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Institutional dynamics and barriers in wind energy development

A case study of Tamil Nadu and Andhra Pradesh, India

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Abstract

Tamil Nadu state had 719 MW of windfarm capacity by September 1998 out of the country's total figure of 992 MW, while Andhra Pradesh had 58 MW installed capacity. 1995-96 saw a boom when 282 MW windfarms were set up in Tamil Nadu and the capacity in Andhra Pradesh increased by 39 MW. Subsequently, there was a steady decline in the windfarm development in both the states.

This case study attempts to trace the reasons for the boom and the factors that have contributed to the slump in windfarm development in these two states. The role of institutions in determining the effectiveness of national and regional public sector initiatives to promote and disseminate wind energy in the two states is discussed. The study has also looked into the financial, technical, transaction and institutional barriers, which inhibit the diffusion of wind energy in the states.

It is suggested in the paper that for rapid growth of wind energy development in Tamil Nadu and Andhra Pradesh, important measures are needed, which include creation of wind fund, establishment of co-operative windfarms, setting up of wind estates, linking generation to incentives for optimum production, promotion of reliable water pumping windmills and wind battery chargers for small-scale applications.

The results of the case study may be used to improve public policy intervention in disseminating wind energy in India. It may also be relevant to multilateral and bilateral aid agencies in their projects and/or programmes to promote cost-effective wind energy technology dissemination in developing countries.

Keywords: Wind energy; institutional barriers; windfarm cooperatives; India

Contents

1 Introduction

Renewable sources of energy have a vital significance in the context of growing concern about sustainable energy supply and protection of the environment from adverse effects of fossil fuel utilisation. The current pattern of energy consumption and the growing energy requirements on economic development and population growth are considered to be essentially unsustainable. The staggering increase in the burden of oil import, the crippling effects of power shortage and the deterioration in environmental quality are some of the critical issues facing India today.

Worldwide, vast amounts of carbon dioxide and other greenhouse gases that are being dumped into the atmosphere by fossil fuel burning and other economic activities are causing grave concern about the possible global warming and attendant consequences. It is becoming increasingly clear that any effective strategy to eliminate global warming must involve rational and efficient use of energy, and a gradual transition from reliance on fossil fuels to alternative and environment friendly energy technologies. A major component of this strategy will admittedly be the promotion of renewable energy systems. In this respect, wind energy is expected to play a big role.

The advantages of harnessing wind energy include the following:

- wind energy is freely available
- the production and use of wind energy does not pollute the atmosphere
- wind energy does not cause acid rain and done not contribute to greenhouse effects
- a windfarm irrespective of its size has a low gestation period
- the primary energy used to produce a wind turbine can be recovered in about a year

2 Early efforts in India to tap wind energy

In India wind energy was first tapped in the 1950s for its potential to pump water for domestic use and for irrigation as an alternative to diesel/electric pumpsets. Wind pumps were imported on a modest scale and installed on an experimental basis at a number of sites. A National Water Pumping Windmill Demonstration Programme was subsequently introduced by the Government of India during the 6th (1980-85) and 7th (1986-91) plan periods and about 2,800 units of the 12-PU-500 wind pumps for shallow well water pumping were installed around the country. In addition, over 200 indigenously developed gear type pumping units have also been installed in 9 states under an Operational Research Programme (ORP). Unfortunately, due to various technical and non-technical reasons, the 12-PU-500 could not succeed except in some regions.

A Wind Resource Assessment Programme was taken up in 1985, comprising wind monitoring, wind mapping and complex terrain projects. The programme covered 25 states with over 600 stations. 83 masts of 20-25 meter height with sophisticated continuous wind data recording instruments, and 172 masts of 5-meter height with cup counter anemometers were set up in the country. Five volumes of Wind Energy Resource Survey for India have been published so far which cover wind data from 198 wind monitoring stations (Wind Energy Resource Survey in India-I, 1990; II-1992; III-1994; IV-1996 and V-1998).

The programme for demonstration of windfarms was initiated in 1985. Since 1992, private investors and developers have taken the lead in setting up commercial wind power projects in the country. Since Tamil Nadu state has become the leader in windfarm installation in the country, this study attempts to analyse the factors that contributed to the early growth and the pitfalls that led to the slump in wind energy development, including institutional barriers. In addition, a comparative analysis of wind power development in a neighbouring state, Andhra Pradesh, is conducted.

A package of incentives have been offered by the central government, such as accelerated depreciation, tax holiday, soft loans, custom and excise duty relief, liberalised foreign investment procedures, etc. Private investors and developers took advantage of these incentives and set up windfarms.

The list of wind sites with their latitudes, longitudes, annual mean wind speeds and annual wind power density measured at 20/25 m height and extrapolated to 30 m height in Tamil Nadu and Andhra Pradesh are given in Table 1. The wind energy potential and the resources in India exploited by September 1998 are shown in Table 2.

Table 1: Potential sites for wind power projects in Tamil Nadu and Andhra Pradesh.

S. No	Station	Latitude		Longitude		Annual Mean Wind Speed (KMPH)		Annual Mean Wind Power Density (W/SQ.M)	
		°	ʿ N	°	ʿ E	Measured at 20/25 m	Extra-polated at 30 m	Measured at 20/25 m	Extra-polated at 30 m
Tamil Nadu									
1.	Achankuttam	08	57	77	28	18.60	20.00	270	335
2.	Algiyapandiyapuram	08	56	77	39	20.90	22.30	301	371
3.	Andhiyur	10	36	77	11	19.10	20.60	177	213
4.	Andipatti	09	59	77	35	19.00	19.60	266	298
5.	Arasampalayam	10	51	77	03	20.50	21.80	195	232
6.	Ayikudy	09	00	77	21	21.40	23.50	305	390
7.	Edayarpalayam	10	55	77	07	22.40	23.80	273	323
8.	Ennore	13	16	80	19	19.30	20.80	139	177
9.	Gangaikondan*	08	51	77	35	18.40	19.00	246	267
10	Kannankulam*	08	10	77	46	21.30	22.20	238	268
11	Kattadimalai	08	14	77	33	23.70	25.30	312	380
12	Kayattar I	08	58	77	44	20.30	21.50	294	342
13	Kayattar II*	08	57	77	43	20.50	20.90	285	302
14	Kethanur	10	54	77	13	21.10	22.30	259	305
15	Kumarapuram*	08	16	77	35	22.00	22.70	288	315
16	Mangalapuram	09	03	77	22	22.30	23.40	312	257
17	Meenakshipuram	09	52	77	18	16.40	17.50	224	267
18	Meetukadai	10	52	77	23	18.00	19.20	184	221
19	Muppandal	08	16	77	33	25.50	27.60	406	519
20	Myvadi	10	36	77	19	19.60	21.00	251	305
21	Naduvakkurichi	09	07	77	30	16.80	18.00	157	190
22	Nettur*	08	54	77	33	19.90	20.20	338	358
23	Onamkulam*	08	58	77	51	19.90	20.30	247	258
24	Ottapidaram	08	54	78	01	18.50	20.00	221	280
25	Ovari	08	18	77	53	18.20	19.20	160	184
26	Panakudi	08	19	77	33	22.90	23.90	366	408
27	Pongalur	10	58	77	21	19.10	20.40	213	251
28	Poolavadi	10	45	77	16	21.20	23.00	283	343
29	Poosaripatti*	10	41	77	08	19.30	20.00	168	188
30	Puliyamkulam	08	19	77	44	18.90	20.80	188	245
31	Rameswaram	09	17	79	20	23.90	26.40	290	398
32	Sankaneri*	08	12	77	40	22.60	23.40	258	287
33	Sembagaramanpudur	08	16	77	31	21.70	23.00	300	367
34	Servallar Hills	08	42	77	21	17.80	18.90	207	247
35	Sultanpet	10	52	77	11	19.00	19.10	203	204
36	Talayathu	08	48	77	39	20.50	21.50	324	364
37	Tuticorin	08	50	78	08	17.60	19.00	148	185
38	Vakaikulam	08	45	78	00	16.60	17.00	167	201
39	Thannirpandal	10	57	77	19	18.20	21.00	216	330

S. No	Station	Latitude		Longitude		Annual Mean Wind Speed (KMPH)		Annual Mean Wind Power Density (W/SQ.M)	
		°	' N	°	' E	Measured at 20/25 m	Extra-polated at 30m	Measured at 20/25 m	Extra-polated at 30 m
Andhra Pradesh									
1	Badhrampalli Kottala*	14	55	77	24	21.30	21.50	248	255
2	Bhimunipatnam	17	54	83	27	19.10	20.10	195	229
3	Bandarlapalli*	15	01	78	04	20.79	21.60	240	265
4	Jammalamadugu 1*	14	49	78	23	17.50	18.30	161	184
5	Jammalamadugu 2*	14	46	78	22	18.60	19.40	165	183
6	Jangamguntla	15	39	79	08	16.03	16.60	149	164
7	Kadavakallu*	14	48	77	56	22.10	22.30	303	308
8	Kakula Konda	13	43	79	21	23.10	25.00	332	404
9	Kondamithepalli *	15	03	78	03	21.22	22.00	252	282
10	M.P.R. Dam	14	54	77	25	19.90	20.70	228	245
11	Mustikovala	14	15	77	32	20.20	20.80	201	216
12	Nallakonda*	14	07	77	34	22.80	23.10	276	288
13	Narasimha Konda	14	30	79	52	20.10	22.50	186	261
14	Nazeerabad*	17	11	77	55	21.00	21.60	176	189
15	Pampanoor Thanda*	14	38	77	24	19.60	20.10	182	194
16	Payalakuntla	14	53	79	02	20.10	20.40	230	241
17	Puttaparthy*	14	09	77	48	17.70	18.00	149	156
18	Ramagiri I	14	17	77	31	19.50	20.90	205	246
19	Ramagiri III	14	22	77	32	19.40	20.20	190	213
20	Singanamala	14	46	77	44	23.80	24.20	366	377
21	Tallimadugula*	14	22	77	32	22.20	22.50	260	267
22	Tirumala	13	40	79	22	20.40	21.90	26	282
23	Talaricheruvu*	14	57	78	03	18.11	19.30	144	179
24	Tirumalayapalli	14	54	78	11	19.00	20.80	154	195
25	Vajrakarur	14	58	77	19	19.46	20.90	173	205

* 25 m mast

Table 2: Wind energy potential and resource exploited in India.

Sl. No.	State	Gross Potential (MW)	Technical Potential (MW)	Installed Capacity (MW)
		(a)	(b)	(c)
1.	Andhra Pradesh	2200	1231	58
2.	Gujarat	3100	1271	167
3.	Karnataka	4120	687	18
4.	Kerala	380	353	2
5.	Madhya Pradesh	3000	775	19
6.	Maharashtra	1920	2108	8
7.	Orissa	840	338	1
8.	Rajasthan	1210	397	--
9.	Tamil Nadu	900	1011	719
10.	West Bengal	180	775	--
11.	Other States	2150	--	--
	TOTAL	**20000**	**8946**	**992**

(a) assuming 0.5% of land availability for wind power generation in potential areas.
(b) as on 31.03.98, assuming 20% grid penetration.
(c) as on 30.09.98.
Source: Ministry of Non-conventional Energy Sources (MNES)

Table 1. indicates that most of the windy sites exist in Tamil Nadu like Muppandal, Edayarapalayam, Poolavadi, Kethanur, etc. From Table 2., it is evident that the bulk of Windfarm installations are in Tamil Nadu. Table 3. reveals that there was a steady increase in windfarm activities from 1992-93 to 1995-96, then followed by a sharp decline.

Statewise and year-wise wind power capacity addition (MW) in India is shown in Table 3.

Table 3: State-wise & year-wise wind power capacity addition (MW).

State	Upto 3/92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99 by Sept.	Total
Andhra Pradesh	0.550	0.000	0.000	5.425	38.925	9.390	1.500	2.000	57.790
Gujarat	14.515	1.630	10.625	37.745	51.158	31.137	20.100	0.000	166.910
Karnataka	0.550	0.000	0.000	0.000	2.025	3.270	11.165	1.250	18.260
Kerala	0.000	0.000	0.000	0.000	2.025	0.000	0.000	0.000	2.025
Madhya Pradesh	0.590	0.000	0.000	0.000	6.300	2.700	2.700	6.155	18.445
Maharashtra	1.100	0.000	0.000	1.500	0.000	2.700	0.225	2.520	8.115
Orissa	1.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.100
Tamil Nadu	22.310	11.070	50.465	190.865	281.680	119.765	31.140	11.580	718.875
Others	0.465	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.465
TOTAL	41.180	12.700	61.090	235.535	382.113	169.032	66.830	23.505	991.985

Source: MNES

The power production state-wise and year-wise in the country through windfarms (by September 1998) is shown in Table 4.

Table 4: State-wise & year-wise wind power projects (kWh).

State	Upto 3/92	1992-93	1993-94	1994-95
Andhra Pradesh	1120745	63349	161525	619748
Gujarat	42188099	18793320	21673823	37833399
Karnataka	--	--	--	'--
Kerala	--	--	--	59146
Madhya Pradesh	1080146	406900	336059	250906
Maharas-htra	3429901	518610	208620	1138350
Orissa	1174856	0	0	0
Tamil Nadu	63911415	68674598	72389409	151374106
TOTAL	112905162	88456777	94769436	191275655

State	1995-96	1997-98	1998-99	Total
Andhra Pradesh	7676741	51925399	28757138	130304277
Gujarat	58230856	132409292	44642564	473627669
Karnataka	315603	11715975	12117771	31399954
Kerala	2041468	1867326	1085455	7618545
Madhya Pradesh	813273	7426841	6436489	22727809
Maharas-htra	1162914	3308370	2201637	14546180
Orissa	0	0	0	1174856
Tamil Nadu	426198886	779801751	521646244	2786166064
TOTAL	496439741	988454954	616887298	3467565354

3 Initiatives and policies led to windfarm boom in Tamil Nadu

- good windy sites like Muppandal were available at that time

- the sites were nearer to towns for accessibility to labour force and to provide accommodation to personnel involved in the projects

- the sites were well connected with highways

- the grid network by Tamil Nadu Electricity Board (TNEB) was well connected and mostly passing through the sites

- active promotional steps by TNEB, TEDA (Tamil Nadu Energy Development Agency) and local authorities

- boom in the textile market and the cement industry where huge profits were earned, and tax concessions, such as 100% depreciation, 5 years tax holiday were availed for setting up windfarms. Moreover, these industries need electric power and as such windfarms came handy for captive power consumption

- power cuts in summer months was a handicap for industries. Incidentally, during summer months wind energy generation was at its peak and supplemented the TNEB power supply position

- most wind turbine manufacturers and suppliers were situated in Tamil Nadu and as such investors and developers were confident about supply of the machines and after sales service of the machines

- TNEB took the first step to set up windfarms at sites like Muppandal, Kayathar and Kethanur, proving the viability of windfarms thus inducing confidence among private windfarm developers

- since the land at the identified windy locations was privately owned, the purchase and acquisition of the land was quick without any hitch

- Chennai Port has excellent facilities for import of heavy machinery of wind turbine generator (WTG) components facilitating intra-state transportation

- TNEB extended all facilities for private entrepreneurs like consultant services, processing of the application for issuance of the No Objection Certificate (NOC), CEIG (Chief Electrical Inspectorate to the Government) clearances, extending grid connection to windfarms and executing new dedicated substations. Above all, TNEB has established an effective system for registering the energy generation by each wind turbine and enabling the wind turbine owners to either adjust their energy bill, or effecting payment to those who sold power generated to TNEB

- TNEB officials assigned to wind energy field were professionally qualified, well knowledgeable and as such executed the job well

4 Factors led to steady decline in windfarm development in Tamil Nadu

- due to unplanned addition of windfarms at sites like Muppandal, Kayathar, Poolavadi etc., inadequate capacity at dedicated substations resulted in shutting down of wind turbines even during peak wind speed periods with loss of generation and hence revenue loss to windfarm owners

- connecting WTGs to weak and rural feeder lines in the absence of dedicated substations at some windfarm sites, poor grid--poor generation --loss of revenue

- TNEB imposing penalties for excess RKVAH (Reactive Kilo Volt Ampere Hour)[2] consumption

- improper maintenance of WTGs by some suppliers during warranty period and by owners beyond warranty

- inadequate facilities by some manufacturers of WTGs at sites for repairs as well as at their works. This led to long delays, breakdown periods and loss of generation

- rotor blade failures in some cases due to manufacturing defects as well as lightning strike

- disregard for earthing regulations and lightning protection leading to unduly large breakdown of control systems which resulted in very expensive repairs and long breakdown periods

- reduction in tax concessions enacted by the Union Government led to corresponding reduction in tax benefits to investors to put in windfarms

- introduction of Minimum Alternate Tax (MAT) further eroded the gains of setting up windfarms

- withdrawal of third party sale

- withdrawal of capital subsidy of 10% project cost subjected to a maximum of Rs.15 lakhs

- slump in textile and cement business activities

- liquidity crunch

- difficulties in availing loans from banks especially for newly floated companies

[2] A measure of reactive power.

- disproportionate hike in interest rates subsequently imposed by Indian Renewable Energy Development Agency Ltd (IREDA) for loans to set up windfarms

- the earlier irrational import policy led to substantial numbers of unworthy and uncertified machines, which resulted in failures of some models and cast aspersions in investors about the technology itself. As a result, the market for wind turbines dramatically shrunk, leaving even the genuinely good machines in trouble

- applying wind speed data from limited number of anemometers (two for 300 MW in Muppandal) resulted in wide variation from predicted wind turbine generation and actual generation, thus creating doubts about the viability of wind projects

5 Barriers to wind energy development

Although subsidies and financial incentives were given liberally to wind energy, this technology remained marginalised in the overall energy scenario. Wind energy contributes about 1% of the total power available in India. While working out cost-benefit analysis and calculating internal rate of return for any power project, hidden or indirect subsidies on pricing a resource and infrastructure were never taken into account in conventional energy sources. On the other hand, economic analysis of wind energy projects rarely supported their economic justification. Most projects were supported for their renewable nature, social and environmental benefits.

Wind energy systems are now regarded as costlier than conventional power systems, but if one were to take into account the life-cycle costs, and not merely the upfront costs,[3] the former will be found competitive. If environmental benefits are accounted, the economics of wind energy will further improve. The general impression that wind energy will not be commercially viable without subsidies will vanish, if one takes into account the indirect subsidies of the State Electricity Boards through lower tariff for certain segments of consumers. If the tariff for conventional power is corrected and a level playing field is provided, wind energy systems will be commercially viable and become competitive in the energy market.

5.1 Financial barriers

Lack of adequate financial resources has been a chronic problem for setting up wind energy projects. In India, IREDA played a crucial role in supporting wind projects. IREDA's lending terms are presented in Table 5.

[3] Upfront cost means initial investment.

Table 5: IREDA's financing guidelines for wind energy sector (effective from May 6, 1998).

Category - Financing Guidelines for Wind Farm Developers

S. No	Financing Scheme	Interest Rate (Exclu-sive of interest tax)	Loan Repayment including Moratorium Period (years)	Mora-torium Period (Max. Years)	Minimum Pro-moter's Contri-bu-tion	Term Loan/Lending Norms
A.	**Project Financing Scheme**					
1.	International Funds	13%	10	1	25%	100% of eligible equipment cost limited to a maximum of 75% of total project cost
2.	IREDA Funds	14%	10	1	25%	Upto 75% of total project cost
B.	**Equipment Financing Scheme**					
1.	Equipment financing (upto 2 MW per party per financial year)	15%	10	1	10%	Upto 90% of the cost of eligible equipment (Eligible Equipment comprise of WEG, Tower, Control Panel and Transformer)
Category – Financing Guidelines for Manufacturers/Suppliers of Wind Electric Generators						
1.	Commercial demonstration scheme for above 600 KW machines - 5 MW per financial year	12%	10	1	25%	Upto 75% of the project cost
2.	Manufacturers cum developers scheme upto 5MW/party/year. (with the option for transferring wind farm to eligible developer with the transfer of proportionate loan within one year)	13.5%	10	1	25%	100% of eligible equipment cost limited to a maximum of 75% of total project cost
3.	Market development assistance (including export promotion)	12%	5	1	25%	1. Upto 75% of the last 3 years average expenditure on promotional efforts 2. Minimum loan amount of Rs.2.5 lakhs and a maximum of Rs.10 lakhs per client
Category – Eligible State Electricity Board/Utility						
1.	Grid interconnection facility scheme for evacuation of electricity	15%	10	1	25%	100% of eligible equipment cost limited to a maximum of 75% of total project cost
Category – Financing Guidelines for Renewable Energy Users						
1.	Transmission/distribution facility scheme (where borrower uses no less than 50% of the electricity requirement from renewable energy)	15%	10	1	25%	100% of eligible equipment cost limited to a maximum of 75% of total project cost

Source: IREDA

Through IREDA, bilateral development institutions from the Netherlands, Denmark and international development assistance agencies like the World Bank contributed to the boom in wind energy projects in Tamil Nadu.

There is a need to create more financial institutions to support wind projects. A wind fund of Rs.1,000 crores (1 crore = 10 million, 1 US$ = Rs.42,8) in line with the one in the UK can be created in India to support wind projects exclusively. Such a fund will provide equity finance for small-scale wind energy projects and will offer investment opportunities to individuals and institutions alike.

5.2 Transaction barriers

Transaction barriers to wind energy are similar in many ways to those in developed and developing countries (Martinot, 1998; Stern and Aronson, 1984; Reddy, 1991; Levene, 1994; World Bank, 1993; Jackson, 1993). In India, many of the sources of risk, institutional structures and conditions, experiences and skill deficiencies are unique. The result is greater uncertainty in transactions about opportunities, costs, and benefits.

5.3 Technical barriers

In the conventional power sector, fossil fuel resources are limited, but the technology to harness them is well established. By contrast, wind energy resources are unlimited, but the technology to harness it is still in the development stage. Thus, non-availability of cost-effective, commercially viable technology for utilisation of wind energy constitutes one of the barriers. Lack of standardisation in system components leads to wide ranges in design features and technical standards. Absence of long-term policy instruments has resulted in difficulties in manufacturing, service and maintenance of wind turbines.

The mismatch between locally manufactured components and imported parts have resulted in weakening the reliability of the overall system in some cases. The absence of effective service and maintenance networks, combined with inadequate user training, leads to a loss of confidence among entrepreneurs and customers. Another barrier is lack of co-ordination among research groups, academic institutions, and the private wind industry.

5.4 Institutional barriers

Institutional barriers constitute the real constraint, not only to the development of renewable energy sources like wind, but also to their wider dissemination. Technologies that are of immediate relevance in a developing country like India are now available. While improvements may be required in individual cases, especially to reduce production costs, the hardware for harnessing wind energy is relatively well known and reliable. What is required is an appropriate institutional infrastructure capable of planning and implementing coordinated programmes at all levels, and of mobilising community support at the micro economic level where project being implemented. This strategy calls for a different approach that needs to be compartmentalized, according to the sources of energy supplies and yet to be integrated and coordinated to bring the results to the general public. This new strategy will require an integrated institutional approach involving political will to support it consistently, and institutional arrangements to implement it, and involvement of people to sustain it (Monga, 1997).

Wind energy is being promoted in India, because of its usefulness as a decentralized energy system. Its introduction initially generated a good deal of interest from the scientific perspective, rather than due to its potential to meet energy demands on a decentralized basis. A growing gap between demand and supply, environmental considerations and the decentralized nature of wind projects has made people in India realise the significance of wind energy in meeting growing energy demands. Initially, wind projects were promoted in India as panacea for all unsolved energy problems. The main emphasis on wind projects was on target achievement rather than on consumer satisfaction of capacity building. Little efforts were made to strengthen the institutions involved in the diffusion of wind energy, or provide an enabling environment to entrepreneurs to promote commercialisation of wind technology. This resulted in raising undue demands and expectations that wind energy were unable to fulfill.

A multiplicity of agencies has resulted in duplication, overlapping and coordination problems in the implementation of wind projects. Multiplicity of agencies has also resulted in unnecessary delays. A bureaucratic structure with a target-oriented approach has led to rigidity in instructions and a centralised planning process which is the opposite of the decentralised nature of wind energy. Most of the decisions are still taken at the central level with little flexibility given to the field agencies and institutions at the grassroots level.

6 Training programmes in wind energy

Development and successful implementation of a complex technology like wind energy requires sufficient information and inputs of skilled manpower. It is imperative that energy education, including wind energy, should be included at various levels in schools, colleges and universities, and other academic institutions. Regular four-year bachelor degree course in wind energy specialisation will be useful in the design, development and evaluation of this technology.

7 Windfarm co-operatives

In India, most of the windfarms are set up by big industries mainly as a tax shelter plan. Unless wind projects are mass based, it is hardly possible to get the political support besides resources to support wind projects. Comparatively, wind energy development in Denmark where the installed capacity in July 1998 was at 1,259 MW is worth emulating in Tamil Nadu. About 75% of the wind turbines in Denmark are owned by local associations and private individuals (Meyer, 1995). More than 100,000 families are involved as share holders. Over the past decade, the popularity of wind turbines had grown to such an extent that today they cater for 7 per cent of the country’s total electricity consumption. This, in turn, provided an excellent basis for renewed community spirit and the growth of interest in energy and environment matters.

Another success story that needs close examination is the phenomenal success of wind energy in Germany which has been relegated to the top position in the world with installed capacity of 2,390 MW in July 1998. The wind energy boom in Germany is mainly due to the Renewable Energy Feed in Tariffs (REFITs) granted there, apart from investment grants given initially, and some research activities. All private producers of electricity from renewable energy are statutorily granted a fixed price, which the utilities are obliged to pay. The price is calculated on the basis of the average electricity rates in Germany (Wagner, 1998).

8 Suggested policy changes to boost windfarms in Tamil Nadu

In India, currently accelerated depreciation is allowed on wind projects. The main aim of extending this incentive to windfarm owners and developers is that wind energy supplement power to conventional energy systems. Unfortunately, in majority of the cases, this liberal incentive has ended merely as a tax shelter plan. This has far reaching consequences on the power generation by wind turbines. It is high time that the government should seriously consider to link depreciation benefits to generation of power, so that the wind turbines produce optimum power. There is wide variation in the incentives offered by different state governments, as indicated in Table 6. It is hoped that the government of Tamil Nadu introduces third party sale and sales tax benefit like what is introduced in Madhya Pradesh.[4]

Table 6: Policies introduced and incentives declared by the state governments for private sector wind power projects.

Items	Andhra Pradesh	Tamil Nadu	Karnataka	Kerala	Uttar Pradesh
Wheeling	2% of energy	2% of energy	2% of energy	2% of energy	2% of energy
Banking	12 Months	12 Months	12 Months	6 Months	12 Months
Buy-back	Rs.2.25/kWh (5% esc., 1997-98)	Rs.2.25/kWh (5% esc., 1995 -96)	Rs.2.25/kWh (5% esc., 1994-95)	To be agreed mutually	Rs.2.25/kWh (5% esc., 1995-96)
Third Party Sale	Allowed	Not allowed	Allowed	--	Allowed
Capital Subsidy	20% (max Rs.25 lakhs)	--	Same as for other industries	15 % (max. Rs.5 lakhs)	same as for other industries
Other Incentives	Industry Status	No generation tax	No generation tax for 5 years	--	--

Items	West Bengal	Gujarat*	Madhya Pradesh	Maharashtra
Wheeling	2% of energy	2% of energy	2% of energy	2% of energy
Banking	6 Months	6 Months	--	12 Months
Buy-back	to be decided on case to case basis	Rs.1.75/ kWh (no esc.,)	Rs.2.25/kWh (no esc.,)	Rs.2.25/kWh(5% esc., 1994-95)
Third Party Sale	Not Allowed	Not Allowed	Allowed	Allowed
Capital Subsidy	--	--	Same as for other industries	30% (max. Rs.20 lakhs)
Other Incentives	--	Sales Tax (Exemption/deferment upto 50% of investment)	Sales Tax (Exemption/ deferment upto 100% of investment)	Sales Tax (Exemption upto 100% of investment)

* Policy expired on 31.03.98.

[4] 100 percent sales tax benefit is available only in Madhya Pradesh State, but not in Tamil Nadu or Andhra Pradesh States. Though I have not discussed about wind energy in Madhya Pradesh, which has only 18 MW installed capacity so far, it is a very progressive measure. If it is introduced in Tamil Nadu and Andhra Pradesh, it will have salutary effect to further the progress of windfarms in these states.

9 Water pumping windmills in Tamil Nadu

In Tamil Nadu, 850 water pumping windmills were installed, of which 120 were geared type deep well wind pumping systems. The rest were 12-PU-500 type with 12 bladed pumping unit with 500cm. diameter rotor fitted to the windmill. The performance of 12-PU-500 windmills has not been satisfactory, due to variety of reasons like improper siting and installation, lack of user awareness, design problems, substandard material usage in the fabrication of windmill to bring down the cost and an improper implementation strategy (Murugappa Polytechnic, 1992).

As wind pumping is a well-established technology, it offers an alternative to diesel and electric pumps. Since there are many areas with good wind regimes in Tamil Nadu, water pumping windmills will be a boon to conserve electricity (which is heavily subsidised for agricultural purposes) which can find applications in other areas. It is hoped that MNES will promote reliable and sturdy windmills for irrigation in the country in general and Tamil Nadu in particular.

10 Wind battery chargers for small applications

Wind energy generators can also charge batteries, which can store energy for lighting, radio communication, hospital equipment and to power various emergency related equipment. In India, about 50 wind chargers were installed on a pilot scale. Their performance has not been satisfactory. Tamil Nadu offers good sites to supply power in a decentralised way to charge batteries through wind.

Comparatively, today over 100,000 wind chargers are working in Inner Mongolia and studies indicate that levelised costs of off-grid, household scale renewable energy systems are cost-competitive with conventional diesel generators and pv/wind hybrid systems. Thus, wind chargers appear to be an economic means of providing year-round electricity service and meeting the rising energy demands of remote households in Inner Mongolia (Berdner, 1994; Byrne, 1997; China Electric Power, 1996; He and Shi, 1995; Li, 1991 and Zhu, 1988).

11 Wind energy development in Andhra Pradesh

In Andhra Pradesh, the installed capacity of windfarms stood at 58 MW by the end of September 1998. About 50 MW of this capacity is at Ramagiri. Table 3. indicates that 1995-96 was a boom with installed capacity totaling 38.9 MW, followed by a sharp decline subsequently as what happened in Tamil Nadu.

11.1 Reasons for slow progress of windfarms in Andhra Pradesh

- in Andhra Pradesh, the land for setting up windfarms used to be allotted by Non-Conventional Energy Development Corporation of Andhra Pradesh (NEDCAP). There was undue delay in the process of acquiring the land as well as allotting it. Windfarm developers who want to avail tax benefits were unable to meet the deadline, because of delay in the allotment of land. Though Andhra Pradesh was estimated to have about 1,200 MW of wind capacity, the land alienation has become a stumbling block for the progress of windfarm development. However, the policy of land allotment has recently been changed and now the government is allotting land at the market price. The District Administration has been empowered to give advance clearance for land to set up windfarms in the state

- Ramagiri has a complex terrain. The consultants and manufacturers of wind turbines overestimated the generation at Ramagiri based on the wind data from 3 anemometers. The actual generation fell by about 25% from estimated generation. This led to doubts of the investors on the viability of wind projects in Andhra Pradesh. A study on power generation of 5 wind turbines at Ramagiri revealed wide variation in percentage of generation with reference to 576 level from 24.2% to 7.8% (Subrahmanyam, 1998).

- in complex terrain, wind data has to be obtained from an anemometer close to the site where windfarms are to be set up. In California, during ‘80s there was one anemometer per 150 to 350 turbines or 10-20 MW, while in the ‘90s one anemometer is required for every two or three 200 KW machines or 0.5 MW capacity (Gipe, 1995 and Lynette, 1988). Such an approach is needed in Andhra Pradesh

- introduction of MAT as well as increase in interest rates charged by institutions like IREDA contributed to the slow-down of wind activities in Andhra Pradesh

- local law and order problems led to the closure of windfarms for some periods at Ramagiri. However, the intervention of the government helped to restart the windfarms there

11.2 Some progressive measures initiated by NEDCAP to boost windfarms

NEDCAP, a nodal agency responsible for the promotion of renewable energy sources in Andhra Pradesh, has taken effective steps to have a 33/220 KV substation with a ring structure exclusively for evacuating power from the windfarms at Ramagiri.
Since most of the identified sites in the Ananthapur District in the state are hilly areas, NEDCAP has undertaken contour survey of all the potential areas at 3 meters intervals (Reddy, 1997).

Another innovative concept initiated by the NEDCAP is Wind Estate. This is mainly to assist small developers in acquiring land and in the procurement of machinery at reasonable prices, erection, operation and maintenance by NEDCAP on behalf of small developers. Work is in progress to set up a 20 MW wind estate at Kadavakallu by NEDCAP.

Introduction of sales tax benefits will help to attract investors to set up large windfarms in Andhra Pradesh where 320 water pumping windmills were installed, but their performance was far from satisfactory. It is hoped both the MNES and the NEDCAP will promote efficient windmills for irrigation besides wind battery chargers for small applications in Andhra Pradesh.

12 Conclusions and prognosis

The case study of wind energy development in Tamil Nadu and Andhra Pradesh reveals that incentives like depreciation, tax holiday, customs and excise duty relief should continue for some more years until the wind projects sustain on their own. There is a dire necessity to continue wind data studies by setting up more anemometers and windmasts at varying heights of 20, 30, 40 and 50 meters to get accurate wind data rather than relying on extrapolated figures.

Latest methods like Geographical Information Systems (GIS) have to be utilised for large area screening of prospective sites for wind power development. Wind speeds at the height of a wind turbine depend strongly on terrain elevation, exposure, slope, and orientation to prevailing winds, which can be calculated from a GIS-based Digital Elevation Model (DEM). In addition, with the appropriate database, a GIS can account for other factors that affect wind site suitability, such as the distance to transmission lines, proximity to protected areas, and type of vegetation cover.

The cost of wind turbines has to be brought down considerably by indigenising the components. Thorough micro siting by competent experts is a must. This will enable investors to choose the best site and matching it with suitable machines for optimum generation. The central government in co-operation with different state governments can fix uniform incentives for a healthy growth of windfarms in the country. Creation of a wind fund and people's participation through windfarm co-operatives will give a fillip to the declining wind energy development in the country in general and Tamil Nadu and Andhra Pradesh in particular.

Before permitting wind projects, the respective State Electricity Boards should ensure that suitable evacuation facilities through a dedicated substation and stable grid are in place. For optimum generation of energy by windfarms, depreciation and other incentives should be coupled to energy generation rather than a mere tax shelter plan. A remunerative price based on the ever increasing tariff by conventional sources should be fixed for wind energy generated electricity, which will enable faster growth of windfarms.

Since Tamil Nadu and Andhra Pradesh have strong agricultural base, reliable water pumping windmills will be a boon to conserve energy as a supplementary to electric and diesel pumpsets in windy areas. The central and state governments of Tamil Nadu and Andhra Pradesh should promote water-pumping windmills on a large-scale.

Wind battery chargers have also a role to play in the states of Tamil Nadu and Andhra Pradesh for small-scale power applications. The Centre for Wind Energy Technology (C-WET) coming up in Chennai and the wind turbine test station at Kayathar in Tamil Nadu through DANIDA (Danish International Development Agency) assistance are expected to fill up the gap of setting and ensuring standards to maintain quality in wind turbines. To achieve the Ninth Plan (1997-2002) targets for power generation, an average 9,000 MW per year is required to be put up in the country.

With improved design for wind turbines, financial package, political will to support large-scale wind projects through public sector undertaking, and a remunerative price for wind generated electricity, it is hoped that wind energy will play a supplementary role to meet the growing power demands in the country in general, and Tamil Nadu and Andhra Pradesh in particular.

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