Renewable Energy Generation Tariff Determination in Practice

Capacity Building Programme for Officers of Electricity Regulatory Commissions
IIT Kanpur
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Rakesh Shah
Director- Regulatory Affairs
SunEdison Energy India Limited

Legal and Policy Framework for promotion of RE

Legal Framework

- Federal Structure
- Electricity is a concurrent subject.
- Principal Central legislation:
  - Electricity Act, 2003
    - Basic policy and regulatory framework
- Regulatory Framework
  - Central level
    - Central Electricity Regulatory Commission (CERC) (inter-State issues)
  - Province level
    - State Electricity Regulatory Commission (SERCs) (intra-State issues)
  - Forum of Regulators - for harmonization

The Electricity Act, 2003 : Enabling provisions

- Section 86(1)(e): Specify Renewable Purchase Obligation (RPO) from renewable energy sources
- Section 61(h): Tariff regulations to be guided by promotion of renewable energy sources
- Section 3: National Electricity Policy, Tariff Policy and Plan
- Section 4: National Policy permitting stand alone systems including renewable sources of energy for rural areas

The Electricity Act, 2003: Sec. 86(1) (e)

- The State Commission shall discharge the following functions, namely:

"promote cogeneration and generation of electricity from renewable sources of energy by providing suitable measures for connectivity with the grid and sale of electricity to any person, and also specify, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution licensee;"

The Electricity Act, 2003: Sec.61(h)

- The Appropriate Commission shall, subject to the provisions of this Act, specify the terms and conditions for the determination of tariff, and in doing so, shall be guided by the following, namely:-

(h) the promotion of co-generation and generation of electricity from renewable sources of energy;

National Electricity Policy:
(12th February, 05)

- Urgent need of promotion renewable sources of energy
- Efforts need to be made to reduce the capital cost of such projects
- Cost of energy can be reduced by promoting competition
- Adequate promotional measures would have to be taken for development of technologies and sustained growth of these sources
- SERCs to provide suitable measures for connectivity with grid and fix percentage of purchase from Renewable sources
- Progressively the such share of electricity need to be increased

Tariff Policy: (6th January 2006)

- Appropriate Commission
  - shall fix RPO
  - shall fix tariff
  - Initially fix preferential tariffs
- In future Discoms to procure RE through competitive bidding within suppliers offering same type of RE
- In long-term, RETs need to compete with all other sources in terms of full costs
- CERC to provide guidelines for pricing non-firm power if RE procurement is not through competitive bidding

National Action Plan on Climate Change (NAPCC), 2008

- National level target for RE Purchase
  - 5% of total grid purchase in 2010, to be increased by 1% each year for 10 years: 15% by 2020
- SERCs may set higher target
- Appropriate authorities may issue certificates that procure RE in excess of the national standard
  - Such certificates may be tradable, to enable utilities falling short to meet their RPO
  - RE generation capacity needed: From 18000 to 45500 MW by FY2015

Jawaharlal Nehru National Solar Mission (JNNSM) 2010

- One of the eight Missions under NAPCC, launched by the Government of India in January 2010.
- The objective of the JNNSM is to establish India as a global leader in solar energy.
- Mission aims to achieve grid tariff parity by 2022 through
  - Large scale utilization, rapid diffusion and deployment at a scale which leads to cost reduction
  - R&D, Pilot Projects and Technology Demonstration
  - Local manufacturing and support infrastructure
  - 0.25% SPO by 2012-13 and 3% SPO by 2022

Tariff Policy Amendment : 2011

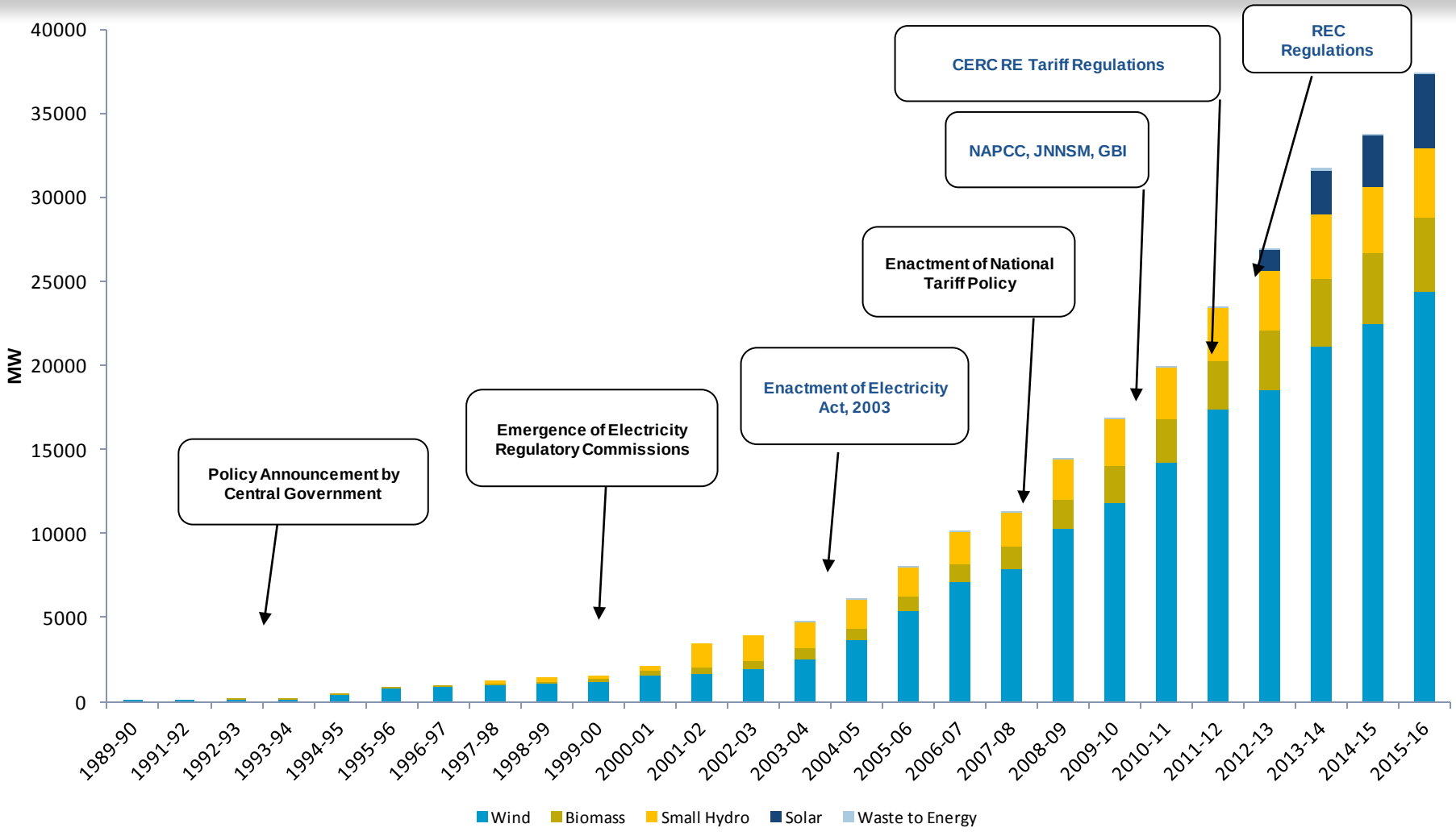
Para 6.4 (1) of the Tariff Policy amended on dated 20/1/2011

- SERC shall fix a minimum percentage of the total consumption of electricity in the area of a distribution licensee
- Such purchase should takes place more or less in the same proportion in different States
- SERCs shall also reserve a minimum percentage for purchase of solar energy
  - **Up to 0.25% by the end of 2012-2013**
  - **Further up to 3% by 2022**
- Renewable Energy Certificate (REC) would need to be evolved with separate **Solar specific REC**

Regulatory Intervention

- Renewable Purchase Obligation (RPO)
- Preferential Tariff
- Facilitative Framework for Grid Connectivity
- Market Development (Tradable Renewable Energy Certificates)

Renewable Energy Development



RPO & RE Tariffs : Played important role in RE Capacity addition

Achievement of Renewable Energy in India (as on 30.09.2015)

Sector	Cumulative Achievements in MW
Wind Power	24376.26
Solar Power	4344.91
Small Hydro Power	4146.90
Bio-Power (Biomass & Gasification and Bagasse Cogeneration)	4418.55
Waste to Power	0127.08
Total	37413.70

Sl. No.		Wind	SHP	Biomass	Bagass	W to E	Solar	Total
1	Andhra	14497	978	578	300	123	38440	54916
2	Arunachal P	236	1341	8			8650	10236
3	Assam	112	239	212		8	13760	14330
4	Bihar	144	223	619	300	73	11200	12559
5	Chhatisgarh	314	1107	236		24	18270	19951
6	Goa		7	26			880	912
7	Gujarat	35071	202	1221	350	112	35770	72726
8	Haryana	93	110	1333	350	24	4560	6470
9	Himachal P	64	2398	142		2	33840	36446
10	Jammu & K	5685	1431	43			111050	118208
11	Jharkhand	91	209	90		10	18180	18580
12	Karnataka	13593	4141	1131	450		24700	44015
13	Kerala	837	704	1044		36	6110	8732
14	Madhya	2931	820	1364		78	61660	66853
15	Maharashtra	5961	794	1887	1250	287	64320	74500
16	Manipur	56	109	13		2	10630	10811
17	Meghalaya	82	230	11		2	5860	6185
18	Mizoram		169	1		2	9090	9261
19	Nagaland	16	197	10			7290	7513
20	Orissa	1384	295	246		22	25780	27728
21	Punjab		441	3172	300	45	2810	6768
22	Rajasthan	5050	57	1039		62	142310	148518
23	Sikkim	98	267	2			4940	5307
24	Tamil Nadu	14152	660	1070	450	151	17670	34152
25	Telangana						20410	20410
26	Tripura		47	3		2	2080	2131
27	Uttar Pradesh	1260	461	1617	1250	176	22830	27593
28	Uttarakhand	534	1708	24		5	16800	19071
29	West Bengal	22	396	396		148	6260	7222
30	Andaman & N	365	8				0	373
34	Delhi					131	2050	2181
36	Puducherry	120				3	0	123
37	Others					1022	790	1812
	Total	102772	19749	17536	5000	2554	748990	896602

Renewable Energy Tariff Design

Renewable Energy Policies

- Feed-In Tariff (FiT)
- Competitive Bidding
- Renewable Energy Certificates
- Net Metering

FITs are the most widely used policy mechanism globally

Feed-In-Tariff Definition

Feed-in Tariff (FIT):

A renewable energy policy that offers a guarantee of payment to renewable energy developers for the electricity they produce.

Access to the grid

- Must be able to connect
- Guarantee in interconnection
- Connection must be simple, timely, and at reasonable cost

Priority Purchase

- Renewable energy must be first priority
  - Must run status
- Producer must be assured that the electricity they produce is purchased
- Only exception is “system emergencies”

Contract Length

- Tariff levels are usually guaranteed for a longer period
  - 20 years or more
  - Longer contracts = lower initial tariff
  - Shorter contracts = higher initial tariffs
- Standardized Contract (Model PPA)

In this way FiT provides long-term certainty about receiving financial support, which is considered to lower investment risks

Specific tariff design

- Differentiated by technology
  - wind, solar, biomass, hydro, etc.
- Differentiated by project size
  - higher prices for small projects
  - lower prices for large projects
- Differentiated by resources qualities
- Differentiated by application
  - higher prices for rooftop solar , BIPV
- Differentiated by project location

Ancillary design elements

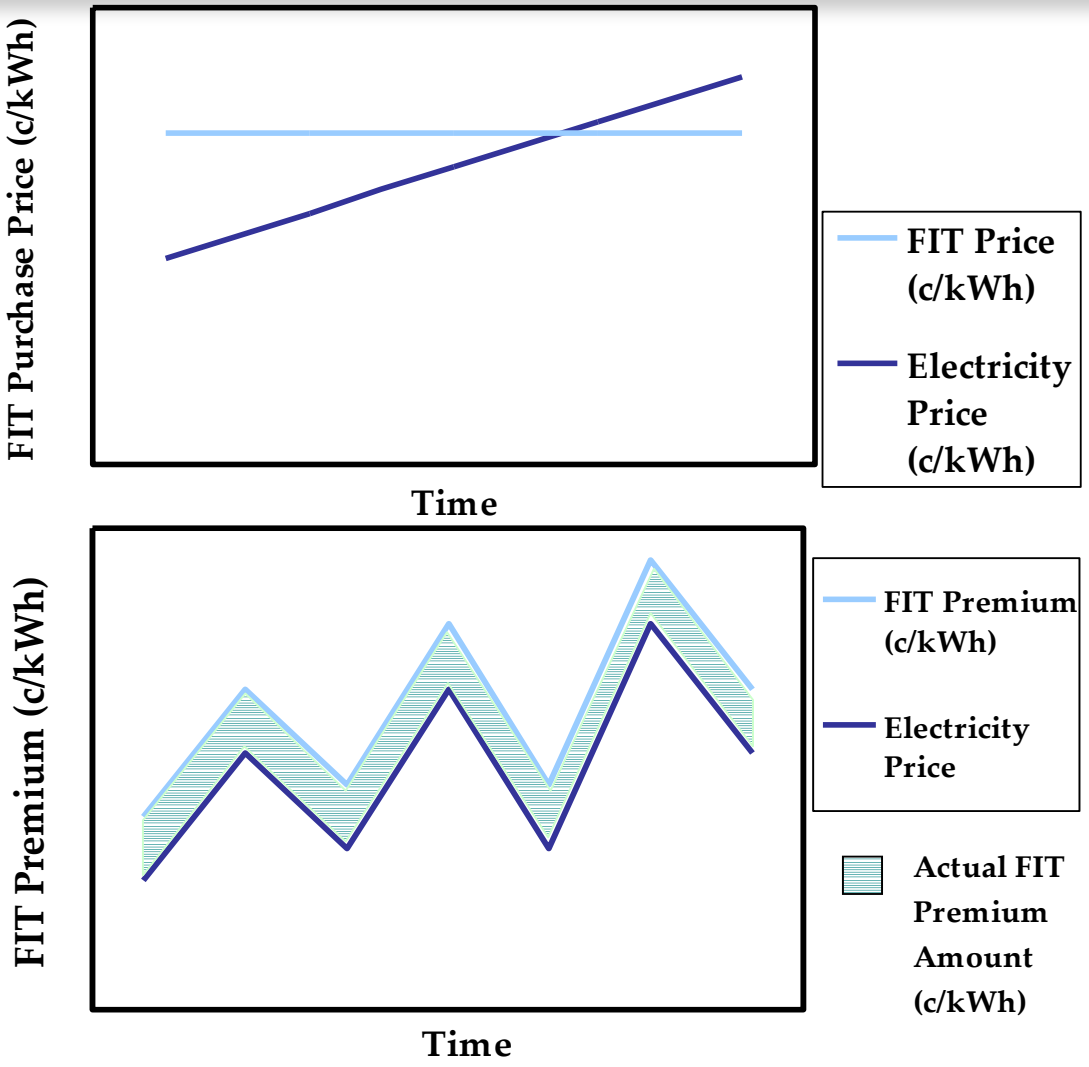
- Pre determined tariff degression
- Responsive tariff degression
- Annual inflation adjustment
- Front-end loading (i.e., higher tariffs initially, lower tariffs later on)
- Time of delivery (coincidence with demand to encourage peak shaving)

Fundamental FIT Payment Choice

(1) Fixed Price FIT Payment

Fixed Price FITs most common

(2) Premium FIT Payment (above market price)



Front loading payment stream

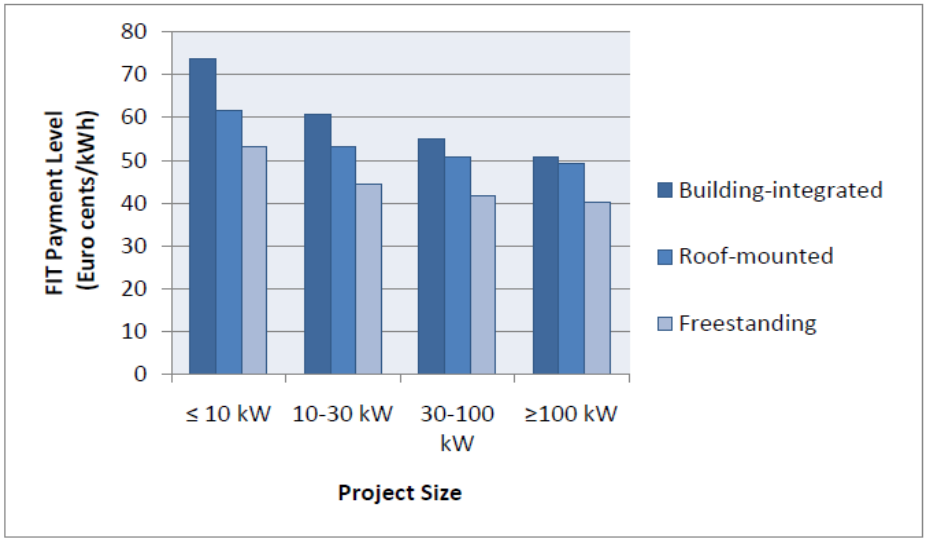
- Instead of having a constant tariff level for the complete support duration, it can be considered to increase tariffs for the first years of a project while decreasing tariffs in the last years.
- Without increasing the total sum of financial support, this can help to reduce financing cost.

Differentiation by Project Size

(i.e., kW or MW Capacity)

- Lowest payment level is typically offered to the largest plants
  - Reflecting the gains that result from economies of scale
- Differentiating FiT payments by project size is another means of offering FiT payments that reflect actual project costs

E.g.: France, Germany, Switzerland, and Italy provide the highest tariff amounts for the smallest PV installations



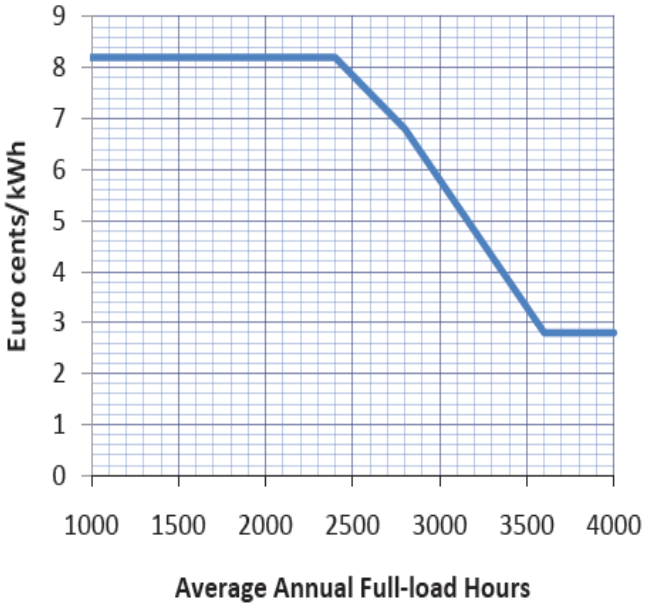
Source: SFOE 2010

Switzerland's solar PV payment

Differentiation by Resource Quality

- Different payments to projects in areas with a different cost of production
  - to encourage development in a wider variety of areas, which can bring a number of benefits both to the grid and to society
  - to match the payment levels as closely as possible to RE generation costs
  - For e.g. areas with a high-quality wind resource will produce more electricity from the same capital investment, all else being equal, leading to a lower levelized cost (FIT)

Denmark, France, Germany, Portugal, and Switzerland have implemented resource adjusted payment levels



On Shore wind farm FIT Payment Level (10 to 15 Years)
Source: France 2006, NREL 2010

Differentiation by Project Location

- Varied payments to projects mounted in different physical locations (without regard to resource quality)
  - To encourage project development in particular applications,
  - To encourage multi-functionality (e.g. solar PV),
  - Target particular owner types such as homeowners,
  - To meet a number of other policy goals

System Location	Payment Level (€ cents/kWh)
BIPV on recently constructed[42] residential buildings, schools, & health facilities	58
BIPV (on other recently constructed buildings)	50
Simplified BIPV	42
Freestanding PV (>250 kW)[43]	31.4
Source: France 2010a	

France FIT Payment Differentiation by Location for PV Systems (2010)

Predetermined Tariff Degression

- Used to keep tariffs in line with evolving cost realities through decreases in the payment level, at either specific points in time, or as capacity targets are reached
- Fixed annual percentage declines, or According to a "responsive" formula that allows the rate of degression to respond to the rate of market growth
  - Degression rates will be greater for rapidly evolving RE technologies such as PV
  - Degression creates greater investor security by removing the uncertainty associated with annual program revisions and adjustments

Tariff Degression for Landfill Gas Facilities in Germany (Germany RES Act 2008) Payment levels (€ cents/kWh) Based on an annual degression of 1.5%						
Project Size	In-Service Year					
	2009	2010	2011	2012	2013	2014
0-500 kW	9.00	8.87	8.73	8.60	8.47	8.34
500 kW-5 MW	6.16	6.07	5.98	5.89	5.80	5.71

FIT: Responsive Degression

- Degression is adjusted according to the rate of market growth (Germany RES Act 2008)
- In Germany's case, if the annual installed PV capacity in a given year exceeds a certain amount, the percentage rate of annual degression is increased by 1%; if it falls short of a certain annual installed capacity, the degression rate is decreased by 1%

German Responsive Degression Rates

Year	Market Condition (this year)	Next year's annual degression rate
2009:	< 1,000 MW installed	Declines 1% (e.g. 8% to 7%)
	Between 1,000-1,500 MW installed	No change
	1,500+ MW installed	Increases 1% (e.g. 8% to 9%)
2010	< 1,100 MW installed	Declines 1% (e.g. 8% to 7%)
	Between 1,100-1,700 MW installed	No change
	1,700+ MW installed	Increases 1% (e.g. 8% to 9%)
2011	< 1,200 MW installed	Declines 1% (e.g. 8% to 7%)
	Between 1,200-1,900 MW installed	No change
	1,900+ MW installed	Increases 1% (e.g. 8% to 9%)

Source: Adapted from Jacobs and Pfeiffer 2009; see also Germany 2008 and 2010

Inflation Protection

- Feed-In Tariffs are index linked to the Retail Prices Index (RPI), which means the tariff is subject to inflation
  - Protects invested capital
- Higher protection = lower initial tariffs
- Prices adjusted periodically
  - For new projects
  - Inside existing contracts

Greater protection offered on the value of project revenues, adjusting FITs for inflation can reduce the perceived risk of the policy for investors

Periodic Review

- Determines if targets being met
- Allows price adjustment
  - If profits are too high
  - If targets are not being met
- Allows addition of new technologies
- Every 2-5 years

Fiscal and other support incentives

- Direct production incentives/Generation Based Incentive
- Investment subsidies
- Low-interest loans
- Loan guarantees
- Flexible/accelerated depreciation schemes
- Investment or production tax exemptions

Advantages of FIT Policies

- Offer a secure and stable market for investors
- Stimulate significant and quantifiable growth of local industry and job creation
- Only cost money if projects actually operate (i.e. Fits are performance-based)
- Provide lower transaction costs
- Can secure the fixed-price benefits of RE generation for the utility's customers by acting as a hedge against volatility

Advantages of FIT Policies

- Settle uncertainties related to grid access and interconnection
- Enhance market access for investors and participants
- Predictable revenues : Enable traditional financing
- Encourage technologies at different stages of maturity, including emerging technologies
- Customize the policy to support various market conditions, including regulated and competitive markets

Other benefits are that FIT policies

- Have a measurable impact on RE generation and capacity
- Tailor the policies using a range of design elements that will achieve a wide range of policy goals
- Are compatible with RPS mandates
- Can help utilities meet their RPS mandates
- Can provide a purchase price to renewable energy generators that is not linked to avoided costs
- Demonstrate a flexible project-specific design that allows for adjustments to ensure high levels of cost efficiency and effectiveness

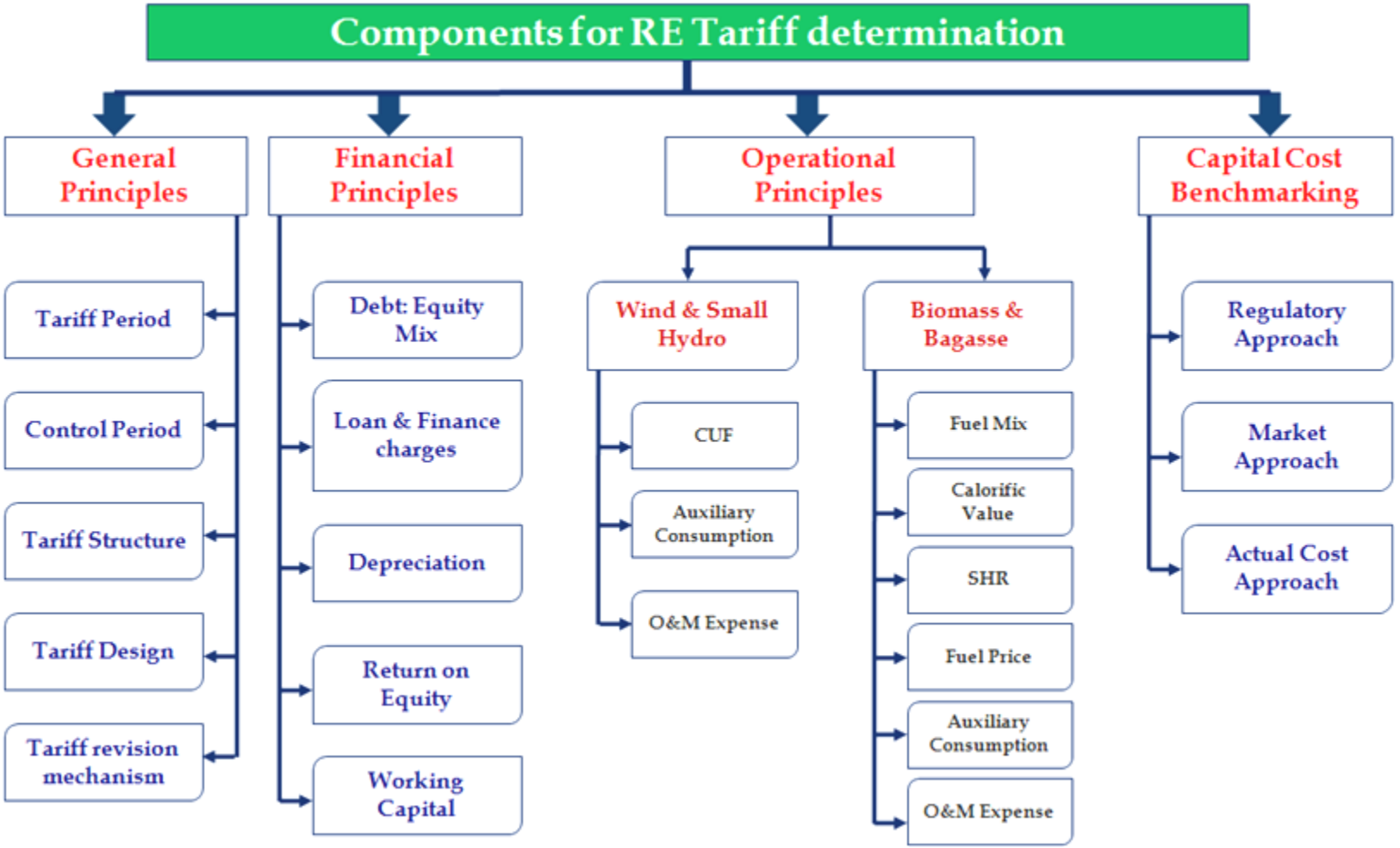
Disadvantages of FIT Policies

- FITs can lead to near-term upward pressure on electricity prices, particularly if they lead to rapid growth in emerging (i.e., higher-cost) RE technologies
- FITs may distort wholesale electricity market prices
- FITs do not directly address the high up-front costs of RE technologies – instead, they are generally designed to offer stable revenue streams over a period of 15-25 years, which enables the high up-front costs to be amortized over time

Disadvantages of FIT Policies

- FITs do not encourage direct price competition between project developers
- It may be difficult to control overall policy costs under FIT policies, because it is difficult to predict the rate of market uptake without intermediate caps or capacity-based degression
- It can be challenging to incorporate FITs within existing policy frameworks and regulatory environments
- FITs are not “market-oriented,” primarily because FITs often involve must-take provisions for the electricity generated, and the payment levels offered are frequently independent from market price signals

Components of cost plus RE Tariff Determination



CERC RE Tariff Regulations, 2012

Levellised tariff

- Generic tariff on levellised basis for the Tariff Period
- RE technologies having fuel usage :
  - Single part tariff with two components: Fixed and variable
  - Tariff shall be determined on levellised basis for fixed cost component
  - While the fuel cost component shall be specified on year of operation basis
- For the purpose of levellised tariff computation, the discount factor equivalent to Post Tax weighted average cost of capital
- Levellisation to be carried out for the 'useful life'

A balanced approach vis a vis concerns of front loaded tariff, back loaded tariff etc.

Generic v/s Project specific tariff

- Provision for project specific tariff on case to case basis, for new RE technologies like:
  - Municipal Solid Waste to Energy Projects
  - Hybrid Solar Thermal Power plants
  - Hybrid options (i.e. renewable–renewable or renewable–conventional sources)
  - Any other new renewable energy technologies as approved by MNRE

The financial norms specified for determination of Generic Tariff except for capital cost, would be ceiling norms while determining the project specific tariff

Tariff Period

- Wind, Biomass, Bagasse based cogeneration projects:13 years

  - **Regulatory support during the 13 year tariff period will provide certainty to the project developer to meet its debt service obligations**
  - **After this period, the competitive procurement of RE will ensure that power is procured at most reasonable rate, and benefit passed on the consumer**

- Small hydro projects below 5 MW: 35 years
- Solar PV and Solar thermal power projects: 25 years
- Biomass Gasifier and Biogas based power projects: 20 years

  - **Longer duration of tariff support in view of smaller size/nascent technologies**

Capital Cost Benchmarking

- Various approaches are evaluated for development of benchmark capital cost for different RE technologies
  - **Regulatory Approach:** Norms as approved by various SERCs are most simple and easy to follow
  - **Market Based Approach:** Project awarded through competitive tender process carried out by public and private entities
  - **Actual Project Cost Approach: Information furnished by developers as a part of project appraisal requirements to various financial institutions/banks to avail** loan or to UNFCCC for registering the project to avail CDM benefits
  - **International Project Cost based Approach**

Subsequently suitable indexation mechanism devised to consider the year on year variation for the underlying capital cost parameters

Financial Principles

- **Debt : Equity Ratio** considered at 70 : 30. For project specific tariff,
  - In case of equity funding in excess of 30%, to be treated as normative loan.
  - In case of equity funding lower than 30%, actual equity to be considered.
- **Return on Equity**
  - Value base at 30% of capital cost or actual equity (whichever is lower).
  - Pre-tax ROE: 19% p.a. for first 10 years and 24% p.a. from 11th year onwards.
- **Loan Terms**
  - Tenure of loan considered as 12 years.
  - Interest rate : SBI Base rate + 300 basis points
- **Depreciation**
  - 'Differential depreciation' approach over loan period & 'Straight Line' method over the remaining useful life.
  - Allowed upto 90% of capital cost considering salvage value as 10%.
  - On SLM basis at 5.83 % p.a. for first 12 years and remaining depreciation to be spread over balance useful life of asset.

Financial Principles

Useful Life

- Wind Energy : 25 years
- Biomass power / cogeneration : 20 years
- Small hydro power : 35 years
- Solar PV and Solar thermal : 25 years

Sharing of CDM benefits

- Share of developer to be 100% for 1st year after COD.
- Share of beneficiary to be 10% in second year to be increased progressively at 10% per year till it reaches 50%.
- Thereafter, sharing shall be on equal proportion basis.

Financial Principles

Working Capital

Technology	O&M expense	Receivables	Maintenance spares	Fuel cost
Wind/ Small Hydro/ Solar	1 Month	2 Month	15% of O&M expense	
Biomass/ Non-fossil Fuel Co-generation	1 Month	2 Month	15% of O&M expense	4 months of fuel stock at normative PLF

- Interest rate equivalent to average SBI Base rate plus 350 basis points

TECHNOLOGY SPECIFIC PARAMETERS

Wind Energy

Eligibility Criteria :

- New Wind energy projects

Capital Cost:

- Rs 575 Lakh/MW for first year of Control Period (FY 2012-13)
- Linked to indexation mechanism over Control Period

O&M expense:

- Rs 9 Lakh/MW for first year of Control Period (FY 2012-13 with escalation at 5.72% / annum

Capacity Utilization Factor :

Annual Mean Wind Power Density (W/m^2)	CUF
Up to 200	20%
201-250	22%
251300	25%
301-400	30%
> 400	32%

Small Hydro Projects

S. No.	Particular	Unit	Description
1.	**Capital cost**		
	Himanchal Pradesh and Uttarakhand (Below 5 MW)	Rs Lakh/ MW	770
	Himanchal Pradesh and Uttarakhand (5 MW to 25 MW)	Rs Lakh/ MW	700
	Other States (Below 5 MW)	Rs Lakh/ MW	600
	Other States (5 MW to 25 MW)	Rs Lakh/ MW	550
2.	**Capacity Utilisation Factor (CUF)**		
	Himanchal Pradesh and Uttarakhand	%	45%
	Other States	%	30%
3.	**O&M cost**		
	Himanchal Pradesh and Uttarakhand (Below 5 MW)	Rs Lakh/ MW	25
	Himanchal Pradesh and Uttarakhand (5 MW to 25 MW)	Rs Lakh/ MW	18
	Other States (Below 5 MW)	Rs Lakh/ MW	20
	Other States (5 MW to 25 MW)	Rs Lakh/ MW	14
4.	Auxiliary Consumption	%	1%

Biomass Power Projects

Eligibility Criteria:

- Biomass power projects based on Rankine cycle technology and using biomass fuel sources, provided use of fossil fuel is restricted only to 15% of total fuel consumption on annual basis.

S. No.	Particular	Unit	Description
1	Capital Cost	Rs Lakh/MW	450
2	Plant Load Factor		
	1st yr during stabilization	%	60%
	remaining period of the 1st yr	%	70%
	Next year onward	%	80%
3	Auxiliary Consumption	%	10
4	Station Heat Rate	kCal/kWh	4000
5	O&M Expenses	Rs Lakh/MW	24

CERC RE Tariff (Third Amendment) Regulations, 2015, 10/7/2015

38. Station Heat Rate

- *The Station Heat Rate for biomass power projects using fossil fuel up to 15% of calorific value on annual basis shall be as under:*
- *a. 4126 kcal/kWh for project using travelling grate boilers*
- *b. 4063 kcal/kWh for project using AFBC boilers*

43. Calorific Value

For Biomass based projects using fossil fuel up to 15% of calorific contribution, the Calorific Value of fuel used for the purpose of determination of tariff shall be 3174 kcal/kg

Non- Fossil Fuel Based Co-generation

S. No.	Particular	Unit	Description
1.	Capital Cost	Rs Lakh/MW	420
2.	Auxiliary Consumption	%	8.5
3.	Station Heat Rate	kCal/kWh	3600
4.	O&M Expenses	Rs Lakh/MW	15
5.	Plant Load Factor	Operating days	PLF
	Uttar Pradesh and Andhra Pradesh	180 days	45%
	Tamil Nadu and Maharashtra	240 days	60%
	Other States	210 days	53%
6..	GCV	kCal/kg	2250

Solar PV & Solar Thermal

S. No.	Particular	Unit	Solar PV	Solar Thermal
1.	Technology Aspect		crystalline silicon or thin film etc.	Concentrated solar power (CSP) technologies viz. line focusing or point focusing
2.	Capital cost	Rs Lakh/ MW	691	1200
3.	CUF	%	19%	23%
4.	O&M cost	Rs Lakh/ MW	9.0	13
5.	Auxiliary Consumption	%	NA	10%

MSW and RDF based on Rankine cycle technology power projects : 7th Oct. 2015

- Useful Life- 20 years
- Capital Cost Norm for FY 2015-16:
  - Rs1500 lakh/MW: for municipal solid waste based
  - Rs900 lakh/MW: for refuse derived fuel based
  - Provided that the Capital Cost norms for the remaining years of the control period, for municipal solid waste and refuse derived fuel based power projects shall be reviewed on annual basis.
- Plant Load Factor: MSW / RDF
  - During Stabilisation: 65% / 65%
  - During the remaining period of the first year (after stabilization): 65% / 65%
  - From 2nd Year onwards: 75% / 80%
  - The stabilisation period shall not be more than 6 months from the date of commissioning of the project
- Auxiliary Consumption: 15%

MSW and RDF based on Rankine cycle technology power projects : 7th Oct. 2015

- Station Heat Rate: 4200 kcal/kWh for power projects which use municipal solid waste and refuse derived fuel
- Normative O&M expenses (FY 2015-16):
  - 6% of normative capital cost
  - Annual escalation @ 5.72% per annum.
- Calorific Value: 2500 kcal/kg for refuse derived fuel
- Fuel Cost:
  - Refuse derived fuel price during FY 2015-16 shall be Rs 1,800 per MT.
  - Normative escalation factor of 5% per annum
- No fuel cost considered for determination of tariff for the power projects using municipal solid waste
- Tariff 2015-16 : MSW: Rs./kWh 7.04, RDF: Rs.7.90 /kwh

RE Tariff Order 2015-16
SO4 of 2015 (suo-moto)

Wind

	Annual Mean WPD (W/m2) at 50 mtr HH	CUF	2009-10 ` /kWh	2010-11 ` /kWh	2011-12 ` /kWh
Zone-1	200-250	20%	5.63	5.07	5.33
Zone-2	250-300	23%	4.90	4.41	4.63
Zone-3	300-400	27%	4.70	3.75	3.95
Zone-4	> 400	30%	3.75	3.38	3.55
	WPD at 80 mtr		2012-13 ` /kWh	2014-15 ` /kWh	2015-16 ` /kWh
Zone-1	Upto 200	20%	5.96	6.34	6.58
Zone-2	200-250	22%	5.42	5.76	5.98
Zone-3	250-300	25%	4.77	5.07	5.27
Zone-4	300-400	29%	3.97	4.23	4.39
Zone-5	> 400	32%	3.73	3.96	4.11

Solar PV & Solar Thermal tariff

	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Solar PV							
Module Cost USD/Wp	3.40	2.20	1.75	0.85	0.60	0.59	0.52
Capital Cost Rs. Crore/MW	17.00	16.90	14.42	10.00	8.00	6.91	6.06.
Tariff Rs./kWh	18.44	17.91	15.39	10.39	8.75	7.72	7.04
Solar Thermal							
Capital Cost Rs. Crore/MW	13.00	15.30	15.00	13.00	12.00	12.00	12.00
Tariff Rs./kWh	13.45	15.31	15.04	12.46	11.90	11.88	12.05

Small Hydro Power

	09-10	10-11	11-12	12-13	13-14	14-15
HP, Uttarakhand and NE States (Below 5MW) ` /kWh	3.90	3.59	3.78	4.14	4.38	4.45
HP, Uttarakhand and NE States (5MW to 25 MW) ` /kWh	3.35	3.06	3.22	3.54	3.75	3.80
Other States (Below 5 MW) ` /kWh	4.62	4.26	4.49	4.88	5.16	5.25
Other States (5MW to 25 MW) ` /kWh	4.00	3.65	3.84	4.16	4.40	4.46

Competitive Bidding for Tariff Discovery

Solar PV Tariffs discovered in Bidding

Previous bid results					
	Year	Capacity on Offer (MW)	Highest Bid (Rs./KWh)	Lowest (Rs./KWh)	Weighted Avg. Price (Rs./KWh)
NSM Batch 1	Dec'10	150	12.76	10.95	12.16
NSM Batch2	Dec'11	350	9.39	7.49	8.79
Orissa Phase 1	Mar'12	25	8.98	7.0	8.36
Orissa Phase 2	Dec'12	25	9.50	7.28	8.73
Karnataka	Apr'12	60	8.5	7.94	8.34
Madhya Pradesh	Jun'12	125	12.45	7.9	8.05
Tamil Nadu	Mar'13	150	14.5	5.97	6.48*
Rajasthan	Mar'13	75	8.25	6.45	6.45 (L1)
Andhra Pradesh	Apr'13	226	15.99	6.49	6.49 (L1)
Punjab Phase 1	June'13	270	8.75	7.2	8.41
Uttar Pradesh Phase 1	Aug'13	130	9.33	8.01	8.9
Karnataka Phase 2	Aug'13	130	8.05	5.5	6.87
Madhya Pradesh Phase 2	Jan'14	100	6.97	6.47	6.86
Andhra Pradesh Phase 2	Oct'14	500	5.99**(7.03 Levelized)	5.25** (6.17 Level.)	5.75** (6.75 Level.)
Karnataka	Nov'14	500	7.12	6.71	6.94
Telangana	Nov'14	500	6.9	6.46	6.72
Punjab (Capacity 5-24 MW)	Feb'15	100	7.45	6.88	7.17
Punjab (Capacity 25-100 MW)	Feb'15	100	7.56	6.88	7.16
NTPC Anantapur	May'15	250	-	-	6.16*** (L1)
Uttar Pradesh Phase 2	June'15	215	8.6	7.02	8.04
Madhya Pradesh	June'15	300	5.641	5.051	5.36
Telangana Group 1****	August'15	500	5.8727	5.4991	5.73
Telangana Group 2****	August'15	1500	5.8877	5.1729	5.62
Punjab	Sept'15	500	5.98	5.09	5.65

*5% escalation for 10 years
** 3% escalation for 10 years. Separate L1 for 9 districts
*** EPC Bids with Domestic content requirement. Capital subsidy of Rs. 1 Cr/MW
****Results for the lowest bid for 500 and 1500 MW respectively. The sub-station wise final list to be declared soon

With such a low tariff Discoms will replace future their power requirement with solar and hedge power purchase cost

Telangana and Andhra Pradesh's bid size of 1000 MW each, convey that with reduction in cost of generation of solar PV legislative support in the form of RPO/SPO would not be required

All time low tariff discovered in November 15 :
Andhra Pradesh : 500 MW: Rs. 4.63/kWh

FIT Related Concerns

Challenges

- Significant variation in approach and principles for FIT determination across states in
  - Variation in technical and operational norms
  - Control period and Tariff period
  - Capital Cost indexation not followed by many states.
  - Differences in financial parameters and treatment for time value for money

- Policy makers and many State Commissions are debating continuation of Preferential RE Tariff route as against adoption of Tariff based Competitive bidding route.
- Uncertainty on such critical policy/regulatory matters related to mode of procurement be detrimental to growth.
- Should FiT co-exist with REC

Possible Solutions

- National Tariff Policy / FOR could draw up transition roadmap for the regulatory regime for each RE technology.
- FiT for Wind and Solar could be thought of for large MW additions

Thank You

Solar Tariff

Policy	Total Capacity	Year	Lowest Tariff	Highest tariff
NSM Batch 1	150	2011	10.96	12.76
NSM Batch 2	350	2012	7.49	9.44
Karnataka 1	80	2012	7.94	8.5
Odisha	25	2012	7.28	L1 matching
Madhya Pradesh 1	200	2012	7.95	8.05
Tamil Nadu	1000	2013	6.48 +esc.	L1 matching
Rajasthan	100	2013	6.45	L1 matching
Punjab	200	2013	7.67	8.74
Karnataka 2	135	2013	5.51	8.05
Karnataka 3	50	2014	6.66	7.74
Chhatisgarh	100	2014	6.44	7.9
Madhya Pradesh 2	100	2014	6.47	6.97

FIT Related Concerns

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TECHNOLOGY SPECIFIC NORMS: WIND ENERGY

Wind - Capital Cost

Wind

Capital Cost

CUF

O & M Cost

RE Tariff Regulations-2009

Year	Date of Regulations/Order	Capital cost `Lacs/MW
2009-10	17.09.2009	515.00
2010-11	26.02.2010	467.13
2011-12	09.11.2010	492.52

Wind - Capital Cost

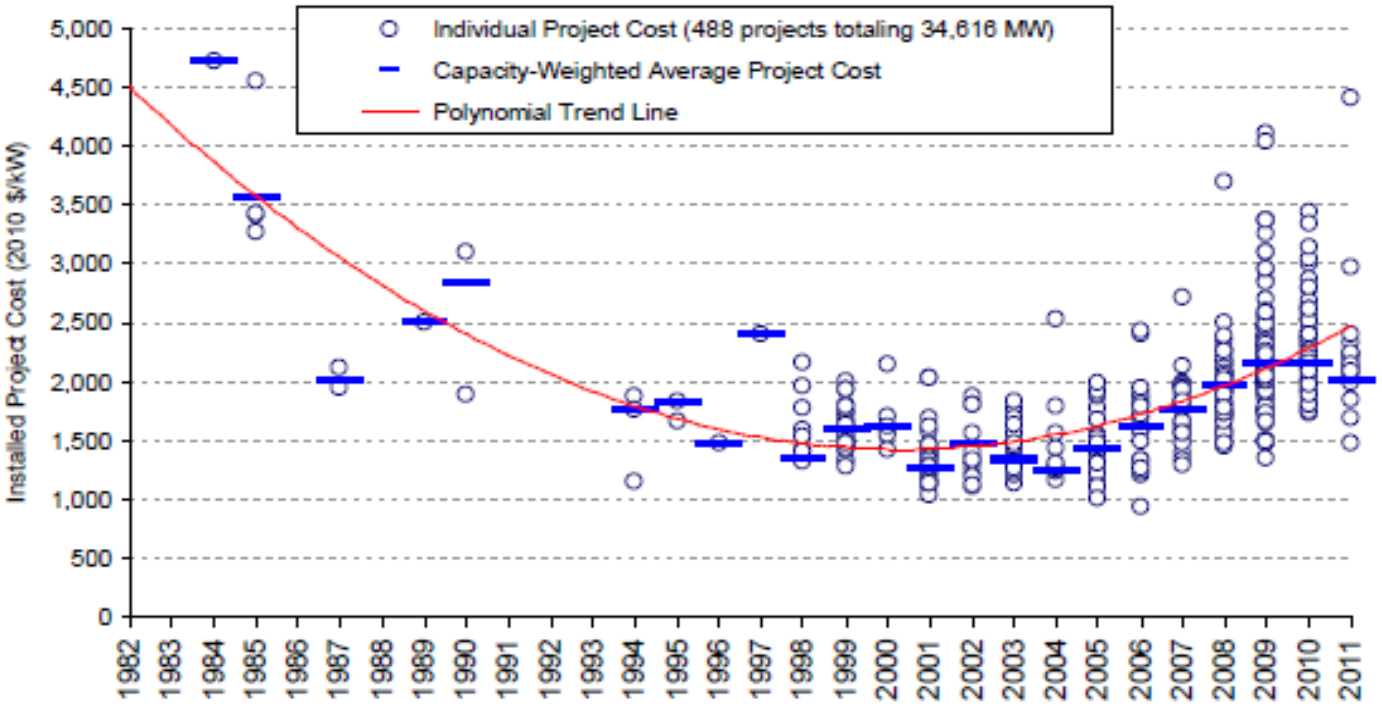
Wind

Capital Cost

CUF

O & M Cost

International Trend: Installed Project Cost - USA



Note: 2011 data represent preliminary cost estimates for a sample of 17 projects totaling 1.1 GW that have either already been or will be built in 2011, and for which reliable cost estimates were available.

Source: Berkeley Lab (some data points suppressed to protect confidentiality)

U.S. Department of Energy's report on "2010 Wind Technologies Market Report": June - 2011 prepared by the Lawrence Berkeley National Laboratory (LBNL)

- 1 GW of capacity that either have been or will be built in 2011 suggests that average installed costs may decline in 2011

Wind - Capital Cost

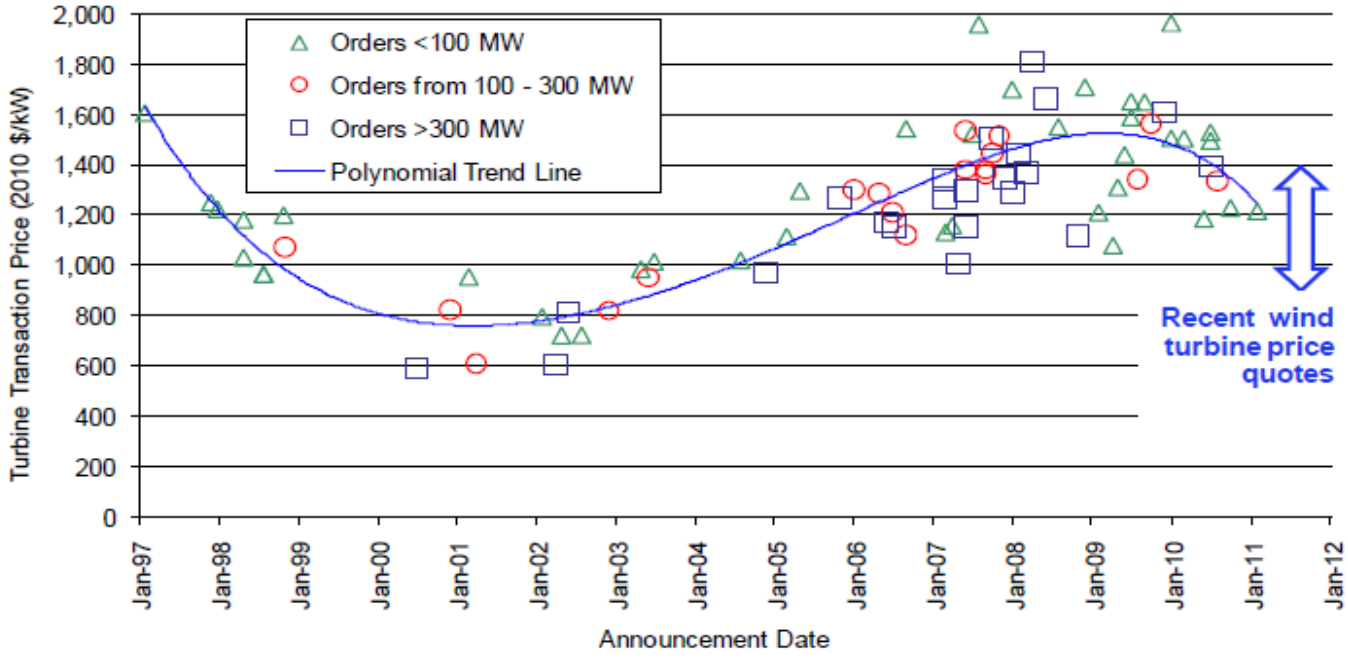
Wind

Capital Cost

CUF

O & M Cost

International Trend: Turbine Cost - USA



Source: Berkeley Lab

U.S. Department of Energy's report on "2010 Wind Technologies Market Report": June - 2011 prepared by the Lawrence Berkeley National Laboratory (LBNL)

- **In US total Project costs which were bottomed out in 2001-04; rose by $850/kW on average through 2009; held steady in 2010 at around $2,160/kW and appear to be dropping in 2011 at around $2000/kW**

Wind - Capital Cost

Wind

Capital Cost

CUF

O & M Cost

Capital Cost considered by other SERCs

Name of the Commission	Date of Order/Regulation	Capital cost ` Lacs/MW
CERC (2009-10)	17.09.2009	515.00
KERC	11.12.2009	470.00 (inc. evacuation cost)
CERC (2010-11)	26.02.2010	467.13
MPERC	14.05.2010	500.00 (inc. evacuation cost)
OERC (FY 10-11 to12-13)	14.09.2010	467.13 (As per CERC)
CERC (2011-12)	09.11.2010	492.52
MERC (2010-11)	29.04.2011	489.53 (As per CERC)

Wind - Capital Cost

Wind

Capital Cost

CUF

O & M Cost

Capital Cost:

Source	No. of Projects	MW	Weighted Average Capital Cost ` Cr./ MW
IREDA (FY 10-11)	10	570	5.90
IREDA (FY 11-12)	4	220	5.90
UNFCCC (FY 09-10)	14	137	5.23
UNFCCC (FY 10-11)	5	84	5.47
Tender (FY 10-11)	5	34	6.00
Total	38	1045	

Wind - Capital Cost

Wind

Capital Cost

CUF

O & M Cost

2.1 MW-S88		
Component Breakup	% cost	Net Cost
SUPPLY OF WTG WITHOUT TT	58%	33265546
SUPPLY OF BLADE	9%	5284916
SUPPLY OF TT	12%	6761086
SUPPLY OF TRANSFORMER	1%	751232
ERECTION	2%	974985
COMMISSIONING	0%	108272
MEDA CHARGES	1%	315517
MEDA Application Fees	0%	5259
ZP Road charges	0%	210345
CIVIL WORKS	5%	2925897
ELEC LINE & SUPPLY	4%	2299406
LAND	3%	1442365
EVACUATION	5%	3155174
	100%	57,500,000

Wind: Capacity Utilisation Factor

Wind

- Capital Cost
- CUF
- O & M Cost

RE Tariff Regulations-2009

Annual Mean Wind Power Density (W/m2) at 50 mtr hub height	CUF
200-250	20%
250-300	23%
300-400	27%
> 400	30%

- **MNRE Circular dated 1.08.2011: No restriction will exist for WPD criteria as far the development of wind power project is concerned**

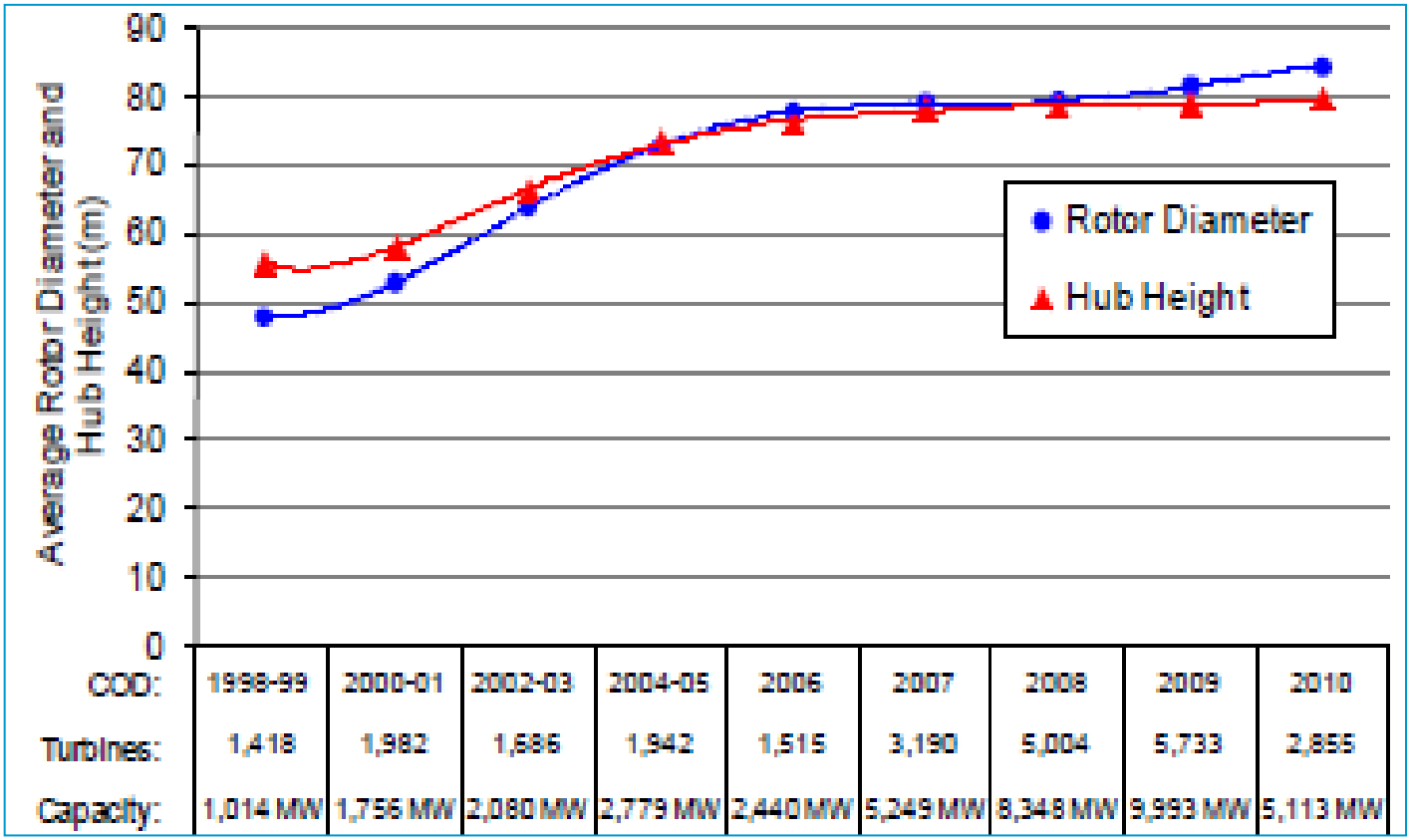
Historical Increase in Hub Height & Rotor Diameter: USA

Wind

Capital Cost

CUF

O & M Cost



Wind Energy Installation: FY 10-11

Wind

Capital Cost

CUF

O & M Cost

Developer / State	MAH	KAR	TN	RAJ	MP	GUJ	AP	Total	%	Hub Height
Suzlon	107.2	93.95	191.55	333.5	42.6	183.1		951.9	**40.48**	65 75 78 80
Enercon	31.2	116	112	103.2		78.4	63.2	504	**21.43**	50 56 57 65
Vestas		39.6	115.5			20.4		175.5	**7.46**	70 78 80
Maruti Windfarm	21.15							21.15	**0.90**	
RS Windfarm	41.25							41.25	**1.75**	
TS Windfarm	25							25	**1.06**	
Sriram EPC	1		25			2.5		28.5	**1.21**	41
Vestas RRB			99					99	**4.21**	65
Gamesa			213.35			14.45		227.8	**9.69**	
Regen		4.5	96			7.5		108	**4.59**	75 85
SWPL					6	0.45		6.45	**0.27**	45
GWL			31.93			3		34.93	**1.49**	
Pioneer Wind	2.25		28			2		32.25	**1.37**	50
WinWind			29					29	**1.23**	70
Cwel			14.03					14.03	**0.60**	
INOX			2					2	**0.09**	80
Kenersys	10		2					12	**0.51**	80
Shiva Wind			1.5					1.5	**0.06**	50
TTG			0.25					0.25	**0.01**	
LeitWind			36.3					36.3	**1.54**	65
IWPL						1		1	**0.04**	
TOTAL	**239.05**	**254.05**	**997.41**	**436.7**	**48.6**	**312.8**	**63.2**	**2351.81**	**100**	
%	**10.16**	**10.80**	**42.41**	**18.57**	**2.07**	**13.30**	**2.69**	**100.00**	**84.46**	

LBNL : Reassessing Wind Potential Estimates for India:

Wind

Capital Cost

CUF

O & M Cost

Wind Power Class	50 m		80 m			100 m			120 m		
	WPD	WS	CF	WPD	WS	CF	WPD	WS	CF	WPD	WS
1	0-200	0-5.6	-	0 - 200	0-5.6	-	0-200	0-5.6	-	0-200	0-5.6
1a	*NA*	*NA*	*20%*	*200 -251.3*	*5.6 -6.0*	*20.0%*	*200-220*	*5.6-5.7*	*20.0%*	*200-237.9*	*5.6-5.9*
1b	*NA*	*NA*	*NA*	*NA*	*NA*	*21.6%*	*220-276.5*	*5.7-6.2*	*23.3%*	*237.9-299*	*5.9-6.3*
2	200 -300	5.6-6.4	25%	251.3 - 375.1	6.0 -6.9	27.0%	276.5-412.7	6.2-7.1	29.0%	299-446.3	6.3-7.3
3	300 -400	6.4-7.0	32%	375.1 - 490.8	6.9-7.5	34.0%	412.7-540	7.1-7.7	35.5%	446.3-583.9	7.3-7.9
4	400 -500	7.0 - 7.5	36%	490.8 - 603.6	7.5-8.0	37.5%	540-664.2	7.7-8.3	39.0%	583.9-718.2	7.9-8.5
5	500 -600	7.5-8.0	39%	603.6 - 732.6	8.0 -8.6	40.5%	664.2-806.1	8.3-8.8	42.0%	718.2-871.6	8.5-9.1
6	600 -800	8.0 - 8.8	42%	732.6 - 975.1	8.6-9.4	43.5%	806.1-1,072.9	8.8-9.7	45.0%	871.6-1,160.1	9.1-10

Source : LBNL