



Electricity Markets Training Program
(EMTP)



Introduction



What is APEX?



- APEX was established in 1996 to foster cooperation among electricity market operators worldwide.
- APEX is a specialized organization that unites electricity market operators for sharing of information and knowledge.
- APEX holds a yearly annual conference for its **48 members**.
- Electricity Market Training Program (EMTP) is a collaboration with APEX and CPPA-G.





EMTP TRAINING CALENDAR



28 AUG 2023

**SESSION 01 -
SETTING THE
PERSPECTIVE**

2 OCT 2023

**SESSION 02 -
DEMAND, GEN. &
ACILLARY
SERVICES**

30 OCT 2023

**SESSION 03 -
ECONOMIC
OPTIMIZATION OF
THE POWER
SYSTEM**

27 NOV 2023

**SESSION 04 -
TRANSMISSION
SYSTEM &
DEMAND
MANAGEMENT**

29 JAN 2024

**SESSION 05 -
ELECTRICITY
MARKETS -
DESIGN &
OPERATIONS**

26 FEB 2024

**SESSION 06 -
COMPLEX
ELECTRICITY
MARKETS**

25 MAR 2024

**SESSION 07 -
EMISSION
MARKETS**

29 APR 2024

**SESSION 08 -
NASCENT
GENERATION &
STORAGE
TECHNOLOGIES**

EMTP on the GLOBE – 214 participants



Completed sessions: **5** Total Training hours: **22** Avg. participants / session: **180**



MEET THE TEAM



Omer H. Malik

Board Member – APEX
Course Director - EMTP



Tim Horger

Senior Director
PJM Interconnection
(USA)



Dhruv Dhiman

Vice President
Indian Energy Exchange (IEX)
(INDIA)



Jorge Bircher

Partner
MRC Consultants
(SPAIN)



Ricardo C. Perez

Partner
PSR - Energy Consulting & Analytics
(BRAZIL)





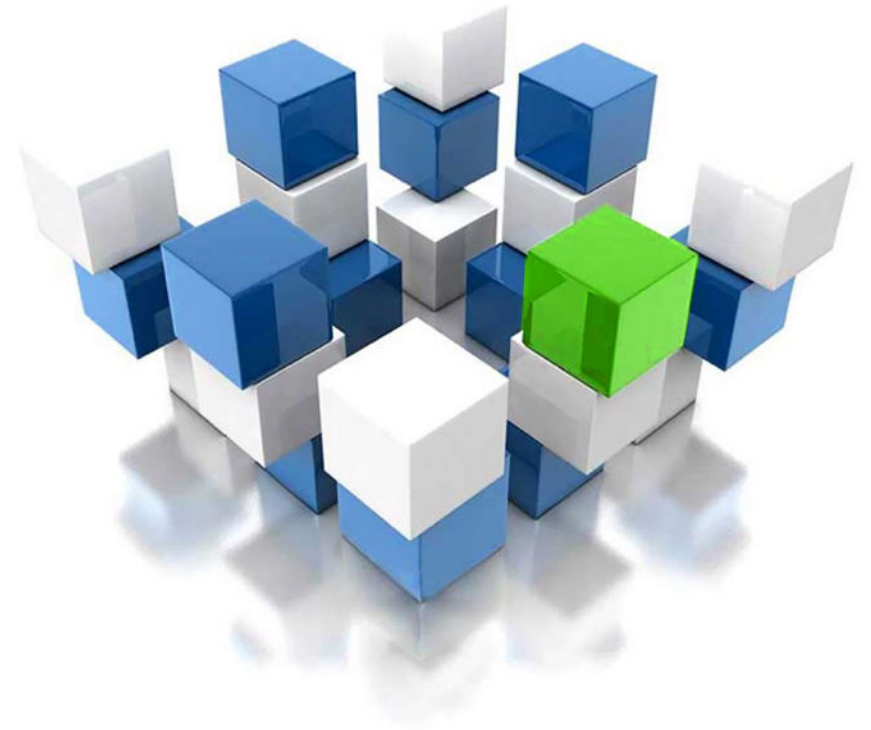
Agenda for Today



Agenda for Today

- **Electricity Markets Landscape** by Omer Haroon Malik
 1. **Indian Electricity Market** by Dhruv Dhiman
 2. **PJM Interconnection** by Tim Horger
 3. **Session Break and Quiz**
 4. **Spanish Electricity Market** by Jorge Bircher
 5. **Brazilian Electricity Market** by Ricardo C. Perez
 6. **Q & A session**





Important Note!



Important Note!

- Please sign in your Google Classroom
- The Classroom may be accessed using the following link or class code: **s7yybxi**

<https://classroom.google.com/c/NjE4Nzk1OTkyNjAz?cjc=s7yybxi>





Electricity Markets Landscape

Introduction of Electricity Markets

1982



Chile
Central Interconnected System (CIS)

1990



United Kingdom
Wholesale Electricity Market (WEM)

1993

Wholesale Electricity Market (WEM)



Argentina

1995



Columbia
Wholesale Electricity Market (WEM)

1996



Australia
National Electricity Market (NEM)

1998



Brazil, Spain & USA

2000



Germany & EU
Electricity Exchange (EEX)
NordPool

2004



Philippines
Wholesale Electricity Spot Market (WESM)

2007-8



Turkey, Russia & India

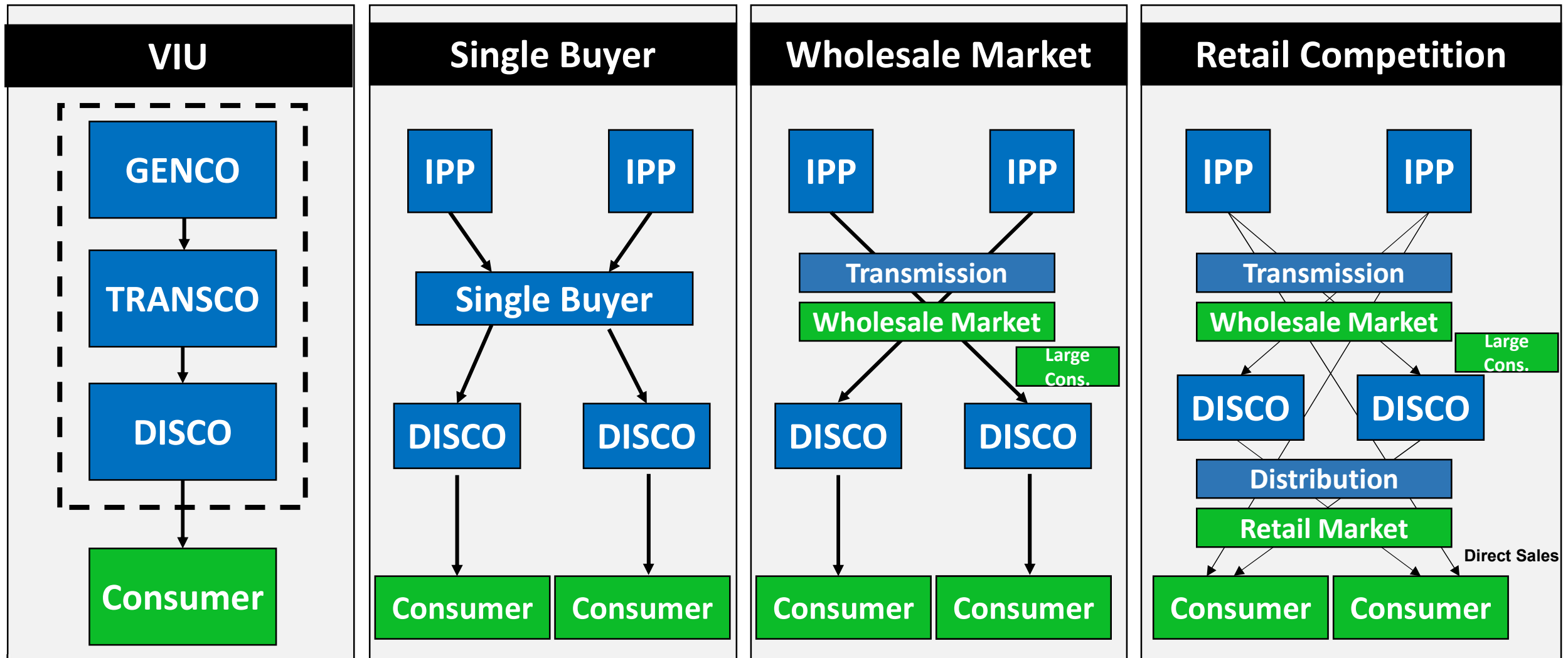
2024



Worldwide expansion



Market Structure



Models at a Glance

Competitive electricity markets worldwide



Architecture: Every Market Design is Unique?

European Countries

- Net Pool
- Day Ahead Market
- Intraday Market
- Balancing Market
- EPEXSPOT/Nord Pool Exchange

TURKEY

- Net Pool
- Day Ahead Market
- Intraday Market
- Real time Market

PHILIPPINE

- Gross Pool
- IMO is independent & SO is part of Transmission Company
- Hour Ahead Market
- Real time Market

INDIA

- Long term PPAs
- Day Ahead Market
- Regional ,State & National SO
- Exchange exist

BRAZIL

- Real Time Market for Imbalance Settlement
- Weekly System Marginal price
- System Operator and Market Operator are Separate

NYISO

- Day Ahead Market
- Real Time Market
- Security constraints Economic Dispatch
- Price Based Pool

AESO

- Gross pool
- Price Based
- ISO Model
- 7 day ahead scheduling

PERU

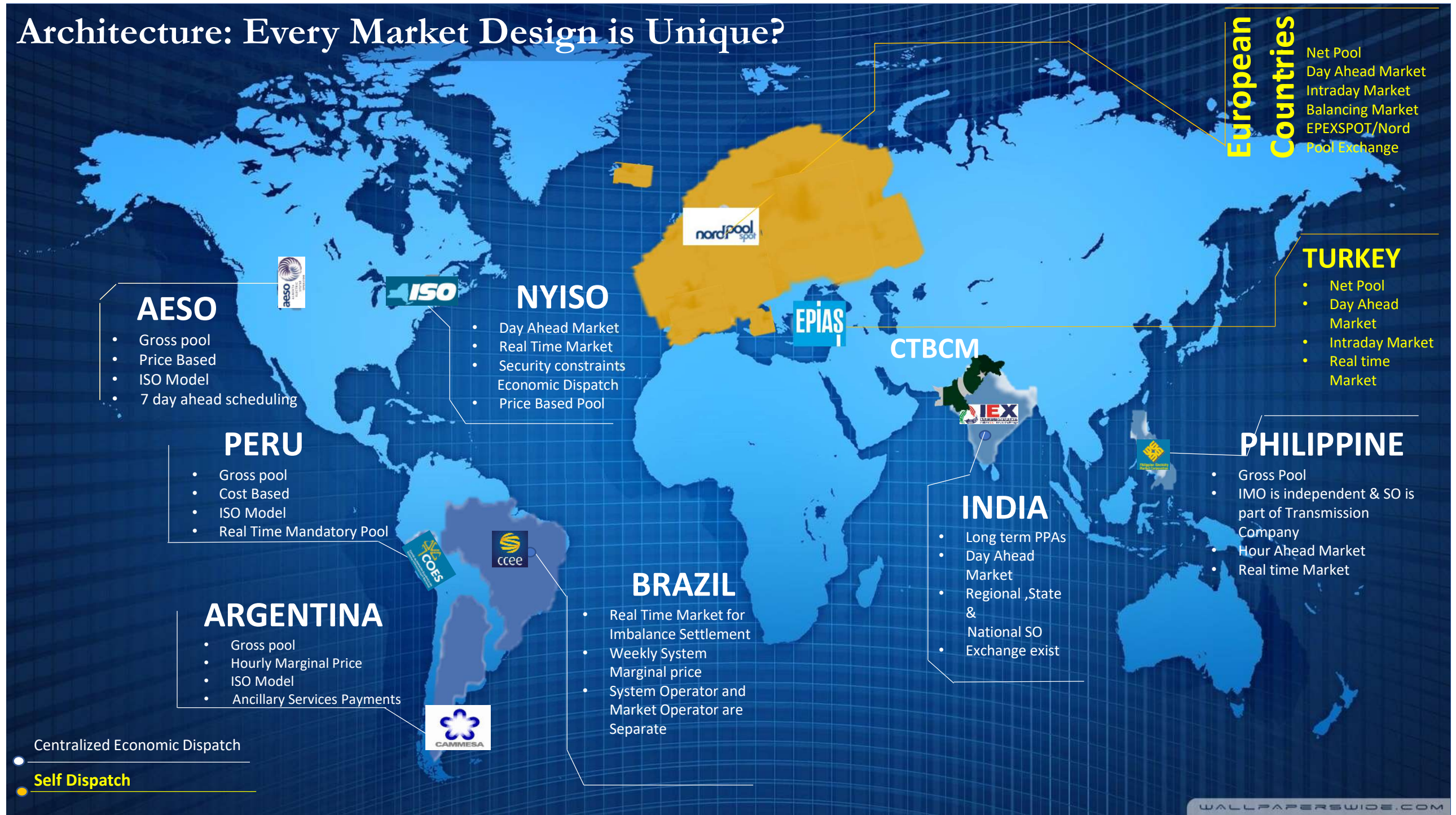
- Gross pool
- Cost Based
- ISO Model
- Real Time Mandatory Pool

ARGENTINA

- Gross pool
- Hourly Marginal Price
- ISO Model
- Ancillary Services Payments

Centralized Economic Dispatch

Self Dispatch



Design Choices

#	Parameters	Options	Example
1	Integration of Legacy Contracts	<ul style="list-style-type: none"> • Forced market integration • Voluntary renegotiation • Adaptation of market design • Virtual Generation • Contractual Buy-Outs 	<ul style="list-style-type: none"> • Adaption of Market Design in Mexico, Pakistan • Buy-Out in Philippines
2	Security of Supply	<ul style="list-style-type: none"> • Left to Market Forces • Ensured through central obligations 	<ul style="list-style-type: none"> • EU markets • US markets
3	Power Procurement	<ul style="list-style-type: none"> • 100% procurement from Market • Bilateral Contracts 	<ul style="list-style-type: none"> • Latin American Markets
4	Market Opening Speed	<ul style="list-style-type: none"> • All consumers allowed at once • Gradual Transition 	<ul style="list-style-type: none"> • US & EU Markets, Turkey • Brazil, India, Pakistan

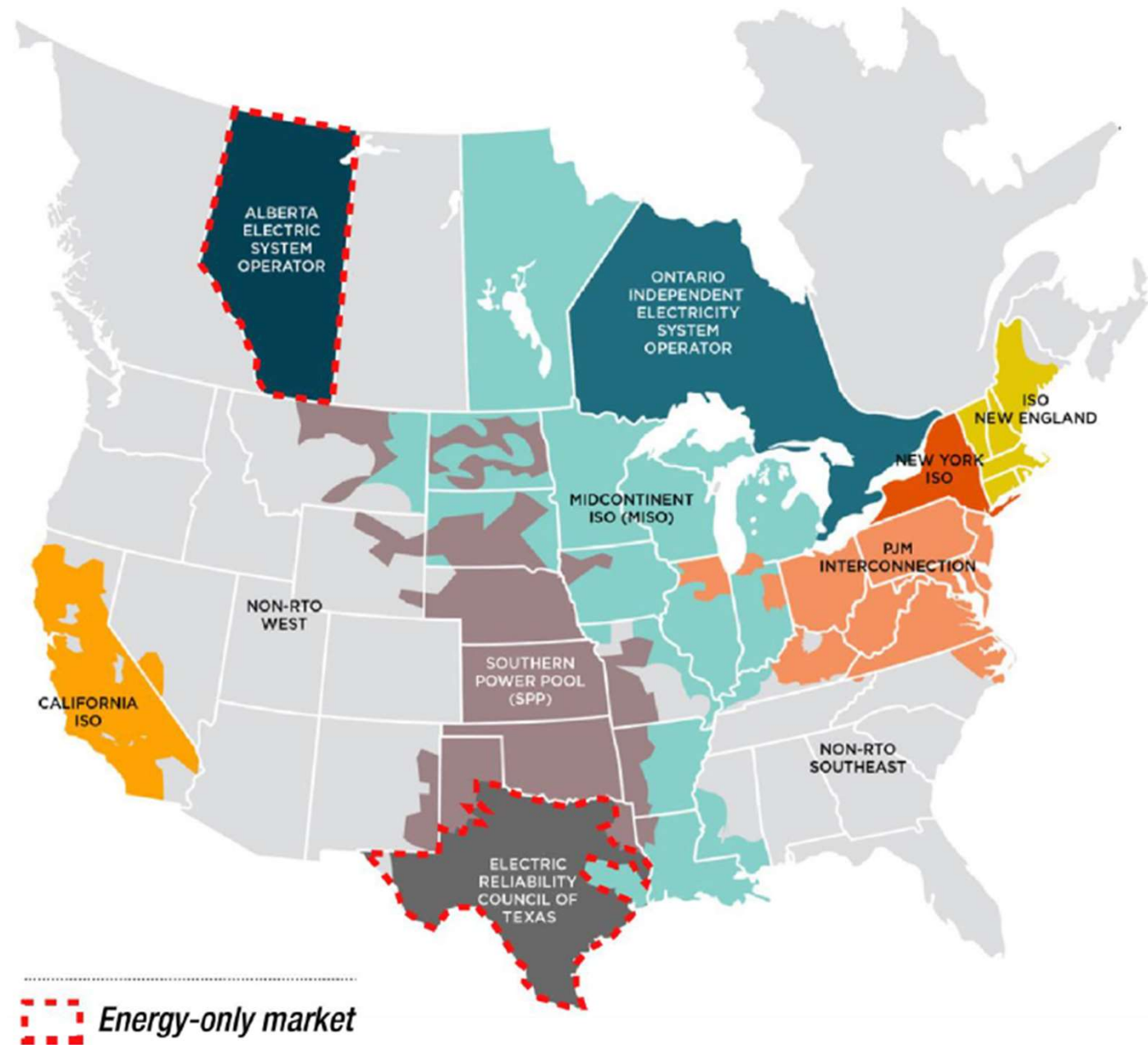


Design Choices

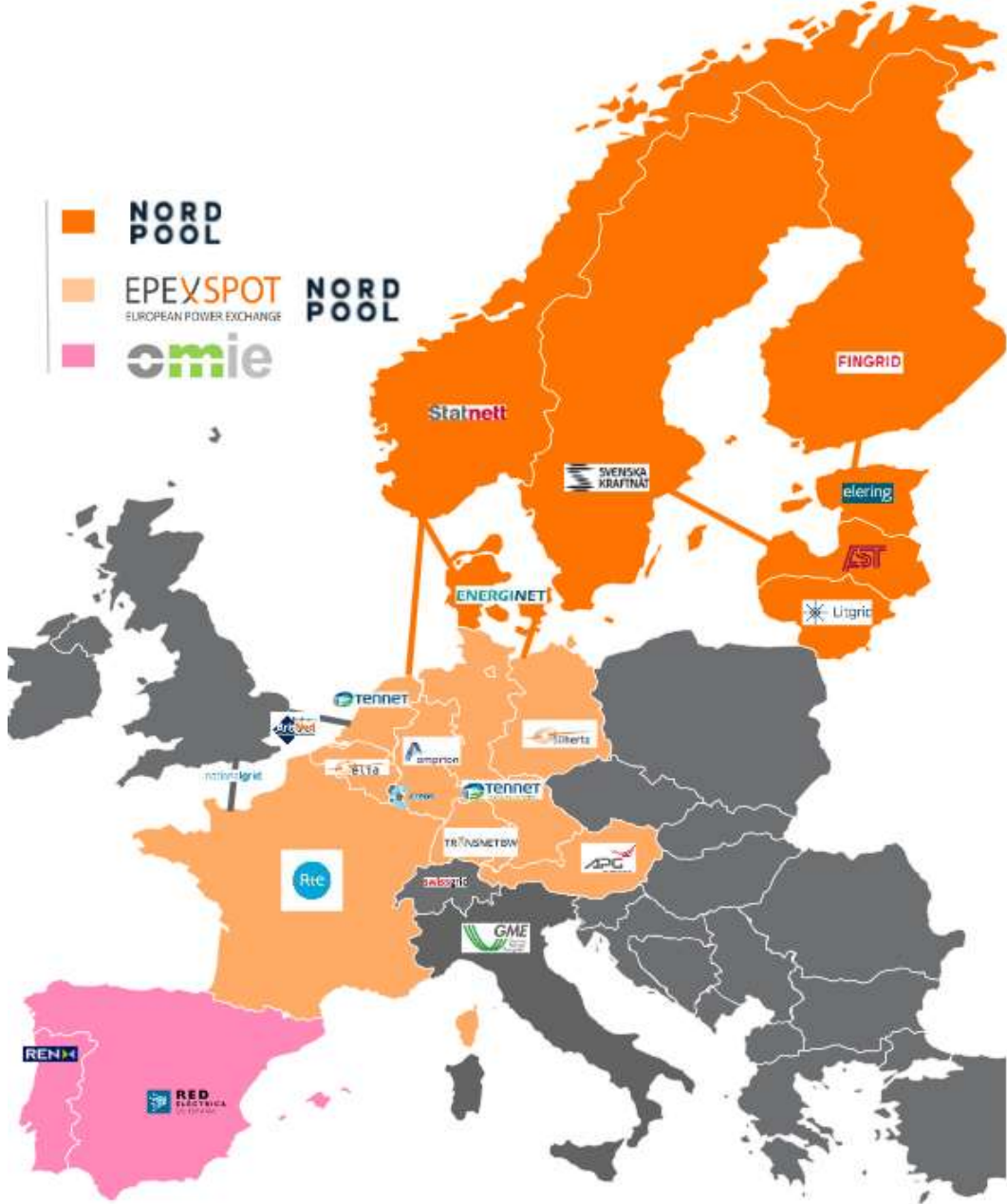
#	Parameters	Options	Examples
5	Open Access Charges (Grid Charges, Cross subsidies, stranded cost)	<ul style="list-style-type: none"> • Only Grid Charges Applicable • Grid Charges + Stranded Cost applicable • Grid Charges + Cross Subsidy + Stranded Cost 	<ul style="list-style-type: none"> • Brazil • US Markets • Philippines, India
6	Dispatch Criteria	<ul style="list-style-type: none"> • Central Dispatch <ul style="list-style-type: none"> • Price based • Cost based • Self-Dispatch 	<ul style="list-style-type: none"> • US Markets • EU Markets
7	Power Procurement by Low performing DISCOs	<ul style="list-style-type: none"> • Individual procurement • Combined procurement 	<ul style="list-style-type: none"> • US & EU Markets • Brazil
8	Market Architecture	<ul style="list-style-type: none"> • Day Ahead, Intra-Day and Real time Market • Ex-ante Real time Market with Balancing Ex-post • Ex-Post Balancing Market 	<ul style="list-style-type: none"> • US and EU Markets • Philippines, Canada • Latin American Markets
9	Institutional Structure	<ul style="list-style-type: none"> • ISO Model • ISOs & SO, MO and TNO separate Entities • MO, TSO (SO + TNO) 	<ul style="list-style-type: none"> • US Markets • Latin American Markets • EU Markets
10	Market Index	<ul style="list-style-type: none"> • 5 minute to hourly Marginal prices 	<ul style="list-style-type: none"> • Canada • Brazil



Electricity Market – PJM USA



Electricity Market - Spain



Electricity Market - Brazil

Cost-based dispatch

Audited costs, water values centrally calculated by ISO with dispatch models
Transparency & avoids market power

Price-based dispatch

Bidding scheme, as in the US/EU
Market monitoring uses dispatch models
Effective market signals

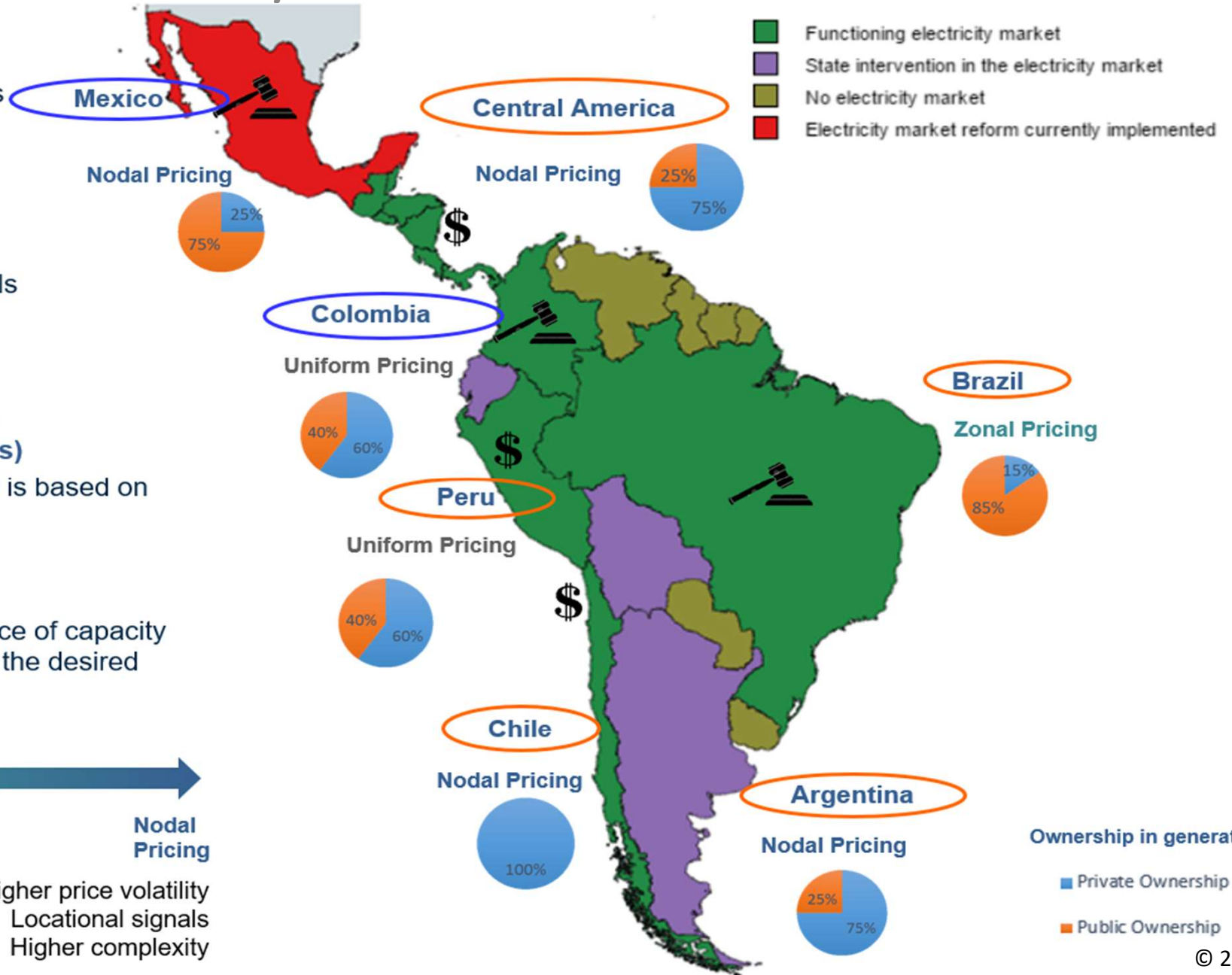
Capacity adequacy mechanisms

\$ Price-based (capacity payments)

Capacity payments fixed and quantity is based on investors' response

Quantity-based

Forward auctions to determine the price of capacity additions in advance, as a function of the desired quantity



Electricity Market - India

