MINUTES OF THE 16TH ANNUAL GENERAL BODY MEETING

OF

FORUM OF INDIAN REGULATORS (FOIR)

Venue	:	**"GULMOHAR" Hall, First Floor Convention Centre India Habitat Centre, Lodhi Road NEW DELHI.**
Date	:	**10th June, 2015**
List of Participants	:	**At Annexure – I (enclosed)**

The 16th Annual General Body Meeting (AGM) of the Forum of Indian Regulators (FOIR) was chaired by Shri S. Krishnan, Chairperson, PNGRB / Hony. Chairman, FOIR.

2. Shri Gireesh B. Pradhan, Chairperson, CERC and Hony. Vice-Chairman, FOIR welcomed the Members of the FOIR in the 16th AGM. In his address, he remarked that FOIR has been in existence since 15 years and has been regularly meeting by way of various conferences, workshops and meetings. He briefly mentioned about the decision taken in the Special General Body Meeting wherein it was decided that CERC would host the Regulatory Research Training Institute (RRTI) in its premises for 2 years. Chairperson, CERC shared with the members that efforts are being made to operationalise the RRTI and it is aimed to have the physical infrastructure ready by the end of year 2015. He also mentioned that FOIR has invited experts from National

Renewable Energy Laboratory (NREL), USA to share their experience on Grid Integration of Renewable Energy.

As per practice, the Chairpersons / Members of the Regulatory Commissions who had joined after the previous AGM of the FOIR were welcomed and introduced to the Members of the FOIR.

3. The welcome address was followed by presidential address by Shri S. Krishnan, Chairperson, PNGRB / Hony. Chairman, FOIR. He emphasized on the need for going in for a low carbon economy. He talked about the growing need for Renewable energy as, in future more than fifty percent of the energy needs would be met by Renewables owing to increasing population and limited availability of fossil fuels. He expressed his gratitude for being honoured with the responsibility of chairing the "FOIR".

4. Thereafter the Annual General Body took up the agenda items for discussion and decision thereof.

AGENDA ITEM NO. 1 : Confirmation of Minutes of the 15th Annual General Body Meeting of "FOIR" held on 26th June, 2014 at New Delhi.

Minutes of the 15th Annual General Body Meeting of "FOIR" held on 26th June, 2014 at New Delhi and as circulated were confirmed.

AGENDA ITEM NO. 2 : Reconstitution of the Governing Body for the FY 2015-16.

The proposed reconstitution of the Governing Body of FOIR for FY 2015-16 was noted and endorsed. Shri V.S. Verma, Ex-Member, CERC opined that Former Members of Regulatory Commission should also have a representation in the Governing Body of FOIR. Since this would require a change in the bye laws of FOIR, a written request from Shri V.S. Verma was sought before this could be taken up for discussion in the Governing Body.

AGENDA ITEM NO. 3 : Annual Accounts of "FOIR" for FY 2014-15.

The salient features of the Balance Sheet and Income & Expenditure Account along with the Schedules and Notes on Accounts of "FOIR" for the FY 2014-15 were explained by the "FOIR" Secretariat. The Forum noted and endorsed the same.

AGENDA ITEM NO. 4 : Appointment of Auditors for FY 2015-16 and fixing their remuneration.

The proposal for engaging an Auditor for auditing the accounts of "FOIR" for the year 2015-16 through Comptroller and Auditor General (CAG) vide their empanelled Chartered Accountants was endorsed. It was also approved that Chairperson, CERC would be authorized to approve the name of statutory auditors and its fees and out- of- pocket expenses, if any.

AGENDA ITEM NO. 5 : Budget of FOIR for FY 2015-16.

The salient features of the Budget Estimates of "FOIR" for the FY 2015-16 were explained by the "FOIR" Secretariat.

On the issue of membership subscription receivable from ASCI and TERI (Rs. 6,00,000/-), the AGM was apprised that the Governing Body of FOIR directed "FOIR" Secretariat to write to ASCI and TERI seeking the outstanding subscription fee giving 3 months time to respond. In case no response is received within 3 months, their membership would automatically stand cancelled and the corresponding amount shown as receivable would be written off from the balance sheet.

The proposed budget for the FY 2015 -16 was noted and endorsed.

"FOIR" WORKSHOP

Presentation on Grid Integration of Renewable Energy "International Experience and Lessons for India" by National Renewable Energy Laboratory (NREL), USA

A Presentation on Grid Integration of Renewable Energy "International Experience and Lessons for India" was made by Shri Ravi Vora, Advisor – International Programs in Renewable Energy & Grid Integration and Dr. Bris Mathias Hodge, Manager, System Reliability, Planning & Grid Integration, National Renewable Energy Laboratory (NREL), USA

The presentation highlighted the following issues:

- European Experience in Renewable Energy and Grid Integration
- Regulatory Role in Variable Renewable Energy
- USA Experience in Renewable Energy and Grid Integration \(successful management, RE variability on the grid)
- India's integration experience (critical factors for success, challenges faced by regulators and role of power market reforms)
- Opportunities for Indian Regulators (RRV)

A copy of the presentation made is **enclosed** at **Annexure-II**. The presentation was appreciated by the members of the FOIR.

At the end, Members present conveyed their gratitude and deep appreciation to the staff of "FOIR" Secretariat for their arduous efforts at organizing the meeting.

The meeting ended with a vote of thanks to the Chair.

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/ ANNEXURE – I /

LIST OF PARTICIPANTS ATTENDED THE 16TH ANNUAL GENERAL BODY MEETING OF FORUM OF INDIAN REGULATORS (FOIR) HELD ON 10TH JUNE, 2015 AT INDIA HABITAT CENTRE, NEW DELHI.

S. No.	Name	Designation
1.	Shri S. Krishnan	Chairperson, PNGRB & Hony. Chairman, FOIR
2.	Shri Gireesh B. Pradhan	Chairperson, CERC & Hony. Vice-Chairman, FOIR
3.	Shri A.K. Singhal	Member, CERC & Hony. Secretary, FOIR
4.	Shri A.S. Bakshi	Member, CERC & Hony. Treasurer, FOIR
5.	Shri Digvijai Nath	Chairperson, APSERC
6.	Shri Naba Kumar Das	Chairperson, AERC
7.	Shri Umesh Narayan Panjiar	Chairperson, BERC
8.	Shri Narayan Singh	Chairperson, CSERC
9.	Shri P.D. Sudhakar	Chairperson, DERC
10.	Shri Pravinbhai Patel	Chairperson, GERC
11.	Shri Basharat Ahmed Dhar	Chairperson, J&KSERC
12.	Shri S.K. Chaturvedi	Chairperson, JERC for Goa & all UTs except Delhi
13.	Dr. Dev Raj Birdi	Chairperson, MPERC
14.	Shri Anand Kumar	Chairperson, MSERC
15.	Shri Vishwanath Hiremath	Chairperson, RERC
16.	Shri T.T. Dorji	Chairperson, SSERC
17.	Shri S. Akshayakumar	Chairperson, TNERC
18.	Shri Niharendu Chakraborty	Chairperson, TERC
19.	Shri Desh Deepak Verma	Chairperson, UPERC
20.	Shri H.L. Bajaj	Ex-Chairperson, CEA
21.	Shri V.S. Ailawadi	Ex-Chairperson, HERC
22.	Shri K.S. Chaube	Ex-Chairperson, HERC
23.	Dr. V.K. Garg	Ex-Chairperson,, JERC for UTs
24.	Shri Vijoy Kumar	Ex-Chairperson, UPERC
25.	Shri D.C. Bajaj	Member, AERA
26.	Shri D. Devaraj	Member, AERA
27.	Dr. P. Raghu	Member, APERC
28.	Shri P. Rama Mohan	Member, APERC
29.	Shri S.C. Jha	Member, BERC
30.	Shri V.K. Shrivastava	Member, CSERC
31.	Shri J.P. Singh	Member, DERC
32.	Shri B.P. Singh	Member, DERC

33.	Dr. M.K. Iyer	Member, GERC
34.	Shri K.M. Shringarpure	Member, GERC
35.	Shri M.S. Puri	Member, HERC
36.	Shri Sunil Verma	Member, JSERC
37.	Shri R.K. Kishore Singh	Member, JERC for Mizoram & Manipur
38.	Shri H.D. Arun Kumar	Member, KERC
39.	Shri D.B. Manival Raju	Member, KERC
40.	Shri K. Vikraman Nair	Member, KSERC
41.	Shri Aswini Kumar Das	Member, OERC
42.	Shri Sivapada Swain	Member, OERC
43.	Shri Vinod Pandya	Member, RERC
44.	Shri Raghuvendra Singh Rathore	Member, RERC
45.	Shri S. Nagalsamy	Member, TNERC
46.	Shri L. Manohar Reddy	Member, TSERC
47.	Shri H. Srinivasulu	Member, TSERC
48.	Ms. Meenakshi Singh	Member, UPERC
49.	Shri Indu Bhushan Pandey	Member, UPERC
50.	Shri C.S. Sharma	Member, UERC
51.	Shri K.P. Singh	Member, UERC
52.	Shri Tapan Chatterjee	Ex-Member, AERC
53.	Shri D.P. Sinha	Ex-Member, CERC
54.	Shri V.S. Verma	Ex-Member, CERC
55.	Shri M. Deena Dayalan	Ex-Member, CERC
56.	Shri S.K. Jayaswal	Ex-Member, BERC
57.	Shri S.R. Sethi	Ex-Member, DERC
58.	Shri R.K. Sharma	Ex-Member, GERC
59.	Shri K.K. Garg	Ex-Member, MPERC
60.	Shri A. Velayutham	Ex-Member, MERC
61.	Shri B.C. Jena	Ex-Member, OERC
62.	Shri V.K. Khanna	Ex-Member, UERC
63.	Shri R.D. Gupta	Ex-Member, UPERC
64.	Ms. Shubha Sarma	Secretary, CERC
65.	Shri S.K. Chatterjee	Joint Chief (RA), CERC

Regulatory & Policy Role: Renewable Energy & Grid Integration

International Experience & Lessons for India

FORUM OF INDIAN REGULATORS
New Delhi, India
June 10th, 2015

Dr. Bri Mathias Hodge & Ravi Vora,
NREL, USA

Agenda

- **Introduction**
- **Approach**
  - **Enabling Requirements**
  - **Market structure Impact**
  - **Cost benefits: Stakeholders vs. Customers vs. Society**
- **European experience: Relevance vs. Irrelevance**
- **USA RE Grid Integration Experience:**
  - Why is US experience more relevant to India?
  - State level policies dominate except PTC
  - Successful management: RE variability on the grid
  - National /Social vs. Consumer benefits
- **India Integration Experience:**
  - India's experience to-date vs. 172GW RE target
  - Critical Factors for Success & Major Issues
  - Regulators' Challenges: RE Grid integration
  - Role of Power Market Reforms
- **Conclusions: Opportunities for Indian Regulators (RRV)**
- **Recommendations**

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Introduction & Approach

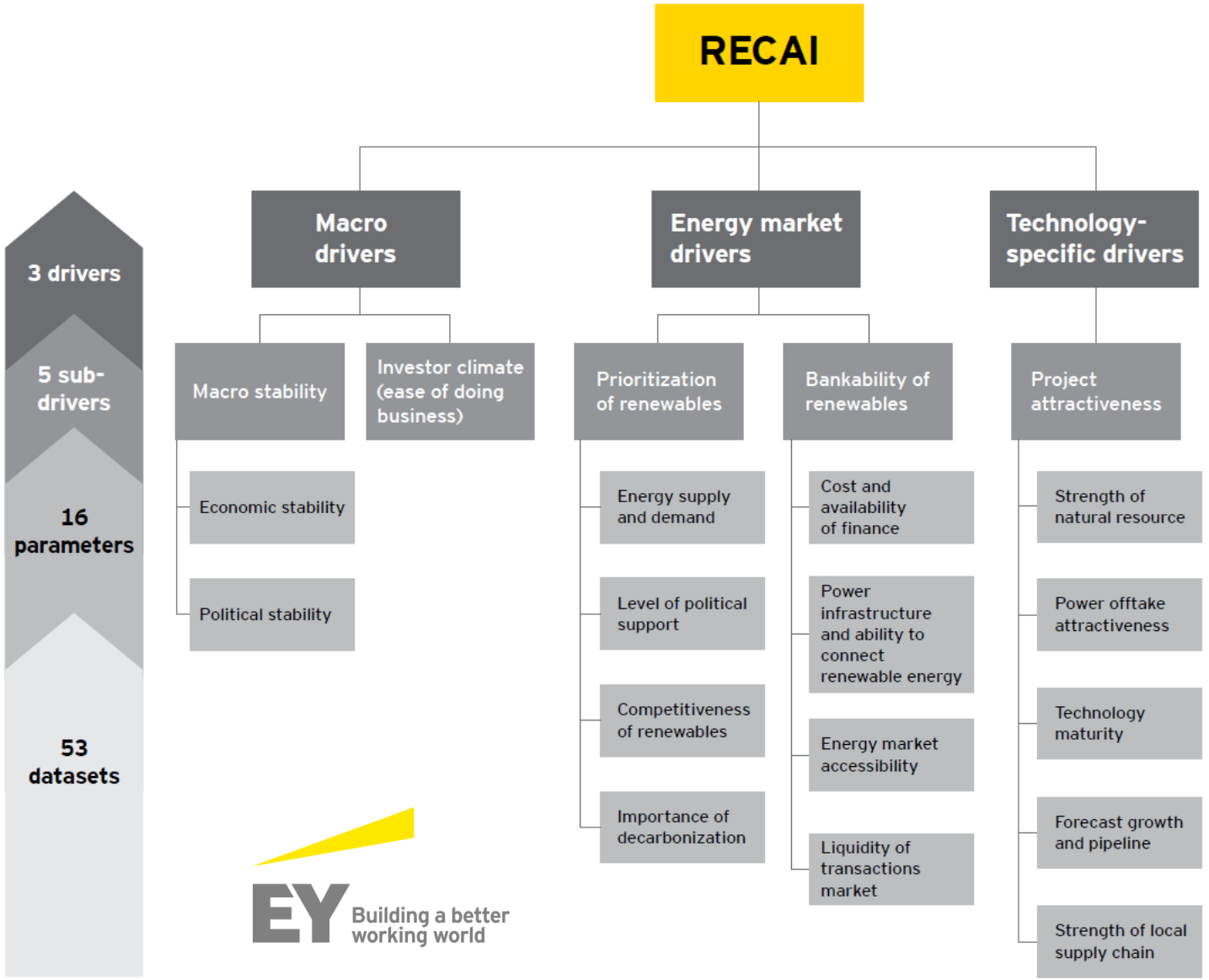
Policy Makers vs. Regulators: Criteria for Success

Criteria	Role
Achieve targeted mix and total RE capacity	Policy makers define portfolio mix through integrated resource plan
Reduce tariff / LCOE to below grid parity	Policy makers set goals & provide Incentives to reduce RE tariff / LCOE **Regulators ensure long term reduction of cost of RE on grid**
Grid capacity and access	Policy makers optimizes grid capacity; **Regulators balance benefits vs. costs and financibility**
Minimize RE grid integration cost	Policy makers create incentives **Regulators direct stakeholders with requisite checks and balances**

Regulatory Role in Variable Renewable Energy

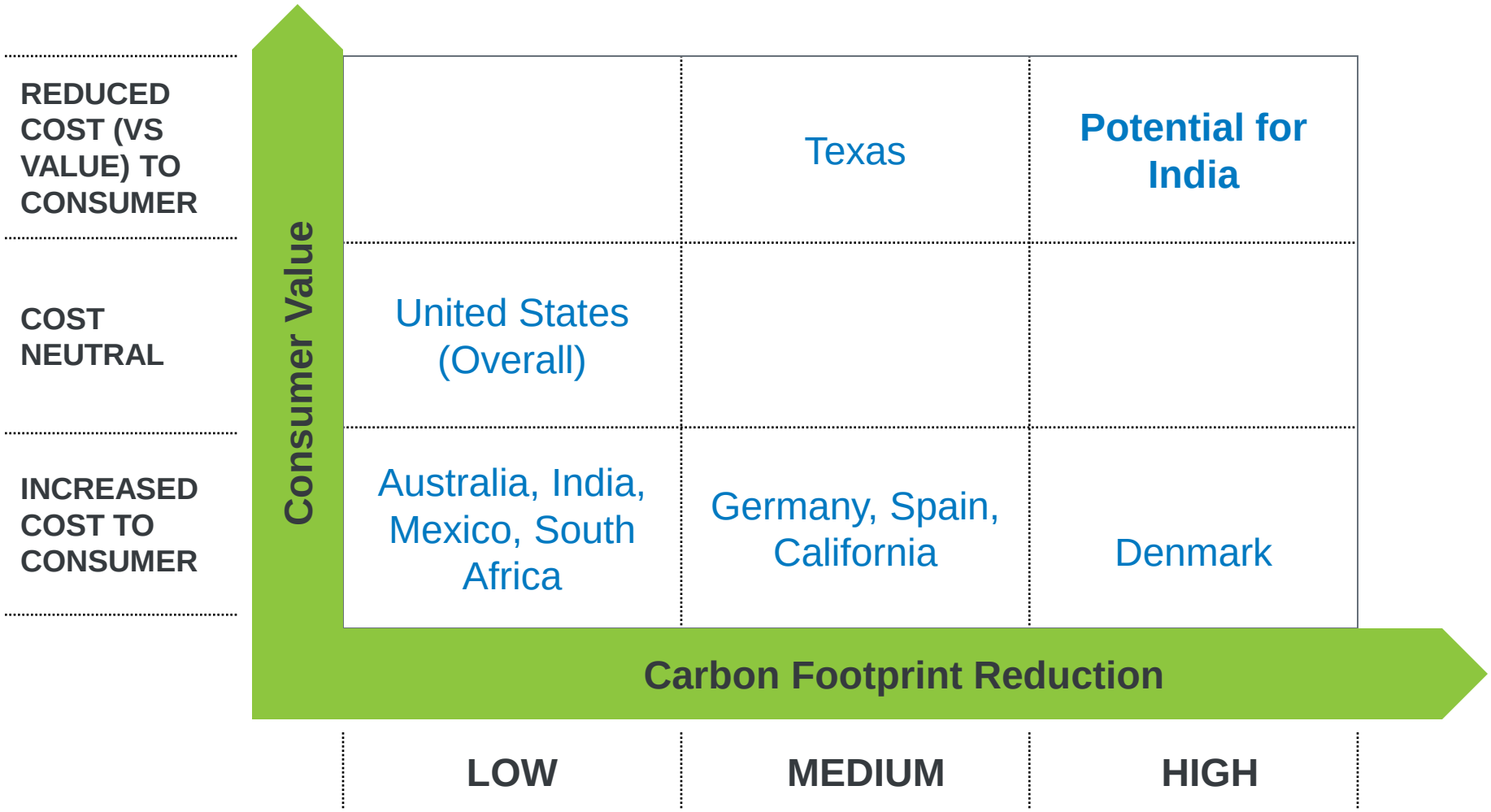
1. Facilitating new variable renewable energy generation
2. Providing adequate grid infrastructure
3. Ensuring short term security of supplies (flexibility)
4. Enabling long term security

Renewable Energy Country Attractiveness Index (E&Y)



Source: Ernst & Young Renewable Energy Country Attractiveness Index (http://www.ey.com/recai)

Sustainable Clean Energy vs. Cost to Consumers



U.S. Market Structure Impact

- Beyond state level Renewable Portfolio Standards, wind and solar have to compete against alternate electricity supplies (typically large hydro and natural gas) and trading
- Ten-year federal production tax credit (PTC) helps reduce RE tariffs, enables RE to be more competitive, and reduces cost to consumers.
- US has made significant progress towards RE grid parity (e.g. Texas and MISO) unlike Europe with high feed in tariffs
- Lack of sustained legislative and policy framework for PTC creates cyclical RE capacity additions
- RE capacity growth is supported by a very liquid hedgable power market with multiple long and short term off takers with a diverse and large credit capacity at affordable cost of capital. Enables merchant power project financing

RE Cost/Benefits for India's Public Stakeholders

	Government	Stakeholders	Consumers
Source of Influence	Central and state Govt institutions	Effective lobbying by private and public sector	Limited and delayed influence.
National vision/objectives	Carbon reduction, seek long term grid parity of RE, energy security	Define requirements for both build new RE capacity and DISCO's to execute requisite financeable PPAs	Focus on reducing cost of electricity and quality /reliability of service
RE Portfolio Standards at state & central level	Reducing carbon emission and achieve energy security. State level enforcement a problem!	Ensure requisite incentives and subsidies	Expect tangible benefits to consumers (i.e. reduced cost and increased reliability)
Reliable, cost efficient grid integration of RE	Plan, develop, execute requisite infrastructure; establish rules and regulations to achieve least cost solution with improved energy supply reliability	Seek ability to recover incremental costs to enable RE grid integration requirements; seek pass through incremental costs	Seek protection or mitigate impact of increased cost of RE grid integration on its tariff

Market Structure Implications

Type of market structure (example)	RE grid integration impact
Vertically integrated single market (e.g. South Africa). Limited counter party for trading.	Cost and risks centralized with potentially higher costs. Fewer options for balancing and restrictive role for regulators
State or country level market with access to external balancing resources to achieve critical size of diversity and external low cost resources (e.g. CAISO/BPA-USA; Germany/Norway & France)	Balancing high level RE with large size/diversity with neighboring grid and enable active/liquid power market trading. California: RE PPA subject to regulatory approval. Germany: Declining feed-in tariff
Large wholesale liquid and credit worthy market with few traders and short/medium term trades at intra and inter-state level. (e.g. MISO-USA).	MISO: diversified multi-state and cross-border (US-Canada) balancing area resource access to enable cost efficient and reliable real time balancing with increased RE generation market share
Unbundled competitive energy market (e.g. ERCOT-Texas) RE IPP: Transition from Utility PPA to Merchant PPA with innovative financing tied to market hedging	Critical large size very liquid power market with breadth and depth of market liquidity. Large number of credit worthy traders along with parallel long term hedging of natural gas enables merchant RE wind farm financing.

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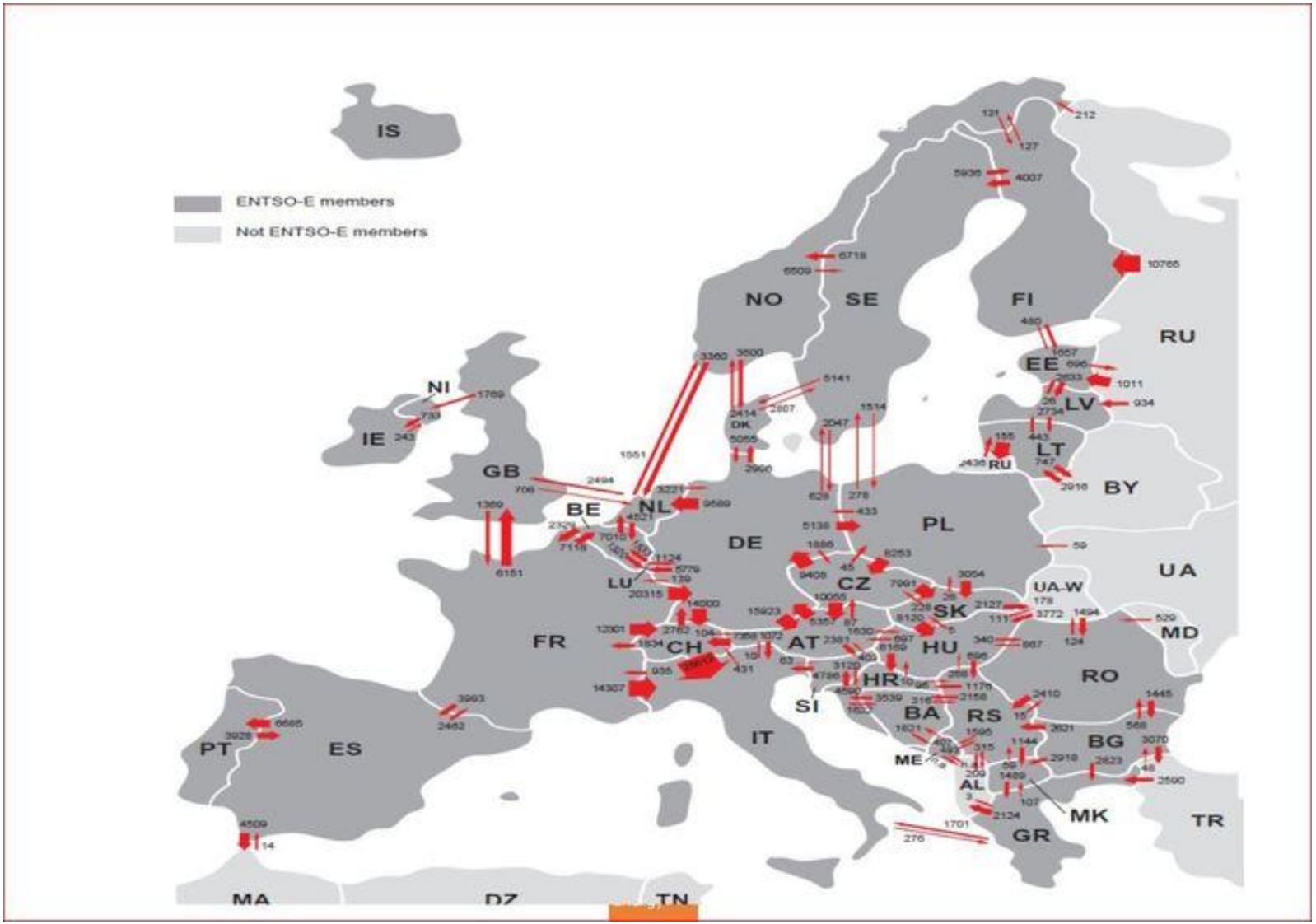
European and U.S. Renewable Energy Integration Experience

EU Grid Interconnection



European Experience: Relevant Highlights & Considerations

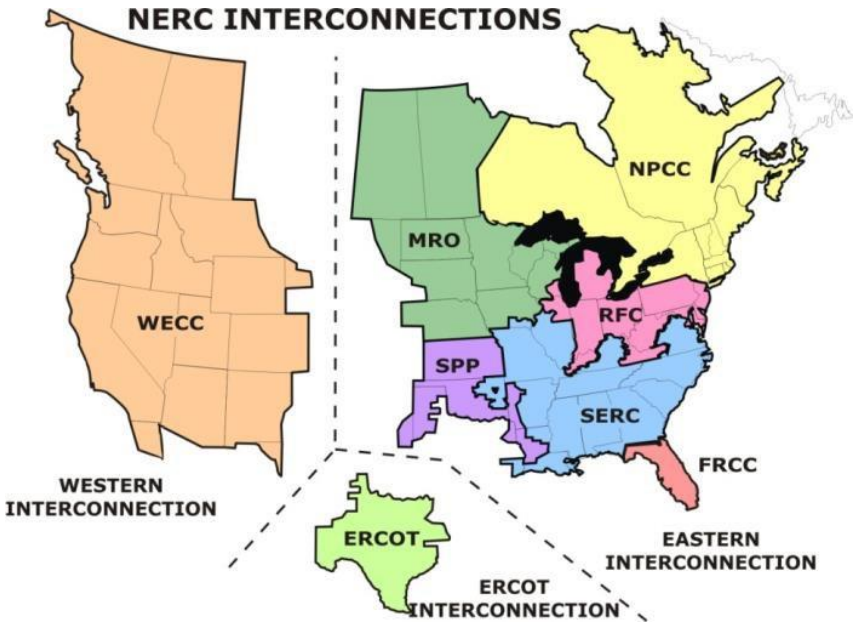
Relevant Highlights

- High level RE market penetration: Denmark, Germany
- Successful integration of high level of variable generation in the grid: Importance of market structure
- Significant change in base load coal fleet operation, especially in Germany
- Advancements in wind and solar energy forecasting
- Critical role of Northern European Grid integration and resources critical to RE grid integration (Gas and hydro power from Norway; Nuclear power from France)

Factors for Consideration

- High feed-in tariff: Expensive and unaffordable from Indian perspective
- Socializing most of grid integration costs
- Limited consistency between EU members on RE policies and regulations.
- Spain not fully connected to North European grid

US Power Grid: Regional ISOs (No National Grid)



US Experience: Relevant Highlights & Considerations

Relevant Highlights

- **Role of competitive market to bring costs down and limited feed-in tariffs**
  - Feed in tariff limited to small distributed Solar PV market; Competitive wind IPP for state level RPS
  - Impact of RE production tax credit on cost of RE to the grid.
- **Federal vs. state policies and regulations**
- **Critical role of Independent System Operators and market structure in RE Grid integration**
  - Many ISO operate market operations
  - Ancillary service and cost management
  - System balancing over large geographic area with diversity of RE generation and load profile
- **Complimentary role between system operators and state regulators**
- **Texas experience (Chooses to be outside of FERC jurisdiction):**
  - High wind energy market penetration with lowest wind LCOE and lower overall energy cost to consumers
  - Competitive market via separation of content and carriage
  - ERCOT's competitive renewable energy zone transmission upgrading project and its funding
- **Emerging disruptive role of distributed generation on existing utility business model in Sunshine states**

Factors for Consideration

- Lack of national Renewable Portfolio Standards
- Lack of national grid: E.g. Cannot transfer power between MISO or Ercot and Calif
- Cumbersome and slow transmission build out especially inter-state projects

U.S. Policy and Market Structure Impact

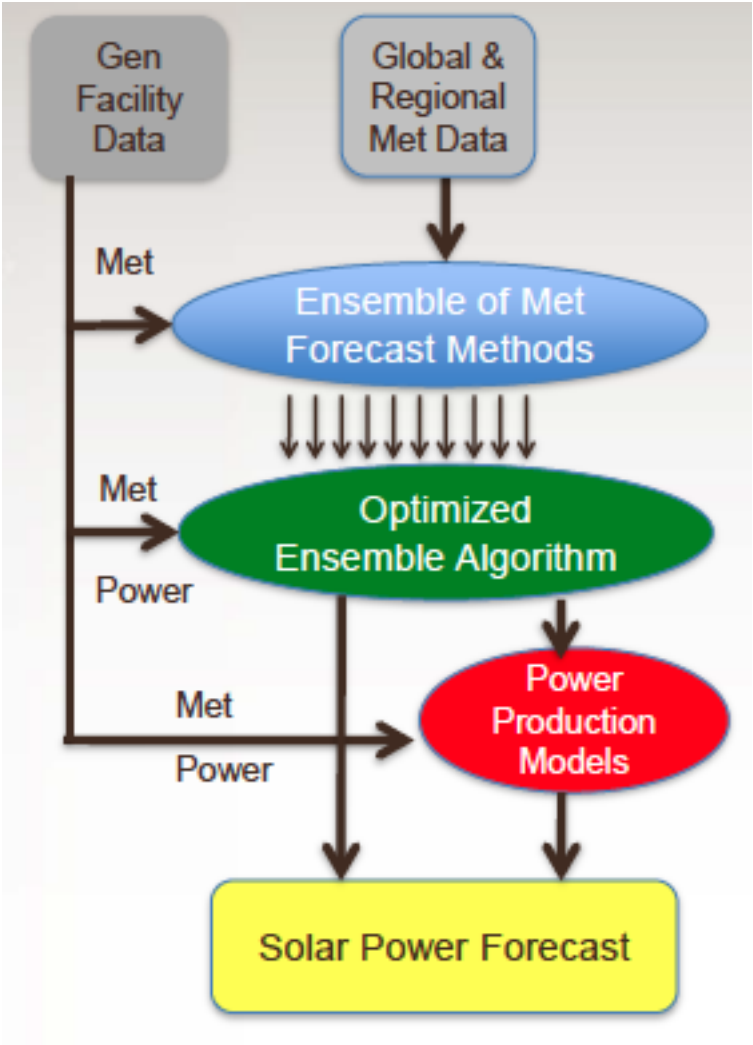
- Beyond state level Renewable Portfolio Standards, wind and solar have to compete against alternate electricity supplies (typically large hydro and natural gas) and trading
- Ten-year federal production tax credit (PTC) helps reduce RE tariff, enables RE to achieve grid parity, and reduces cost to consumers.
- US has achieved significant reduction in RE tariff/LCOE over last ten years unlike Europe with high feed in tariffs
- Lack of sustained legislative and policy framework for PTC creates cyclical RE capacity additions
- RE capacity growth is supported by multiple long and short term off takers with a diverse and large credit capacity at affordable cost of capital. Enables risk hedging

Wind Forecasting & Application-More Advanced

	MISO	PJM	ERCOT	CAISO
Peak load	113,519 MW (7/22/2014)	141,678 MW (06/17/2014)	66,732 MW (8/25/2014)	45,089 MW (9/15/2014)
Total installed capacity (2014)	~199,000 MW	~203,000 MW	~99,000MW	~70,000 MW
Wind capacity (2014)	13,211 MW	5,848 MW	14.000 MW	7,741 MW
Wind Forecast since	2008	2009	2008	2004
Wind power forecasting	•**Long-term:** hourly updated forecasts for each hour for the next 7days, for the same Commercial Pricing nodes. •**Short-term:** 5-minute granular forecasts for each CP node for the next six hours updated every five minutes. •**Ramp forecast** under consideration	•**Long-term:** hourly updated, from 48 hours ahead to 168 hours ahead. •**Medium-term:** Updated from six hours ahead to 48 hours ahead. •**Short-term:** Updated with frequency of every ten minutes, forecast interval of 5 minutes for next 6 hours. •**Ramp forecast** under evaluation (5 min interval for next 6 hrs)	•**Short-Long:** Hourly 50% (and 80%) probability of exceedance forecast for an upcoming 48-hour period, updated hourly and delivered 15 minutes past the hour. •ERCOT Large Ramp Alert System forecasts probabilistic **ramping** events	•**Medium-term:** Hourly forecast for each hour of next nine days, delivered daily by 5:30 a.m. 20% and 80% probability of exceedance values applied. •**Short-term:** 5-minute forecast for the next six hours, delivered every five minutes. •**Developing ramp forecasting** with PNNL
Utilization	•Hourly forecast to inform reliability unit commitment, transmission outage coordination, transmission security, peak load, wind ramps •Short term forecast used in economic dispatch	•DA transmission security and reserve adequacy assessments •Developing automated procedures	•DA and hour-ahead reliability unit commitment •Wind forecast errors used to determine monthly requirements of non-spinning reserves	•DA generation forecast is advisory •Short-term forecast used as energy schedule for regional transmission operations
Forecast	MISO pays for central wind power forecasting system; costs are assigned to load	PJM pays for central wind power forecasting system; costs are assigned to load	ERCOT pays for central wind power forecasting system; costs are assigned to load	All eligible intermittent generators pay fee of $0.10/MWh.

Nascent Solar Energy Forecasting

- **Input Data**
  - Global and regional meteorological data
  - Data from gen facilities and nearby sites
- **Ensemble of Forecast Methods**
  - Statistical and physics-based models
  - Wide range of characteristics (update frequency, input data requirements, performance by look-ahead time etc.)
- **Optimized Ensemble Algorithm**
  - Statistically combines individual forecasts according to relative historical performance
  - Produces deterministic and/or probabilistic met forecast
- **Power Production Model**
  - Translates met forecast to power forecast
  - Statistical or physics-based



Source: John Zack Solar Power Production Forecasting: Overview of Methods and Input Data Needs. AWS Truepower ERCOT ETWG Meeting Austin, TX. April 30, 2014

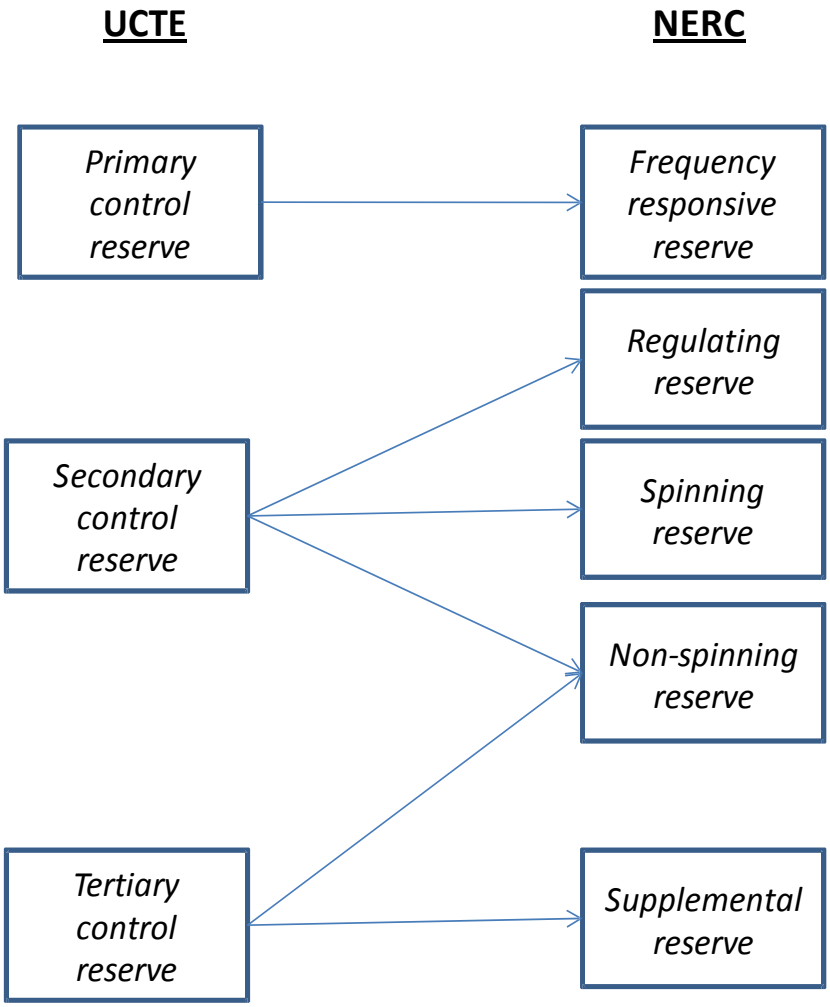
Current Market Types in the U.S.

- Day-Ahead Energy Market
- Real-Time Energy Market
- Ancillary Services Market
- Financial Transmission Rights Markets
- Capacity Markets

Taxonomy of Ancillary Services

There is an increased need for ancillary services to effectively manage larger size of variable RE (over 5%) on the grid

Union for the Co-ordination of Transmission of Electricity (UCTE)



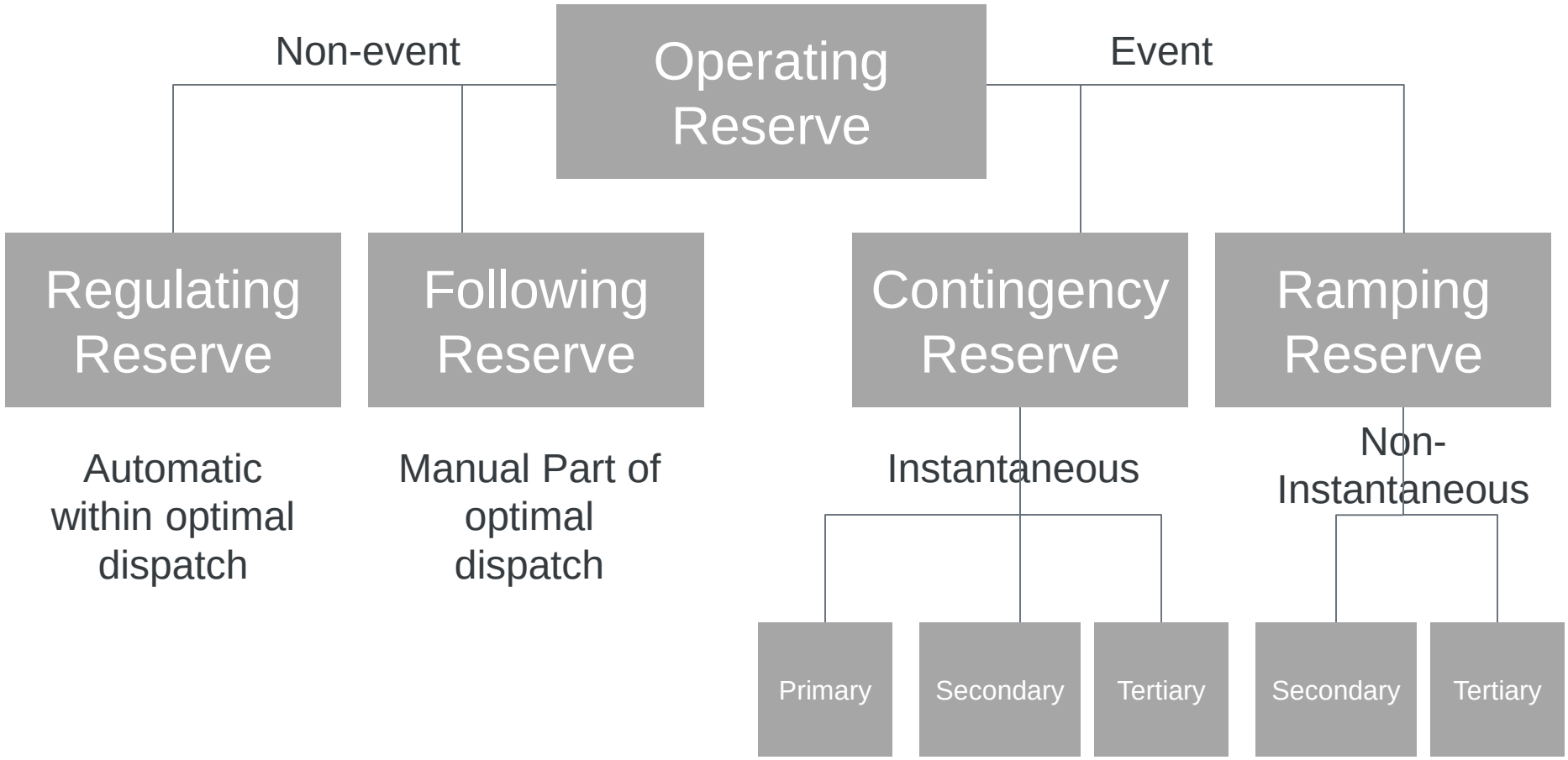
North American Electric Reliability Corporation (NERC)

Source: Erik Ela, NREL

Ancillary Services Mechanism in the U.S.

- **Ancillary services can either be cost-based or market-based**
  - Markets: regulating and contingency reserves, load following/energy imbalance
  - Cost-based mechanisms: voltage support and black start capability
- **Most ISOs set the required amount of ancillary services and choose the least-cost option**
- **Many areas will co-optimize ancillary services with energy to obtain an overall least-cost solution**
- **Prices reflect marginal cost to provide service, which includes availability cost & opportunity cost**

Operating Reserve Categorization



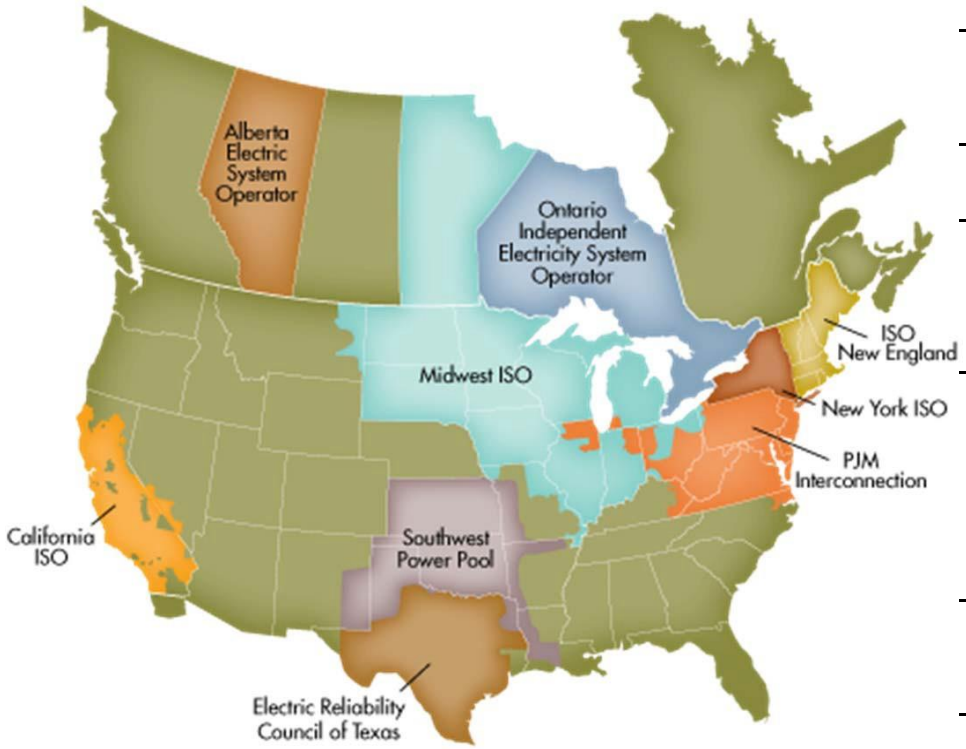
Characteristics of RTO/ISO Regions

Figure 78
Characteristics of RTO/ISO Regions

Region	Energy Market Structure	Scheduling	Wind Forecasting	Wind Forecasting Frequency	Capacity Market	Capacity Reserve Margin:
PJM	Real-Time & Day-Ahead LMP-based markets	Must offer in day-ahead market if capacity resource (to be changed if Capacity Performance Proposal is approved)	Centralized forecasting since 2009, RTO/ ISO pays for central forecasting service	Provided up to 168 hours ahead; Updated every 10 minutes	Yes, currently allows participation of wind, unclear if pending Capacity Performance Proposal will allow full participation of wind.	25.93%
New York ISO (NYISO)	Real-Time & Day-Ahead LMP-based markets	Must bid price curve for real-time market, optional for day-ahead	Centralized forecasting since 2008; montly fee of $500 plus addition $7.50 per MW	Provided twice daily covering next two business days; Updated every 15 minutes	Yes, allows participation of wind	16.53%
ISO New England (ISO-NE)	Real-Time & Day-Ahead LMP-based markets	Can submit bid curve or self-schedule for day-ahead market; not required	Implemented in 2014	4 hour ahead updated every 5 minutes, 48 hour ahead updated every 3 hours, 7 day ahead updated daily	Pay for Performance implemented in 2014, allows participation of wind	23.75%
MidContinent ISO (MISO)	Real-Time & Day-Ahead LMP-based markets	Virtually all wind resources are now Dispatchable Intermittent Resources, fully integrated into scheduling and dispatch and responsible for imbalances.	5 minute updates provided for next 6 hours; hourly updates for next 6 1/2 days.	5 minute updates provided for next 6 hours; hourly updates for next 6 1/2 days.	Voluntary	17.01%
Southwest Power Pool (SPP)	Real-Time & Day-Ahead LMP-based markets, implemented in March 2014	Wind resources are integrated into market scheduling and dispatch.	Centralized forecasting since 2011; RTO/ ISO pays for central forecasting service	6-hour and 12-hour forecast models	None	36.17%
Electric Reliability Council of Texas (ERCOT)	Real-Time & Day-Ahead LMP-based markets	ERCOT provides dispatch instructions at 5-minute intervals	Centralized forecasting since 2008; RTO/ ISO pays for central forecasting service	Ensemble forecasts and statistical analysis	None	14.31%
California ISO (CAISO)	Real-Time & Day-Ahead LMP-based markets	Can sell into real-time market, schedules set 37.5 minutes before operating hour	Centralized forecasting since 2008; variable resources pay $0.10/ MWh	Ensemble forecasts and statistical analysis	None	15%

Source: AWEA 2014 Year-End Market Report

Regulating Reserves

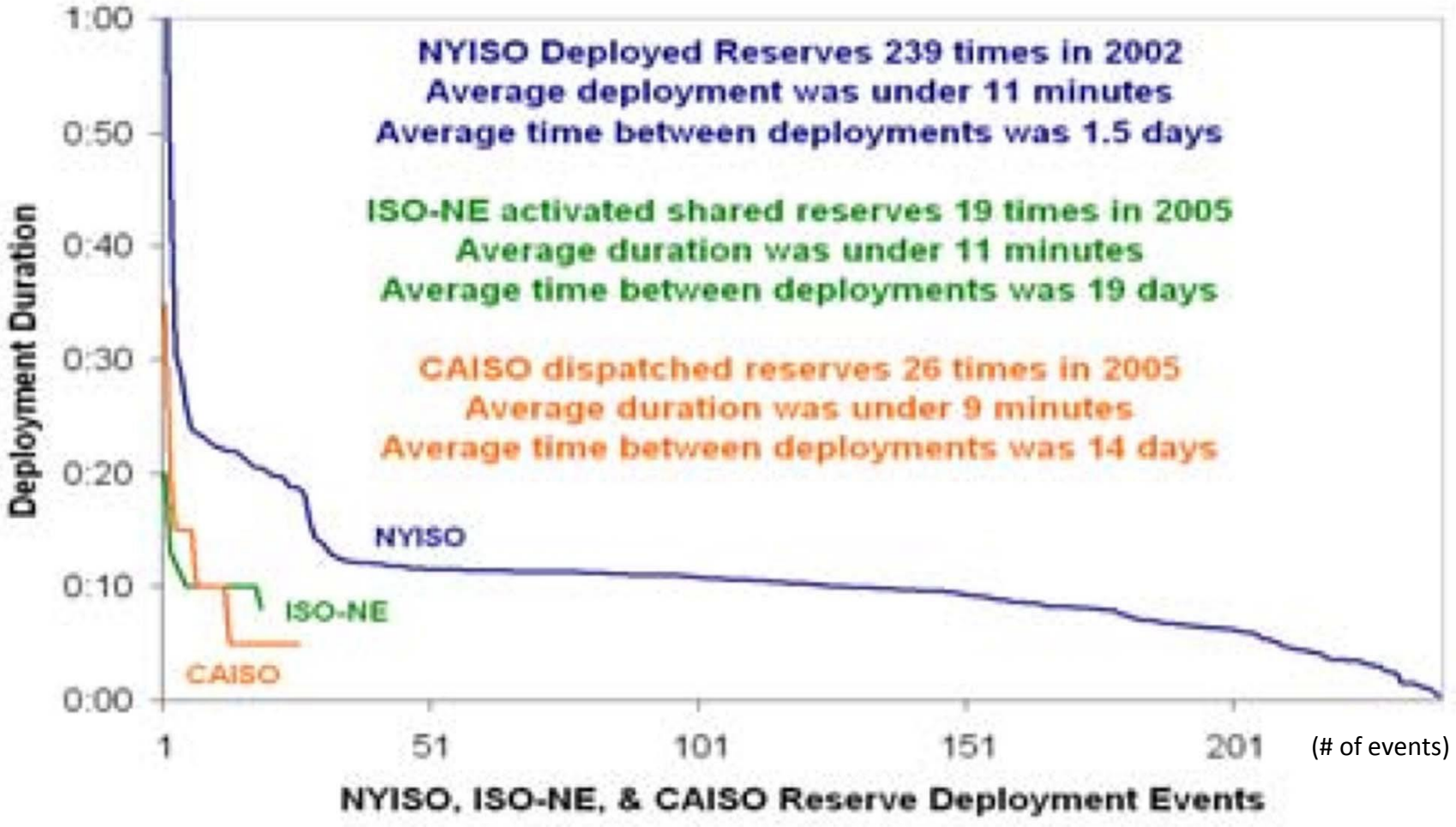


Region	Separate/ Combined	Rule
PJM	Combined	Based on 1% of the peak load during peak hours and 1% of the valley peak during off-peak hours.
NYISO	Combined	Set requirement based on weekday or weekend, hour of day, and season.
ERCOT	Separate	Based on 98.8th percentile of regulation utilized in previous 30 days of same month of previous year and adjusted by installed wind capacity.
CAISO	Separate	Use a requirement floor of 350-MW up and down regulating reserves which can be adjusted based on load forecast, must-run instructions, previous CPS performance, and interchange and generation schedule changes.
MISO	Combined	Requirement made once a day based on conditions before the day-ahead market closes.
ISO NE	Combined	Based on month, hour of day, weekday/sat/sun.

Source: Erik Ela, NREL (2012)

Contingency Reserves

ISOs differ in frequency of deployment of contingency reserves



Source: Brendan Kirby (2012)

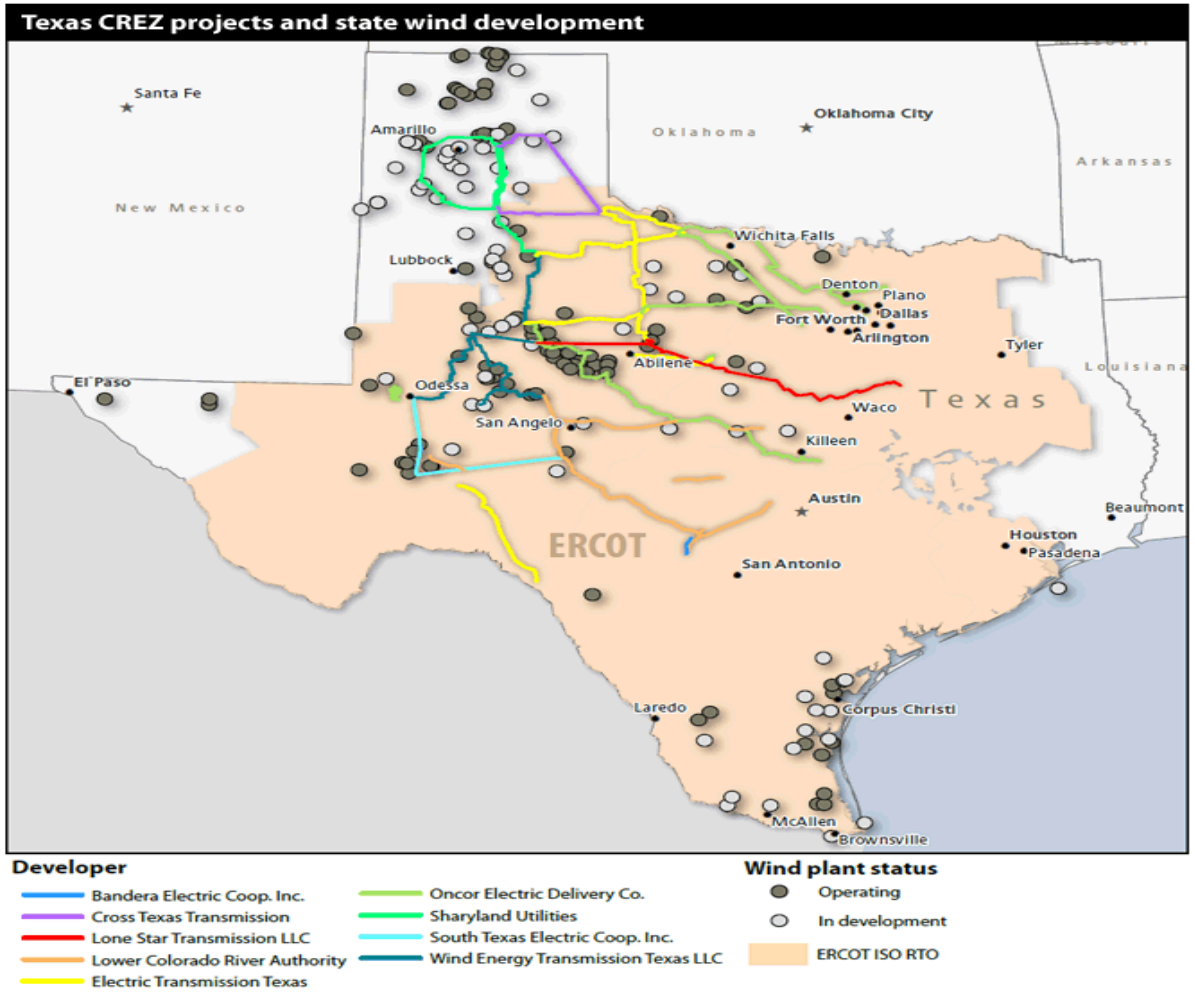
New Sources of Ancillary Services

- **Wind & solar power generators**
- **Demand response**
- **Storage**
- **Distributed Generation**

Ensuring Adequate Grid Infrastructure

Case Study: CREZ Transmission Project

Should this slide be here or somewhere else? Such as after reserves?



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India's Renewable Energy Integration Experience

India: Renewable Experience To-Date

- **Over 34,000 MW (YTD 2015) RE IPP capacity added as of August 2014[1]**
- **Driven by Central mandate and national Renewable Portfolio Standards (RPS) but inconsistent state level enforcements**
- **Question: Should all states have same RPS obligations?**
- **Mixed results:**
  - Post COD RE Wind IPP performance: Issues in Tamilnadu. Tamilnadu wind forecasting initiative a positive step
  - Many designated RE off-takers with poor credit quality and /or limited capacity (i.e. State DISCOs)
  - Undesirable delays in financial closing for some RE IPPs
  - Strong dependence on tax depreciation investors with inadequate O&M and despatch management services
  - Inadequate enabling environment to attract international capital and correspondingly high cost of capital
  - Weighted average cost of capital for RE IPP remains high.
  - Need to improve REIPP procurement process.

[1] Ministry of New and Renewable Energy, Government of India
First Renewable Energy Global Investment Promotion Meet & Expo (RE-INVEST) Presentation, February 2015, New Delhi, India

Critical Factors for Success for RE generation

- Creating enabling environment to allow international capital markets and new technology to enter large scale Indian RE IPPs
- Streamlined, standardized national project contract agreements with involvement of key private and international financial and legal stakeholders
- Creation of critical mass and active liquidity of monetizable energy markets to allow utility scale RE IPP to replace user based long-term PPAs
- Creation of marketable RE obligations with wheeling and banking
- Tax policies to reduce RE tariff and cost to the grid
- Requisite T&D upgrade, expansion, with designed regulation for rate recovery
- Regulatory frame work needed for wheeling and banking

Major Issues in RE Grid Integration

- **Greening the grid at national and state level:**
  - Anticipated accelerated share of distributed generation (including solar PV)
  - Risks of underutilization and or stranded transmission and generation assets
  - Impact on managing grid and utility scale variable generation at least cost
- **Absence of enabling environment and development of effective, enforceable rules and regulations**
- **Lack of mechanisms for contingency and spinning reserves and ancilliary services and related need for cost/benefit analysis**
- **Strategies for cost recovery of spinning reserves and ancilliary services**

Regulators' Challenges in RE Grid integration

- Co-jurisdictional coordination
- Roles & Responsibilities between Regulators and independent system operators
- Balancing stakeholders interests vs. public interest
- Role of competition versus legislated DISCOs
- Enabling cost efficient market balancing mechanism and its cost allocation
- Creation of ancillary service market

Role of Power Market Reforms

- **Scope and types of power market reforms**
  - Separation of carriage vs. content
  - Creation of competitive energy market at wholesale and at consumer level
- **Need for changing DISCO & utility business models**
- **Impact of competitive power market**
- **Benefits of power market reforms for RE**
  - Reducing overall energy costs
  - Enable cost efficient financing of new generation and grid infrastructure including new technology adoption
  - Importance of public-private partnerships

India: Stakeholder Opportunities

Stakeholder	Opportunities
Policy Makers: Central Government	Drive power market reforms; create incentives and penalties to stakeholders; tax incentives to reduce RE LCOE and promote improved enabling environment to attract foreign and Indian capital
Policy Makers: State Government	Compete to create best and most attractive RE market vs. other states; standardized approvals for all states and coordination
Power Trading Corporation	Pivotal role to create a national energy trading clearing house and to facilitate risk hedging and monetize wheeling /banking
PGCIL / POSOCO	Provide least cost and timely network infrastructure/ green corridors to support inter-state wheeling, banking and trading.
Regulators (Central / State)	Central: Facilitate inter-state wheeling and banking; Enable use of National trade clearing house; States: Common framework
Utility /DISCO companies	Leverage existing business to maximize benefits of RE to consumers and its share holders and integrate distributed generation
RE IPP	Seek competitive transparent process; reduce cost of capital; achieve lowest LCOE and monetize growing RE asset portfolio
Capital Markets	Leverage existing RE asset portfolio to monetize to create liquidity at lower cost; Financial instruments for energy and electricity trading and hedging with counter parts

RE Integration in Large vs. Smaller Balancing Area

Grid integration of RE is more efficient in a larger/broader balancing area compared to a smaller one

- Greater size and diversity of generating sources
- Potentially reduced variability from geographic portfolio diversity of RE generation sources
- More frequent ramping up and down with reduced base load generation will result in higher operating cost and need to mitigate life cycle reduction risks and hence the need to recover such incremental costs.
- Demand response management using smart meters/grid and market incentives will become increasingly important factor in managing larger levels of variable RE on the grid.
- Trend towards centralized wind forecasting geographically and amongst participants.
- Ancilliary services for load becoming more important and FERC Order 888 regulations may need to be revised
- Need for non-spinning reserves to manage large multi-hour wind ramping

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Conclusions and Recommendations

Conclusions

- Achieved renewable capacity:
  - RE: 32GW (12.7%) ; Hydro: 40.8GW (16.1%)[1]
- **Current RE deployment pace inadequate//to achieve target?**
- Possible to achieve targeted RE capacity while reducing RE LCOE and to maximize benefits to consumers
- Multiple policy and regulatory obstacles:
  - Minimize cost of RE grid integration
  - Leverage RE to improve grid performance and efficiencies with right policies and regulations
  - Competitive power market is essential
- Timely transmission infrastructure strategy with public-private sector partnership
- Policy framework & regulatory checks and balances are critical for timely formulation of rules and regulations for RE grid integration
- TRANSFORMATIONAL OPPORTUNITY

[1] Ministry of New and Renewable Energy, Government of India
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Recommendations

- Multi-prong strategies to achieve 165+GW RE capacity by 2022 while reducing energy LCOE on the wire
- **Public policies—Power market reforms:**
  - Create critical mass and liquidity in power market with multiple creditworthy buyers and sellers
  - Financial and business restructuring of power market at central and state level
  - Creation of national RE clearing house and develop efficient real time RE energy market liquidity
  - Enable private sector investment in T&D network
- **Regulatory checks & balances at central and state level: RE grid integration of targeted generation capacity mix**
  - Balance the interests of government, grid stakeholders, and public. Serves the best interests of consumers
  - Oversee central and state policy implementation/enforcement (provide checks & balances)//What is this point? How is this different from the top? Who Oversees?

THANK YOU

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