031	531	5
2006–07	10098	447	4
2007-08	10122	501	5

Source: TNEB, Statistics at a Glance - 2008 Annual Report

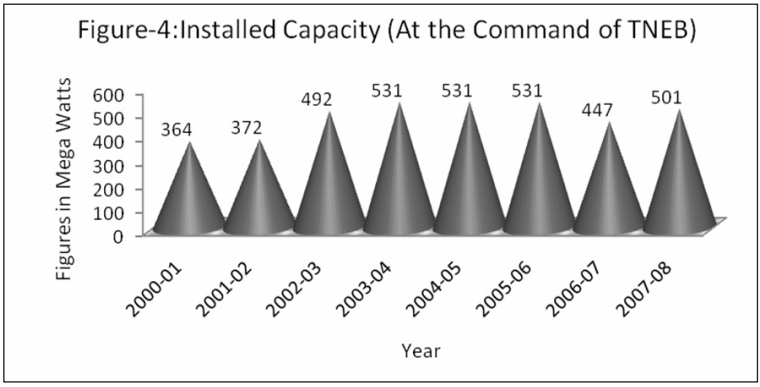
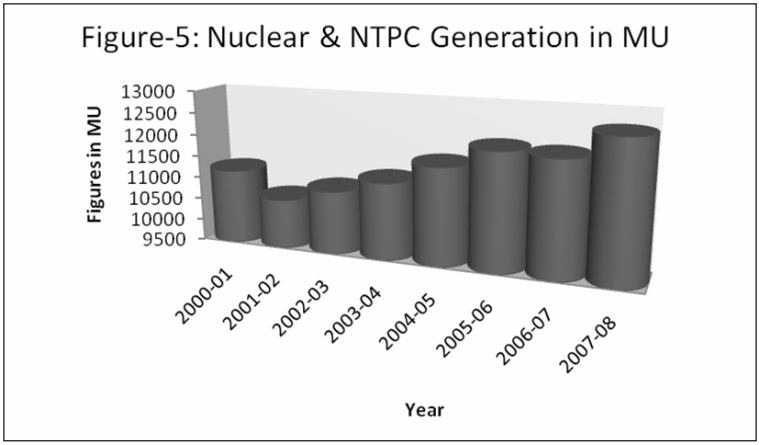


Table 12 gives us the year wise generation from Nuclear Power Stations from along with NTPC 2000–2001 to 2007–2008:

Table 12 : Generation From Nuclear and NTPC

Year Ending march	Total Gross	Nuclear&NTPC	
	MU	MU	%
2000–01	41764	11200	27
2001–02	43920	10623	24
2002–03	46389	10933	23
2003–04	49498	11242	23
2004–05	52345	11698	22
2005–06	56726	12133	22
2006–07	63563	12080	19

Source: TNEB, Statistics at a Glance - 2008 Annual Report



Share from the Central Sector Projects

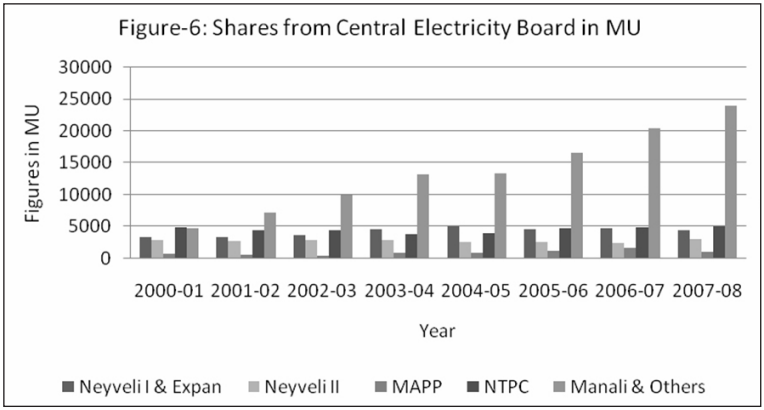
The Electricity Regulatory Commissions (ERC) Act, 1998 was enacted with the objective of distancing Government from the tariff regulation. The Act provided for Electricity Regulatory Commissions at the Centre and the States for rationalization of electricity tariff, transparent policies regarding subsidies etc. The ERC Act, 1998 has since been replaced by the Electricity Act, 2003. The Central Electricity Regulatory Commission (CERC) created under the provisions of ERC Act, 1998 has been recognized as the CERC under the Electricity Act, 2003.

Table 13 gives the share from the NLC and NTPC to TNEB year wise from 2000–2001 to 2007–2008

Table 13 : Share from NLC and NTPC to TNEB

Year	Neyveli I & Expan	Neyveli II	MAPP	NTPC	Manali & Others	Total
2000–01	3328	2972	710	4900	4707	16617
2001–02	3375	2773	601	4475	7134	18358
2002–03	3659	2832	402	4442	9928	21263
2003–04	4584	2842	965	3816	13177	25384
2004–05	5059	2629	913	4010	13284	25895
2005–06	4658	2661	1173	4814	16505	29811
2006–07	4734	2460	1684	4887	20317	34082
2007–08	4515	3068	1064	5003	23924	37574

Source: TNEB, Statistics at a Glance - 2008 Annual Report



Conclusion

From above graph we have seen that the shares from the CEB to TNEB has risen from 34,082 MU in 2006-07 to 37,574 in 2007-08. Compared to all other means, generation through thermal plant was higher in 2007–08 with the generated capacity of 21,355 MU and in 2006–07 it was 21,228 MU, an increase of 127 MU than the previous year. , While the Thermal Power Plants have higher generation, it has been a costly means of production. In addition these plants also affect the atmosphere and produces greenhouse gases. Fly ash (wastes produced in Thermal Plants) also pollutes the surrounding habitation including the flora and fauna. Emission of Carbon dioxide also contributes towards climatic change and global warming. While it is important to generate more power, it should not be at the cost of adverse impact on the environment, hence alternate solutions are to be sought.

Tamil Nadu Energy Development Agency

The Tamil Nadu Energy Development Agency (TEDA) is the Nodal Agency of the Ministry of New and Renewable Energy (MNRE), Government of India, for the promotion of renewable energy schemes in the state. It has been registered as a society under the Societies Registration Act and is functioning since 1985. It is under the administrative control of the Energy Department. Tamil Nadu Energy Development Agency has set the following as its main objectives:

- Identifying and estimating the potential for renewable energy in the state.
- Creating awareness on the potential and prospects by use of renewable energy.
- Enhancing renewable energy contribution in the overall energy mix in the State Grid.
- Abatement of green house gas emissions caused from increasing use of conventional fuels by promoting the use of renewable energy/stand alone.
- Systems to combat global warming.
- Developing and implementing sustainable energy security policy towards attaining energy independence in small villages.

Renewable Sources of Energy

The changing climate is one of the major challenges we face today. Rise in global average temperatures, increase in sea

levels and melting of glaciers and ice sheets have underlined the immediate need to address this issue. Developing countries are more vulnerable to the impacts of climate change. Natural climates induced by climate change will have significant impact on economy and development. Essentially, we need to tackle the problem of increasing concentration of green house gas (Carbon) emissions. To reduce carbon emission we need to promote clean and efficient technologies, harness renewable energy sources and adopt better waste management technologies etc.

In order to overcome the above mentioned problems, the Central and State Governments are making concerted efforts to identify alternatives to the use of fossil fuels which pollute the atmosphere and cause global warming. These alternative sources require very low operating cost and are also easier to handle by the user.

Renewable energy sources offer scope for power generation in dispersed mode and at the load points there by eliminating line loss. More over, they are eco-friendly and do not pollute the environment. Considering these merits the Government of Tamil Nadu has given special emphasis to the development of renewable energy sources offering incentives and support for the implementation of renewable energy projects.

While the supply of oil resources remain finite and demand for the same continues to escalate, it becomes that for true energy security a major shift in the structure of energy sources from fossil fuels to renewable energy is mandated. So we have to concentrate on the sources that are obtained from the nature to develop the nation.

Some of the renewable energy sources are

- Hydro energy
- Wind energy
- Solar energy
- Bio-gas energy.

The two main reasons for adopting Renewable Energy are

- Projected extinction of fossil fuel.
- Reduce green house gas emissions into the atmosphere and combat global warming.

Hydro Energy

Hydro-Electricity Projects

Hydro power is a renewable, economic, and non-polluting source of energy. Hydro power stations have the ability of quick starting, stopping and load variations offering operational flexibility and help in improving reliability of power system. Hydro stations are the best choice for meeting the peak demand. Hydroelectric projects have long useful life extending over 50 years and help in conserving scarce fossil fuels. They also help in opening up avenues of development in remote and backward areas. Development of hydro power resources is important for energy security of the country.

The hydro-electricity projects that are operating in Tamil Nadu and the generation capacities of these projects from the year 2000–2001 are seen in table 14.

Table 14 : Hydro Station Generation (Units in MU)

Station	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08
Pykara	344	377	251	142	212	257	171	160
Moyar	148	163	104	56	90	175	174	180
Kundah-I	295	239	129	73	246	326	343	347
Kundah-II	739	577	316	172	669	857	846	903
Kundah-III	433	348	206	123	416	517	522	551
Kundah-IV	142	125	71	40	163	191	502	226

Kundah-V	87	56	45	18	75	90	72	93
Mettur Dam	83	94	43	15	25	90	91	152
Mettur Tunnel	623	319	90	69	308	640	656	594
Periyar	486	460	227	213	492	441	515	291
Suruliyar	92	87	75	48	102	126	108	122
Papanasam	125	99	65	46	89	130	145	137
Sarkarpathy	159	150	95	52	114	115	150	153
Aliyar	183	120	108	86	161	204	175	184
Kadampari	186	157	202	406	257	582	428	456
Sholayar - I	326	227	267	148	270	306	316	375
Sholayar - II	56	32	37	52	81	73	63	64
Kodayar - I	237	151	109	106	136	154	225	201
Kodayar - II	89	66	45	46	72	90	89	84
Servalar	35	24	18	17	35	54	42	47
Lower Mettur	430	365	169	96	256	342	417	356
Pykara Mini	6	7	4	2	5	11	10	10
Vaigai Small	20	21	4	6	13	18	20	27
Bhavani	30	28	18	9	38	38	52	46
Poonachi	2	2	2	2	4	5	2	2
Maravakandi		2	1	1	1	3	2	2
Lower Bhavani RBC	14	1	0	1	23	25	69	37
Sathanur	16	16	2	2	10	23	8	5
Parsons Valley	64	35	19	18	56	53	59	53
Thirumurthy mini	-	-	1	2	3	5	4	6
Mukurthi Mini	-	-	1	1	2	3	3	2
Aliyar Small	-	-	-	-	2	8	4	11
Pykara Ultimate Stage	-	-	-	-	-	189	281	475
Perunchani Mini	-	-	-	-	-	-	-	1
Bhavani kattalai	-	-	-	-	-	-	-	92
Amaravathy	-	-	-	-	-	-	-	10
Total	5450	4348	2724	2068	4426	6141	6564	6455

Source: TNEB, Statistics at a Glance - 2008 Annual Report

The generation from hydel source for the year 2008–2009 was 5386 MU as against 6455 MU in the previous year due to less rain in catchment areas. The storage as on 1.04.09 was 733.184 MU as against 1243.74 MU during the same time last year. Hence the available water is being utilized judiciously during peak hours to meet the demand.

While discussing with various officials of the TNEB and Government of Tamil Nadu it was pointed out that in Tamil Nadu Power Generation from all the existing Hydro-Electric Power Projects has reached the optimum level and that there is no further scope for new projects. The only thing we can do is increase the installed capacity i.e., increase the generator capacity. Moreover in Tamil Nadu the flow of water from the rivers is limited and on account of irregular monsoons in the catchment areas all the dams go dry in the summer season making further development of the waters for generation of power is difficult.

The state's limited hydel potential is estimated to be of the order of 3737.6 MW. Commissioning of major projects with more than 100 MW capacities has become a rare phenomenon after the exploitation of all the possibilities. Succession of Lower Mettur Barrage (120 MW) commissioned on October 1988 was possible by Pykara Ultimate Stage with 150 MW on September 2005, after a gap of nearly two decades. This breakthrough coupled with a comfortable storage position due to record rainfall had resulted in an overall increase in the hydel generation. The quantum of generation from the hydel sources had reached an all-time high level of 6455 MU in 2007–2008.

TNEB has several new records from all the 33 hydro electric projects put together in 2006–2007. The energy generation from these sources had an all time high level of 6564 MU, the previous peak was 5450 MU in 2000–2001. The performance of hydel projects is highlighted by the yardstick of quantum of output – 17 years out of two decades had a comfortable stay by exerting more than 3300 MU to the State Grid. The PLF, the single reliable indicator, also places the hydel projects at the supreme state. The hydel PLF was recorded at 33% in 2005–2006 against 25% in 2004–2005.

The hydel output depends not only on the efficiency of the project but also the water availability which is unpredictable. All the hydel projects put together had generated 2.87 MU/MW, on an average, during 2005–2006 against 2.22 MU in 2004–2005 and 1.04 MU in 2003–2004.

Wind Energy

The wind sector in India has seen phenomenal growth during the past few years, catapulting India to fourth position in the world in terms of wind power installations.

Wind has considerable potential as a global clean energy source, on account of being both widely available, though diffuse, and producing no pollution during power generation. The amazing growth of wind power in the past ten years is attributable to a multiplicity of enabling factors, including the evolution of a conducive policy and regulatory framework. The good thing is that the transition to renewable sources of energy has begun, and this transition is being led by wind power.

Growing concern for environmental degradation has led to resurgence in the world's interest in renewable energy resources. Wind is commercially and operationally the most viable renewable energy resource.

During the early 1990s, with the opening of Indian economy in general, and private sector investments in the power sector in particular, the Department of Non-Conventional Energy Sources (DNES) issued guidelines for promotion of renewable energy projects. The guidelines charted a market framework, which would make the private sector investments viable, based on the data generated from demonstration projects already operational

in India. The total economic benefits available to wind energy projects in the private sector are listed in table 15.

Table 15 : Economics of Wind Energy Investments in the Early 1990s

S. No.	Item	Particulars
1.	Assumed cost of the wind turbine	Rs. 100
2.	Corporate tax (including surcharge)	57.5%
3.	Allowable depreciation	100%
4.	Benefit due to tax shelter	Rs. 48.3
5.	Sales tax benefit (50% of capital cost)	Rs. 42
6.	Effective return on day one on an investment of Rs. 100	Rs. 90.30
7.	Investment to recover	Rs. 9.70

Source: TNEB, Statistics at a Glance - 2008 Annual Report

As can be seen from table 15, the investment risk in wind energy projects was reduced to less than 10% of the capital cost by using tax-planning instruments the same coupled with preferential tariffs for sale, captive consumption, or third-party sales thereby incentivizing public and private organizations to invest in wind energy projects. These incentives provided a boost for investing in wind energy and witnessed a visible increase in wind energy projects in 1994-95 in India.

The Electricity Act, 2003, under Section 86(i)e, mandates each Structural Engineering Research Centre (SERC) to ensure that a portion of power generated is from renewable sources and leaves it to the commissions to determine the percentage.

Another major boost to setting up of wind turbines came from an altogether unexpected source viz, the Textile Ministry. In order to bolster the industry's global competitive ability, the Ministry came up with a funding mechanism in the form of the Textile Up-gradation Fund Scheme in 1999, which had a 5% subsidy component (now withdrawn). The industrialists used the fund to install turbines – which give them captive power – as a hedging mechanism against the increasing costs of power. These investors see wind energy as a 'price security' investment that ensures that their energy cost remains frozen for 10–20 years.

Tamil Nadu is endowed with three lengthy mountain ranges on the Western side with a potential of 1650 MW in Palghat pass in Coimbatore District, 1300 MW in Shengottai pass in Tirunelveli District and 2100 MW in Aralvoimozhi pass in Kanniyakumari District and 450 MW in other areas totalling 5500 MW. There are 41 Wind potential sites in eight districts in the state, according to the Wind assessment studies carried out by TEDA with the funding assistance of MNRE and the State Government. Under this programme identification of high wind prone zones with annual mean wind speed of 18 km/hr and above and annual mean Wind Power Density (WPD) of 150 W/m^2 and above, at 50 m height was undertaken by TEDA with financial assistance from Ministry of New and Renewable Energy (MNRE), Wind farms have so far been set up in 26 sites of the above, almost entirely by the private sector, except 19 MW of Demonstration Wind farms in 8 locations set up during 1986 to 1993, jointly by TEDA and TNEB, but now run and maintained by TNEB. The total installed capacity of wind mills in the state including the 19 MW under public sector is 4287 MW (8451 Machines) as on 31 March 2009. The addition made during the year 2008–2009 was 431 MW. The capacity addition made during Tenth Five Year Plan (2002–2007) and the two years under Eleventh Five Year Plan are in table 16.

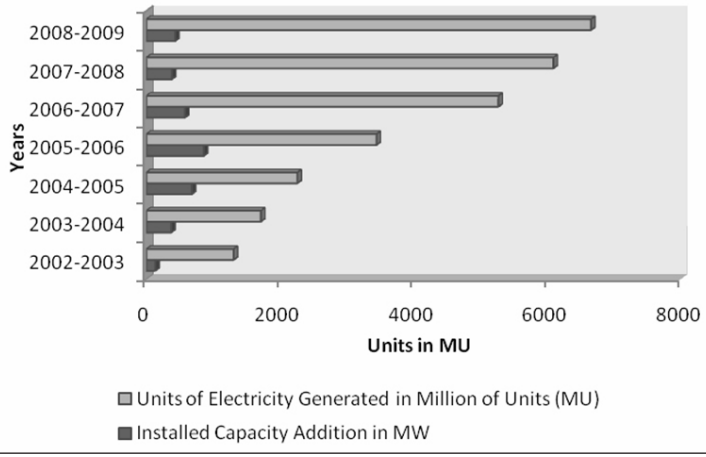
Table 16 : Capacity Additions

Year	Installed Capacity Addition in MW	Units of Electricity Generated in Million of Units (MU)
2002–2003	133	1305.703
2003–2004	371	1714.475
2004–2005	679	2260.732
2005–2006	858	3444.281
2006–2007	577	5268.840
Total	**2618**	**13994.030**
2007–2008	381	6092.369
2008–2009	431	6655.150

Source: TNEB Policy Note - 2009

In addition to promotion of wind power generation, Government of Tamil Nadu encourages the installation of windmills for water pumping.

Figure-7: Wind Energy Installed and Generation Capacity



So far 871 water pumping windmills have been installed all over Tamil Nadu, 4 water pumping windmills will be installed with Tamil Nadu Government subsidy of Rs. 20,000 each over and above the central subsidy during 2001–2002 against the sanction made for 8 pumps.

- Tamil Nadu ranks first in the country with the installation of 8451 Wind Electricity Generators with a total capacity of 4287 MW under government funded demonstration programme.
- The first private sector wind farm of the country was set up in Tamil Nadu during 1990.
- 61% of the National installed capacity of the wind farms has been contributed by Tamil Nadu.
- The single largest area of private wind farms of the country is in Tamil Nadu with an installed capacity of over 415 MW and this is next only to the cluster of wind farms existing at California in United States of America.

- The wind farms in Tamil Nadu have generated 6655.10 Million Units of electricity up to 31 March 2009 and fed to the TNEB grid.

In recognition of Tamil Nadu's commendable achievement in wind power generation, the state was awarded the first prize for wind power programme in 2002–2007.

Wind resource assessment studies were carried out in 69 wind prone zones by setting up wind monitoring stations since 1986, out of which 41 sites having annual mean wind speed of 18 km per hour and above with annual mean wind power density of 150/200 W/m^2 and above at 30m/50m level, have been declared by MNRE as potential and viable for commercial projects. Windmills have so far come up in 26 sites. Nine new wind-monitoring stations are under installation (one completed) through Centre for Wind Energy Technology (C-WET) a Government of India undertaking in various districts with 20% cost sanctioned by the State Government and balance 80% cost provided by MNRE to C-WET.

In order to increase the availability of power especially to the farmers, Hybrid Systems which will be run using both Wind and Solar Energy could be used. Ministry of Non-conventional Energy Sources, Government of India is providing up to 50% subsidy for these systems.

The main advantages of power generated from wind energy are

- The capital cost is comparable with conventional power plants. For a wind farm, the capital cost ranges between 4.5 crores to 6.85 crores per MW depending upon the type of turbine, technology, size, and location.
- Construction time is less.
- Fuel cost is zero.
- Operation and Maintenance cost is very low.
- Capacity addition can be in modular form.
- There is no adverse effect on global environment. The whole system is pollution free and environment friendly.

Table 17 : Comparison between Fossil Fuels and Wind

Availability	Usable as it exists	Has to be produced and made usable Through laborious and environmentally damaging processes
Limitation On availability	Inexhaustible resource	Limited in reserves, expected to get completely exhausted in the coming 60 years
Transportation	Used where it is available	Have to be transported from the site for further processing exposing environment to danger
Use in production	Zero emission	Used in producing electricity releasing green house gasses
Geo-political implications	Reduces our reliance on oil, safeguarding national security	Over-reliance on oil as a resource has undermined our energy security. E.g. OPEC crises of 1973, Gulf War of 1991 and Iraq War of 2003.
		There is no adverse effect on global environment. The whole system is pollution free and environment friendly.

Limitation

- Wind machines must be located where strong, dependable winds are available most of the time.
- As there are no strong winds all the time, energy from wind machines is considered 'intermittent', that is, it comes and goes. Therefore, electricity from wind machines must have a back-up supply from another source.
- As wind power is 'intermittent', utility companies can use it for only part of their total energy needs.
- Wind towers and turbine blades are subject to damage from high winds and lighting. Rotating parts, which are located high off the ground can be difficult and expensive to repair.
- Electricity produced by wind power sometimes fluctuates in voltage and power factor, which can cause difficulties in linking its power to a utility system.
- The noise made by rotating wind machine blades can be annoying to neighbouring settlement.

Tamil Nadu, which generates more than half the country's total wind power, is inching closer to reaching its estimated wind

power potential of 4500 MW from 41 sites identified so far. As on 31 July 2007, it had 2988 MW installed capacity generated by 6,421 windmills. 'We have several applications totalling an approximate 500 MW generation capacity waiting for NOC from TNEB.' This huge wind power generation is possible because of the tunnelling effect at the three major passes in the Western Ghats, the Aralvoimozhi, Sencotta, and Palghat passes.

The map and statement below indicates how the three passes in Tamil Nadu are endowed with heavy wind flows due to the tunnelling effect during the South West Monsoon:

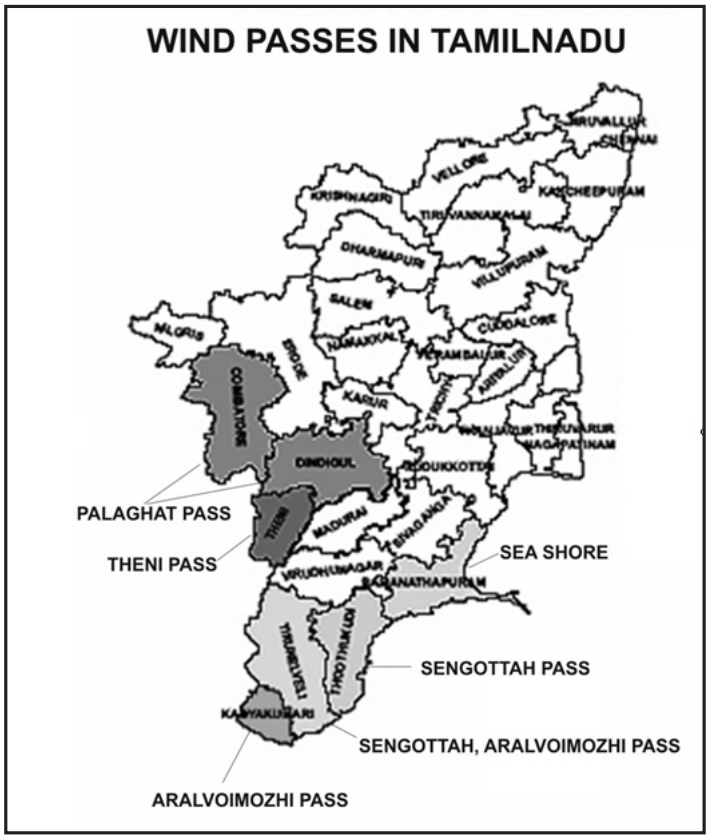


Table 18 : Passes and Wind Speeds

Name of the Pass Districts	Annual average Wind speed (Km/hour)
Palghat Pass Coimbatore, Erode	18–22
Sencotta Pass Tirunelveli, Tuticorin	18–22
Aralvoimozhi Pass Kanyakumari	19–25

Source: TNEB, Statistics at a Glance - 2008 Annual Report

Table 19 lists the wind power installed in 2009.

Table 19 : Wind Power Installed in Tamil Nadu in 2009

WEGs installed by	Installed Capacity in MW
TNEB	19.355
Private	4268.385
Total	4287.740

Source: TNEB, Policy Note - 2009

Role of TEDA in Promoting Wind Power

- During 1986 to 1993, around 120 demonstration wind farms with a total capacity of 19.355 MW were established jointly by TEDA and TNEB in lands owned by TEDA.
- Fund assistance towards cost of the machineries was provided by the Ministry of New and Renewable Energy (MNRE), Government of India.
- The success of these demonstration projects has ultimately resulted in a total installed capacity of around 4280 MW of wind energy which today contributes to 10% of the gross generation (in terms of MU) of the state.

Table 20 : Wind Mill Installed Capacity as on 31 March 2009

S. No.	Year	Installed Capacity in MW		Generation in Million Units
		During year	Cum. Total	
1	Up to 1997	-	676.155	1485.372
2	1997–1998	31.14	707.295	765.854
3	1998–1999	17.765	725.06	928.865

4	1999–2000	45.675	770.735	1156.593
5	2000–2001	41.895	812.63	1094.175
6	2001–2002	44.035	856.665	1257.11
7	2002–2003	133.6	990.265	1305.703
8	2003–2004	371.225	1361.49	1714.475
9	2004–2005	678.375	2040.23	2260.732
10	2005–2006	857.555	2897.78	3444.281
11	2006–2007	577.91	3475.69	5268.982
12	2007–2008	381.075	3856.765	6066.646
13	2008–2009	430.975	4287.74	6655.149 (Up to 28.02.2009)
	Total	4287.740		33403.938 (up to 28.02.2009)

Source: TNEB, Policy Note - 2009

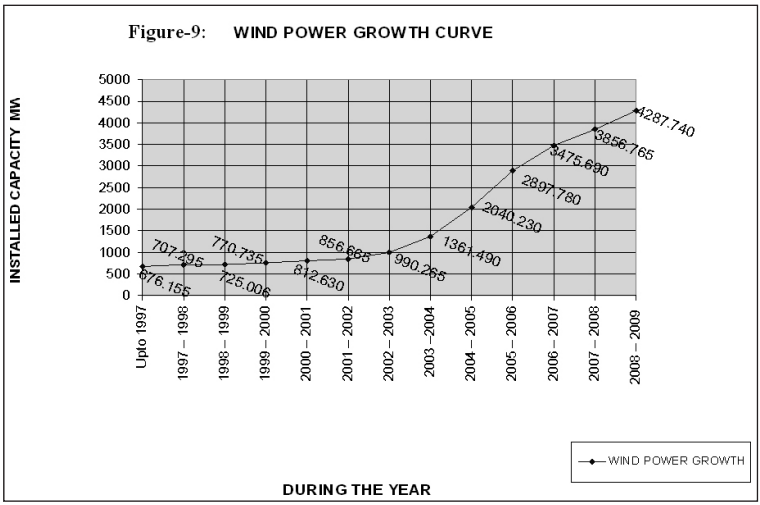


Table 20 and the associated graph shows the growth trend of the wind power (install capacity) through the years. In the year 1997 it started with 676.155 MW then it increased gradually every year after 2003–04. In 2007–08 generated capacity was about 3858.765 MW and now the generation is increased to 4287.74 MW in 2008–2009 and contributes to almost 44% of the country's total capacity.

Proposed Developments

- The primary locations having high wind potential have been exploited leading to installation of new wind mills to secondary locations with less PLF. Most of the wind mills in the primary locations are of lesser capacity and have served for around 10–15 years.

  Hence it becomes necessary to explore the possibility of replacing the aged wind mills by new/higher capacity wind mills with advanced technology.

- To explore the possibility of installing SPV plants between the existing wind mills leading to hybrid operation, since no separate investments are required for power evacuation.

Power borrowed from Central Government Units is generally around 2125 MW and average import cost during the month of December 2008 is Rs. 2.68 per unit. The Tamil Nadu Government proposes to purchase about 500 MW of electricity from power surplus states to provide uninterrupted power supply to domestic and industry users during the summer this year. Most of the power from centre is from NTPC, Talchar, Orrisa.

A package of incentives which includes fiscal concessions, custom duty excise duty exemption and 10 year tax holiday are available for Wind Power projects from Government of India. Intra-state open access regulations have been notified and preferential tariff orders have been issued for Wind Power Projects in Tamil Nadu by the Tamil Nadu Electricity Regulatory Commission (TNERC). As per the revised tariff orders issued in 13 May 2006, the rate is Rs. 2.75 per unit for the projects for which agreements have already been signed and Rs. 2.90 per unit where the agreements are yet to be signed. The wheeling and banking charges remain unchanged at 5% each. The TNERC has issued orders enhancing the rate from Rs. 2.90 to Rs. 3.39 per unit, effective from 1 April 2009.

Facing acute power shortage, Tamil Nadu is increasingly focusing on alternative energy sources, especially the wind energy, as the state – the largest producer of wind power in the country – is poised to increase windmill generation by 40% in 2008.

Solar Energy

Solar energy is radiant energy that is produced by the sun. The sun radiates more energy in one second than people have used since the beginning of time. Nearly 15 % of the sun's energy that hits the earth is reflected back into space. Another 30% is used to evaporate water, which when lifted into the atmosphere, produces rainfall. Solar energy is also absorbed by plants, the land and the oceans. The rest could be used to supply our energy needs.

The solar water heater gained popularity in Florida, California, and the Southwest in America. The industry started in the early 1920s and was in full swing just before World War II. This growth lasted until the mid-1950s when low-cost natural gas became the primary fuel for heating American homes.

The public and world governments remained largely indifferent to the possibilities of solar energy until the oil shortages of the 1970s. Today, people use solar energy to heat the water and to generate electricity.

Advantages

- Solar energy is free – it needs no fuel and produces no waste or pollution.
- Countries that have abundant solar radiation can use solar power to supply electricity to remote areas.
- Handy for low-power uses such as solar powered garden lights and battery chargers, or for helping your home energy bills.

Recent years have seen rapid growth in the number of installations of Photovoltaic panels on the top of the buildings that are connected to the electricity grid. This area of demand has been stimulated in part by Government subsidy programmes (especially Japan and Germany) and by green pricing policies of utilities or electricity service providers (e.g. Switzerland and the USA). The central driving force comes from the desire of individuals or companies to obtain their electricity from a clean, non-polluting, renewable source for which they are prepared to pay a small premium.

Twenty-three other government buildings in Tamil Nadu also meet their power needs from the sun. In fact various equipments such as streetlights, domestic lanterns, water heating systems in government hospitals, public lighting systems in remote hilly areas, home lighting systems, solar photo-voltaic pump sets, sprayers, solar air heaters, cookers and community TV sets, are all solar-powered.

The Government estimates India's Solar Photo-Voltaic energy potential at 22 MW/sq km. Only a very small percentage has been harnessed constructively. Within this small percentage is a growing list of efficient applications – solar refrigerators, solar radios, even solar hearing aids, as well as good old calculators and cookers. The world's first solar-powered crematorium, set up in Gujarat, will save about 600 pounds of firewood for each body cremated.

Part of the reason for Tamil Nadu's success, particularly in the area of solar power, is the abundant availability of sunshine. But that is only half the reason – the administration has actually made an effort to encourage a form of energy that, in the long-run, is cheaper and easier to service than conventional sources.

Photovoltaic

Photovoltaic (PV) comes from the words 'photo' meaning light and 'volt', a measurement of electricity. The cost per kilowatt – hour to produce electricity from PV cells is currently three to four times as expensive as from conventional sources. However, PV cells make sense for many uses today, such as providing power in remote areas or other areas where electricity is difficult to provide. Scientists are researching ways to improve PV cell technology to make it more competitive with conventional sources.

While the use of solar energy will not cause air or water pollution, the use of the photo voltaic cells to harness that energy consumes silicon and produces some waste products. In addition, large solar thermal farms can harm desert ecosystems if not properly managed. Most people agree, however, that solar energy, if it can be harnessed economically, is one of the most viable energy sources for the future.

Solar Power Generation

In order to promote the use of solar Energy for producing grid quality power in the country, the ministry of New and Renewable Energy (MNRE), Government of India, has introduced new guidelines in January 2008, whose salient features are given below.

For the first time, generation based incentives will be provided for grid interactive solar power generation. A maximum amount of Rs. 12.00 per Kwh will be provided as incentive for electricity generated from solar photovoltaic and Rs. 10.00 per KWh for electricity generated through the solar thermal route and fed to the grid from a power plant of 1 MW capacity and

above. This incentive will be provided to the project developers at a fixed rate for a period of ten years for the projects which are commissioned by 31 December 2009. This incentive will be available for the existing registered companies, Central and State Power generation companies and public/private sector power project developers who have set up or propose to set up a registered company in India. The maximum capacity per project will be 5 MW either through a single project or multiple projects of a minimum Capacity of 1 MW each. Each state may be allowed to set up to 10 MW under this programme. These projects are to be undertaken on Build, Own and Operate basis. Based on the Global Tender issued by TEDA, 5 MW SPV project and 1 MW Solar Thermal Power Project by private promoters has been identified under this scheme and the proposals received from the firms have been recommended to MNRE. They had also entered into an Energy Purchase Agreement (EPA) with TNEB.

The one great advantage of renewable energy is that it can be generated wherever it is required using available systems namely.

Solar Water Heating Systems

In Tamil Nadu, Totally 3522 domestic solar water heating systems and 419 industrial systems were installed under subsidy schemes of MNRE (up to 1992–93) and the state government as on 31.3.2008. Solar water heating systems have also been installed in 70 government buildings such as hospitals, hostels etc., with 100% funding by the state government. For the year 2007–08, the sate government has sanctioned Rs. 10,000 lakhs for installation of solar water heating systems in government institutions.

Solar Street Lighting System

The most common and widely used outdoor lighting system is the SPV street lighting systems with SPV module capacity of 74 WP, a lead acid battery (12 v 75 Ah) and a CFL of 11 Watt. It can operate from dusk to dawn with automatic switch ON/OFF for 10–12 hours daily.

A Solar PV water pumping system consists of a number of Solar PV modules connected in series-parallel combination to generate sufficient power to operate a motor pump. No battery is provided and hence can be run only during the day when sunshine is available.

Solar educational kits help students on the beneficial use of solar energy.

Solar Traffic Signals

The Solar Traffic signals are operating in five places in Chennai with a Government subsidy of Rs. 1.5 lakhs for each signal.

Solar Vaccine Refrigerators

This scheme with a sanction of Rs. 10 lakhs per year from the State Government is operating in five primary health centres which are in remote villages.

Bio Gas Energy

Biomass is the name given to any organic matter that has been derived from plants as a result of the photosynthetic conversion process. Biomass energy is derived from plant and animal material such as wood from forests, residues from agricultural and forestry processes, and industrial, human, or animal wastes. Biomass is not fossilized material (e.g., oil, coal) but fresh material that can grow again after having been harvested.

The Tamil Nadu Biomass Power Producers Association estimates that a 10 MW biomass power plant can ensure livelihood of over 200 marginalised families. They can be employed in collection, transportation, cutting, chipping of biomass and cultivation of wasteland with energy plants such as juliflora.

The increase of large power projects, nuclear reactors etc., seems to have sidelined the potential of biomass in providing energy security and rural employment round the year all over the country.

Though the Union Ministry of New and Renewable Energy (MNRE) has set ambitious targets of creating energy and employment from biomass, the experience of entrepreneurs in Tamil Nadu and other states shows that the biomass programme is only on paper.

Biogas can easily be produced from current waste streams, such as paper production, sugar production, sewage, animal waste and so forth. These various waste streams have to be slurred together and allowed to naturally ferment, producing methane gas. This can be done by converting current sewage plants into biogas plants. When a biogas plant has extracted all the methane it can, the remains are sometimes more suitable as fertilizer than the original biomass.

Alternatively biogas can be produced via advanced waste processing systems such as mechanical biological treatment. These systems recover the recyclable elements of household waste and process the biodegradable fraction in anaerobic digesters.

Renewable natural gas is a biogas which has been upgraded to a quality similar to natural gas. By upgrading the quality to that of natural gas, it becomes possible to distribute the gas to the mass market via the existing gas grid.

Advantages

The most important advantage of biomass is that it is easily available. In the agricultural industry, residuals such as bagasse (fibres) from sugarcane, straw from rice and wheat, hulls, and nutshells, as well as manure lagoons from cattle, poultry and hog farms are usable. Similarly, the timber industry has a lot to offer. Wood wastes such as sawdust, timber slash, and mill scraps are considered organic materials. Even in cities, paper and yard wastes are usable. Fully utilized biomass reduces pollution in underground water bodies by offsetting the amount of waste in landfills. Methane and other poisonous gasses that form from dead organic matters can be found in landfills and water treatment plants. These can be captured and converted into fuels suitable for generating electricity.

Economic Benefits

Energy producers and consumers will have available a renewable energy option with uniquely desirable characteristics. Biomass

has the greatest potential of any renewable energy option for base load electric power production. It is also the renewable resource with the most promise for producing economically competitive liquid transportation fuels. Co-production facilities will allow the production of electricity when it is needed and ethanol when it is not acting, in effect, as "seasonal peaking" facilities. The energy security of a nation will be significantly enhanced. With sustainable agricultural practices, biomass fuels could replace half or more of the nation's entire current level of gasoline consumption. Burning new biomass contributes no new carbon dioxide to the atmosphere because if we replant harvested biomass, carbon dioxide is returned to the cycle of new growth. Bio conversion and thermal conversion techniques for transforming biomass into fuels are currently under development at NREL and other research laboratories. These new technologies will reduce our reliance on oil and coal with no net addition of carbon dioxide to the atmosphere. New thermal conversion techniques coupled with chemical catalysis are making it possible to exploit the previously discarded lignin fraction by converting it into valuable chemicals that we now get from non-renewable fossil sources.

Environmental Benefits

Agricultural land that might otherwise be converted to residential or industrial use – because we will need fewer and fewer acres to meet the market demand for food – can be used to grow biomass crops which will restore soil carbon, reduce erosion, and chemical runoff, and enhance wildlife habitat. Perennial energy crops can be harvested without damage to the root structure and thus continue to serve as a soil stabilizer and stream buffer and habitat for wildlife. The use of biomass will greatly reduce greenhouse gas emissions. Fossil fuels remove carbon that is stored underground and transfer it to the atmosphere. In a combustion system, biomass releases carbon dioxide as it burns, but biomass also needs carbon dioxide to grow – thus creating a closed carbon cycle. In a gasifier – fuel cell combination, there

is a net reduction of carbon dioxide. In addition, substantial quantities of carbon can be captured in the soil through biomass roof structures, creating a net carbon sink.

Disadvantages

The burning method biomass is not clean. It is similar to the burning of fossil fuels and produces large amounts of carbon dioxide. However, it produces much less harmful pollutants, as the main elements found in organic materials are hydrogen, carbon, oxygen and nitrogen. Furthermore, the extra energy crops and other plants can consume the additional carbon dioxide through photosynthesis.

Rural economies will grow because of the development of a local industry to convert biomass to either electricity or transportation fuel. Because biomass feed stocks are bulky and costly to transport, conversion facilities will be located; where the crop is grown. That means more people have chances of getting employed. Farmers will see their income rise thanks to these new markets – for both agricultural wastes and crops that can be grown sustainably on marginal land. As new markets are created, the rural economy will become more diversified.

After the windmills, the biomass-based plant in Tamil Nadu seems to be helping in mitigating the power shortage in the state.

According to data available with the TNEB, the state has 78 MW of biomass-based generation capacity.

TNEB had targeted to get 30 million units of electricity from these plants. This target was met on 5th May 2009. In the first six days of May, the plants generated 50.77 Million Units of electricity.

The targeted generation for the first six days of May was 5.8 units, which means that the achievement in the period was ten times the target.

In fact this was the trend seen last month also. While the target for April was 30 Million Units, the actual generation exceeded 150 Million Units.

To put this in context, the biomass-based generation contrasts with that of the gas-based plants. With a total capacity of 424 MW, these plants generated only 46 Million Units in the first six days of the month.

Sources in the biomass power industry say that the units are generating more as they are now allowed to sell to third parties, who pay better prices than the Board. Also, the TN Electricity Regulatory Commission on 4th May 2009 raised the tariff for procurement of biomass power from Rs. 3.15 a unit to Rs. 4.50. However, biomass power generation had gathered pace even before the tariff hike.

The estimated power generation potential from Biomass in Tamil Nadu is equivalent of 487 MW as per the District Level Study carried out by Anna University under MNRE funding, another 700 MW potential is available from bagasse based co-generation.

The cumulative installed capacity of grid interactive biomass and bagasse co-generation power projects up to 31 March 2008 was 545 MW (446 MW Bagasse co-generation + 99 MW Biomass Power). During 2007–2008, with regard to bagasse co-generation there was only up gradation in one of the plants from 5.5 MW to 35 MW. Two new plants with a capacity of 64.50 MW have been commissioned. Two Biomass Power projects of 9 MW in Sivagangai District and 7.5 MW in Dindigul district were also commissioned. In the case of co-generation Projects, the total capacity exportable to grid was 256 MW as on 31 March 2008.

In the case of co-generation projects almost all private sugar mills have set up co-generation power plant. But most of the co-operative sugar mills are unable to develop the co-generation projects on account of their poor financial and liquidity position. Therefore TNEB is taking action to fund the co-generation projects in the co-operative sugar mills.

For biomass power project, the technical committee constituted by Government under CMD, TEDA has recommended 22 projects of 227 MW. TNEB has issued consent for 14 projects of 124 MW. This excludes already commissioned projects.

A package of incentives, which includes fiscal concessions such as accelerated depreciation, confessional custom duty, excise duty exemption, income tax exemption on projects for 10 years are available to biomass power projects from Government of India.

Power Generation from Urban and Industrial Wastes

Generation of wastes both in solid and liquid form is associated with industrial and other activities. Civic activities generate solid and liquid wastes while industrial activities mainly generate liquid wastes. Both types of wastes can be used for producing energy through different processes namely bio methanation and combustion.

Biomass Gasifiers

Biomass gasification is basically conversion of solid biomass such as wood, wood waste, agricultural residues etc., into a combustible gas mixture normally called producer gas. They can be utilised for thermal and electrical applications. The required biomass yield can be obtained from energy plantations grown on waste lands. Further, all types of agricultural wastes viz. rice husk, coconut shells, briquettes of various agricultural residues, maize crops branches, and twigs of plants are the possible fuel stocks for the gasifier. Table 21 lists Government of India subsidies for gasifiers.

Table 21 : Government of India (MNRE) Subsidy for Gasifiers

Industrial/ Institutions	
Thermal	Rs. 2.00 lakhs/300 KWe
Electrical Dual Fuel	Rs. 2.50 lakhs/100 KWe
100% Gas Engine	Rs. 15.00 lakhs/100 KWe (Educational Institution) Rs. 10.00 lakhs/100 KWe (Commercial/Industries purpose)
Gasifier Installed under MNRE/ state subsidy	-
Industrial/institution	2670 KWe (Thermal) 2140 KWe (Electricity)
Village Panchayat (small Capacity)	614 KWe (64 Nos.)

Source: TNEB, Policy Note - 2009

The Government of India (MNRE) had sanctioned CFA of Rs. 35 lakhs for installing 1.40 MW Biomass Gasifier (Dual Fuel) for captive power generation plant using Biomass at M/s. Sri Gomathi Mills P. Ltd. Tirunelveli District on reimbursement basis. The plant was commissioned on 10 May 2008.

Bio Gas Plants

Biogas is a flammable gas and is used as fuel. It is technically possible and economically feasible to generate biogas from cattle dung, agro waste, kitchen waste, sugarcane, press mud etc. and also human waste. It is the most appropriate option for meeting the growing energy needs in rural areas. It is a clean and convenient fuel for cooking and lighting in households, and also for power generation in KW scale. The Government of India (MNRE) subsidy is available for installation of Biogas plant up to Rs. 5 lakhs/project or 20% of the project cost. MNRE has sanctioned two biogas based power generation systems, one of 10 KW capacities and another 5 KW capacity to be installed in Coimbatore and Salem Districts respectively by Self Help Groups. The power generated will be utilized for electrification of tribal areas. The Government of India (MNRE) had also sanctioned Central Financial Assistance of Rs. 134.90 lakhs for installation of 1.4 MW captive power generation plant using biogas produced under biomethanetion process from distillery waste through biogas engine at Trichy Distilleries and chemical plant on reimbursement basis. The plant was commissioned on 27 March 2008. The State Government also provided subsidy at 30% of cost for installation of Toilet linked Biogas plants in institutions and Women sanitary complexes in Panchayats. Totally 19 Nos. in institutions and 39 Nos. in Panchayats were installed during 2003-2004 and 2004-2005 through the Director of Rural Development and Panchayat Raj.

Industries and Institutions have greatly benefited by way of saving in power consumption by installing gasifiers and generating power for captive requirements at lesser cost than E.B.

tariff. Totally 10 No. electrical gasifiers of total capacity of 2090 KWe (out of which 1000 KWe in grid connected mode and 1090 KWe in Stand alone mode) and 2 thermal gasifiers of 1250 MW sanctioned by MNRE have been commissioned and the subsidy component of Rs. 278.63 lakhs has been released for the same.

Village Panchayats have also shown great interest in using small capacity gasifiers. Coimbatore District is a pioneer in demonstrating the use of gasifiers for power generation to operate water pumps with 100% producer gas engine. The first ever gasifier of 9 KW capacities was erected at Odanthurai Panchayat in Coimbatore district in 2003 and is running well till date. Including this one, totally 64 Nos. small gasifier systems with total capacity of 614 KW have been commissioned in the local bodies and the subsidy component of Rs. 41.42 lakhs sanctioned by MNRE has been released to them.

The use of gasifiers in crematorium has now become a viable proposition. Besides burning lesser quantity of wood, the contribution to environmental pollution is also reduced. While Chennai Corporation has already installed a number of gasifier crematoriums in the city, the Department of Municipal administration and water supply has planned to install gasifier crematorium in 33 Municipalities and 5 Corporations in the state at a total cost of Rs. 15.20 crores.

Biogas Plants

Biogas technology is one of the oldest and most appropriate option for meeting the growing energy needs in rural areas. It is a clean and convenient fuel for cooking and lighting in households. Biogas is generated as methane gas from cattle dung, night soil, kitchen waste and other organic wastes through a process called anaerobic digestion, which consists of a series of biological and chemical processes.

Domestic biogas plants are implemented through Rural Development Department, while TEDA implements institutional and community biogas plants in higher capacities ranging from

10 to 25 cum. Now subsidy is being provided for electrical power generation. MNRE has sanctioned in February 2007, 2 biogas based power generating systems, [one of 10 KW capacity and of another 5 KW capacity to be installed in Coimbatore and Salem District respectively by Self Help Groups. The power generated will be utilized for electrification of tribal areas. The subsidy component is Rs. 2.80 lakhs out of the total cost of Rs. 24 lakhs.

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