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11 – 15 Feb. 2014, Bangkok

Renewable Energy Certificates: Economics, Market and Regulation

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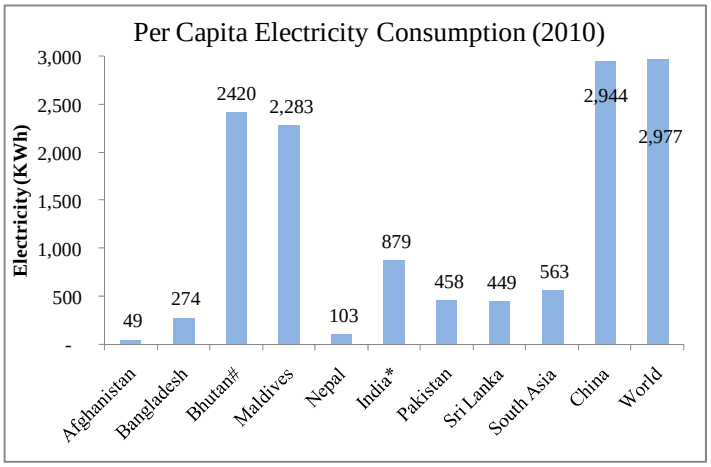
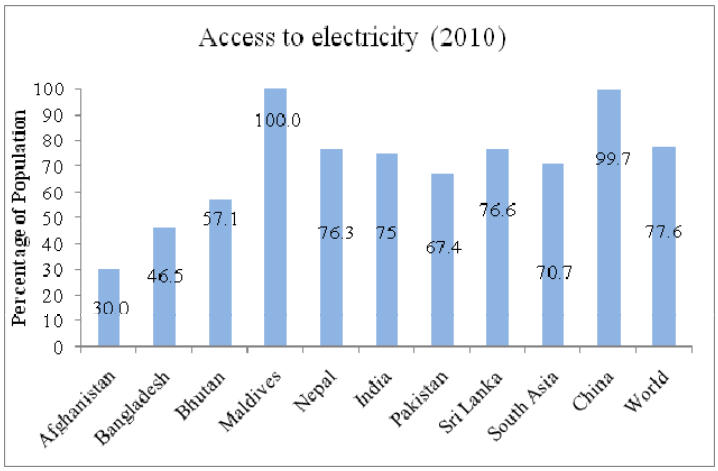
Per capita electricity consumption in South Asia



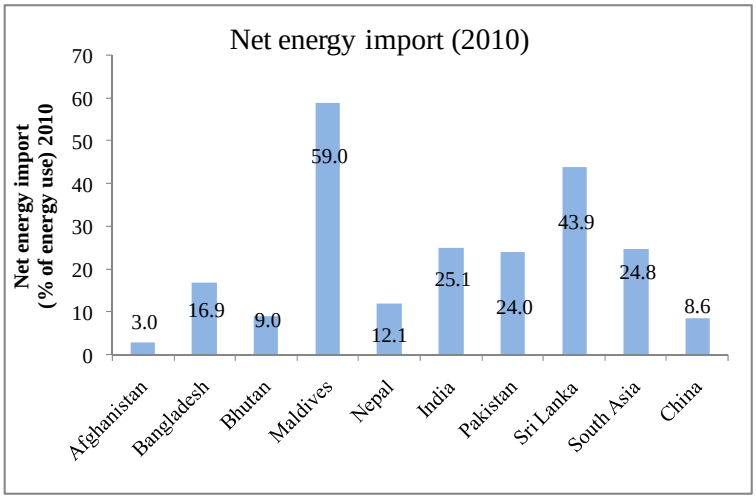
So: WDI (2013), RGoB (2012), CEA (2013)

Access to Electricity in South Asia



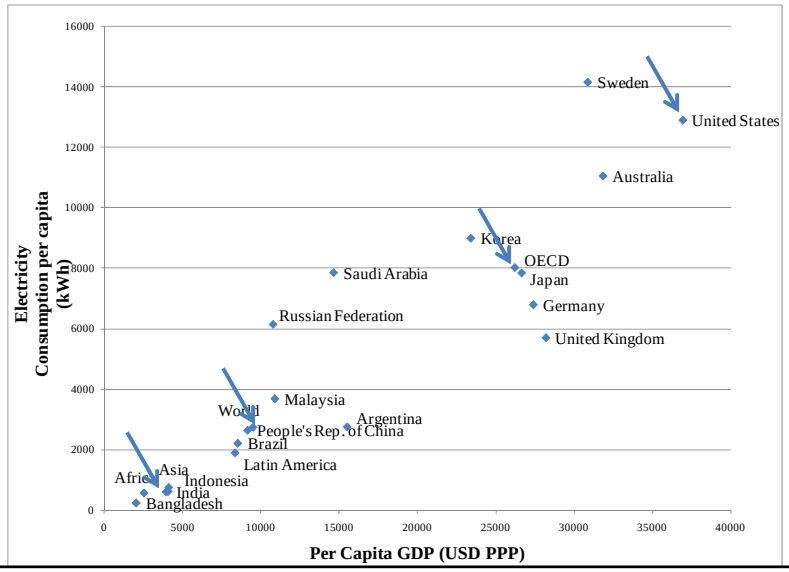
So: World Development Indicators, 2013

Concerns for Energy Security

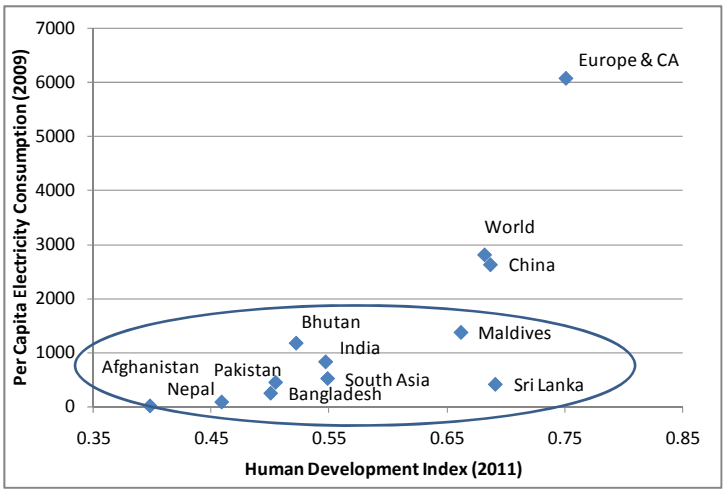


So: World Development Indicators, 2013

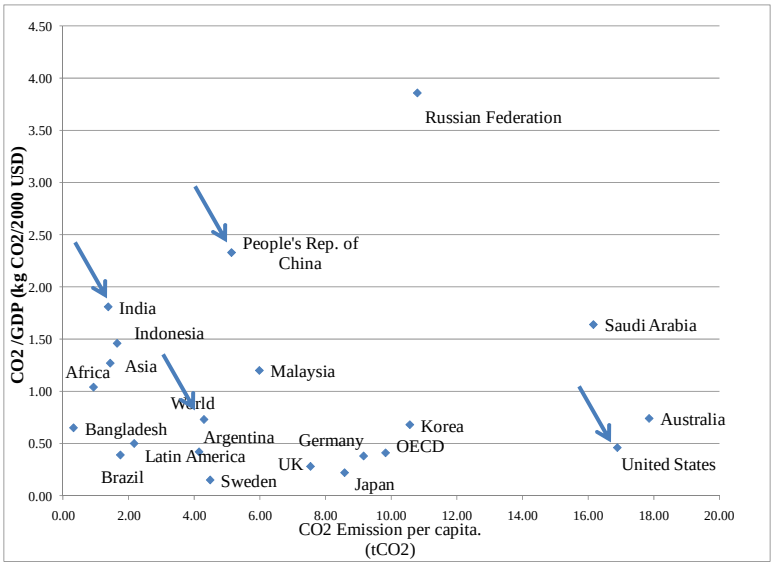
Electricity Consumption and Economic Growth



Electricity Consumption and Human Development Index



CO2 Emissions – Per Capita and per GDP



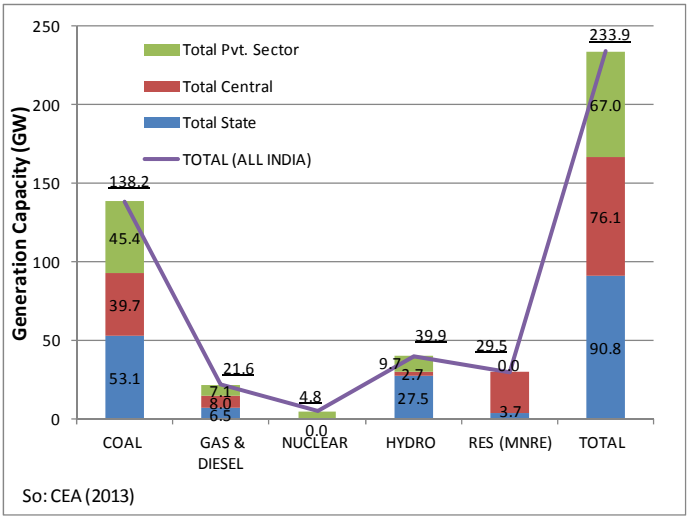
Sustainable Energy Path

- Domestic Drivers
  - Increasing energy demand
  - Lack of fossil resources
  - Increasing energy import (energy security)
  - Low clean energy access
- International Drivers
  - Global warming & Kyoto Protocol
  - Competitiveness

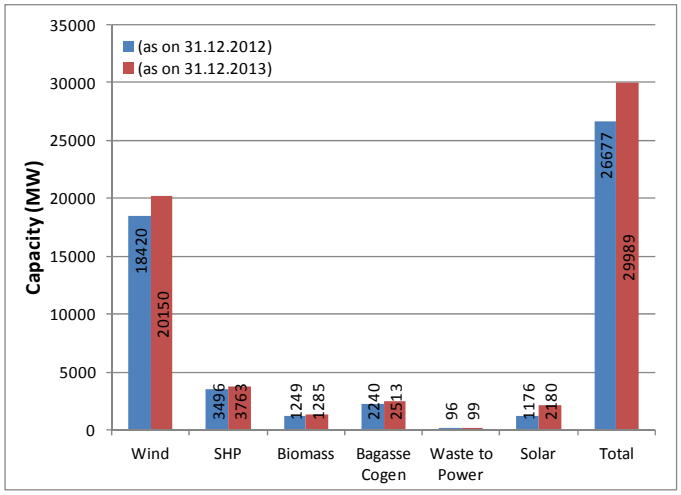
Sustainable Energy Policy Options

- Stimulate Green Investment
  - FiT, RPO, REC
- Address Distortions in Energy Pricing
  - Encourage energy conservation
- Address Environmental Externalities
  - Chimney height, fly ash use, SC technology
- Enhance Energy Efficiency
  - Star Labeling, PAT Scheme

All India Generation Capacity (As on 31 Dec. 2013)

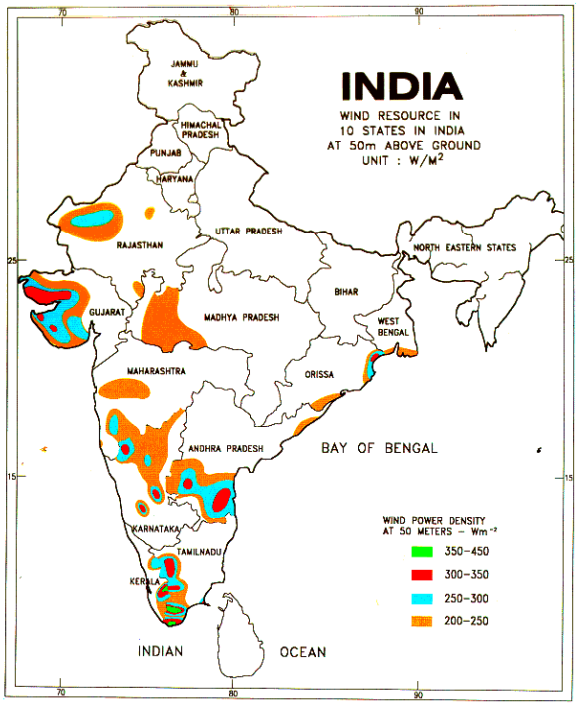


Grid Interactive Renewable Energy Deployment (By Source)



(So: MNRE)

Renewable Energy Resources in India

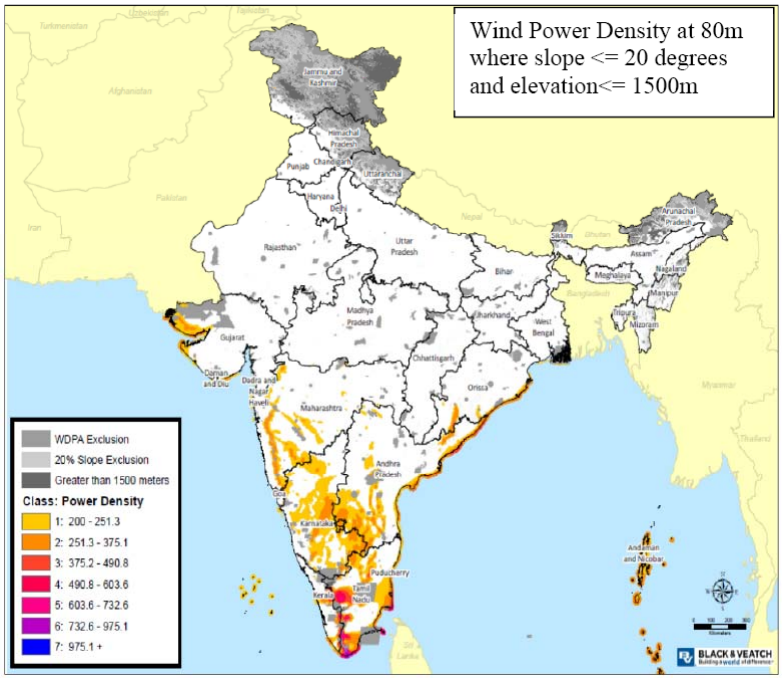


Wind Energy Map of India

Untapped Wind Potential!

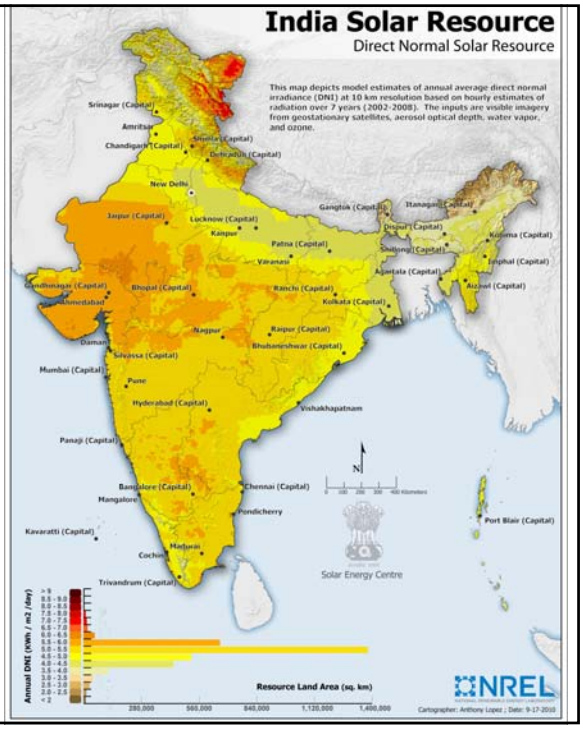
- Hub Height
- Off-share
- Vertical Axis

- LBNL Study projects India's onshore wind potential to be 2,006,000 MW (3,121,000 MW) at 80 m (120 m) hub height!!!



So: Phadke et al. (2012), LBNL

Solar Resources in India



Challenge for Harnessing Renewable Energy

- Resources
- Technology
- Financing
- Policy & Regulation

Role of Policy and Regulation

Low Carbon Growth - Policy Developments in India

- Renewable Energy
  - Electricity Act – Renewable Purchase Obligation
  - Renewable Energy Certificates (REC)
- Energy Efficiency
  - Energy Efficiency Standards
  - Appliance Rating
  - CEA Notification on Use of Super Critical Technology
- National Action Plan for Climate Change
  - JN National Solar Mission

How to make RE story a success?

- We have technology, but
  - Resources are limited (land, env. clearances) and hence to harness)
  - It is expensive (….costs are coming down)
  - It is difficult to get investors to put money into it

Need some Carrots (and small sticks)

Carrots

- Subsidies
- Feed-in Tariffs
- Tax Breaks

Sticks!

- Obligation to buy electricity generated from renewable energy resources, Renewable Portfolio Obligation (RPO)

Electricity Act 2003 and Policy Framework for Renewable Energy

State Electricity Regulatory Commissions (SERCs) to specify a percentage of the total consumption of electricity in the area of a distribution licensee, for purchase of electricity from co-generation and renewable energy sources (renewable portfolio obligation) (Sec. 81 (1) (e)).

SERCs to promote co-generation and generation of electricity through renewable sources of energy by providing suitable measures for connectivity with the grid and sale of electricity to any persons (Sec. 81 (1) (e)).

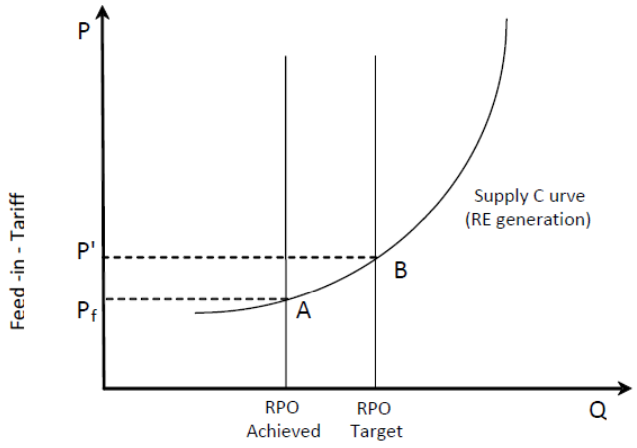
Terms and conditions for the determination of tariff to be prescribed by the SERCs to promote co-generation and generation of electricity from renewable sources of energy. (Sec. 61 (h))

Electricity Act 2003 and Policy Framework for Renewable Energy (Contd.)

National Electricity Policy to be formulated by the central government, in consultation with the state governments for development of the power system based on optimal utilization of resources including renewable sources of energy. (Sec. 3 (1))

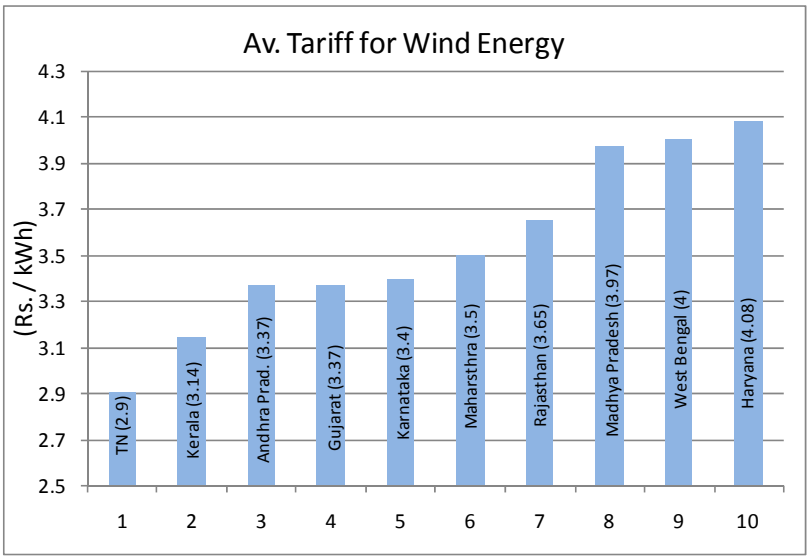
Central Government to prepare a national policy, in consultation with the State Governments, permitting stand alone systems (including those based on renewable sources of energy and other non-conventional sources of energy) for rural areas. (Sec. 4)

Discontinuity in prices in the demand function



Feed-in-Tariff and Shortfall in RPO Compliance

Wind Energy Tariff Across States (2008-09)



Challenges

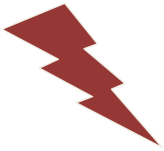
- Economic Efficiency of existing policies
- States have different resource endowments and some have very limited ones (e.g. Delhi)
- How to incentivise renewable resources in remote areas not connected with grid?

100 kW Solar PV plan in Tangtse, Ladakh

Solution?

What differentiates electricity from renewable energy sources?

- Electricity from Conventional energy Sources



- Electricity from Renewable energy Sources

What is Renewable Energy Certificates?

‘Green electricity’ ‘electricity ‘green certificates’

- Sell ‘electricity’ and ‘green certificates’ in different markets

A Market for Nationally Tradable Renewable Energy Credits/Certificates

Renewable portfolio standard with cost based feed-in-tariffs disregard economic efficiency

One of the market related approach would be to unbundle 'Greenness' from electricity.

Nationally tradable renewable energy certificates, which could be sold separately from 'electricity' addresses these issues effectively.

Separation of market for 'energy' and 'renewable certificates' promises a economic efficiency with proper implementation.

A Market for Nationally Tradable Renewable Energy Certificates (Contd.)

Lower cost of compliance for renewable obligation.

Bring new investment as investors have access to a 'national' market as opposed to a particular state.

Alternate Revenue Stream for Investors

- (a) Revenue from sale of 'green electricity' to Discoms under a feed-in-tariff specified by the SERCs.
- (b) Sale of 'Electricity' to Discom at APPC Avg. Pooled Purchase Cost + Sale of RECs at PXs.
- (c) RE based captive consumption, if above RPO can be sold as RECs.

Advantages of Renewable Energy Certificates/Credits (RECs)

- Assist in RPO Compliance (Compliance market)
- Expand participation in promotion of RE (Voluntary market)
- Marketing 'Green/Greener' Electricity to Final Consumers
- Promote efficiency in investment and assist choice of appropriate technology
- Provide incentives for cost reduction and benchmarks for innovation in RE applications
- Avoiding transmission of electricity generated through RE sources
- Assist efficient implementation of promotional policies by the government. (esp. off-grid RE based rural electrification)

Renewable Energy Credits/ Certificates (RECs)

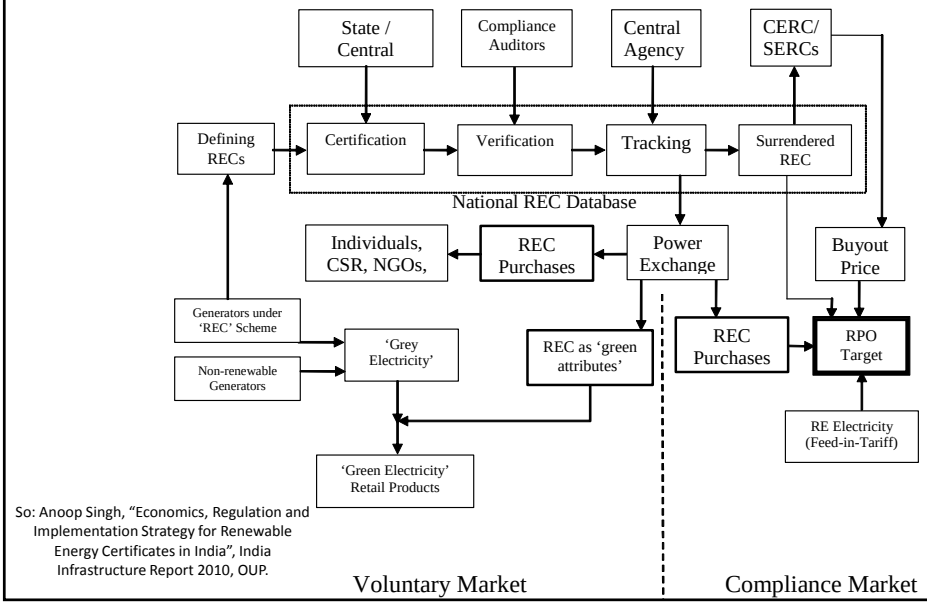
RECs are used for a variety of purposes including

- Disclosure,
- Marketing and
- Compliance monitoring
- These are also called as 'green tags' or Tradable Green Certificates' in Europe, Renewable Obligation Certificates (RECs) in the UK.
- Guarantee of Origin (GO) or Renewable Energy Guarantee of Origin (REGO) is often used in the European Union (EU) to certify that renewable electricity was generation in a particular jurisdiction. This is primarily being used as a disclosure mechanism.

Market for RECs – International Experience

- REC schemes are under operation across various countries including Italy, US, Australia, Belgium etc.
- USA – Arizona, Colorado, Connecticut, Maine, Maryland, Massachusetts, Nevada, New Jersey, New Mexico, New York, Pennsylvania, Rhode Island, Texas, Wisconsin

A Framework for Implementing Renewable Energy Certificates in India



So: Anoop Singh, "Economics, Regulation and Implementation Strategy for Renewable Energy Certificates in India", India Infrastructure Report 2010, OUP.

Issues in Implementing RECs

- Defining RECs
- Eligibility for REC
- Category of Certificates
- Voluntary Markets
- Banking
- 'Buyouts'
- Central Electricity Regulatory Commission (Terms and Conditions for recognition and issuance of Renewable Energy Certificate for Renewable Energy Generation) Regulations, 2010.

CERC's Framework for RECs

Mechanism for RECs

Eligible Sources

- 'Grid Connected' small hydro, wind, solar including its integration with combined cycle, biomass, bio-fuel cogeneration, urban or municipal waste & such sources as recognized by MNRE
- Two Categories of Certificates - Solar and Non-Solar

Eligible Entities

- Grid Connected RE Power Projects having no PPA at preferential tariff with state utilities and having accreditation from a State Agency
- Shall sell electricity at Pooled cost of Power Purchase to distribution utility or at mutually agreed price to any other licensee

Obligated Entities

- As identified by the SERCs - distribution utilities, OA Users, Captive Consumers

Mechanism for RECs (Contd.)

Issuing Authority

- National Load Despatch Center shall issue REC to Generator based on the Energy Injection Report prepared by SLDC

Trading of REC

- Transaction of REC shall take place at Power Exchanges operating under the guidance of CERC

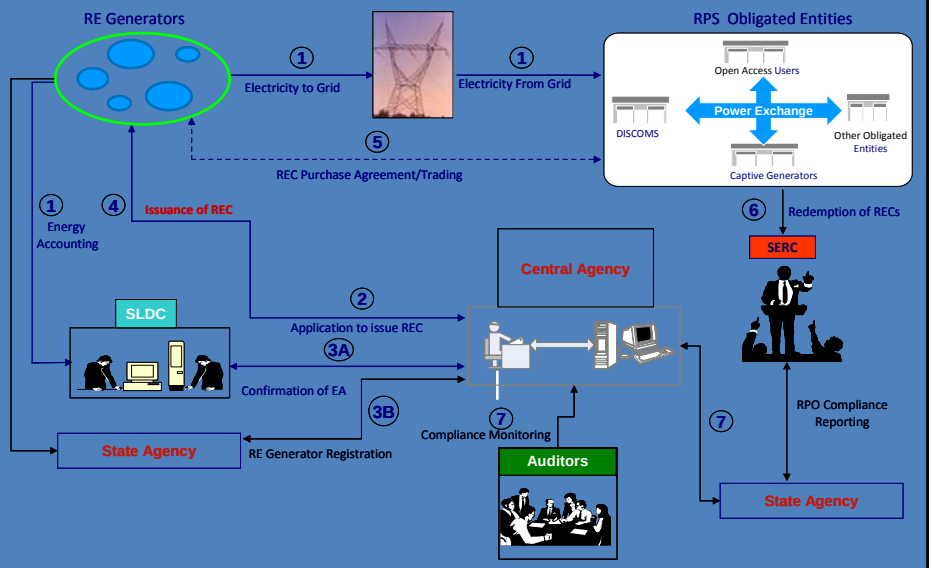
Denomination

- One REC is equivalent to 1 MWh of renewable energy generated and injected into the Grid.

Mechanism for RECs (Contd.)

- REC shall be issued electronically to the Generator
- Floor and Forbearance Price determined by the CERC from time to time
- Obligated entities with shortfall in RPO can buy REC from PXs Exchange Platform and redeem it for RPO compliance.
- RE Generator can apply for issuance of certificate upto 3 months of energy injection in the grid
- REC are valid for 1 year from the date of issuance.

Framework for REC Implementation



REC Regulations – Need for a relook

- Fungibility of RECs & RECx multiplier
- Floor and Forbearance Price – Buyout Price
- Off-grid Projects

Fungibility of Certificates

- Separation of the RECs market into solar and non-solar RECs could be avoided due to the following reasons,
- Loss of liquidity in the market for RECs and hence less efficient price discovery for RECs
- Loss of competition amongst the renewable energy sources (solar and non-solar energy in this case) to reduce costs and improve efficiency would be lost by artificial splitting of the RECs market.

The objective of such a separation split could be…

- Separate renewable portfolio obligation (RPO)
- 'Better' support for solar energy

Both of these objectives can be met by adopting following solution.

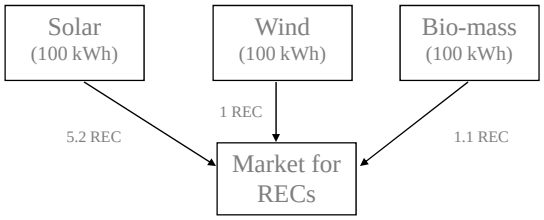
Solution: A Common Market for RECs with multiplier for different RE sources

- Various renewable energy sources could be provided with a different multiplier for equivalent number of RECs. For e.g.

S. No.	Renewable Energy Source	Tariff (Tamil Nadu) (Rs./kWh)	REC Multiplier (RECx)
1	Wind	2.75 and 2.90	1
2	Biomass	3.15	1.1
3	Solar	SERC's FiT + 15 (MNRE)	4-5
4	Solar PV (Gujarat)	13 (12 yrs.), 3 (next 13 yrs.)	
5	Solar Thermal (Gujarat)	10 (12 yrs.), 3 (next 13 yrs.)	~3

- So: updated from Singh, Anoop (2009), "A Market for Renewable Energy Credits in the Indian Power Sector", *Renewable and Sustainable Energy Reviews*, Elsevier

The following example further illustrates the proposed solution.



Ensuring compliance of solar RPO

- Further, if it is desired that solar energy needs greater impetus in the beginning. A higher multiplier can be specified for initial couple of years and then it can be tapered down.
- This multiplier can be decided separately by the respective SERCs for plants located in the respective states or centrally by the CERC.

Value of Green Certificates by Source of RE in Italy

S. No.	Source of Renewable Energy	Budget Law 2008 (GC/MWh)
1	Wind (onshore)	1
2	Wind (offshore)	1.1 (1.5)
3	Geothermal	0.9
4	Tidal	1.8
5	Hydro	1
6	Biomass (short chain)	0.9
7	Biomass (others)	1.1 (1.3)
8	Biogas	0.8

ROC Banding System in UK

S. No.	Technology	ROCx	S. No.	Technology	ROCx
1	Hydro-electric	1	13	Advanced gasification	2
2	Onshore Wind	1	14	Advanced pyrolysis	2
3	Offshore Wind	1.5	15	Anaerobic Digestion	2
4	Wave	2	16	Co-firing of Biomass	0.5
5	Tidal	2	17	Co-firing of Energy Crops	1
6	Solar Photovoltaic	2	18	Co-firing of Biomass with CHP	1
7	Geothermal	2	19	Co-firing of Energy Crop with CHP	1.5
8	Geopressure	1	20	Dedicated Biomass	1.5
9	Landfill Gas	0.25	21	Dedicated Energy Crops	2
10	Sewage Gas	0.5	22	Dedicated Biomass with CHP	2
11	Energy from Waste with CHP	1	23	Dedicated Energy Crops with CHP	2
12	Standard gasification	1	24	Micro-generation (under 50kW)	2
13	Standard pyrolysis	1			

Sunset Clause to Drive Cost Reduction and Innovation

- The REC multiplier (RECx) (suggested above) can be gradually reduced gradually. A falling trajectory of multiplier would provide incentives for cost reduction and innovation to improve technology.
- Such a trajectory for the RECx would provide a cost benchmark for technology developers to be achieved in the near future.
- The RECx multiplier can also be used to set a ‘sunset clause’ for RE sources / technologies that would achieve commercial viability comparable with conventional energy sources or need lower support over time.

Handling Concurrency of FiT and RECs

- The existing power purchase contracts for RES under the FiT can be a part of the REC market thereby increasing market liquidity.
- Solution: Credit equivalent number of RECs to the obligated entities who buy electricity from RES under a FiT or a contractual scheme.
- These should first be compulsorily surrendered towards the RPO. Additional purchases can be offloaded in the market. Seasonality in prices can be better managed by this stock of RECs.

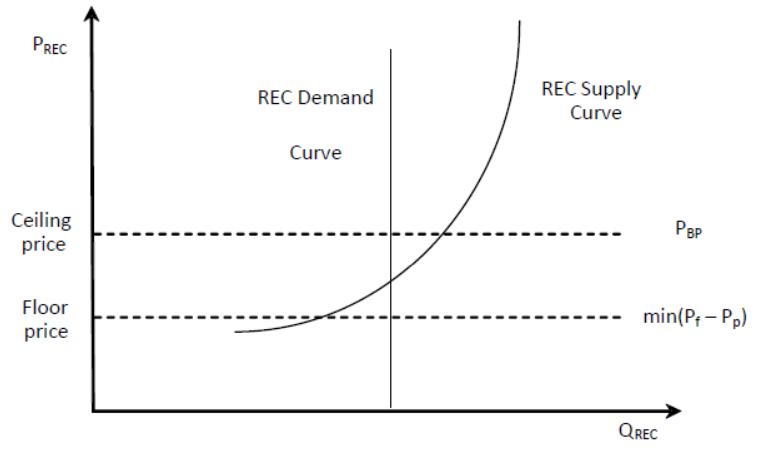
Floor Price of RECs

- FiT provide greater visibility of prices as compared to REC.
- Floor price assures minimum revenue to investors (from RECs).
- Comforts lenders by assures greater revenue to service debt.
- Suggested Floor Price = min (FiT – APPC)

Forbearance (Ceiling) Price of RECs

- Safeguard obligated entities and the consumers from excessive rise in REC price.

Price discovery in the market for RECs



Penalty to Buyout Price for RPO Shortfall

- In economic terms, buyout price should essentially be equal to the marginal social benefit of electricity sourced from RE sources over that from non-renewable sources. In other words it is the value of the environmental attributes of 'green electricity.

Country	Per 1 MWh equivalent REC
Belgium (Flanders)	Euro 125 (from April 2005)
Poland	Euro 60 (2005-06)
UK	£30 (2002-03) £37.19 (2009-10)
Australia	Aus $ 40
Maine (USA)	USD 57.12 (2008)
Massachusetts (USA)	USD 58.58 (2008)

'Economic Efficiency of RECs?'

CERC's Forbearance and Floor Price for RECs

	Non solar REC (Rs./MWh)	Solar REC (Rs. /MWh)
Forbearance Price	3,900	17,000
Floor Price	1,500	12,000

Forbearance and Floor Price for RECs: Encouraging Inefficiency and Windfall Gains

State	RES	Tariff as per RE Tariff Regulation	APPC for 2009-10	Difference between RE tariff and APPC	Effective Peak Tariff for non-solar	Effective Floor Tariff for non-solar	Prevailing Feed-in-Tariff @	Windfall Gain #
(1)	(2)	(3)	(4)	(5) = (3) – (4)	(6) = (4) + P_{FB}	(7) = (4) + P_{FL}	(8)	(9) = (7) – (8) to (6) – (8)
Rajasthan	Wind	5.63	2.57	3.06	6.47	4.07	3.83	0.24 - 2.64
Tamil Nadu	Wind	4.17	2.51	1.66	6.41	4.01	3.39	0.62 - 3.02
Maharashtra	Wind	5.63	2.51	3.12	6.41	4.01	2.86 – 4.29	0 - 3.55
Maharashtra	SHP	4.31	2.51	1.8	6.41	4.01	3.14	0.87 - 3.27
Maharashtra	Biomass	4.76	2.51	2.25	6.41	4.01	4.98	0 - 1.43
Maharashtra	Cogen.	4.8	2.51	2.29	6.41	4.01	4.79	0 - 1.62
Tamil Nadu	Biomass	5.08	2.51	2.57	6.41	4.01	4.66	0 - 1.75

Floor and Forbearance Price: Implicit Price of Carbon

	Units	Non-Solar		Solar	
		For Simple Operating Margin (excl. Imports)	For Combined Margin (excl. Imports)	For Simple Operating Margin (excl. Imports)	For Combined Margin (excl. Imports)
Operating/Combined Margin	tCO2/MWh	1.009	0.859	1.009	0.859
REC floor Price	Rs/MWh	1500	1500	12000	12000
Implicit floor price of carbon	Rs/tCO2	1486.02	1746.01	11888.20	13968.07
Implicit floor price of carbon	Euro/tCO2	24.77	29.10	198.14	232.80
REC forbearance Price	Rs/MWh	3900	3900	17000	17000
Implicit forbearance price of carbon	Rs/tCO2	3863.66	4539.62	16841.61	19788.10
Implicit forbearance price of carbon	Euro/tCO2	64.39	75.66	280.69	329.80

CERC's Forbearance and Floor Price for RECs from 1 April 2012 (Revised on 13.6.2011)

	Non-solar REC (Rs. / MWh)	Solar REC (Rs. / MWh)
Forbearance Price	3480	13690
Floor Price	1400	9800

‘Denomination and issue of Certificates’

- Higher denomination for RECs would be unfavourable to small RE facilities.
- Denomination of a single REC should be smaller than one Megawatt hour (MWh), say, in the ‘units’ of 100 kWh.
- This would allow greater reach of the market for RECs to individuals, philanthropic organizations and corporations willing to buy RECs under their Social Corporate Responsibility etc.

Voluntary Market for RE

RECs offer scope to extend reach of RE beyond RPO.

- Direct purchase of electricity generated from RE sources
- Consumers can directly purchase RECs to meet shadow ‘voluntary commitments’.
- Electric utilities can ‘bundle’ RECs with ‘grey electricity’ to market ‘green electricity’.

Voluntary Purchase of Renewable Energy (USA)

S. No.	Year	2005	2006	2007	2008
1	Residential (GWh)	3,000	3,200	4,500	5,500
2	Commercial (GWh)	5,500	8,700	13,600	18,800
3	Total (GWh)	8,500	11,900	18,100	24,300
4	Share of Commercial	65%	73%	75%	77%

So: Cook and Karelas (2009)

Inclusion of Stand-alone RE generators

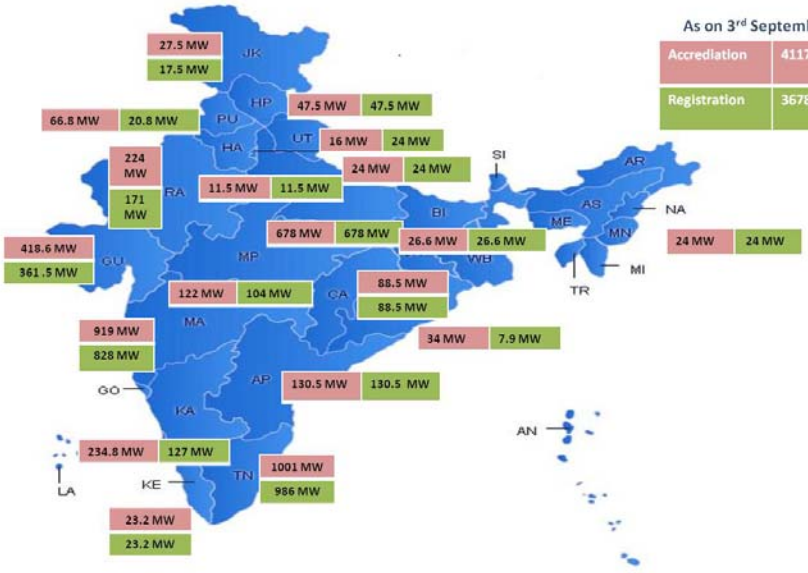
- Renewable energy based distributed decentralized generation & distribution projects are serving the needs of the communities in rural and remote areas.
- By making stand-alone RE generators eligible, the current high costs of energy access in such locations can be partly supported and their viability can be improved.
- Due to 'generation linked' RECs, there is an inbuilt incentive for better operation of the facility.
- This would also encourage new RE based rural electrification projects on stand-alone basis as envisioned under the Electricity Act 2003.

Banking for RECs and Rolling over the RPO

- Banking of RECs credited in a financial year up to the end of the 'next' financial year.
  - Renewable energy sources are prone to natural vagaries and hence energy generation and accrual of RECs can not be reliability projected. Further, some of the SERCs also allow for accumulation of Renewable Portfolio Obligation (RPO) beyond a year for a similar reason.
  - Banking of RECs would be supported well through futures market in RECs and hence would ensure more efficient price discovery in the futures market.
  - This would also facilitate planning by a RE generator / discom in case there is over accumulation or shortage of RECs in a given Financial Year. Such a flexibility would be desirable from the perspective of RE developers as well as discoms.

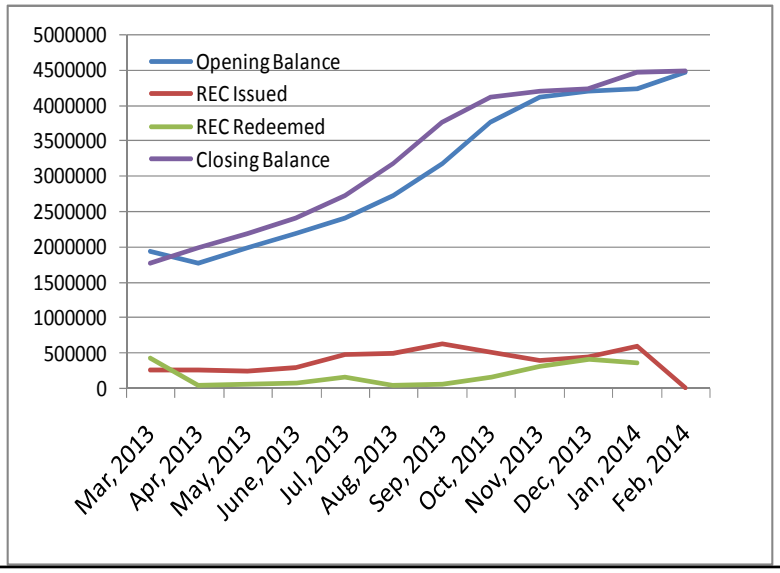
Status of REC Market

State wise Accrediation & Registration Capacity

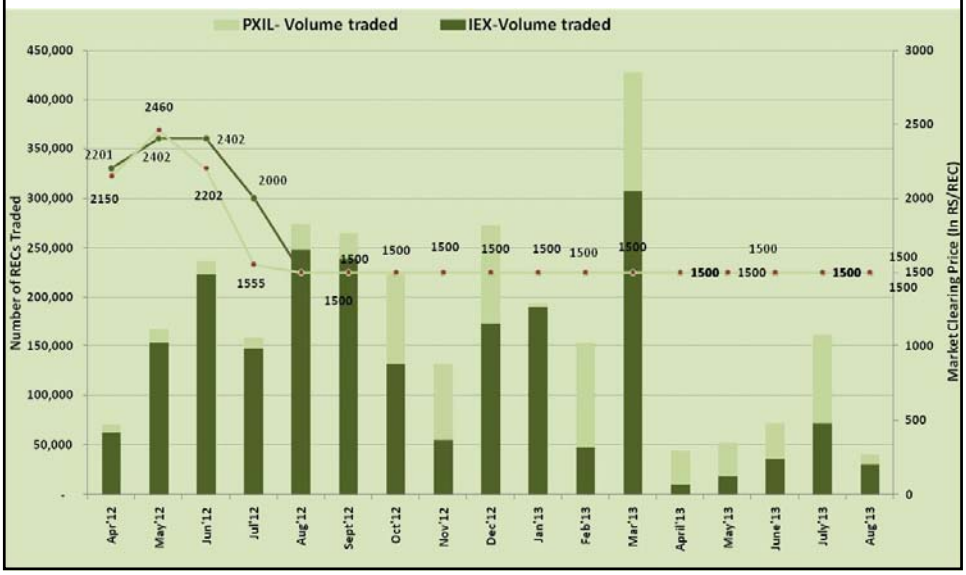


So: IEX

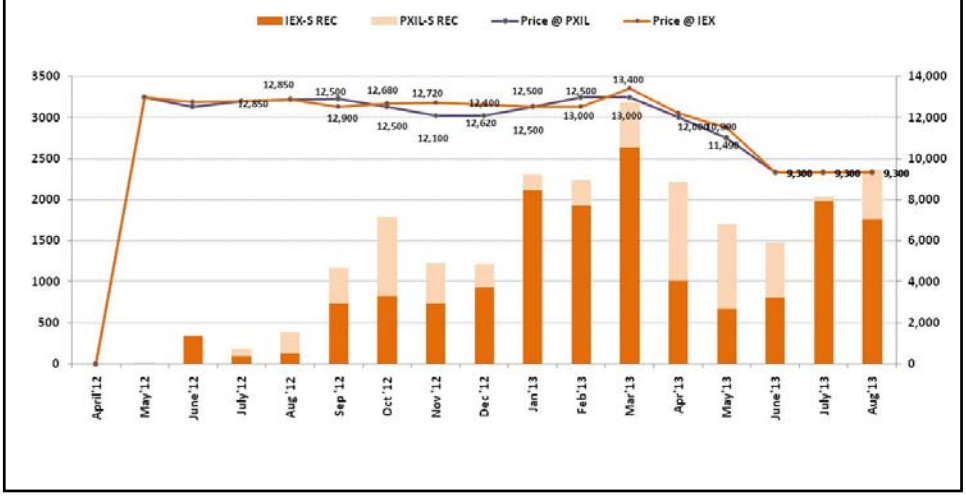
REC Registry



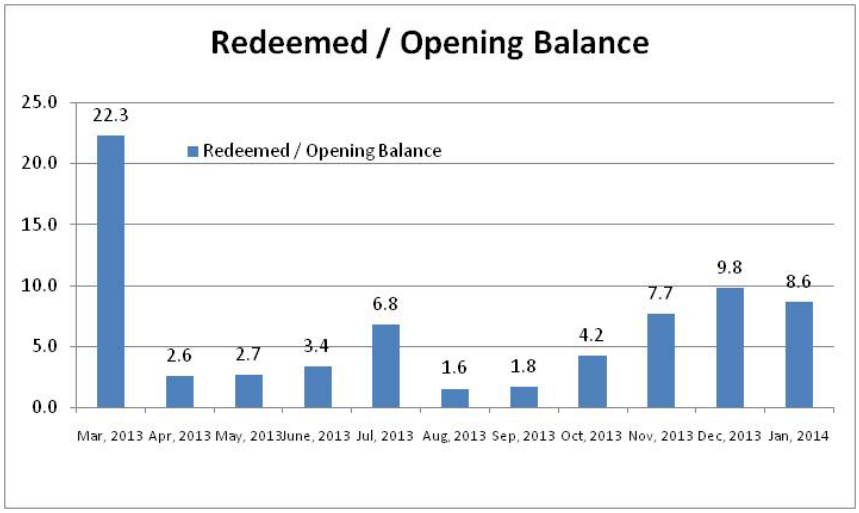
Non-solar REC Market



Solar REC Market



Missing RPO Compliance



Issues to be Addressed

- RPO Compliance needed for market confidence
- Need to link FiT and REC mechanisms (Participation of disocms under FiT regime).
- Voluntary Market
- Banking (and Roll over?)
- Stand-alone systems
- Non-electrical renewable applications for e.g. Solar Thermal (heat)
- 'Buy out policies' (penalty for RPO shortfall) ... and mutualisation.

Suggestions for future Development of REC Market

- Linking FiT and REC Market
- Programmatic Application of Renewable Energy (PARE)
- White Certificates (ECERTs)

REC certificates for Programmatic Application of Renewable Energy (PARE)

- (PARE) can be referred to the program based activities involving a number of users and involving deployment of RE to replace electricity requirement. For e.g. the solar lantern programme, rooftop solar water heaters etc.
- While the scope of existing regulations is limited to 'electricity generated' from RE sources, in the near future, the REC regulations may provide for eligibility for such applications with adequate criteria for usage and measurement of electricity replaced with renewable energy.

Further Readings

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- "Analysing Efficiency of Electric Distribution Utilities in India: a Data Envelopment Analysis" (with Dilip Kumar Pandey), IAEE International Conference, Stockholm 19-23 June, 2011.
- "Modelling Economic Efficiency of Renewable Energy Policies: A Multi-State Model For India", Accepted for World Renewable Energy Congress, 17-19 Oct. 2011, Bali, Indonesia. (with Sundeep Chowdary).
- "Economics of Iran-Pakistan-India Natural Gas Pipeline: Implications for Energy Security in India", Economic & Political Weekly, V. XLIII, No. 7 2008.
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- "Climate Co-benefit Policies for the Indian Energy Sector: Domestic Drivers and North-South Cooperation", *Climate Policy* 9 (5) 529-543 2009
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Thank You

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