
APEx
Association of Power Exchanges
TORONTO 2019

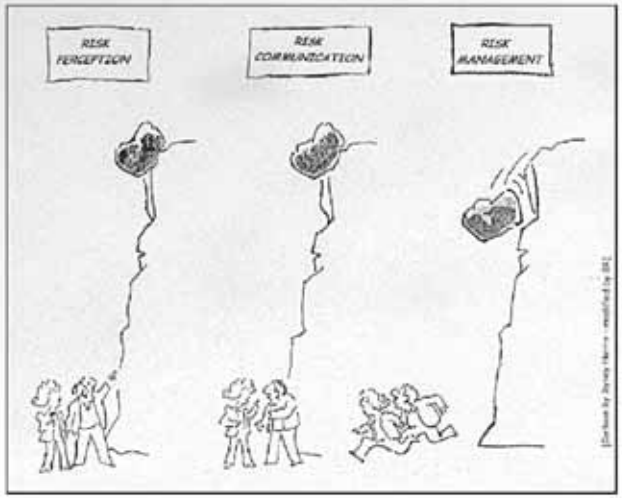
Financial Risk Management Colombian Electricity Market

APEx Toronto
October 2019

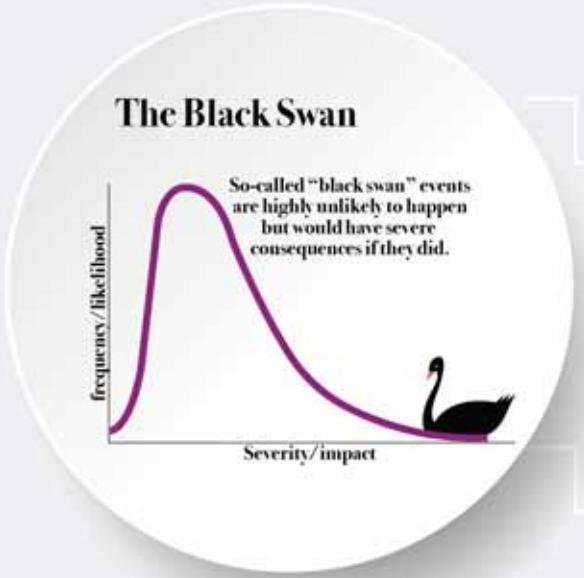
Sumando energías

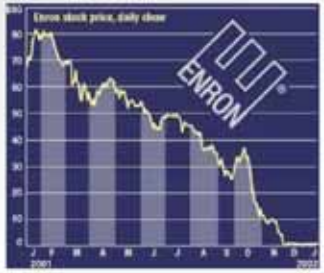
Sometimes these things happen

And we try to manage the risks, but it is difficult



¿Too Big to Fail?





And guess what?...it happened

Default of a retailer that supplies 25% of Demand:

- Financial weakness of the supplier and high exposure to spot price
- **El Niño Phenomenon:** exacerbates the situation with high spot prices
- Supervisor **takes control**

Execution of bank guarantees

- Energy Market: **79 millions USD**

Current Debt

- Spot Market: **27 millions USD**
- Bilateral Transactions: **102 millions USD**
- Finance Sector: **600 millions USD**
- Others: **83 millions USD**

Affected Users

- Regulated: 20%
- Not Regulated: 5%

Our risk management in Colombian Electricity Market

Financial Risk Management tools

• Banking guarantees for payment in the pool market
• Futures to hedge spot price volatility

Financial solvency of participants

• Solvency Margin (CROM).

Early alerts

• Monitoring financial indicators.

AWAITING

• Supplier of Last Resort (SoLR)
• Standardized Contracts Market with Central Counterpary (ClearingHouse).

Lessons learned

- Black Swans Happen!! Be prepared and use the instruments that the market has to offer.
- Financial markets add great value to electricity markets, offering effective instruments to manage financial risks. Including: Clearinghouses.
- It is crucial to have a Supplier of Last Resort to protect final users. Default issues are more sensitive in electricity markets, that is why…

We would like to learn about experiences of other markets in our panel!


Sumando energías
xmsaesp
XM_SA_ESP
XM Filial de ISA
XM SA ESP



MARKET REFORM

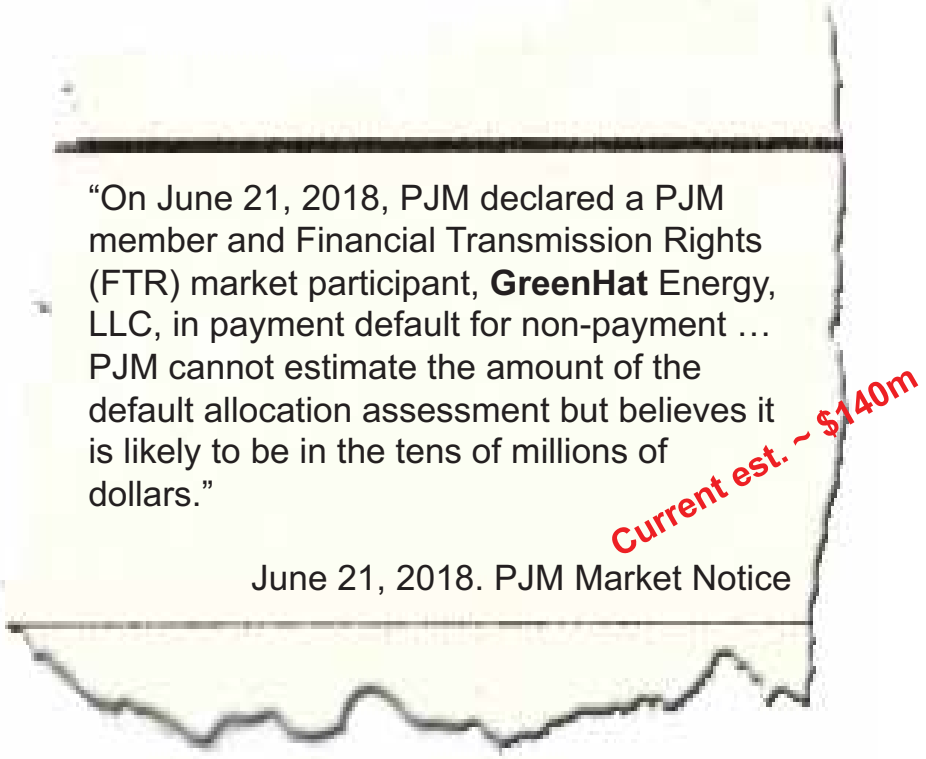
Lessons from the AasHat Defaults
Panel 3: Credit Risk Management
APEx Conference, Toronto

Todd Bessemer

11 October 2019

A New High-Water Mark for Defaults

2018 saw two unprecedented defaults in electricity derivatives markets



MARKET REFORM

Haven't We Been Here Before?

"Those who forget the lessons of history are condemned to relive them"

George Santayana

…the liquidation proceeding is an attempt to recover approximately $250 million Edison is in default on to CalPX market participants.

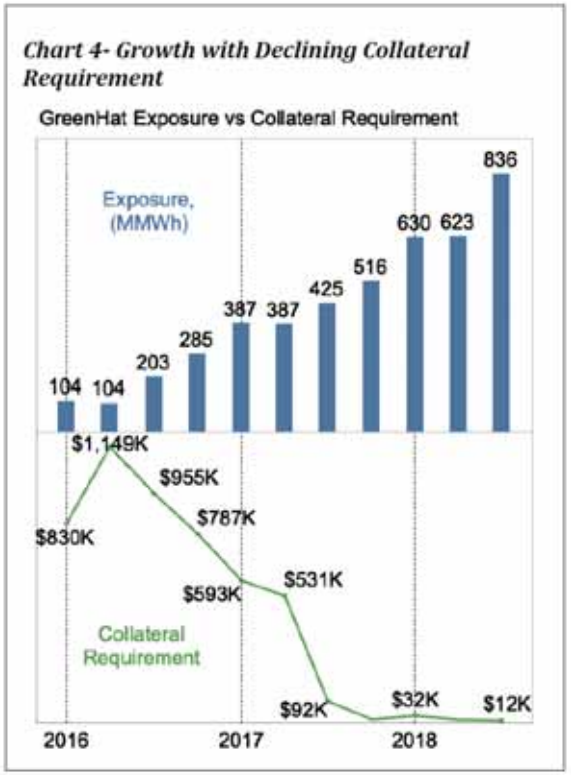
February 2, 2001, CalPX Press Release.

Ultimate loss $51.7m

…The $80 million estimated loss, generated by Tower affiliate Power Edge, has to be borne by PJM's members… Power Edge put up only $3 million in collateral to control the huge, money-losing trade.

January 23, 2008, Baltimore Sun.

Some Specifics on the Greenhat Default



Source: *Report of the Independent Consultants on the Greenhat Default*, Anderson, Wolkoff, et.al., March 2019

- Acquired massive portfolio; the largest in the market, at 836TWh (greater than Germany's annual electricity consumption!).
- These positions were primarily in infrequently traded, illiquid back periods.
- Even when warning signs appeared, PJM felt its rules constrained it from many of the potential courses of action.
- PJM commissioned Independent Consultants' Report, which found a number of failings, including:
  - inadequate risk models
  - inadequate 'know your customer' procedures, and controls to exclude bad actors from the market
  - failure to act after prior defaults
  - insufficient monitoring once issues were known, with Greenhat able to continue amassing large exposures
  - inadequate qualifications and training, of both PJM risk management staff and some of the traders on the market

MARKET REFORM

Some Key Learnings – New and Old

Credit management has been an afterthought in the development of most electricity markets; the obvious exemplar of futures markets has mostly been ignored

- With some exceptions, spot market operators tend to be particularly weak at managing the credit risk of related derivatives markets (e.g. FTRs).
- However, as seen by the Einar Aas default, even futures markets can get it wrong.

Particular Issues:

- Failure to adequately understand (or account for) the interplay between the physical and the financial. e.g. outcomes in locational basis trades are highly influenced by stochastic events in the system, such as line outages or augmentation.
- Looking purely at historical volatility is unlikely to be a sufficient indicator of future risk.

> *"For the FTR market, however, implied volatilities are not available, and there are concerns regarding whether there is a sufficient diversity of trading history for historical volatilities to be sufficient. A more reliable method for deriving volatilities would be to analyze the results of a range of simulated scenarios. This raises the challenge, however, of how many and which scenarios to pick, and how computationally intensive such a process would be."*
>
> PJM Credit and Clearing Project: Findings and Recommendations, June 2008.

MARKET REFORM

Some Key Learnings – New and Old

…also…

- Both the PJM and Nasdaq defaults also show a failure to properly account for liquidity risk – the ability for the position to degrade by the time it can be liquidated – and appropriate adjustments to margin required to cover this.
- Position limits – as a factor of commodity and participant financial strength – were inadequate, allowing outsize positions to be accumulated.

For electricity spot market operators, if you're going to operate a derivatives market, you either need to hire a clearing house, or build one.

APEX - Panel 3: Credit Risk Management

11th October 2019, Toronto, Canada

Hans-Arild Bredesen

CEO, Nord Pool Consulting

Nord Pool Consulting

Ambassadors for modern power market across the world

Unique competence in a wide span of topics

Market design
Specialised competence in overall market design and structuring, with emphasis on local needs

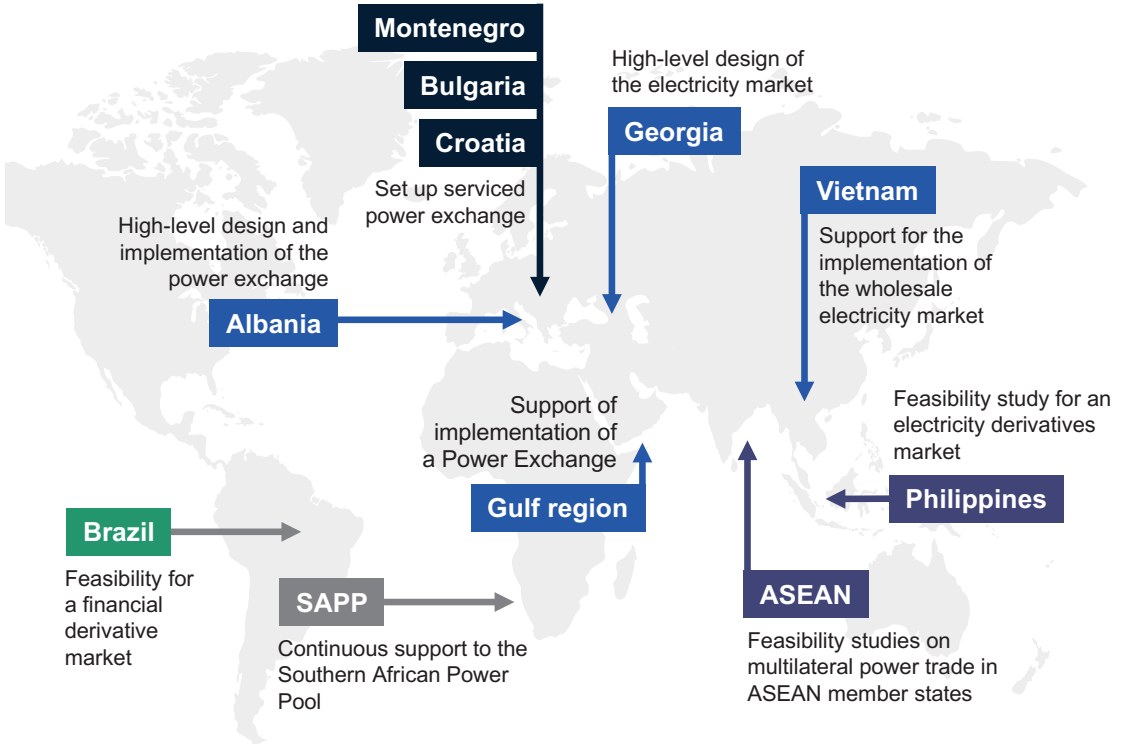
Rulebook development
Development of rule books for all market participants to ensure well-functioning markets

Regulation
Deep insight into regulatory frameworks with continuous lobbying efforts towards regulators and politicians

Market systems
Provision of power exchange backbone systems and MCO services

Competence building
Nord Pool Academy is a vehicle to educate customers and stakeholders on internal and external developments

A selection of projects recently completed



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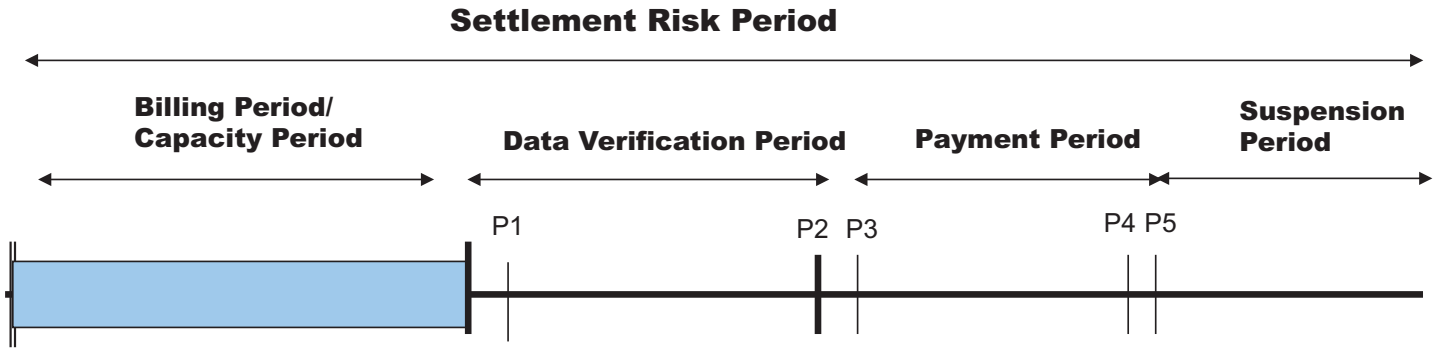
Settlement timeline – risk and payments

A nostalgic picture from the old SEM – but this is still the case…



Settlement period	P1 – Indicative Settlement Statements	P2 – Verification period finished	P3 – Invoice & Initital Settlement statements sent	P4 – Invoice due	P5 – Credit due	Time to remedy, time to SoLR	Settlement Risk Period
Billing Period (Weekly)	BP+1WD at 17:00	BP+4WD at 17:00	BP+5WD at 12:00	BP+8WD at 12:00	BP+9WD at 12:00	2WD+[1]WD	**D+17WD**
Capacity Period (Monthly)	CP+1WD at 17:00	CP+4WD at 17:00	CP+5WD at 12:00	CP+8WD at 12:00	CP+9WD at 12:00	2WD+[1]WD	**D+34WD**

Assumptions: - max 22 work days in month, 5 working days in week
- Validation period is set to 3 working days
- 3 working days before invoice is due

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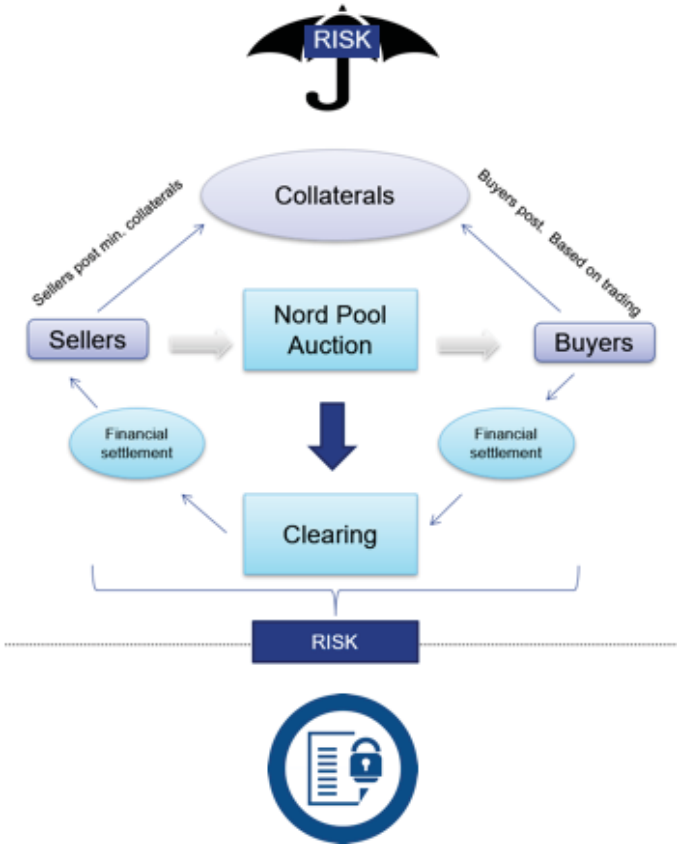
Nord Pool Basic Clearing model

Used for the physical markets



- **Initial Collateral:** Up-front (base) collateral in place before member can trade. Min deposit = € 30.000

  Members estimate maximum daily exposure in MWh

- **Trading Margin** is calculated on a daily basis, as the sum of a member's net MWh position, multiplied by the risk parameter, times the day factor set by Nord Pool.

  ∑ (Daily Net MWh position x Risk Parameter) x Day Factor

- **Risk Parameter** is a parameter set on either a net long or a net short position per delivery country, estimated as a worst case on how high the spot price can be using three years' lookback and 99.7% confidence interval.

- **Day Factor** is a parameter set to account for member's exposure to Nord Pool over weekends.

- **Collateral Call** is the daily collateral call being estimated as the highest of the Daily Margins looking back on the last 30 days. MAX (DailyMargin1, DailyMargin2, … , DailyMargin30)

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… Some key learning points from the Nordics – three different cases

One of the fundamental issues for almost all risk models – is that they are based on historical data

ENRON bankruptcy

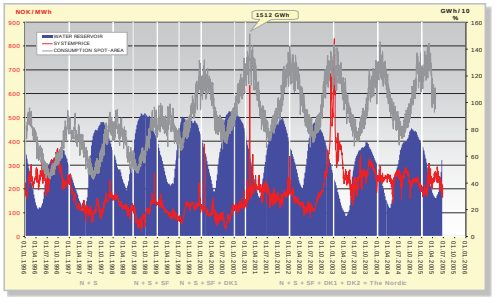
Short description:

- Biggest market participant went bankrupt
- The fall of ENRON went very fast
- The bankruptcy was not connected to our markets, in fact Enron was successful in the European power trading

Key learning points:

- Clear legal rules extremely important
- Internal procedures equally important
- Equal rules based on trading (no special treatment, no rating used)
- …. And it helped that the market could easily support the netting of the positions

COLD WINTER 2002-2003



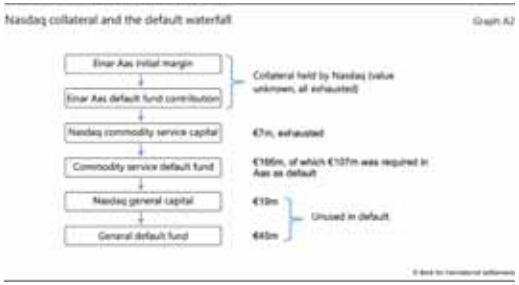
Short description:

- Rapid rise in forward prices in financial market
- Daily margin calls - getting into holiday season
- The banks total exposure in power became a huge issue – not the solidity of the power companies

Key learning points:

- Close cooperation with the market and also providers of services is important
- It was solved by an open communication between both PX, members and banks
- And again, the rules and also Enron story allowed Nord Pool to remain within their rule.
- This was never thought of as a problem…

EINAR AAS



Short description:

- Big bet on price differences between NO/DE
- A “black swan” ….
- Small, one-man company runs out of cash for margin calls and positions closed down
- Nasdaq needs to use Default fund to manage the cashflow

Key learning points:

- No violation of rules
- Q: Should there be more risk parameters?

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So – what to do?

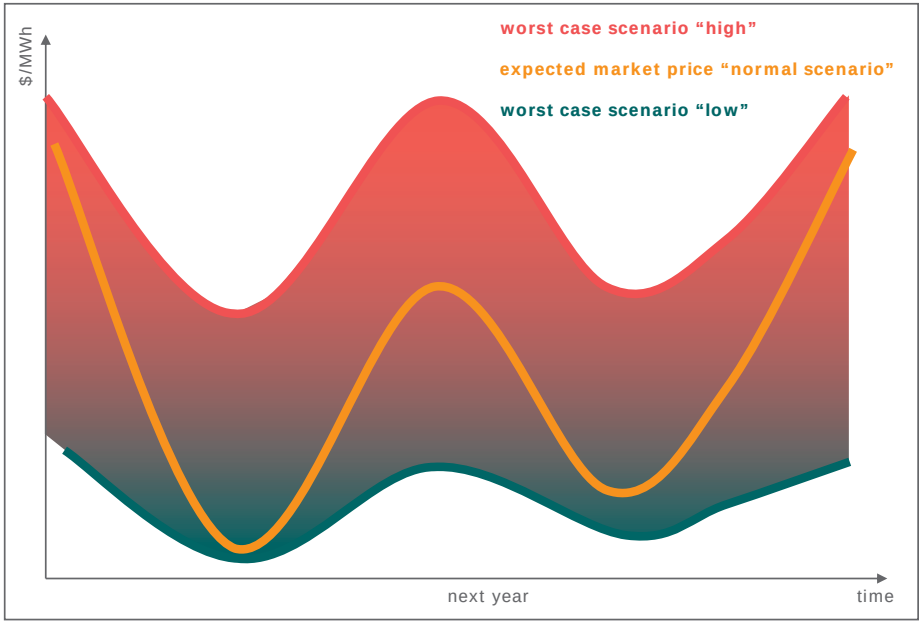
Shall the markets be built to cover for all events?

The physical short term markets will manage
- Shorter and shorter settlement and clearing timeframes
- "Limitless" trading will be more attractive and easier with technology

For the Financial markets, there are still questions to be answered
- The question of cost of collateral vs cost of trading
- A truly hedged market against all risks is almost impossible (and very expensive)
- Will a "black swan" event where you need to call on the default fund every ten years – is that a price the market is willing to pay (for lower cost of trading)?

However:
- The fundamental issue is that to predict the future is still very hard…
- … and most collateral models are using historical data as inputs
-
- So the issue is that if tomorrow looks like today – the risk is minimum, BUT if tomorrow looks fundamentally different from today, the risk is higher

Closing remark:
- In any case – clear, unambiguous and enforceable rules is a key!



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Thank you!

Hans-Arild Bredesen
CEO, Nord Pool Consulting

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NORD POOL

Panel 3: Credit Risk Management

APEx Conference, Toronto
October 11, 2019

Paul Cusenza
Chairman & Chief Executive Officer,
Nodal Exchange & Nodal Clear

nodal

part of eex group

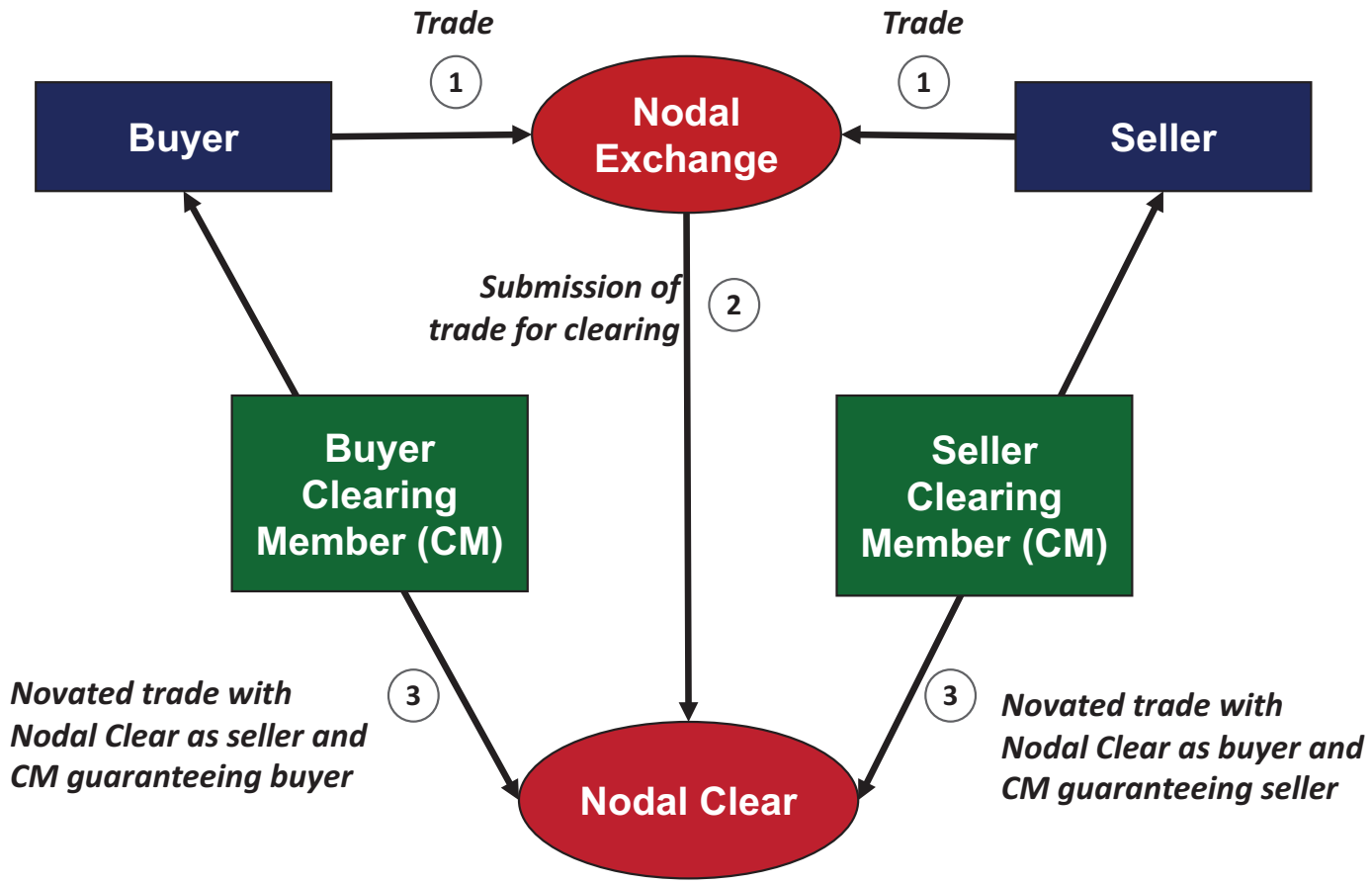
Nodal Exchange Overview

- **Commodity exchange**
  - Designated Contract Market under U.S. CFTC jurisdiction; all contracts are futures contracts
  - 42% market share of U.S. power futures open interest as of Sep 30, 2019 (~850 TWh)
    - Market share up from 31% Sep 30, 2018
- **Power, natural gas, environmental and trucking freight contracts**
  - Providing ability to trade power futures and options on hundreds of hubs, zones, and nodes across seven organized markets (and Mid-C)
    - ISO-NE, NYISO, PJM, MISO, ERCOT, SPP & CAISO
  - Natural gas futures and options contracts for Henry Hub
  - Environmental futures and options on renewable energy certificates, carbon and SO2/NOx emission allowances
  - Recently introduced trucking freight contracts
- **Multiple platforms:**
  - Nodal LiveTrade trading screen as well as Deutsche Börse Group's T7 matching engine with CQG front-end for select contracts
  - Block trades (e.g., broker) submission for clearing
- **All contracts are cleared by Nodal Clear using innovative portfolio margining**
  - Nodal Clear, LLC has been permitted to elect Subpart C under Part 39 of the Commodity Exchange Act
  - Nodal Clear was recognized as a third-country central counterparty by ESMA in March 2017
- **Nodal Exchange became part of the EEX Group on May 3, 2017; EEX Group is in turn part of the Deutsche Börse Group**

Central counterparty clearing is used to manage the credit risk related to futures contracts

- When contracts are to be settled in the future there is risk regarding the counterparty being able to meet payment obligations at that future time
- A central counterparty clearing house acts for a specified market as the ***buyer to every seller and the seller to every buyer***, taking no market position risks only default risk
- These clearing organizations for commodities such as energy are regulated in the U.S. by the Commodity Futures Trading Commission (CFTC) and referred to as **derivatives clearing organizations (DCOs)**
- To protect themselves in the case of a default, DCOs deploy three main tools:
  - **Variation margin:** covers actual movements in the expected settlement price of the contract (mark to market)
  - **Initial margin:** covers the potential price movements that could occur after a potential default and are determined to cover a set number of days to liquidate with a certain degree of confidence. In addition, liquidity margin is also added to this amount to address needing to potentially surpass market prices to quickly liquidate less liquid contracts.
  - **Default waterfall:** used to handle extreme, but plausible credit risks

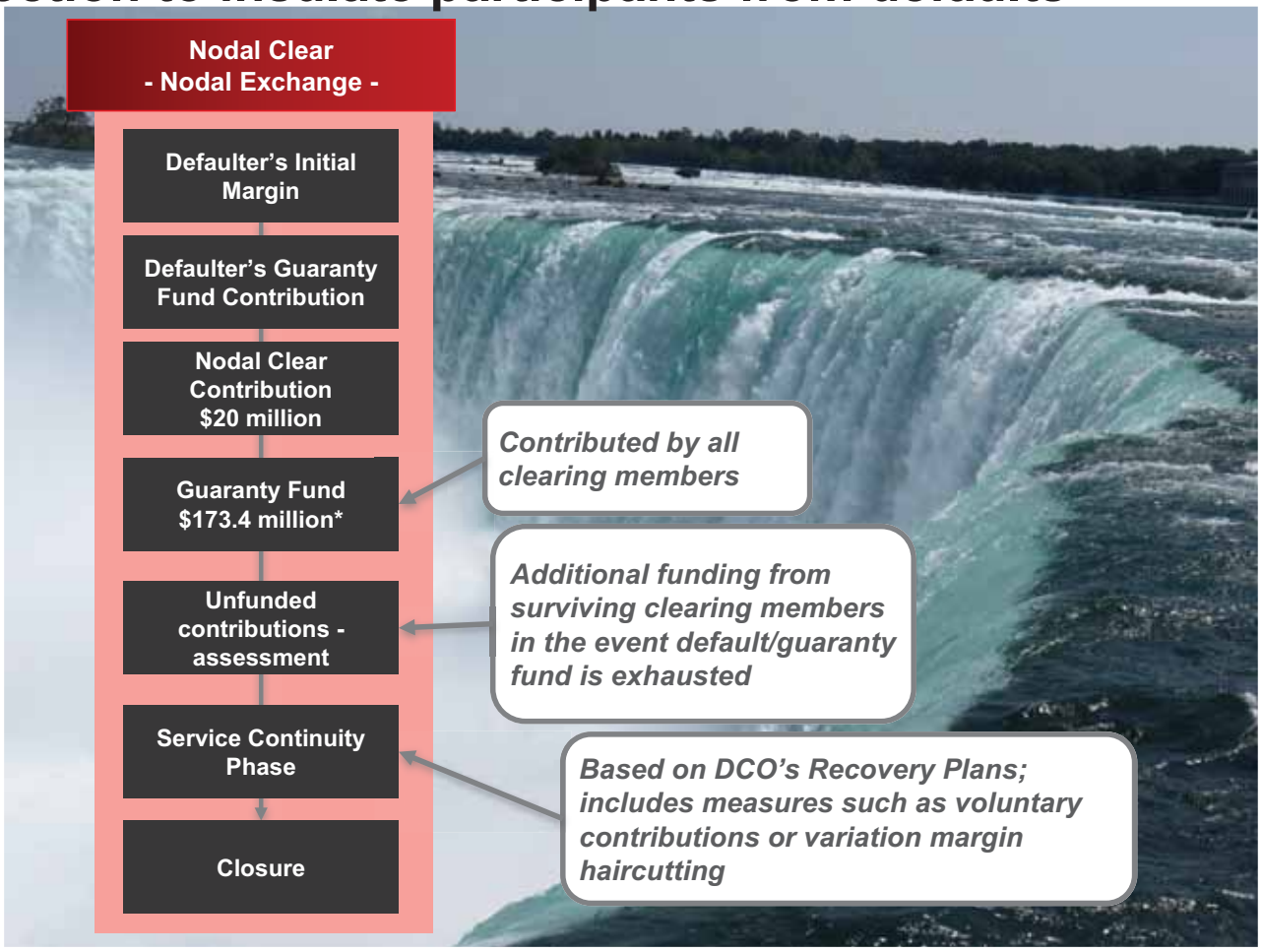
"Novation" in cleared market trading leaves the clearinghouse as the central counterparty; clearing members provide an extra layer of protection



Nodal Clear clearing members

- ADM Investor Services Inc. (FCM)
- BofA Securities, Inc. (FCM)
- BNP Paribas Securities Corp. (FCM)
- Citigroup Global Markets, Inc. (FCM)
- ED&F Man Capital Markets Inc. (FCM)
- Goldman Sachs & Co. (FCM)
- Macquarie Futures USA LLC (FCM)
- Mizuho Securities USA Inc. (FCM)
- Morgan Stanley & Co. LLC (FCM)
- RBC Capital Markets LLC (FCM)
- Royal Bank of Canada
- SG Americas Securities LLC (FCM)
- Wells Fargo Securities LLC (FCM)

Default Waterfall – the clearinghouse has several layers of protection to insulate participants from defaults



* As of August 16, 2019

Lessons learned from 2018 global power industry defaults: key factors to continue to manage

- Clearing Member admission policies
- Credit and compliance monitoring of Clearing Members
- Position monitoring
- Variation margin importance
- Initial margin design – price and liquidity risk management
- “Skin in the Game”
- Guaranty Fund importance
- Default management process

Thank you!!!

For more information please contact:

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Nord Pool, Europe‘s leading power market

Efficient, simple and secure power trading across Europe.

Matias Peltoniemi
Bright Sparks Program

APEx 2019 Toronto
11/10/2019

Nord Pool at a glance

- More than 360 customers from 20 countries trade on Nord Pool's markets.
- Nominated Electricity Market Operator (NEMO) in 15 European countries.
- Offices in Oslo, Helsinki, Stockholm, Tallinn, London and Berlin.
- Over 140 employees work at Nord Pool.
- 524 TWh of power was traded in 2018.

NORD POOL

Nord Pool – Europe's leading power market

Supporting the green shift by providing market solutions for smart cities, electrification and integration of intermittent energy sources

Enabling cross-border resource utilisation and increased security of supply through European market integration

Providing mission critical products and services to the European electricity market

Delivering transparency to ensure market integrity and equal treatment of all participants

Nord Pool Consulting

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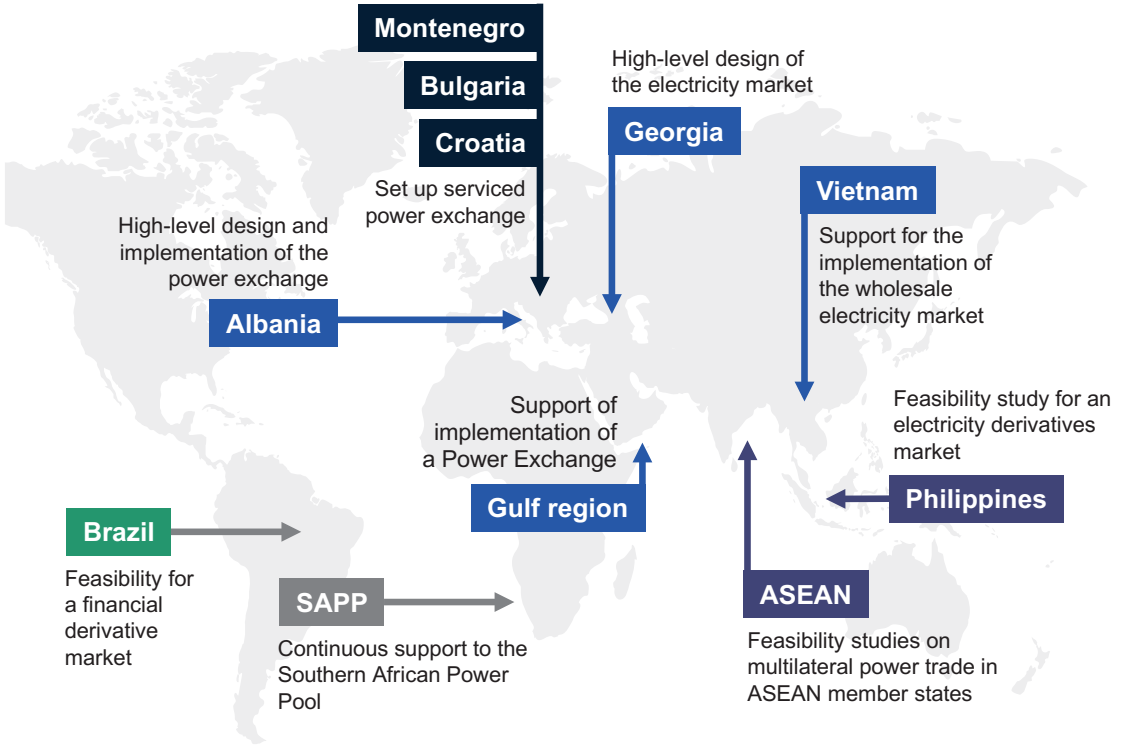

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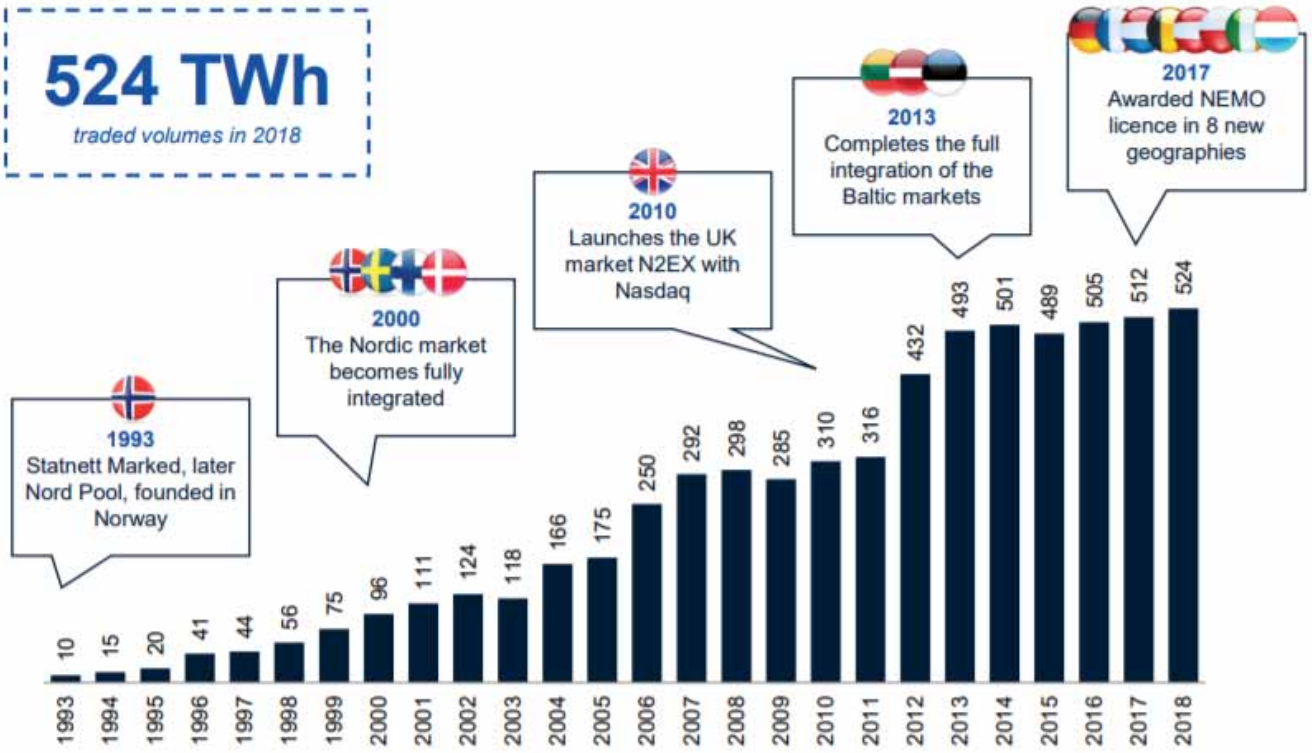
A pioneer in the European spot power market

Nord Pool has been the driving force of the integration of the Nordic power markets, and later Baltic and European power markets

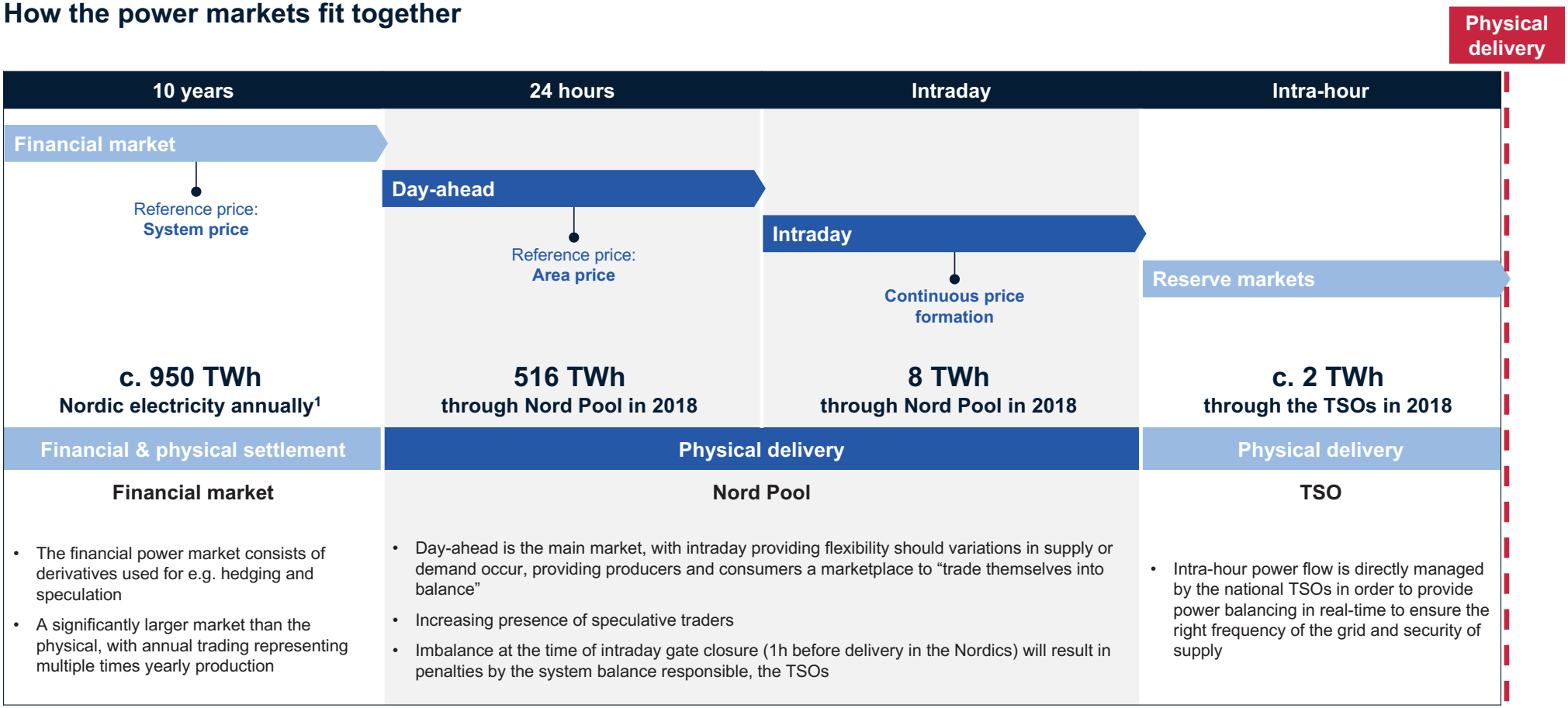


- **The world's first electricity exchange**
- **The world's first multinational electricity exchange**
- **A driving force in European market integration through XBID and PCR projects**
- **A global thought-leader in the field of physical power trading**

NORD POOL

Nord Pool plays a part in the wider electricity market

How the power markets fit together



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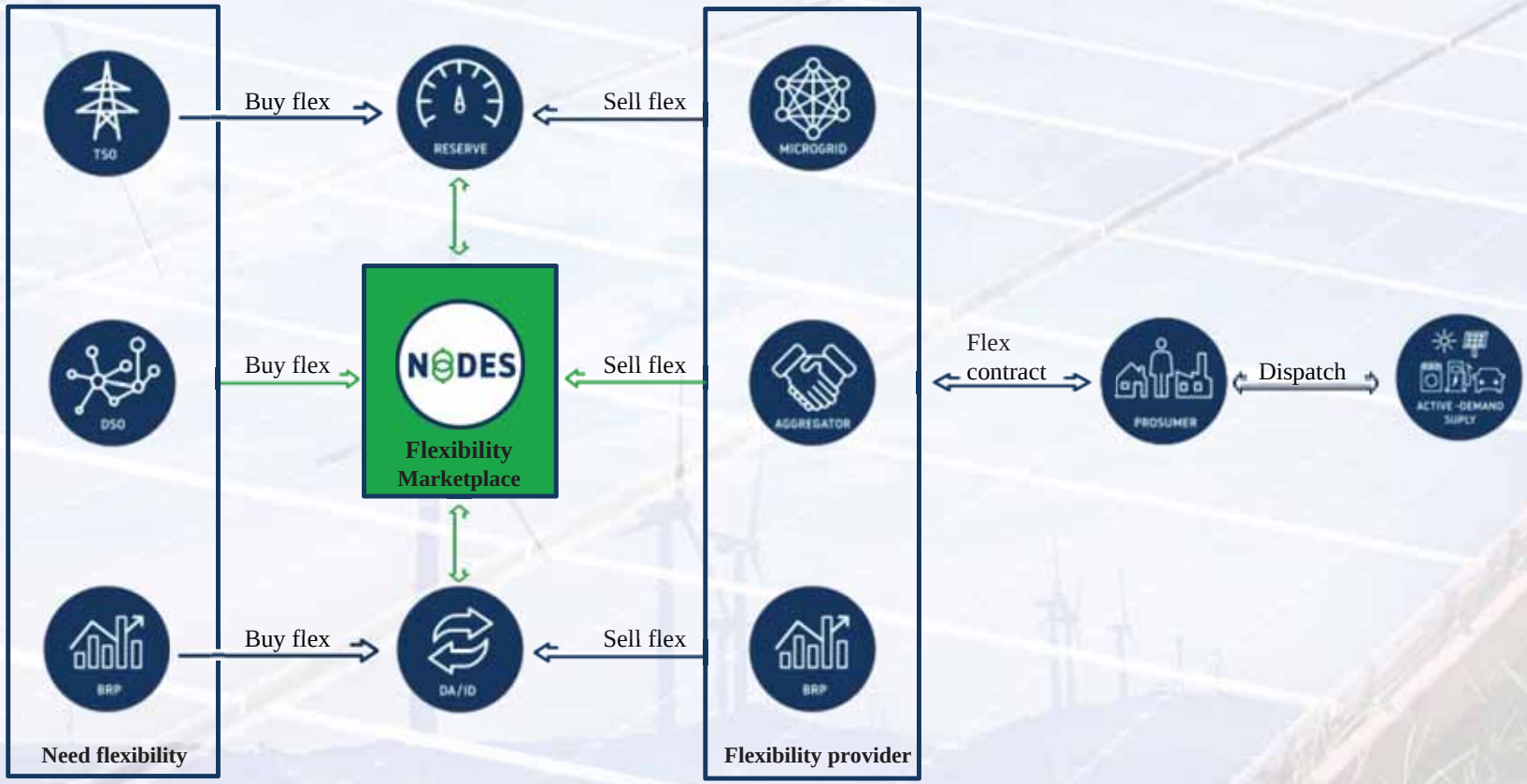
1) Aggregated volume of all Nordic derivatives traded on Nasdaq Commodities in 2018

NODES - Marketplace for decentralised flexibility



Bright Sparks Experience

- APEx launched the Bright Sparks Program to support the development of young energy professionals.

- Bright Sparks Program 2019 has given me opportunity to
  - Attend at the full APEx conference and follow the current market trends and topics
  - Dedicated presentation slot
  - Activities before the conference together with other Bright Sparks
  - Opportunity to interact and network with energy industry professionals
  - Follow and listen into recent developments in the power market sector

- Looking forward to join Bright Sparks Alumni group and sharing experiences!

NORD POOL

Thank you!

NORD POOL CONSULTING

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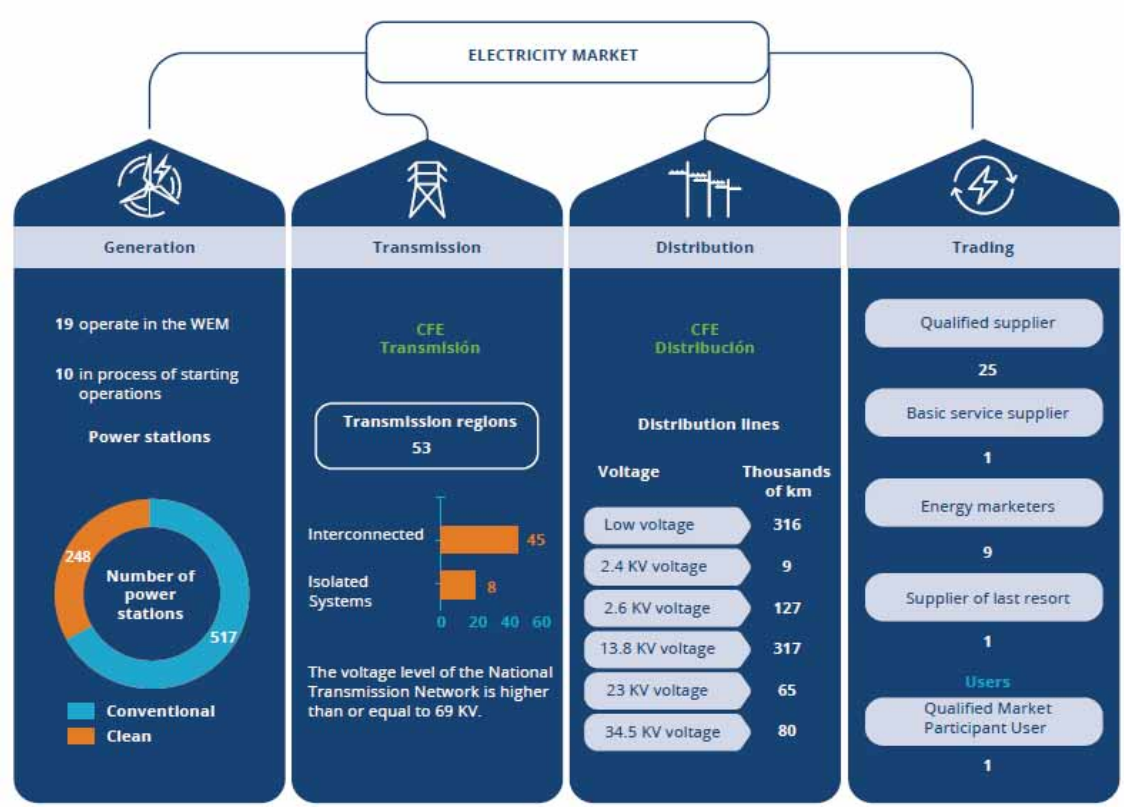
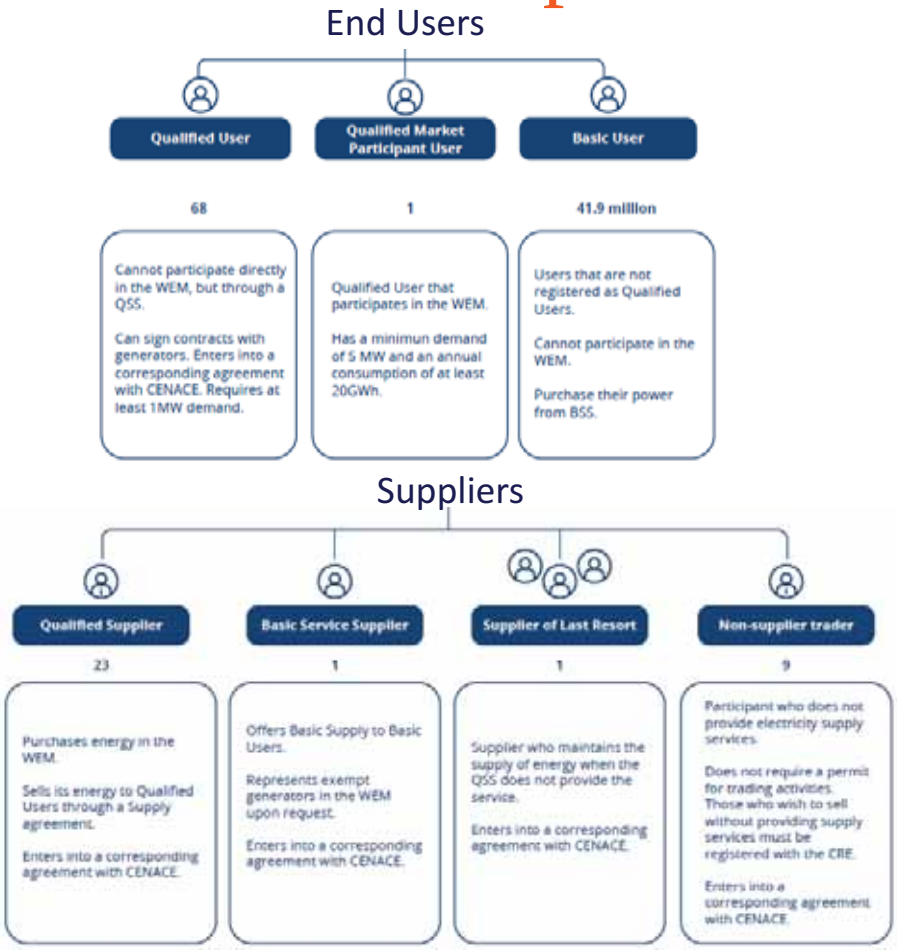
The Energy Market of the Future: Developing Countries Present Unique Challenges or Mexico's WEM

October 2019

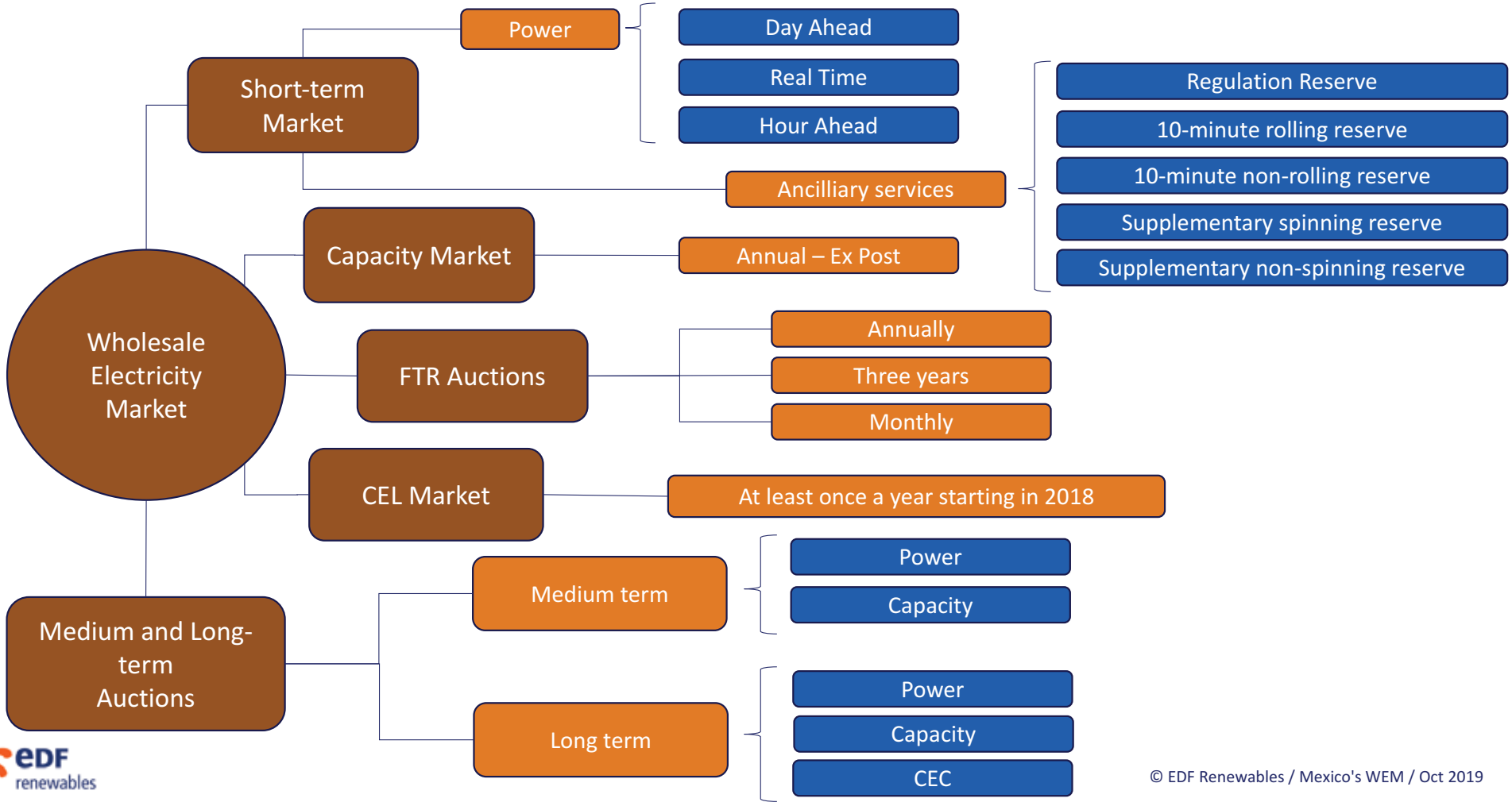
Electric Grid & WEM Structure and Participants





Source: EY with information from CENACE and SENER.

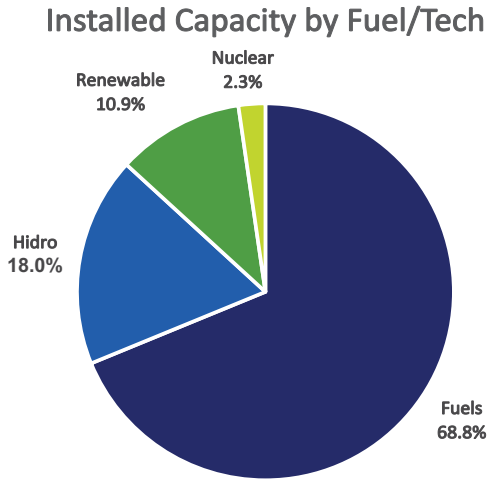
WEM Markets & Products: Not Fully Implemented

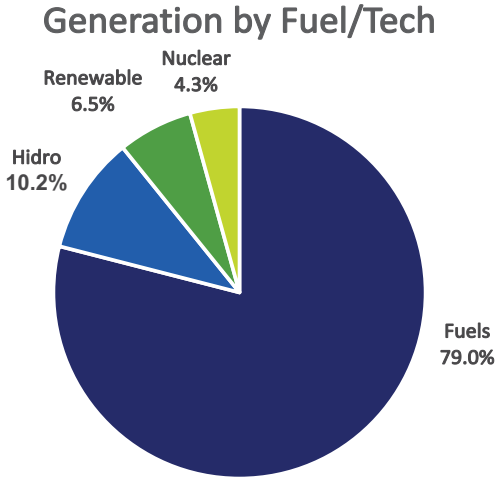


Mexico: Generation Mix by Technology and Fuel

	Installed Capacity by Technology 2018		Energy produced in 2018 by type of technology	
TECHNOLOGY	%	GW	%	TWh
Combined Cycle	**36.50%**	**25.6**	**51.00%**	**161.8**
Conventional Thermal	**17.00%**	**11.9**	**13.20%**	**41.9**
Gas Turbine	4.60%	3.2	2.70%	8.6
Internal Combustion	1.00%	0.7	0.70%	2.2
Coal	**7.70%**	**5.4**	**9.20%**	**29.2**
Cogeneration	2.00%	1.4	2.20%	7.0
Hydro	**18.00%**	**12.6**	**10.20%**	**32.4**
Wind	6.80%	4.8	3.90%	12.4
Geothermal	1.00%	0.7	1.70%	5.4
Nuclear	2.30%	1.6	4.30%	13.6
PV	2.60%	1.8	0.70%	2.2
Biomass	0.50%	0.4	0.20%	0.6
Total		**70.1**		**317.2**

Source: CENACE, PRODESEN





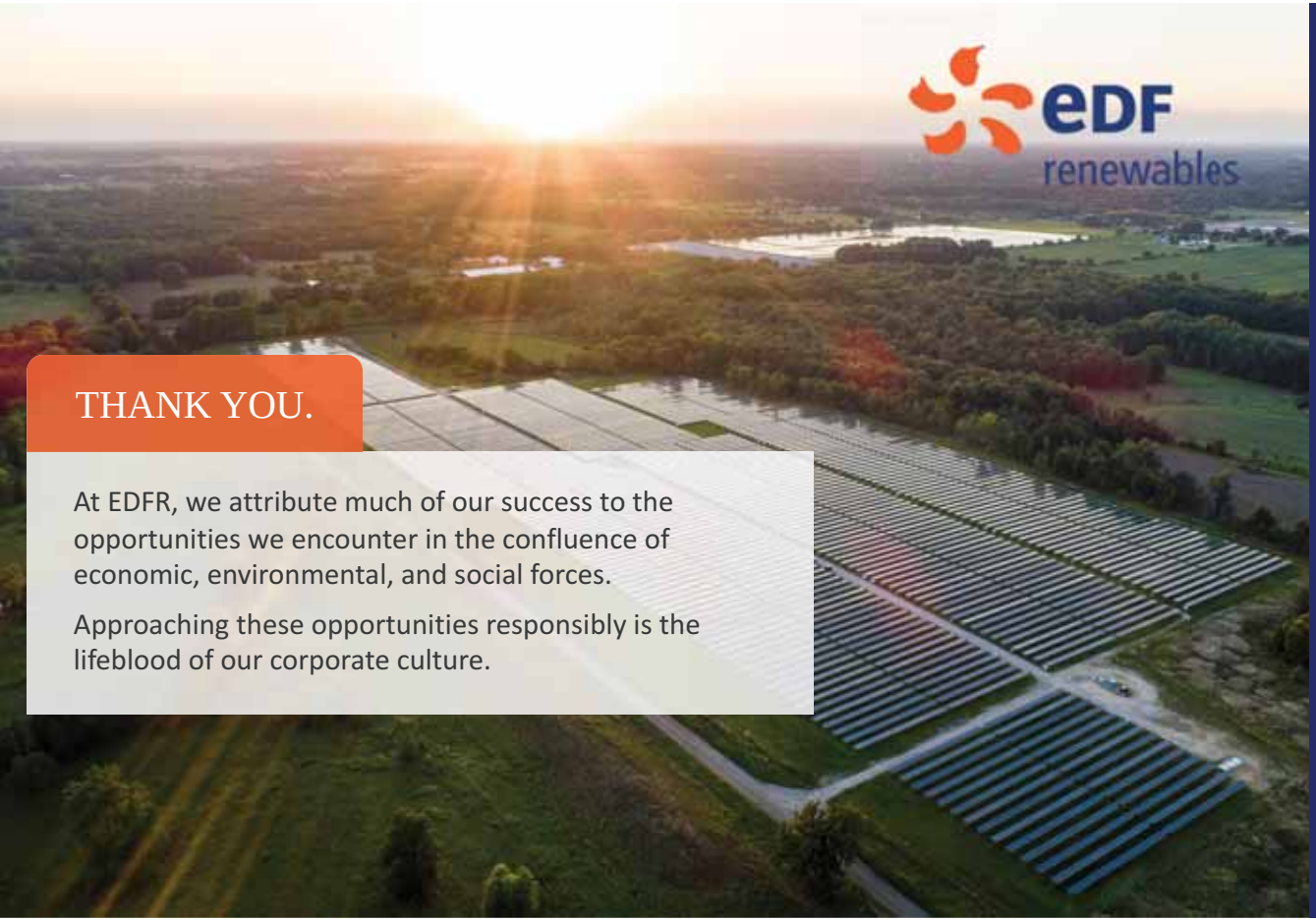
Mexico's Energy Infrastructure

National Electric System (Transmission)

Gas Pipeline Infrastructure

Developing Countries Present Unique Challenges to Energy Market Design & Operation

Presence of large, incumbent players/former state monopolies	Inefficient legacy generating units	Lack of energy infrastructure	Tension between intl commitments / pressure for low carbon economy and political & economic pressures against costs of transition
Resistance to market entrance by private sector; challenges to independence of ISO	Affect valuing of resources; incumbent utilities may seek to manipulate regulation to keep them in operation	Slows transition to lower fuel cost resources; affect valuing of resources and price formation	Economics matter in developing countries and local politics can hijack long term goals



THANK YOU.

At EDFR, we attribute much of our success to the opportunities we encounter in the confluence of economic, environmental, and social forces.

Approaching these opportunities responsibly is the lifeblood of our corporate culture.

connect

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VP Development

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edf-re.com

APEx 2019
PJM Market Challenges and Design

Tim Horger
Director - Energy Market Operations
PJM Interconnection LLC
APEx 2019 Conference

PJM: Future Evolving Markets

Price Formation

challengefuture

Proper reflection of scarcity and valuing of resources that can provide flexibility

Capacity Pricing

challengefuture

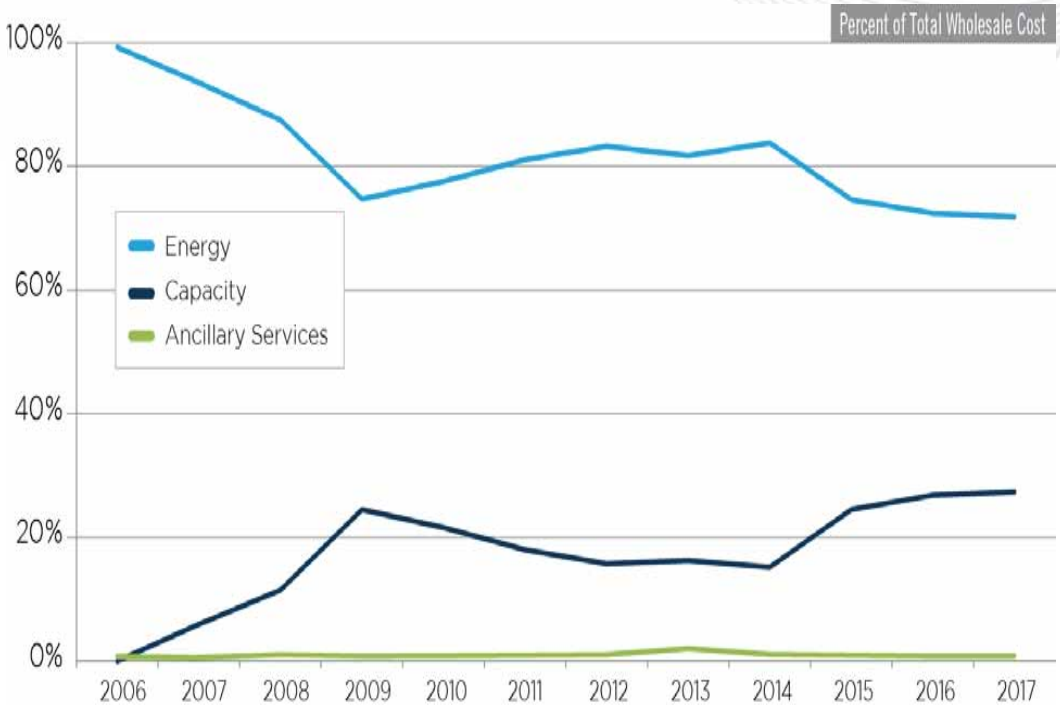
Collaboration with states to accommodate subsidies and portfolio initiatives while ensuring integrity of the competitive wholesale market

Carbon Pricing

challengefuture

Advancing state policy to meet carbon-reduction initiatives while ensuring integrity of the competitive wholesale market

Price Formation: Shift in Costs and Need for Change



How can energy and reserve market prices more accurately reflect the scarcity value of electricity?

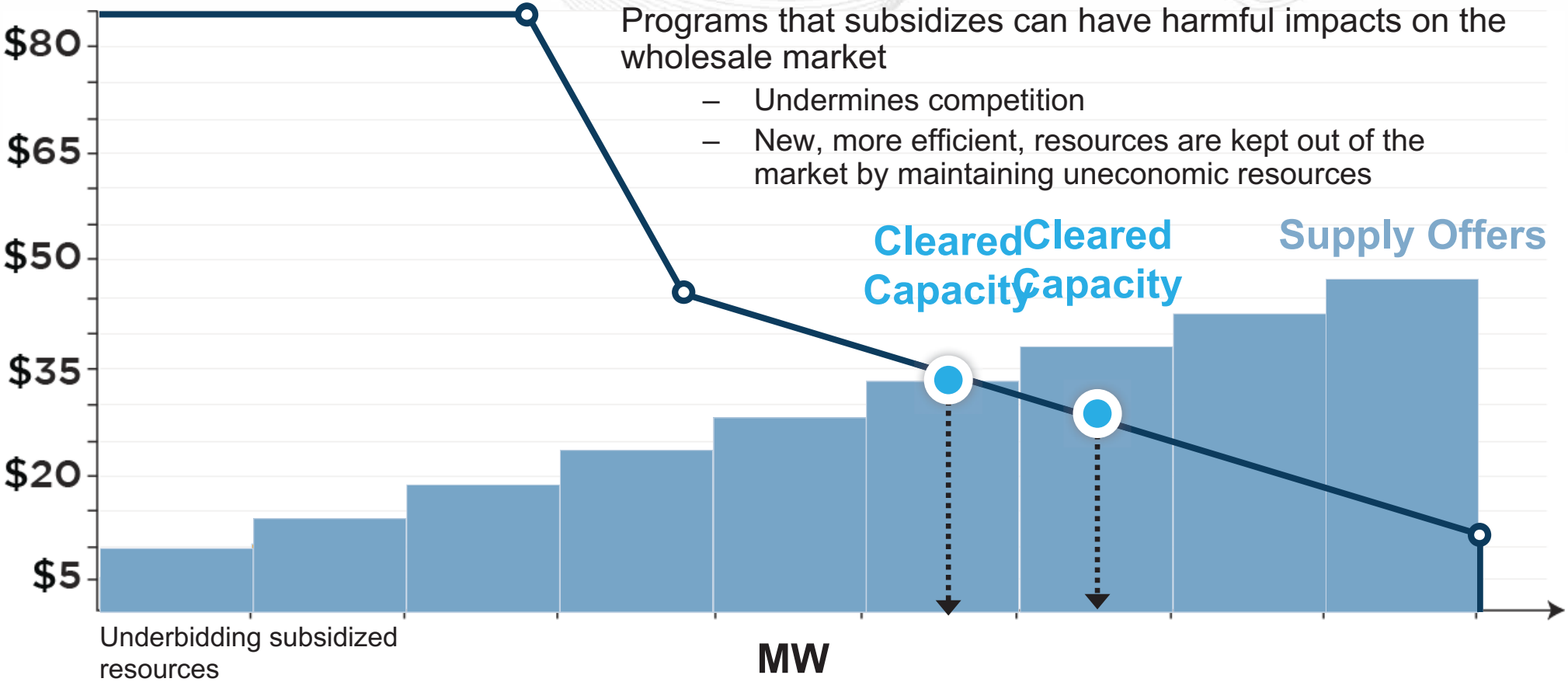
How can the energy and reserve market prices reflect the value of flexibility and other useful resource attributes?

*Proper price incentives and resource attributes achieved when cost recovery properly proportioned between different markets

Subsidies and the Capacity Market

Programs that subsidizes can have harmful impacts on the wholesale market

- Undermines competition
- New, more efficient, resources are kept out of the market by maintaining uneconomic resources



Carbon Pricing: PJM State Differences

Regional vs. Sub Regional market mechanisms need to be considered with assurance of competitive market structure

State with No carbon emission reduction requirements

State with carbon emission reduction requirements

British electricity markets: the case for change

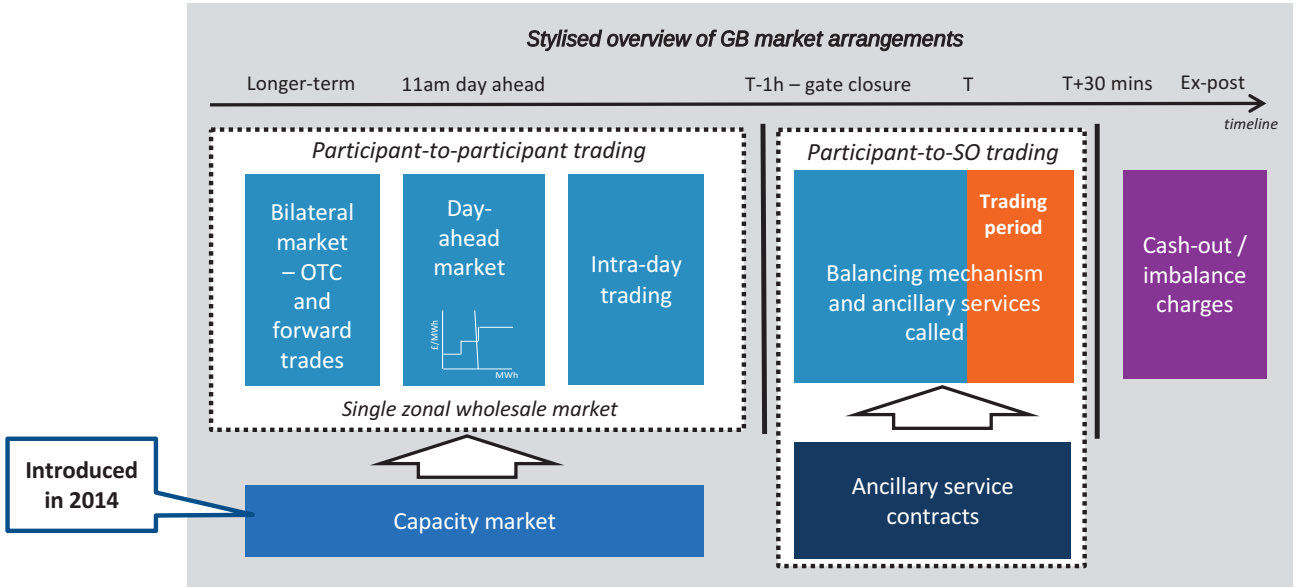
Reflections from 20 years of self scheduling markets and implications for the future

Jason Mann

October 2019

GB electricity wholesale market developed in late 1990s…

- Went live in 2001 – extended in 2005
- Driving philosophy at time was to **maximise use of markets**
- **Significant differences from US Standard Market Design model:**
  1. **Self scheduling** – electricity traded bilaterally ahead of real-time – participants schedule against contracted position
  2. **Large single price zone –** intended to encourage liquidity in trading
  3. **System Operator was "residual balancer"** – limited SO role – rather "the market would deliver wherever possible"

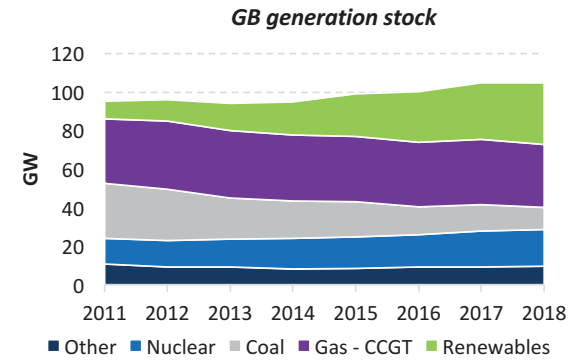


…subsequently transposed into the European Target model

GB market has increasingly struggled to meet original design objectives….

1

Generation investment no longer determined by electricity market

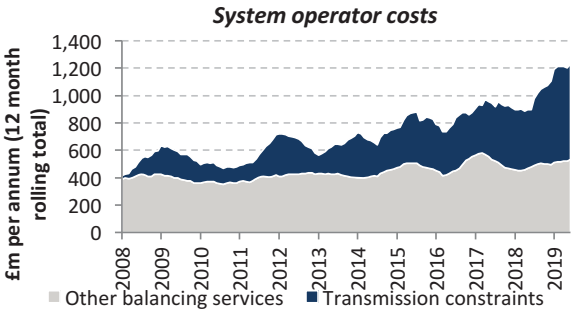


Source: Energy Trends ET5.1 databook (2019)

- Subsidy driven roll out of 30+GW of renewables
- **Limited investment in new thermal plant** since 2010.. ….and coal completely phased out by 2025
- Concerns over security of supply and "missing money" problem led to introduction of Capacity Market in 2014…
- ...but limited success, design issues, and still **no new CCGTs**
- **All GB generation now relies on non wholesale market revenues to be viable**

2

System Operator increasingly not "residual" in market



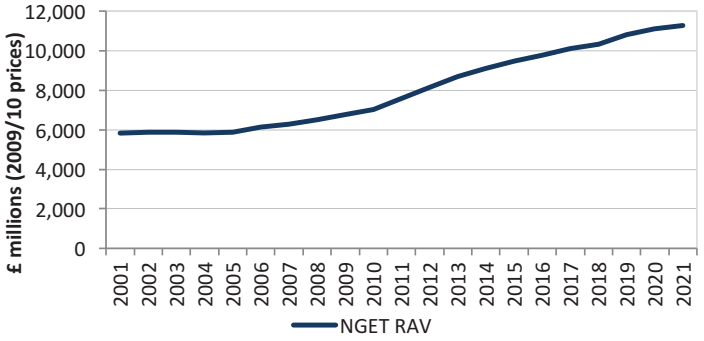
Source: National Grid System Balancing Reports (2019)

- Roll out of renewables has **increased need for SO to procure** more flexibility and balancing services…
- …developed reasonably **sophisticated commercial mechanisms** for procurement.
- **25 fold increase in costs of resolving congestion** since 2008[3]
- Growing influence meant SO forced to become **legally separate** in 2019 from transmission owner (to mitigate perceived biases)

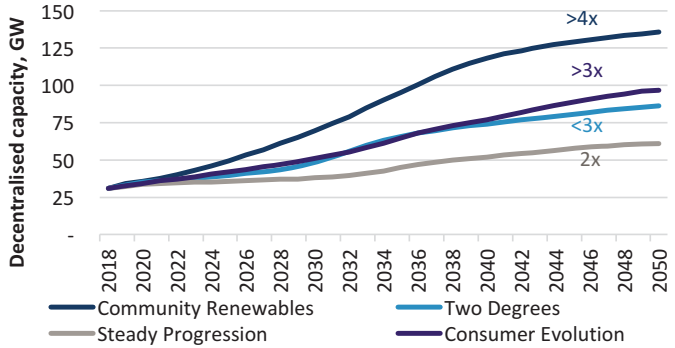
…comparable trends observed in other European countries

Current GB market design may not transpose well from transmission level into distribution level…

To mitigate congestion, GB has seen doubling of transmission asset base (aka "copper plate")…..



…potential for huge roll out of renewables at distribution level has potential to drive congestion and massive network distribution investment programme



With hindsight, market design at the transmission level might have been easy…

	Transmission	Distribution
# of assets to manage	Hundreds	Thousands (millions?)
# of new assets p.a.	Few, large	Many, small
Regulation	Carefully planned	Difficult to regulate + limited experience of congestion mgmt.
Technical challenges	Low (losses)	High (losses, voltage limits & reverse flow issues)

… and to avoid repeating mistakes of past, new market design solutions likely to be needed for the distribution level

- Need for **more granular locational price signals** for participants – possible need for DLMPs?
- **Peer-to-peer trading** seductive, but unlikely to work…
- …therefore **DSO unlikely to be "residual", but will need to co- optimise local** reserves + energy - as per US style ISOs
- Technology to do "heavy lifting" decision making on behalf of small players – **no need for "super-engaged" consumers**

…and current institutional arrangements likely to need to change too, to mitigate natural "asset heavy" biases

Current trajectory

- Single DNO and DSO
- Responsible for network planning, scheduling

✓ Each local DNO would be familiar with its own local network configurations

✗ Potential conflicts of interest between the DO and SO esp. on network planning

✗ Requires a new function / expertise

Independent DSO

- Independent DSO – responsible for network planning and scheduling
- DNO is network owner and asset provider

✓ Independent DSO functions as the aggregator of local resources

✓ Retains local knowledge of system but not conflicted.

✗ Risk of not knowing entire system well enough and therefore increasing congestion costs (esp. if big zones)

Market operator

- Market operator and network planner for all distribution networks

✓ Independent market operator to establish rules and direction for DSOs

✓ "Centre of excellence" in terms of local market design and operation

✓ Easier for national optimisation

✗ Complexity of a new entity and new interactions required

"All-seeing" SO

- Integrated ESO and DSO
- Separate DNOs

✓ Single decision-maker – avoids need to co-optimise twice (see slide above)

✓ Easier for national optimisation

✗ Lacks local knowledge (and potentially legitimacy – could hamper planning and consenting)

Experts with impact ™

Emerging market of the future: system operator perspectives

Frank Montiel
Executive Officer, Strategy and Markets

What has changed

Generation and demand mix

Weather impacting supply and demand

Falling wind and PV build costs and increased gas and coal operating costs

Rate of change

Operational challenges

Investment and operating risks

Future trends

- Ageing power plants and reduced demand growth
- Investment is required at the right place, right time and right type
- Integrated System Plan found that the least-cost replacement of thermal generation that progressively retires can be met by an efficient combination of:
  - Renewable energy
  - Energy storage (PHES and BESS)
  - Backup supply and peaking gas-powered generation
  - Increased transmission to facilitate efficient sharing of renewable energy, storage and backup supply

Challenges and opportunities

To maintain a secure supply of electricity to all consumers:

- Technical limits and power system requirements
- Valuing system services, flexibility and firming and creating efficient market-based mechanisms for procuring and deploying
- Flexible and adaptable market and regulatory constructs that respond quickly to changing needs
- Integration of DER
- Managed generation exits and preserving reliability during the transition
- Facilitating transmission expansion identified in the Integrated System Plan

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The Energy Market of the Future:
Challenges and Opportunities - Global Solution Provider's Perspective

Ravi Pradhan, Siemens Digital Grid

US Journey & Global Needs

….System Operators' drivers and trajectories were different. Now, we intersect on the common point of Renewables & DERs

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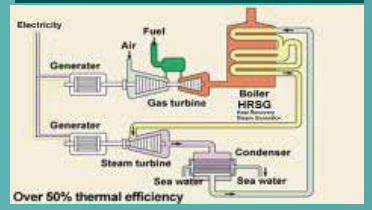
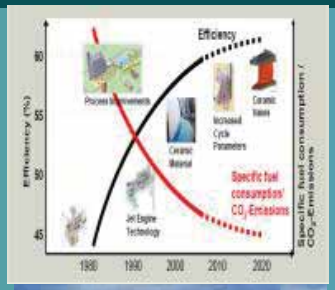
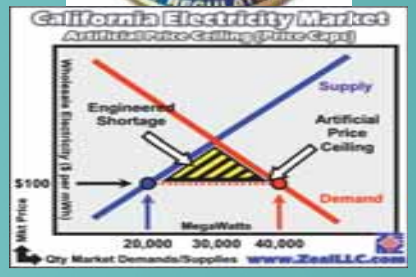
FERC, SMD, Energy & Reserves Wholesale Market	Coal retirement, CC Plants	Clean Energy Act, Renewable Penetration	Flexibility Services, Storage	Digitalization, Distribution Operators, DERS
				
				

YEAR 2010 2015 2018 2020

Market & Solution –
Valuationof Flexibility – “Highs” and “Lows”
Wholesale energy prices …..

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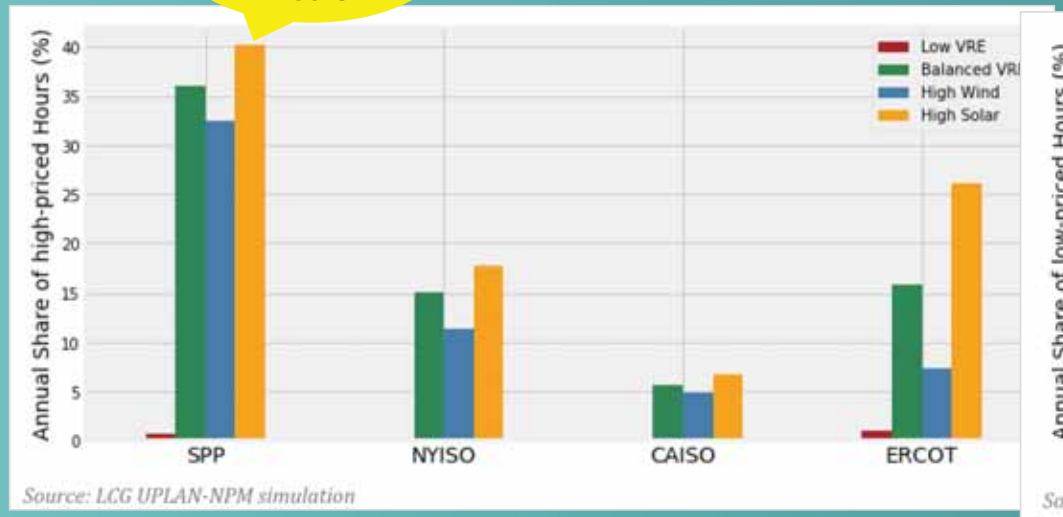
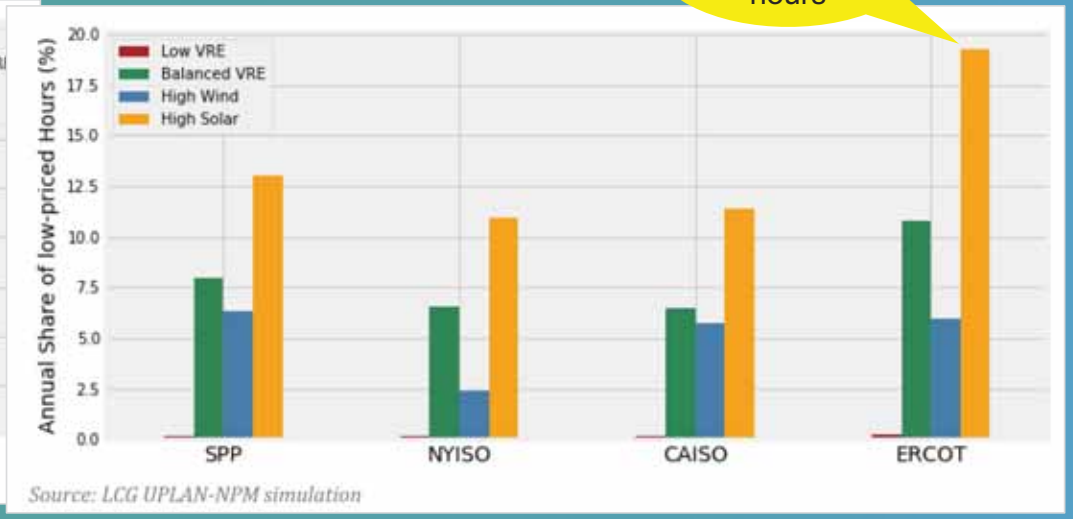
40% high priced hours



20% low priced hours



Needs: flexible capacity and market valuation is the critical need.
Wholesale market solutions are available for use across the globe.
Market tariffs for adding products is slower than solution availability.

Source: Impacts of High Variable Energy Futures on Wholesale Prices and Electric-Sector Decision Making.. Lawrence Berkley National Lab. May 2018

Common Challenges – Solution Space

….System Operators' need

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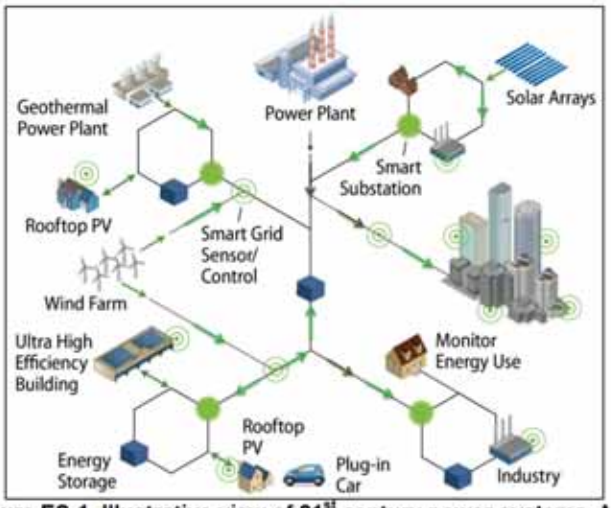

Figure ES-1. Illustrative view of 21st century power systems. *NREL*

Table ES-1. Market Design Considerations Reviewed for Adequacy, Energy, and Ancillary Services

	Adequacy	Energy	Ancillary Services
Market Design Considerations Reviewed	Scarcity pricing	Dispatch resolution	Dynamic reserve requirements (secondary and tertiary reserves)
	Capacity markets	More frequent markets	Primary frequency response
	Capabilities markets	Ramp products	System inertia
	Capacity provision by renewable resources	Negative pricing	Voltage control
		Forecast integration	Co-optimization
		Dispatchable variable renewables	Ancillary service provision by renewable resources

Source: www.NREL.gov/Publications

Solution providers for System and Market Operations: Our investments are predominantly in Optimization, Dispatch and Pricing of Energy & AS products. Adequacy remains largely a political and regulatory issue that evolves slower.

Case Study

California ISO

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Situation

- Solar generation in CA has 10 fold increase in 5 years, and steep ramping challenges in evenings
- CC plants (shale gas) replacing nuclear and coal. (200 CC plants)
- Geographically very large diverse renewable potential across western US.
- CAISO foot print grew by 2 fold in 3 years in Energy Imbalance Market

Business Challenge

Operational challenges due to renewable influx

Nuclear and coal retired, Shale gas (CC plants) increased

React to network contingencies, generator ramping issues

Utilize the vast geographic diversity of renewables

Solution

Siemens Spectrum Power ™ EMM Solution

Siemens is partnering with CAISO to create and update a comprehensive energy market management solution to accommodate renewables into the grid and expand the foot print

Short-term Benefits

Projects exact power generation and demand on the grid interconnection

Greater insight into the power grid to monitor generation and demand across large regions

Avoidance of infrastructure additions

Long-term Benefits

- Increase robustness of the grid in spite of variable energy resources
- Make the senate bill mandated on renewable achievable
- Access to a large marketplace for local renewables
- EIM will generate millions in cost savings ($736 million between June 2019 and November 2014 has been achieved*)

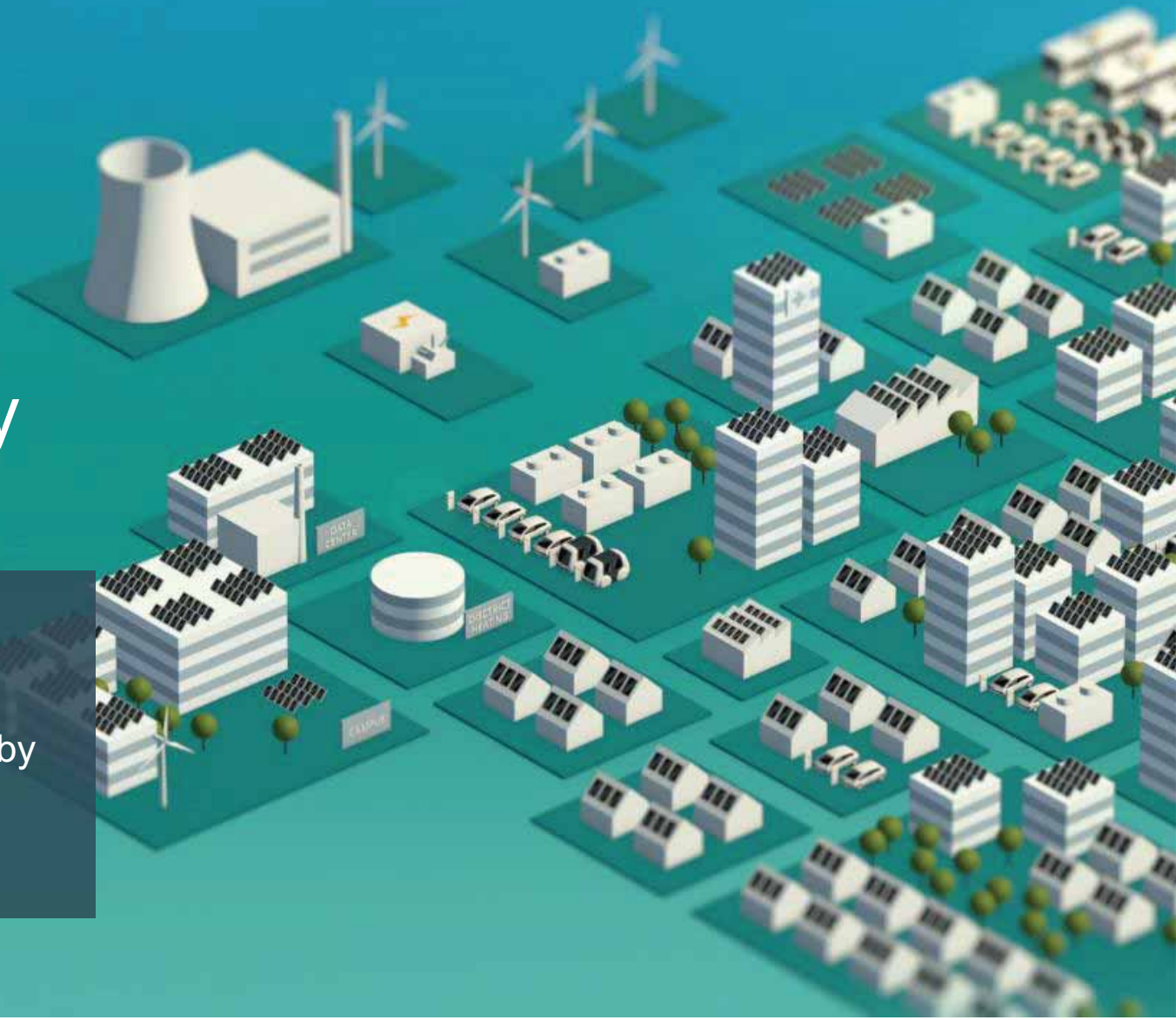
Source: www.WesternEIM.com April 2018

Decarbonization and decentralization

2x
electricity consumption by 2050

>50%
renewable annual energy by 2035

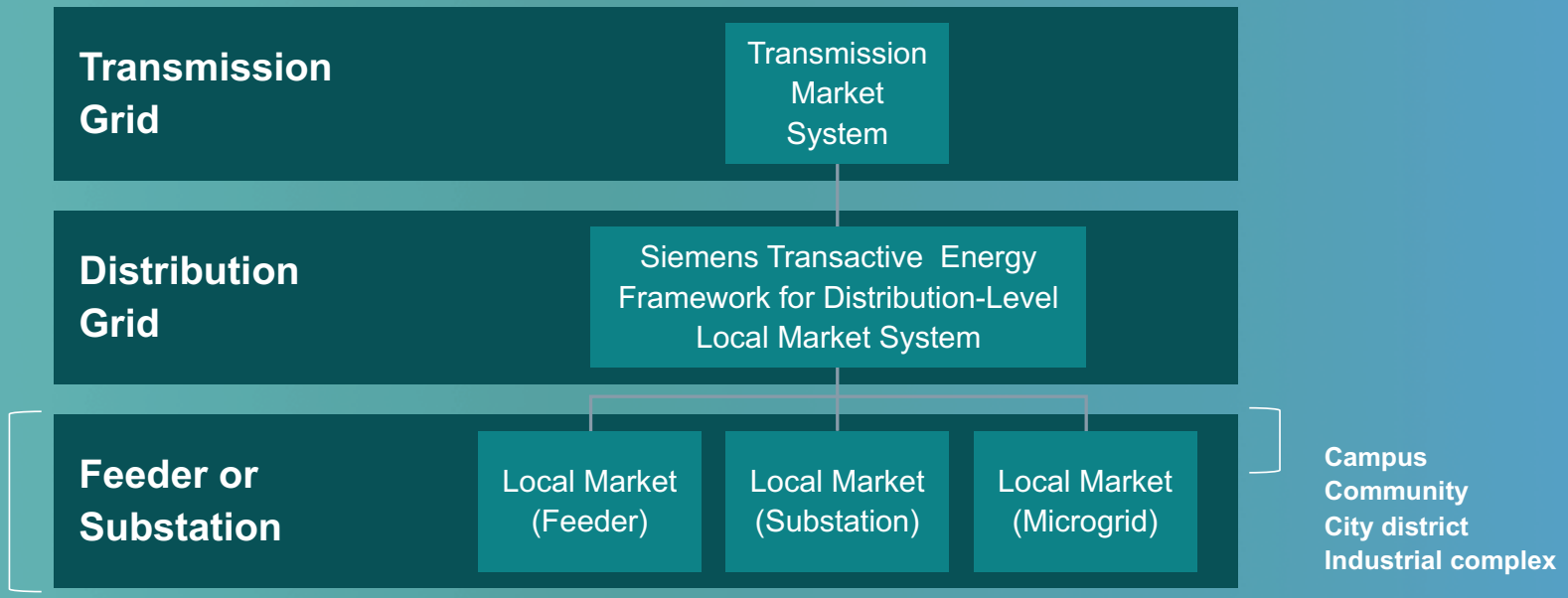
Urbanization and sustainability



70%
of global population will live in cities by 2050

36%
of energy consumed by buildings

Transactive Energy System Approach
3-layer Market Structure



Energy landscape within a transactive energy system

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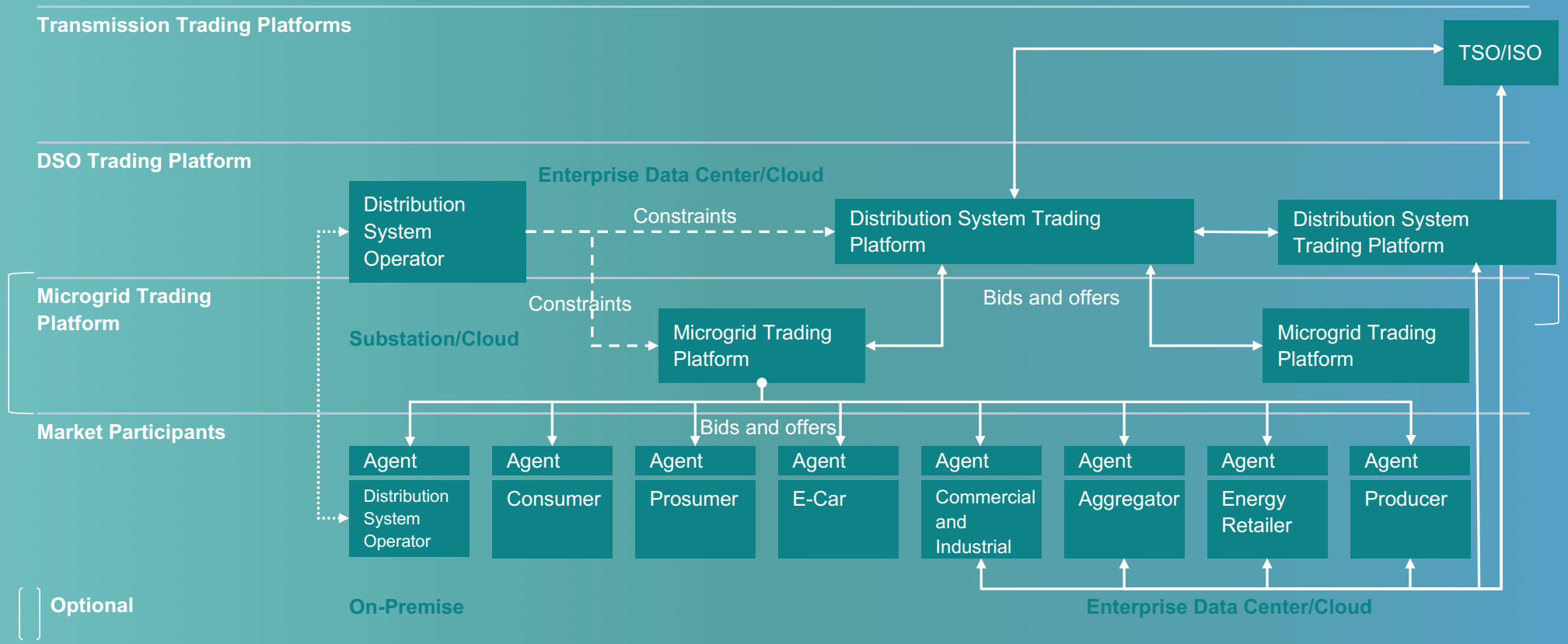


Grid Connected
SIEMENS
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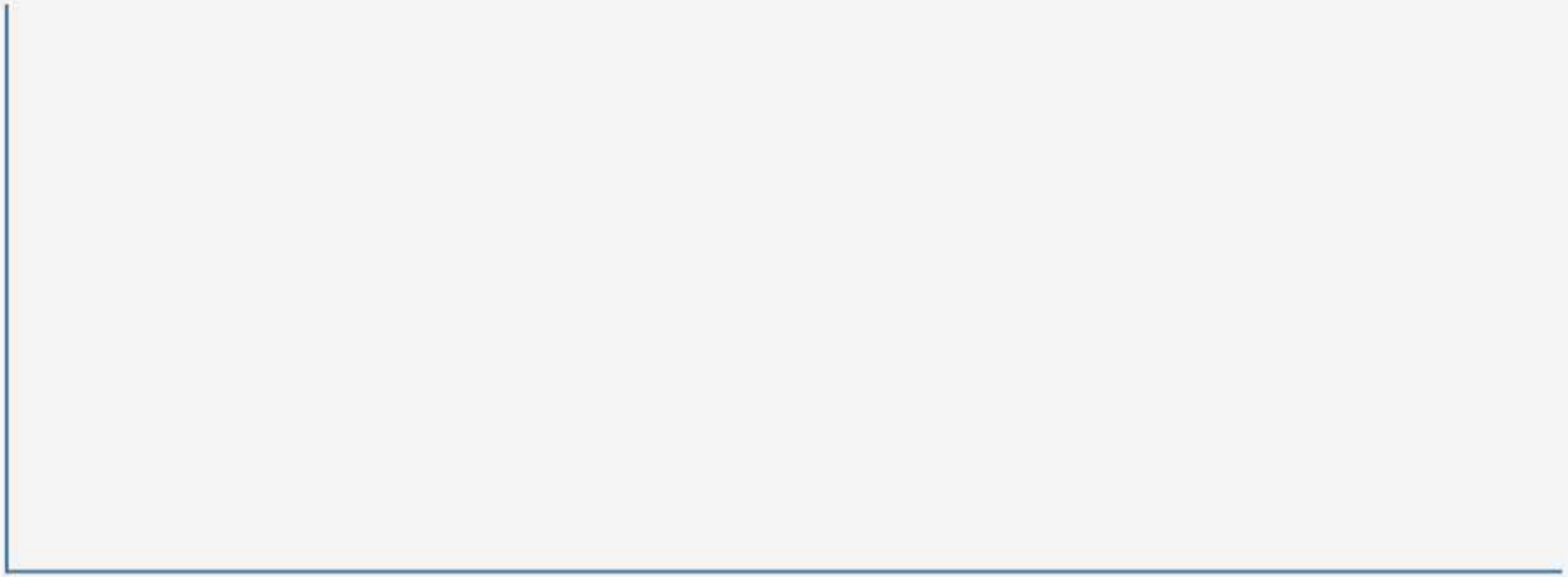
Thank you

Vote on which question to answer

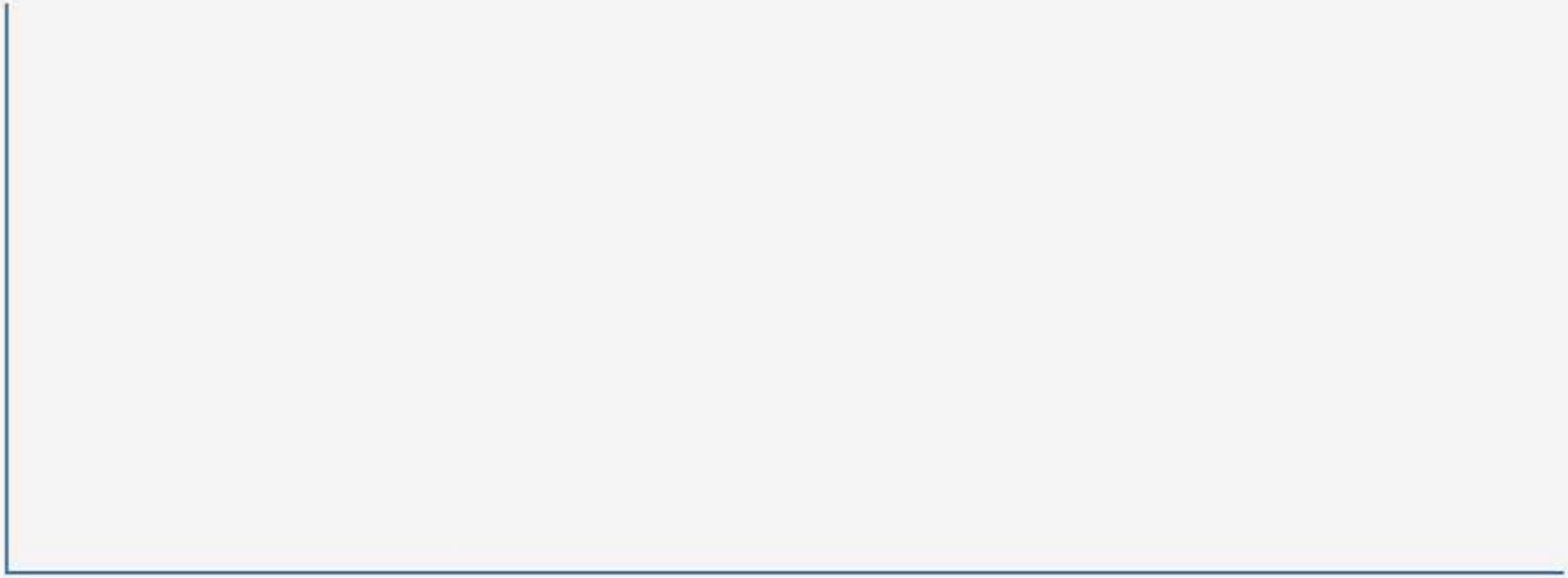


What are the lessons learned from the past that we can draw on to face changes in an effective manner?

Does price still matter in a world of low marginal cost resources?

In a world of ever changing operational needs and rapid advancements in technologies, how do we ensure market design stays flexible to meet those changing needs?

Vote on which question to answer

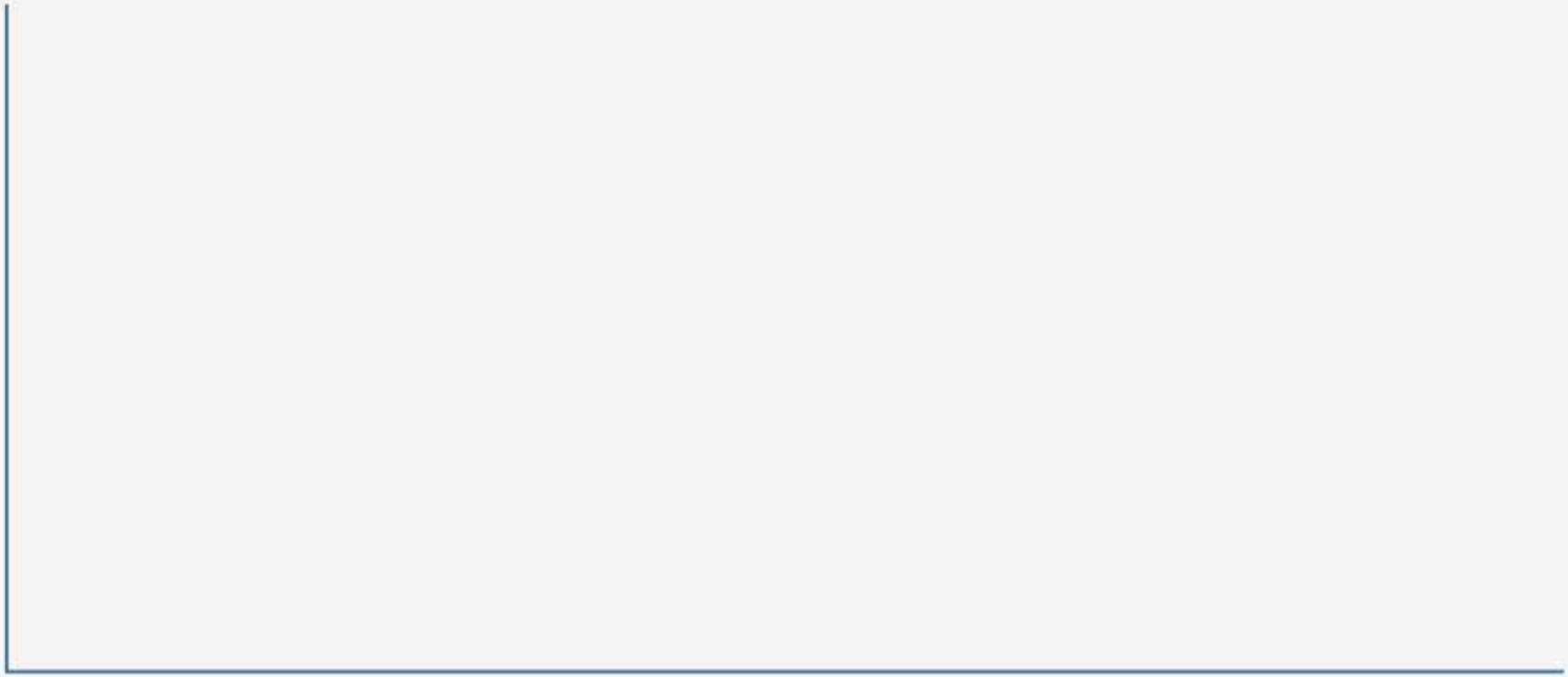


How will the wholesale market straddle the need to integrate distribution level assets on one hand with an opportunity to gain efficiencies through increasing footprints and harmonize market design across different regions?

Can wholesale market operators effectively co-exist with distribution system operators?

If you had a blank sheet of paper to design tomorrow's market, what would it look like?

Vote on which question to answer



COORDINADOR
ELÉCTRICO NACIONAL

EXPERIENCE AND THOUGHTS ABOUT BRIGHT SPARK PROGRAM

Juan Pablo Avalos V.
Head of Research, Development and Innovation Department, National Electric Coordinator

APEx Conference 2019
October 2019, Toronto, Canada

AGENDA

1 About Chilean ISO and The National Grid

2 Energy Transition in Chile

3 Bright Sparks Program

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NATIONAL ELECTRIC COORDINATOR (Chilean ISO)

Independent technical organization in charge of the operation of the national grid and the energy market

- ✓ Responsible for ensuring a secure, reliable and economic energy supply
- ✓ Guaranteeing open access to the transmission systems.

Annual budget around US$ 50 Million and 300 employees.

OTHER FUNCTIONS

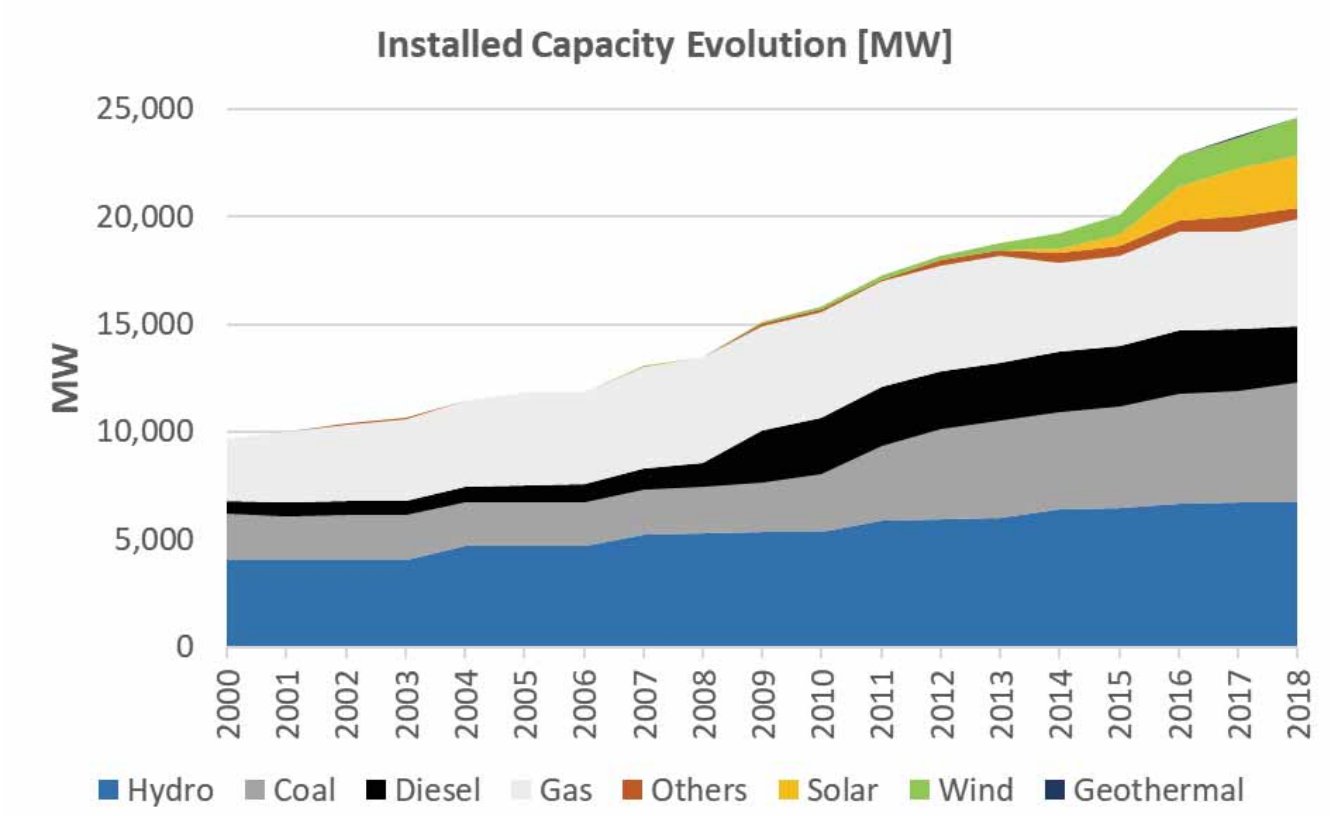
1. Wholesale energy, capacity & ancillary service markets
2. Long-term planning proposal for transmission expansions
3. International bidding process for transmission projects
4. Market competition monitoring
5. **Promote innovation and R&D**

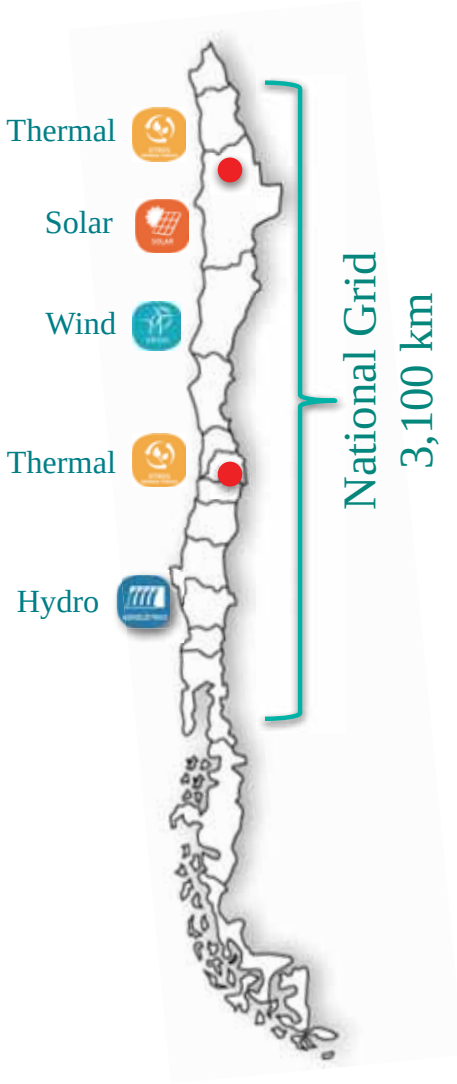
Critical analysis of the grid and market operation performance.

Incorporation of new technologies to system as well as to our processes

Share knowledge and experiences with others ISO/TSO and R&D Centers

ELECTRIC SYSTEM – 2018





Installed Capacity: 24,622 MW

Peak Demand: 10,626 MW

Energy growth: 3.1 %

Transmission Lines: 33,854 km

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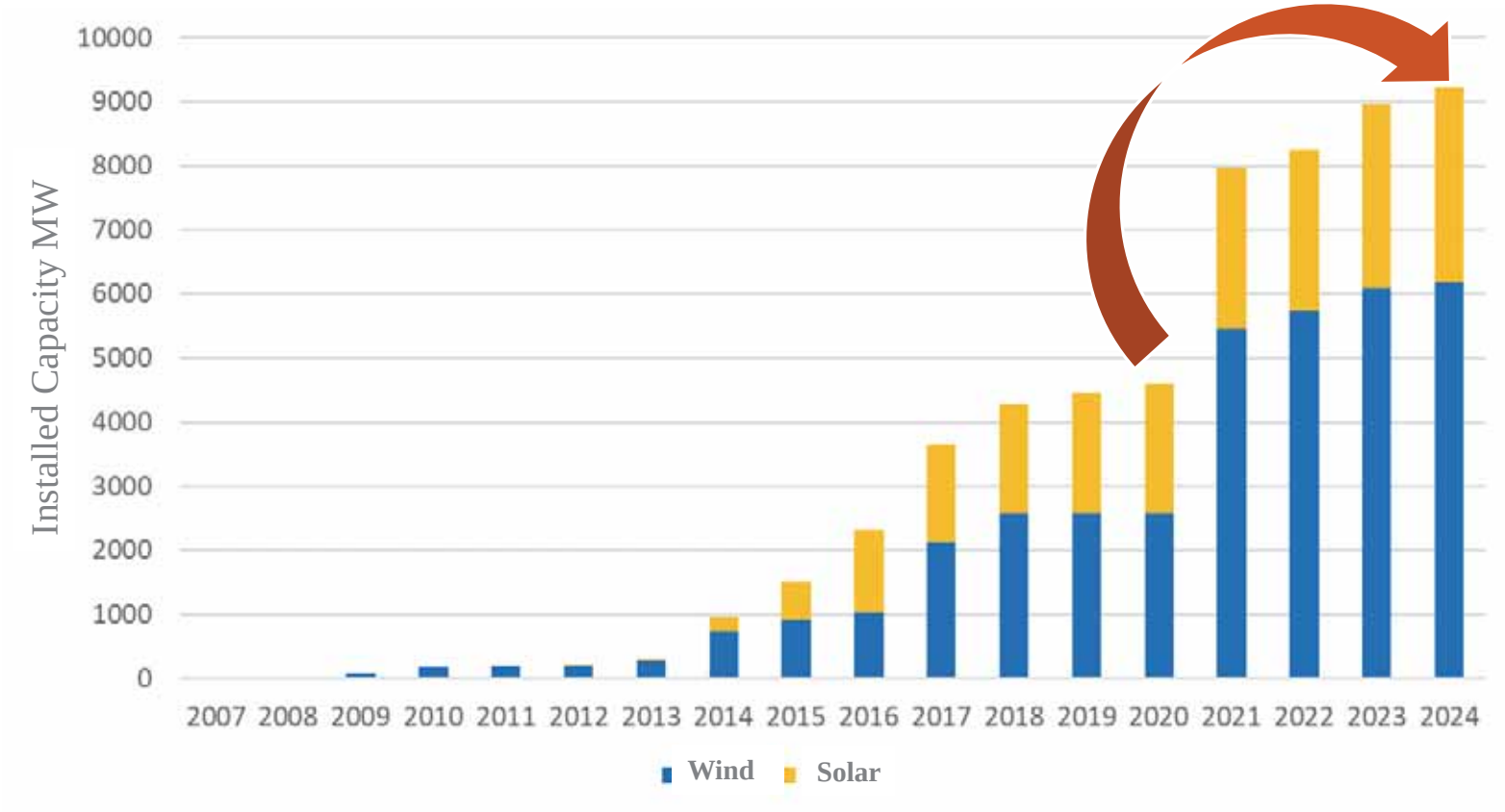
2 **Energy Transition in Chile**

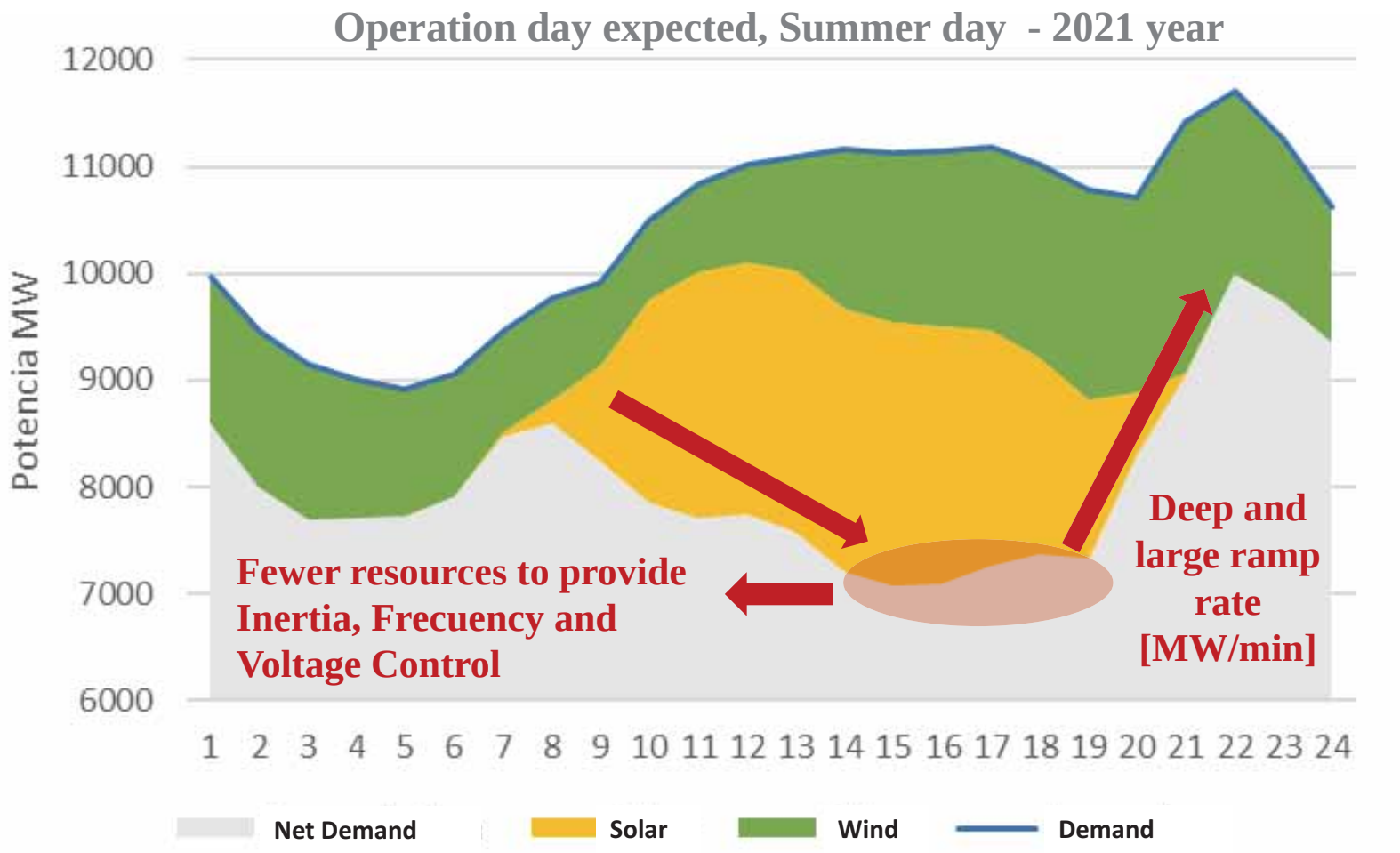
3 Bright Sparks Program

Fast increase of wind and solar energy in Chilean Electricity System



Fuente: Plan de Expansión de Transmisión, Obras comprometidas, 29 de diciembre 2017, CNE

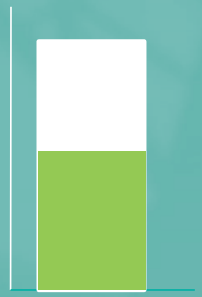
Need of More Flexibility



National Grid Flexibility Sources

FLEXIBLE GENERATION

Max



Large Scale Hydropower Plants

And CCGT

TRANSMISSION

Grid Resiliency

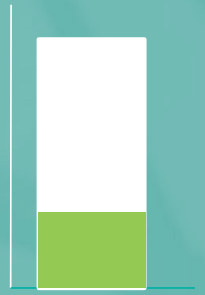
CONSUMERS

Demand Side Management

INTERCONNECTIONS

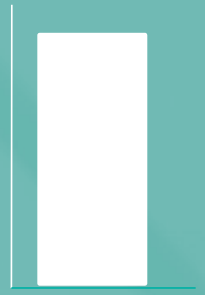
Argentinean Power System
~200 MW AC

MARKETS



Ancillary Services Market

INTEGRATION WITH OTHERS SYSTEMS

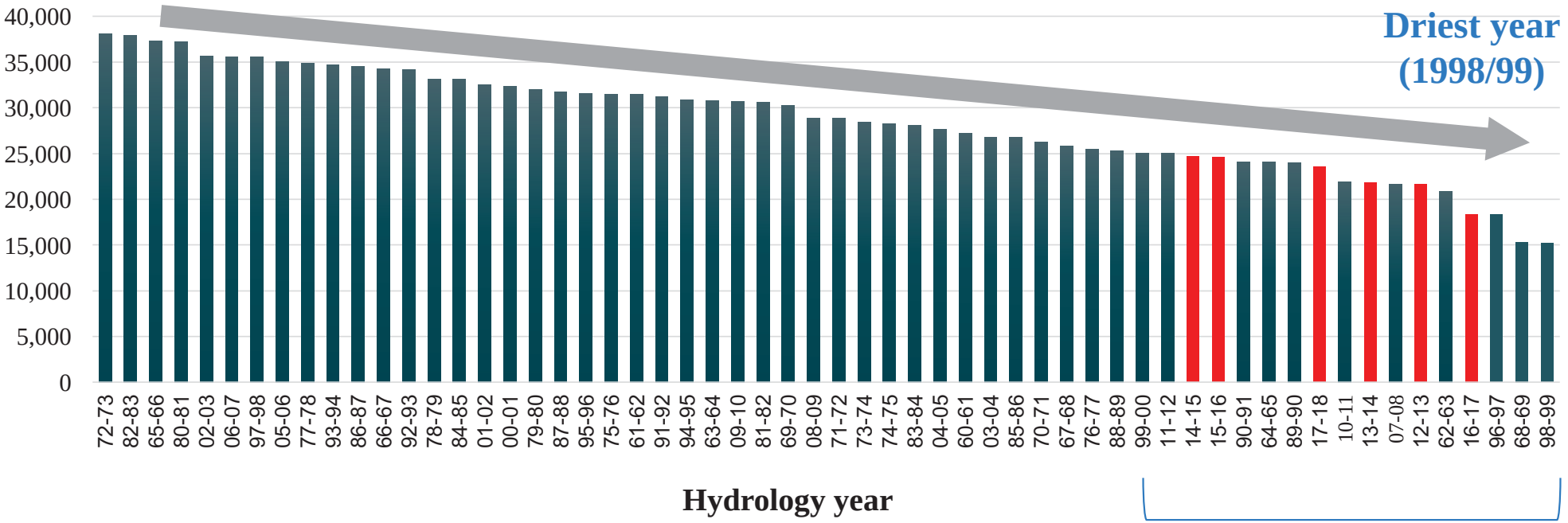


Gas, transport, others

Hydrology Variability

Wettest year (1972/73)

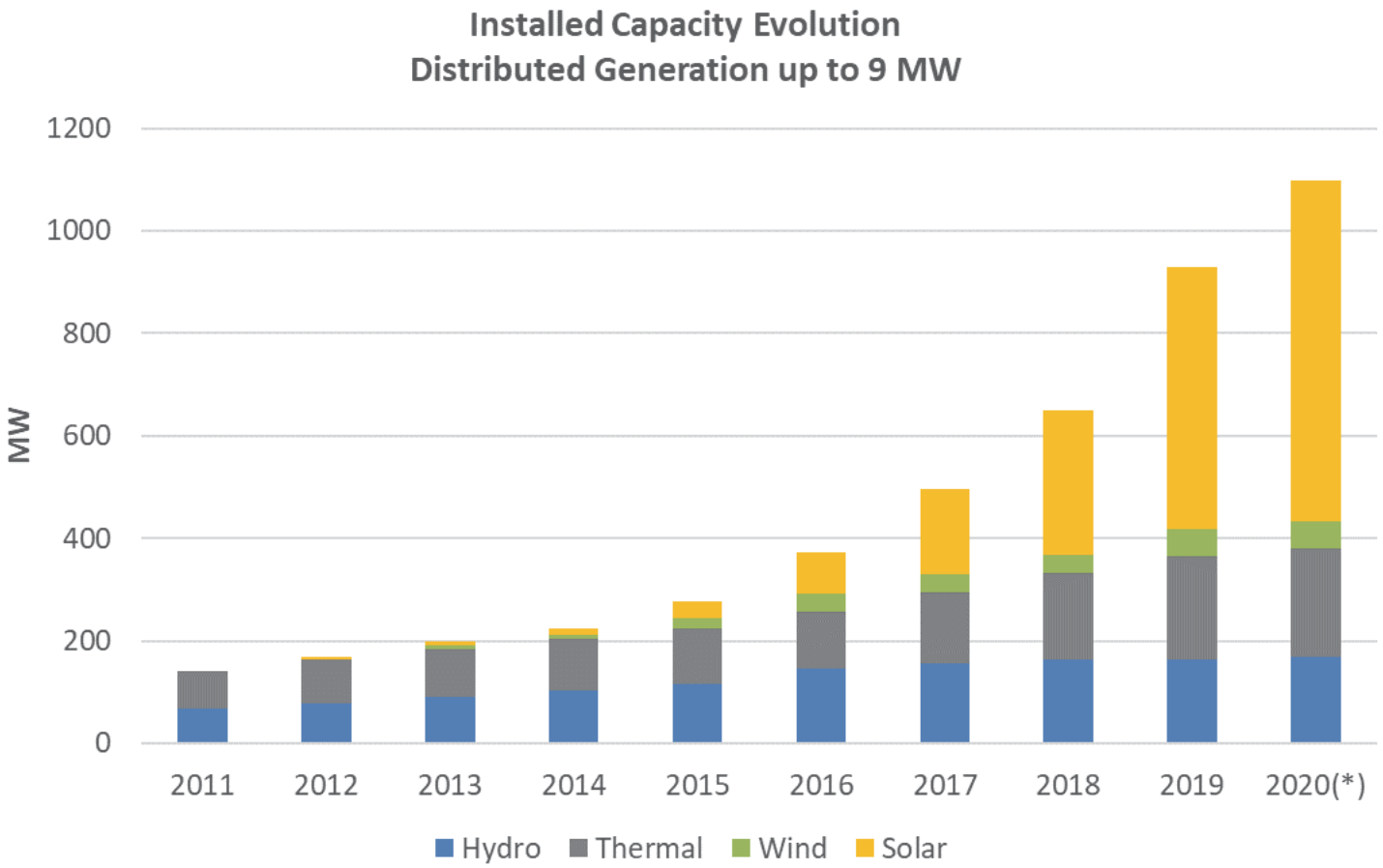
Annual Energy of Hydro Inflow [GWh]
Period 1960-2019



Driest year (1998/99)

Last 6 years (2013-2019) were the driest in the past 60 years

Fast Increase of Distributed Energy Resources

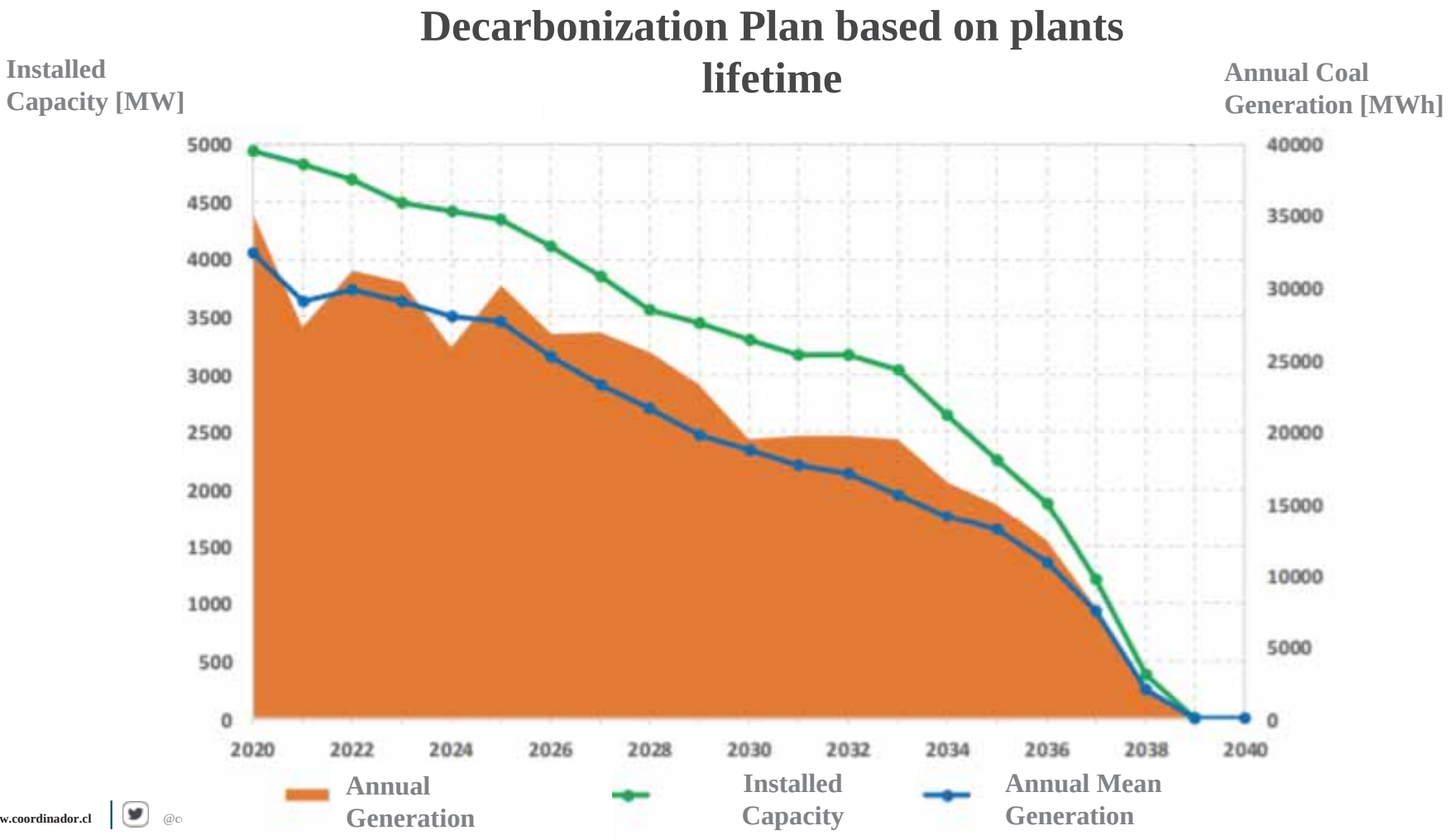


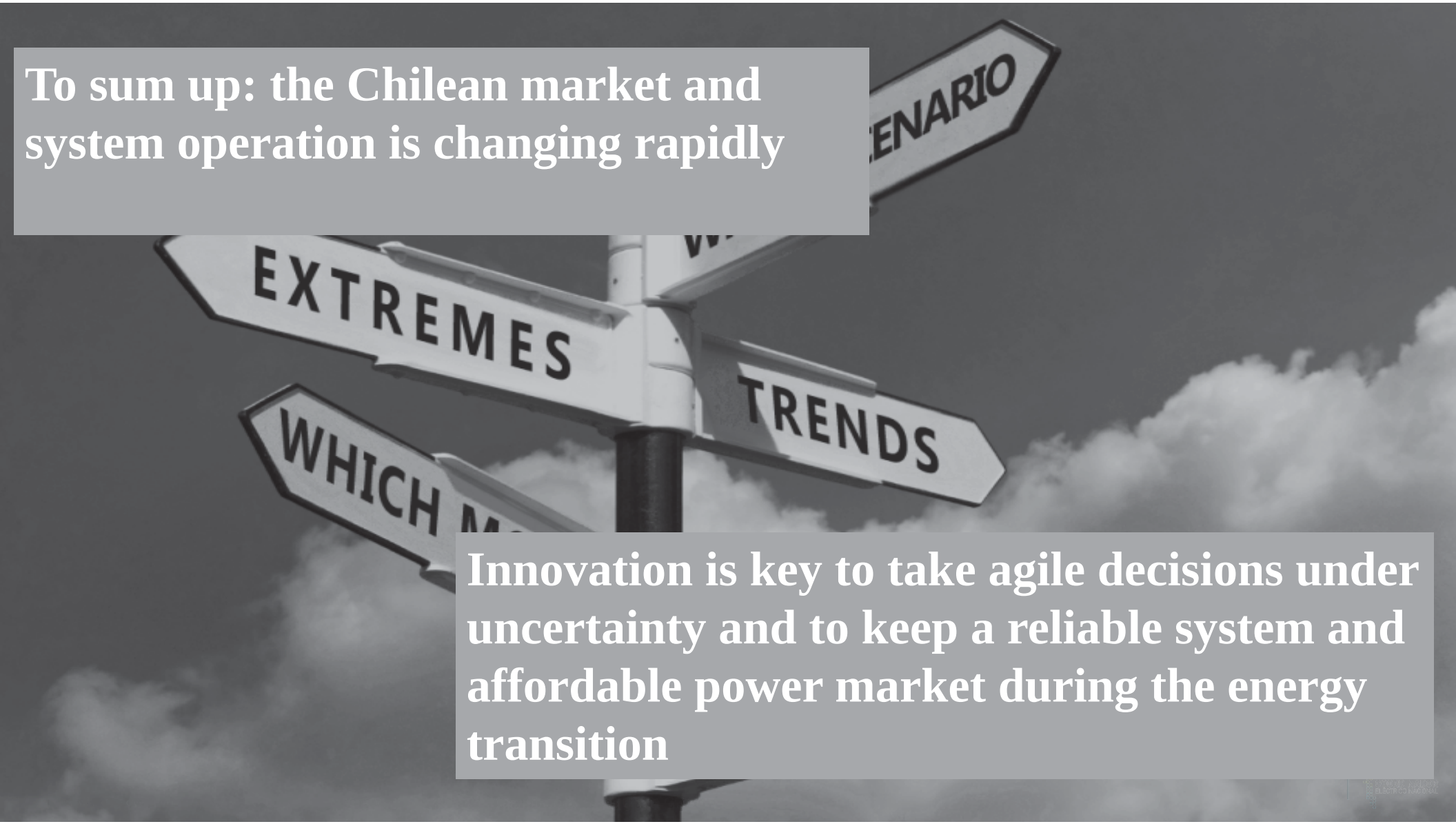
(*): Projects under development

Government Announcements for 2018-2022 period:

- Increase by 4 times the capacity of small generation (<300kW).
- Increase EV penetration by 10 times.

Decarbonization Plan





To sum up: the Chilean market and system operation is changing rapidly

Innovation is key to take agile decisions under uncertainty and to keep a reliable system and affordable power market during the energy transition

INNOVATION IN THE ENERGY TRANSITION

COORDINADOR ELÉCTRICO NACIONAL

1. INNOVATION MANAGEMENT
2. RELATIONSHIP WITH MARKET PARTICIPANTS, R&D CENTERS, ISO/TSO
3. MARKET TOOLS AND MODELS IMPROVEMENTS
4. PILOTS PROJECTS

INNOVATION IN THE ENERGY TRANSITION

1 INNOVATION MANAGEMENT

- Internal assessment

- Innovation Challenges through Design Thinking methodologies:
  - Power System Resilience
  - Distributed Energy Resources
  - Energy Data Management
  - New Business Models in Distribution Sector

INNOVATION IN THE ENERGY TRANSITION

2 RELATIONSHIP WITH MARKET PARTICIPANTS, R&D CENTERS, ISO/TSO

- Assessment of ancillary services capacity of a 110MW solar power plant (First Solar and R&D Center ENGIE Laborelec)
- Research project for determine competition conditions in Ancillary Services Market
- Research Projects Sponsorship:
  - Modelling Energy Storage Systems in Long Term Optimization Models
  - Develop of a Synthetic Inertia Optimal System to Wind Power Plants
  - Wind Forecasting Systems

INNOVATION IN THE ENERGY TRANSITION

3 MARKET TOOLS AND MODELS IMPROVEMENTS

- Wind and Solar Centralized Forecasting through an ooptimal combination of different forecast sources (Machine Learning).
- Improve of hydro Inflow forecasting, through basin physics model and numerical weather models
- Upgrade of the hydrothermal coordination optimization model to represent flexibility requirements and the hydrology uncertainty representation
- Market platform for short-term bidding process of ancillary services
- Real Time Simulation Lab (RTDS)

INNOVATION IN THE ENERGY TRANSITION

4 PILOTS PROJECTS

- New approach to communication systems amongst Control Centers after disasters.
- Data management and real time monitoring of generation plants up to 9 MW.
- System faults characterization through machine learning
- Blockchain (Fuels Declaration and RE Certificates)
- Ancillary Services from Demand Side Response

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3 **Bright Sparks Program**

WHAT THE BRIGHT SPARK PROGRAM DOES REPRESENT?

COORDINADOR ELÉCTRICO NACIONAL

Valuable recognition for my work and career at the Chilean ISO.

We are going in the correct direction.

Global vision and the opportunity for learning best practices from APEx members and the others Bright Spark.

This recognition is a result of a support network: the family, friends and workmates.

EXPERIENCE AND THOUGHTS ABOUT BRIGHT SPARK PROGRAM

THANKS FOR YOUR ATTENTION

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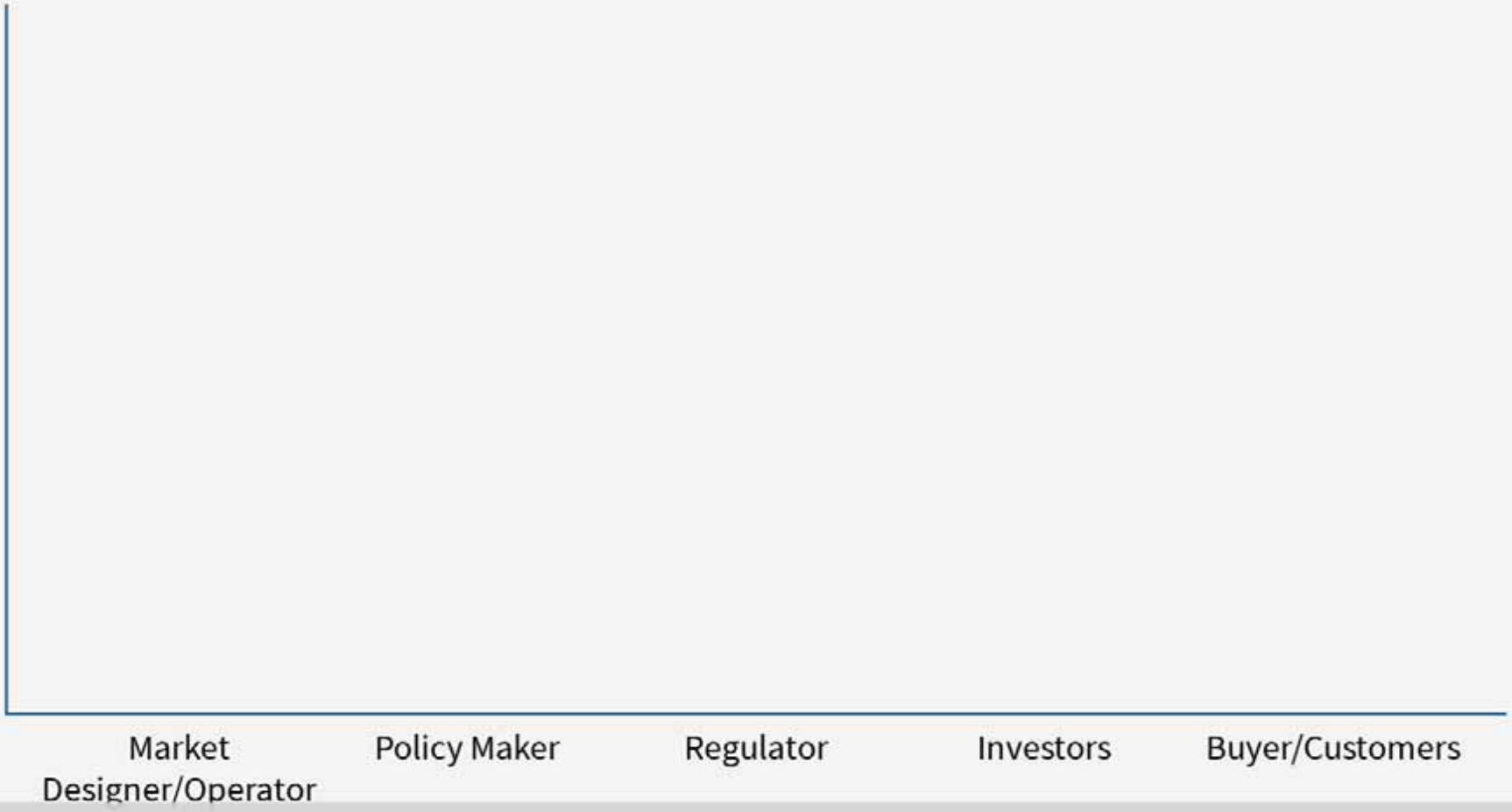
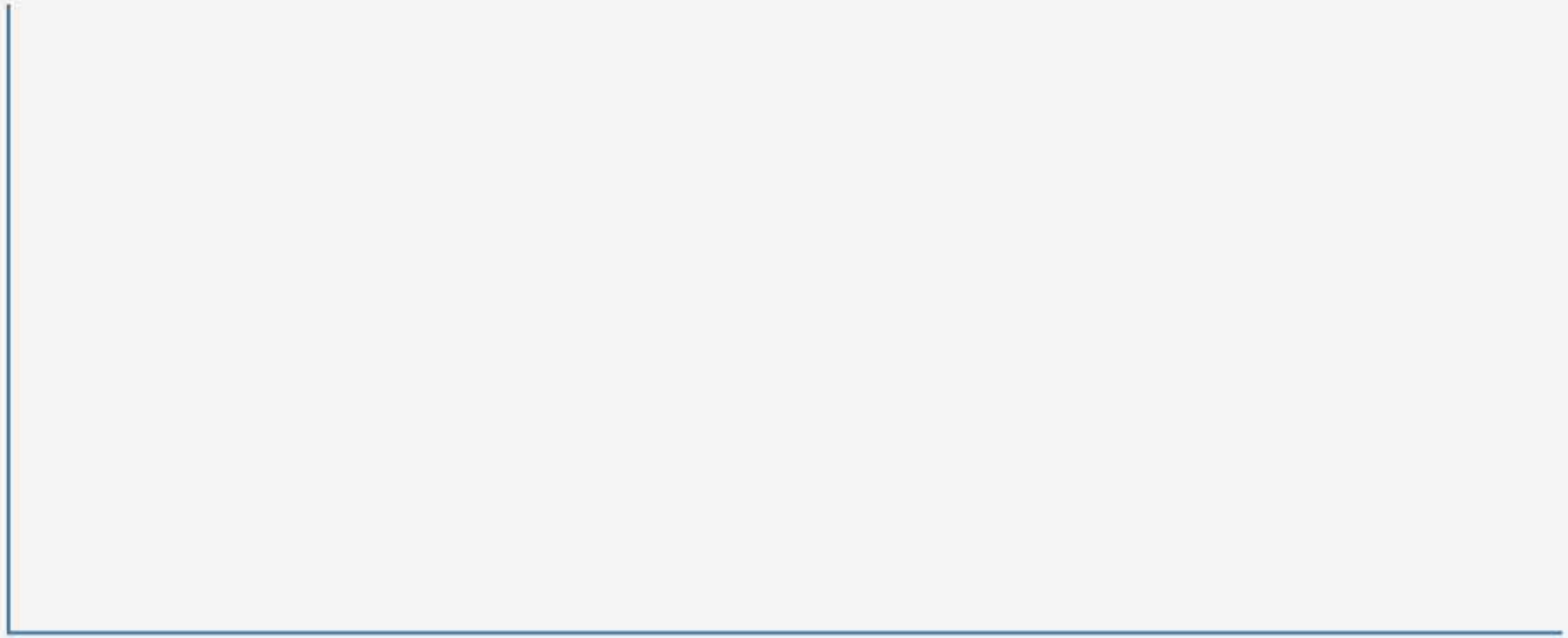
Who ultimately makes a market successful?

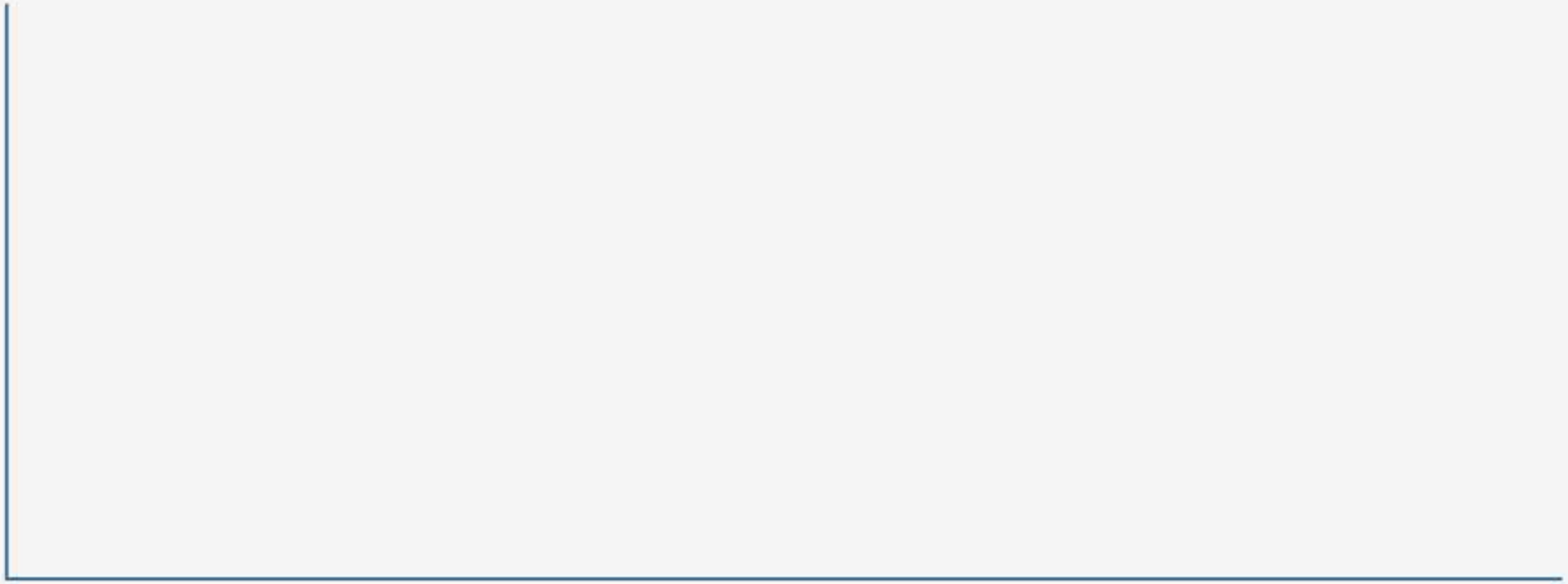


What is most important to the consumer?

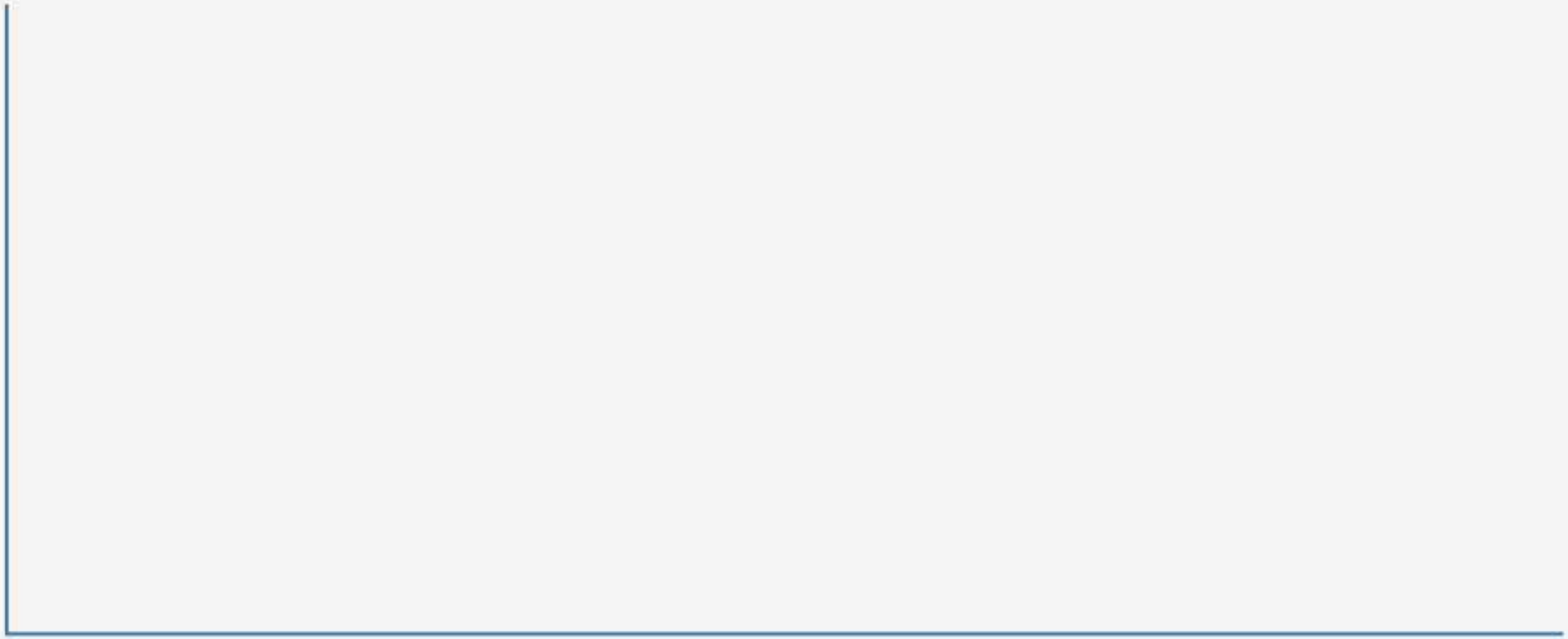
Which technology will be the most disruptive?



Did you think the way Bright Sparks were presented - separated spotlights for each speaker & the Bright Sparks Alumni panel - was effective?



Did you think that the interactive workshops were effective?



Did you think that the virtual panel - conducted through video conference was effective?