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An analysis of various sources of electricity generation in Tamilnadu

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Abstract
Tamil Nadu is the eleventh largest state in India with an area of 130,058 km2 [50,216 sq mi] and the seventh most populous state with a population of 66,396,000. 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. Electricity is a special good and its generation and consumption have to be simultaneous, it cannot be economically stored. Another special feature of electricity is that its demand varies on hourly, daily, weekly, monthly and yearly basis. Its availability is one of the biggest inputs necessary for the sustained growth. This becomes even more important for a state like Tamil Nadu, which is one of the most industrialized and urbanised state in India. This paper mainly tries to analyse the various sources of electricity generation in Tamil Nadu.

Keywords: electricity, power generation

Introduction
The success of economic growth in an economy with sustainable development critically depends upon the macro economic environment coupled with infrastructural development. As such power development is one of the key input for the overall socio- economic development of a state. Keeping this in view due importance has been given to power sector in the plan -periods in Tamilnadu.

India today faces daunting challenge of ensuring sustainable sources for the supply of energy resources to fuel its high rates of economic growth that it has attained in recent years. being a billion plus country, its success or failure has serious implications for the world as a whole. India's energy needs are predominantly met by coal - the most carbon intensive fossil fuel. On the other hand, India is yet to provide modern energy services like electricity (for lighting) and gas (for cooking) to majority of its population. this implies huge growth of energy consumption in future. In this context, coal as the main source of energy, will put her into difficulty on environmental front. Therefore, India has to explore not only new, but also clean sources of energy to meet its future demand. In absolute terms, India is the fourth largest emitter of C02 (Carbon Dioxide) after the United States, Australia and China respectively. While energy demand is definitely growing in India, the per capita picture of the energy consumption and thus CO2 emissions is not a telling figure.

Objective
The objective of the study is to analyse the various sources of electricity generation in Tamil Nadu.

Methodology
This paper mainly attempts to study the various sources of electricity generation in Tamil Nadu For this, the study mainly depended on secondary data which is collected for 21 years from 1992-93 to 2012-13 and Arima model has been used in this study, the data is collected from the following sources:

1. TNEB, statistics at a glance,2008 Report
2. Statistical handbook of Tamil Nadu
3. Tamil Nadu economic appraisal
4. Directorate of statistics

Analysis

Table 1: Total Generation of Electricity from Various Source in Tamil Nadu

Years	Total Hydro (Mu)	Total Thermal (Mu)	Total Gas Turbine (Mu)	Total Windmill (Mu)	Grand Total (Mu)
1992-93	5636.261 (33.24)	11264.644 (66.42)	28.309 (0.17)	29.158 (0.17)	16958.372 (100)
1993-94	4598.564 (26.09)	12962.010 (73.54)	34.562 (0.20)	31.480 (0.18)	17626.616 (100)
1994-95	5846.733 (29.36)	14026.068 (70.42)	14.351 (0.07)	29.481 (0.15)	19916.633 (100)
1995-96	4714.535 (21.45)	17219.659 (78.36)	17.908 (0.09)	22.585 (0.10)	21974.687 (100)
1996-97	4252.439 (18.53)	18597.548 (81.02)	84.065 (0.37)	19.456 (0.08)	22953.508 (100)
1997-98	5286.63 (22.92)	17681.85 (76.66)	78.64 (0.34)	18.85 (0.08)	23065.97 (100)
1998-99	4872 (21.93)	17073 (76.85)	248 (1.12)	23 (0.10)	22216 (100)
1999-00	4444 (18.87)	18861 (80.09)	217 (0.93)	27 (0.11)	23549 (100)
2000-01	5450 (21.67)	19464 (77.40)	215 (0.86)	18 (0.07)	25147 (100)

2001-02	4350.020 (17.01)	20325.451 (79.52)	869.528 (3.40)	17.202 (0.07)	25562.201 (100)
2002-03	2723.951 (10.93)	21079.791 (84.56)	1107.590 (4.44)	17.817 (0.07)	24929.149 (100)
2003-04	2066.606 (8.57)	20430.560 (84.73)	1592.049 (6.60)	24.347 (0.10)	24113.562 (100)
2004-05	4425.637 (16.73)	20004.035 (75.63)	2003.098 (7.57)	17.634 (0.07)	26450.404 (100)
2005-06	6141.151 (22.82)	18794.682 (69.83)	1964.365 (7.30)	14.581 (0.05)	26914.779 (100)
2006-07	6291.688 (21.34)	21228.398 (72.01)	1943.671 (6.59)	17.634 (0.06)	29481.391 (100)
2007-08	6455.159 (22.08)	21355.298 (73.03)	1418.753 (4.85)	12.058 (0.04)	29241.268 (100)
2008-09	5385.543 (18.58)	21022.712 (72.54)	2564.46 (8.85)	10.000 (0.03)	28982.715 (100)
2009-10	5640.355 (20.24)	19882.409 (71.37)	2327.00 (8.35)	11.093 (0.04)	27860.857 (100)
2010-11	5105.092 (19.91)	19085.008 (74.44)	1435.865 (5.60)	12.676 (0.05)	25638.641 (100)
2011-12	5353.576 (19.16)	20323.641 (72.73)	2252.955 (8.06)	12.148 (0.04)	27942.32 (100)
2012-13	2904.94 (11.48)	20663.39 (81.67)	1720.4174 (6.80)	12.660 (0.05)	25301.40 (100)

Source: Statistical handbook of Tamil Nadu.

From the above table it is studied that, the contribution of total hydro was highest during the year 1992-93 with 33.24 percent and throughout the study period fluctuation can be noticed in the total hydro power generation till the year 2012-13, with fluctuations the contribution of total hydro has gone down to 8.57 percent in the year 2003-04 due to insufficient availability of water, insufficient level of rainfall in catchment areas, less storage of water, unfavourable climatic condition, the hydro power generation mainly depends upon water.

The contribution of thermal power generation was less with 66.42 percent during 1992-93 and its contribution has increased to 84.73 during 2003-04 and in the year 1993-94 it has increased to 73.54percent and from the year 1994-95 there was fluctuations in the thermal power contribution till the current year 2012-13 but in between during 2003-04 the contribution has increased to the highest level with 84.73 percent but after the year 2002-03 the thermal power contribution has decreased gradually and it reached to 81.67percent in the year 2012-13 which is more compared to the year 1992-93 and this is more than the hydro power contribution. The contribution of thermal power to the total generation is more than other sources because of high installed capacity and sufficient availability of coal.

The gas turbine's contribution during the year 1994-95 was low with 0.17 percent when it is compared with the hydro and thermal power contributions and in the year 1994-95 its contribution has come down to least level with 0.07 percent, with fluctuation its contribution was raised to 8.85 percent in the year 2008-09. In 2012-13 the contribution is more than the year 1992-93 but it is less when compared to other sources of power generation like hydro and thermal.

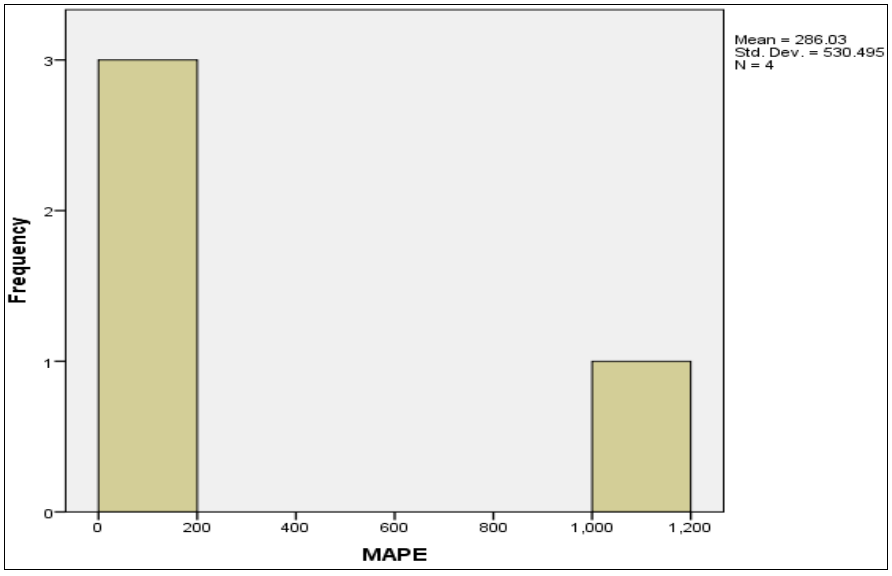
Due to the commencement of new power station like valuthur 1, valuthur -2, kuttalam and kovilkalappal the generation has increased in the year 2012-13.

In the year 1992-93 the windmill's contribution was 0.17 percent and it reduced its contribution to 0.03 percent in the year 2008-09 currently its contribution is much lesser than the year 1992-93 and also when compared to other sources hydro thermal and gas turbine, windmill's contribution towards the total generation is very low. Dependence on wind power generation, which is highly seasonal in nature, is another reason for the massive power deficits in Tamil Nadu.

Among all the power generation sources the contribution of thermal power is more and it is followed by hydro power, gas turbine and windmill, this has been shown with the help of statistical tool.

Table 2: Time Series Modeler – ARIMA Model Description

			Model Type
Model ID	HYDRO	Model_1	ARIMA(0,0,0)
	THERMAL	Model_2	ARIMA(0,0,0)
	GAS TURBINE	Model_3	ARIMA(0,0,0)
	WINDMILL	Model_4	ARIMA(0,0,0)



Model Summary Chart

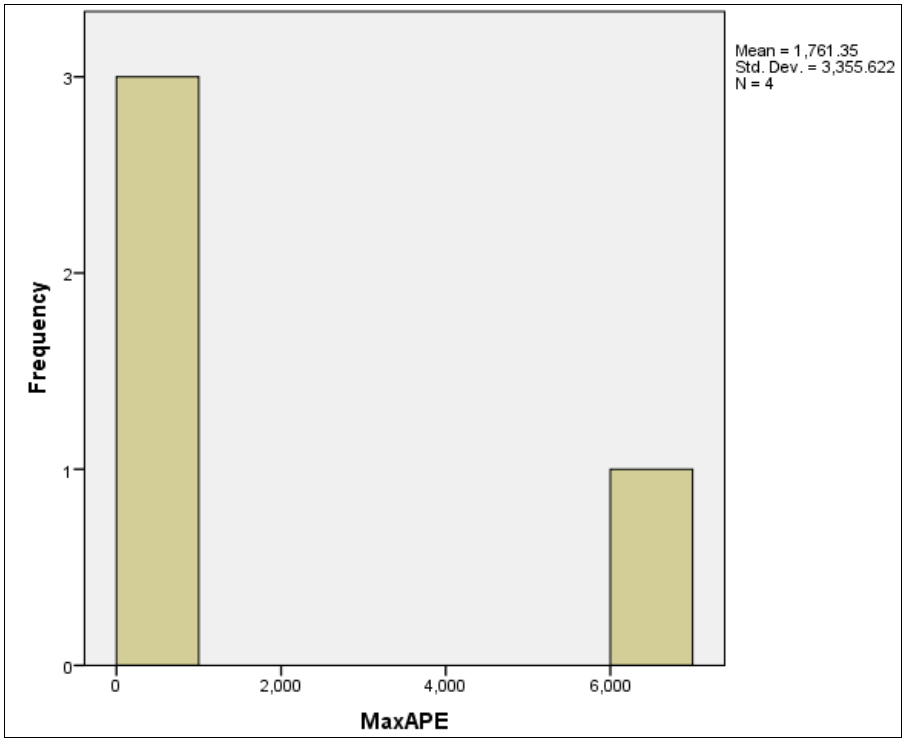


Table 3: Model Summary Model Fit

Fit Statistic	Mean	SE	Minimum	Maximum
Stationary R-squared	.085	.118	.004	.254
R-squared	.085	.118	.004	.254
RMSE	1144.266	1018.231	6.628	2478.161
MAPE	286.035	530.495	10.953	1081.688
MaxAPE	1761.351	3355.622	46.310	6794.609
MAE	864.796	741.563	5.119	1816.506
MaxAE	2301.716	2187.244	11.983	5216.616
Normalized BIC	12.092	5.410	4.073	15.920

Table I shows a goodness of the fit statistics for the first data set. R-squared represents an estimate of the proportion of the total variation in the series that is explained by the model. Largest values (up to a maximum value of 1) indicate better fit. A value of 0,85 means that the model does an excellent job of explaining the observed variations in the series. Mean percentage error (MAPE) for the model is 286%. A measure of how much a dependent series varies from its model-predicted level. Root Mean Square Error (RMSE), i.e. the square root of mean square error is a measure of how much a dependent series varies from its model-predicted level, expressed in the same units as the dependent series. Maximum Absolute Percentage Error (MaxAPE) represents the largest forecasted error, expressed as a percentage. This measure is useful for imagining a worst-case scenario for your forecasts.

Table 4: Model Statistics

Model	Number of Predictors	Model Fit statistics		Ljung-Box Q(18)		
		Stationary R-squared	R-squared	Statistics	DF	Sig.
HYDRO-Model_1	1	.079	.079	16.594	18	.551
THERMAL-Model_2	1	.254	.254	75.521	18	.000**
GAS TURBINE-Model_3	1	.005	.005	128.331	18	.000**
WINDMILL-Model_4	1	.004	.004	82.293	18	.000**

** < 0.01, *<0.05

It is inferred from the table that the various R square values indicates the variations about the power stations. It is found that hydro power station's generation explains almost 7.9%. Thermal power station's generation influences around 25.4%. From the study it is also found that Gas turbine generation's and windmill's generation explains 5% and 4% respectively. Significant values illustrated that Thermal, Gas turbine, windmill differs from each year it shows that these power stations generation changes based on the Years. Since the hydro significant value is greater than 0.05 it shows that there is no changes in power supply based on the years. The significant value of thermal, windmill and gas turbine power stations are lesser than 0.01 so the null hypothesis is rejected at 1% level and alternative hypothesis is accepted.

Findings

Among various sources of electricity generation namely hydro, thermal, gas turbine and windmill, thermal power generation is more and it is followed by hydro, gas and lastly windmill. The windmill generation is very low when compared with the other sources but still Tamilnadu is depending on windmill because it contributes 15% in the supply of electricity and catapulting India to fourth position in the world in terms of wind power installation.

Conclusion

In TamilNadu the generation of the power is less than the consumption of power by different sectors so to fulfil the needs of the consumer T,NE.B is trying to generate more power to satisfy the needs of the consumer so T.NE.B has commenced more new number of hydro power stations since 2000-2001 and also it has increased the installed capacity of thermal power stations and gas power stations so instead of commencing all new project if solar energy is implemented effectively it would be a suitable to solve the power crisis in the state of TamilNadu.

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