

C5 - 00

SPECIAL REPORT FOR SC C5

CHAIRMAN: Alex Cruickshank

SECRETARY: Yannick Phulpin

SPECIAL REPORTERS

Albert Moser, Samir C. Saxena, Anant Venkateswaran

Study Committee C5: *Electricity Markets and Regulation* covers the analysis of the impacts on the planning and operation of electric power systems of different market approaches and solutions. This includes new structures, institutions, actors and stakeholders as well as the role of competition and regulation in improving end-to-end efficiency of the electric power system.

For the 2024 Session, a total of 57 papers were selected based on the three Preferential Subjects (PS):

PS1: CHARACTERISTICS OF A RESILIENT MARKET AND ITS REGULATORY REGIME

- Responds to dynamic changes in the market environment and able to withstand external shocks.
- What markets and regulations have proven resilient so far and are still efficient and successful?
- Governance and institutional arrangements that assist resilience: who makes the decisions and takes the risks?

PS2: PREPARING FOR THE FUTURE WITH MOVING TARGETS

- Innovative approaches to markets and regulation to achieve climate and energy policy targets.
- The design and structure of electricity markets to support capital-intensive, climate neutral investments.
- Market and regulatory arrangements for supply, demand and storage that function across transmission, distribution and behind the meter resources.

PS3: EMERGING MARKETS AND FORMS OF MARKETS

- Markets and regulations addressing the attributes of electricity that customers are seeking from the industry.
- Market based approaches to integrate community and distributed resources.
- New market approaches to overcome the barriers and limitations on current market designs.

PARIS POSTER SESSION

Concise posters for all the papers will be presented during the poster session for SC C5, which is to be held in the morning of Wednesday the 28th of August 2024. During this session, authors will be available to discuss their papers with Session attendees.

A note for authors: posters should be submitted between 3rd of June and the 31st of July 2024. The method and format for the submission of posters will be emailed to you shortly.

PARIS GROUP DISCUSSION MEETING and CONTRIBUTIONS

1. The 2024 Paris Session papers will be available to registered delegates from the Session website, as well as to Study Committee members, observers and reviewers.
2. The General Discussion Meeting for SC C5 will be held on Thursday the 29th of August 2024, from 9.00 AM to 6 PM, Paris time. Registered delegates are invited to contribute to the meeting.
3. Contributors should upload their contributions on the Registration Platform – “Contributions to Group Discussion Meetings” section, using their registration credentials before the 10th of August 2024, for screening and to assist in the organization of the Group Discussion Meeting.

Important points:

- Access to uploading of contributions is only available to duly registered delegates.
 - Therefore, registration for CIGRE Session should be completed before uploading contribution(s) online.
4. The Special Reporters will review the prepared contributions, which should consist of a PowerPoint presentation with a maximum of 3 slides and a written contribution in Word format of a maximum of 1000 words per contribution. A guide for contributors as well as templates and sample pages will be available on the CIGRE 2024 Website - see Group Discussion Meetings in the top menu bar.
 5. If edits are required, the Special Reporters will provide comments to the contributor, who will be asked to upload a revised version.
 6. During the morning of the 28th of August 2024 (at the same time as the Poster Session), contributors should meet with the Special Reporters to discuss their contribution and resolve any last questions. The location for the meeting will be advised prior to the commencement of the Session and suitable times offered to contributors.

PREFERENTIAL SUBJECT 1

CHARACTERISTICS OF A RESILIENT MARKET AND ITS REGULATORY REGIME

Special Reporter: Albert Moser

Eight (8) papers are accepted for PS1 with one paper each from Colombia, Germany, Japan, Singapore, two from India and one international paper.

They cover several topics with respect to resilient markets:

- a) Price caps to cope with high price volatility.
- b) Fuel reserves to cope with threats to energy security.
- c) Further cross-sectoral market integration and further integration of DSM into markets to better utilize available resources.
- d) Incentives to encourage operational resilience.

PS 1 Paper Summaries

Paper 10506: Future Electricity Market Design to Ensure Resilient and Efficient Operations

The paper provides a comprehensive overview of term market design options to ensure market resilience. Key aspects of resilient markets are diversity of energy sources, connectivity and ease of access to market, mechanisms for resource adequacy, flexibility and adaptability, decentralization, financial incentives, regulatory frameworks, and resilient information and communication system.

Price formation should provide reliable availability signals which on the other side may create uncertainty in case of physical or financial shocks. Price caps, capacity mechanisms, new ancillary services (e.g. inertia), CfD, PPA, continuous intraday market, risk preparedness, and cross-border cooperation and coordination are examples of measures to deal with these shocks. Measures can contribute to market, network, operational and financial market resilience.

Network, operational, generation, financial and governance fragility serve as resilience metrics for which several market design characteristics are presented, that support resilience. Particular attention is paid to ensuring resilience by avoiding market manipulation.

Finally, a case study from India underlines the importance of a resilient market design that was able to successfully overcome a politically initiated decline in demand.

Paper 11236: Discussion of Singapore “Guardrails” in enhancing the resiliency of the National Electricity Market of Singapore (NEMS)

This paper describes a temporary price cap introduced in the Singapore electricity market to manage high price volatility following the Ukraine war. The price cap is based on long-term marginal costs of combined cycle gas turbines, including a multiplier that is higher the smaller the spread between spot and forward natural gas prices. It also serves as a trigger and is applied aftermarket clearing, so that the market price without price cap can still be used as trigger for de-activation. Market prices for demand-side management are not capped.

The effects of the price cap on price volatility, the bidding strategy of producers and flexible demand as well as the ability of price signals to indicate scarcity are assessed. It has been shown that the design of the temporary price cap reduces volatility while avoiding negative side effects on the market. The transparency of the conditions for the (de)activation of the price cap, which allows market participants to incorporate the price cap into their bidding strategy, and a wisely chosen level of the price cap that still ensures sufficient revenue for producers are the main reasons for the successful implementation of this regulatory measure. The transparency of the activation conditions has ultimately prevented frequent activation.

Paper 11253: Challenges and future prospects for Japanese wholesale electricity market and balancing market

The paper describes the developments in the Japanese market design due to the 2011 earthquake and the 2011 gas crisis. Two regulatory measures are presented to address two challenges observed.

As there are two months between the spot order of LNG and its arrival and there are no options for storing, an accurate forecast of LNG demand is crucial. A surplus of LNG leads to price risks, while an shortage jeopardizes security of supply. As a result, a mechanism for the procurement of additional LNG by the TSOs via auctions replaced by a mandatory procurement of surplus LNG by market participants was introduced. The amount of surplus LNG is determined by the government, that also compensates for losses and profits from this procurement.

The Japanese market design for reserve capacity has led to shortages in its procurement. To mitigate the observed issues, several measures have been taken: i) move gate closure time for balancing market from week-ahead to day-ahead, ii) reduce product size from 3-hour blocks to 30-min blocks and iii) introduce an additional class of balancing reserve designated to cope with volatility of RES. In addition, a co-optimization for balancing reserve and electricity market will be introduced requiring a move from self to central dispatch model.

Paper 11371: Benchmarking Indian Load Despatch Centres for Excellence and Good Governance: The Experience of LDC Excellence Award in India

The article shows how the presentation of a recognized award can improve the performance of the more than 40 load dispatch centres in India. The participating load dispatch centres operate at national (1 centre), regional (5 centres) or state level (36 centres). For benchmarking purposes, these state-level dispatch centres were categorized into three groups facing similar challenges.

The criteria assessed are stakeholder satisfaction, learning and growth aspects, adequacy and efficiency of internal processes, financial prudence, and future readiness. A total of 32 key performance indicators (KPIs) describe the fulfilment of these criteria. The evaluation criteria are supplemented by a brief write-up justifying the eligibility for the award, as well as an oral presentation to the jury.

The evaluation of these criteria from previous awards provides valuable information on best practices and potential for improvement. In general, the larger the power system operated by the centre, the higher the score, although there are some exceptions, such as for the KPI demand and RES forecasting, customer feedback, installation of rooftop solar systems and library/resource centres. The paper contains many key findings from the past benchmarks.

Paper 11373: Accounting and Settlement of Secondary Reserve Ancillary Services in Indian Power System

The article describes in detail the processes for accounting and settlement the secondary reserve in the Indian power system. The corresponding secondary control system was implemented in 2021. The description of the processes includes the exchange and retrieval of signals, the verification of data, energy accounting, performance metrics and incentives as well as the submission of data to the Regional Power Committee.

The exchange of signals is based on SCADA data in 4-s resolution from both the power plants and the control centre. The dispatch centre's customized accounting software takes SCADA noise into consideration before energy accounting for 15-minute intervals and performance monitoring for 5-minute intervals. The financial billing of energy is based on the ex-ante declared variable costs of the generators. An additional financial incentive is granted depending on the performance. Performance monitoring is also used for disqualification. Practical experience from implementation is also presented in the paper.

Paper 11727: Can Demand Side Management in the Sectors of Industry and Services Increase Market Resilience?

In this paper, simulations show that DSM in conventional and prospective, in cross-sectional technologies and in the tertiary sector brings benefits for the energy system in Germany, which is in transition to climate neutrality in 2045.

26 processes are analysed, 19 of which have suitable DSM potential and are grouped into 4 clusters with similar techno-economic characteristics. The total potential for 2030-2035 is estimated at 5.6-6.3 GW for load reduction and 4.2-4.8 GW for load increase. These clusters of DMS potentials are included in an energy system model to determine future investment needs and dispatch in the German energy system.

The main observation is that industrial DSM can replace investments in about 7 GW of battery storage, but only 2 GWh of energy from these processes will be shifted in 2030 and 1 GWh in 2035. The reason for this is the assumed availability of other flexibility options, e.g. home batteries or electric vehicles.

Paper 11764: Moral Hazard Assessment of Loss Reduction Plans in Colombia

The article describes and analyses the regulatory incentive system in Colombia to reduce or maintain non-technical losses at an economic level. It presents the incentive system based on investments for loss reduction plans as well as their performance, which can lead to the suspension or cancellation of compensation for the loss reduction plan.

A principal-agent model is used to theoretically assess the appropriateness of the loss maintenance and loss reduction plan. Based on this model, a break-even point is calculated for the appropriateness of a particular parameter in the plan. The main result is that, based on this theoretical analysis, the reasons for the failure of the existing incentive system observed in Colombia can be explained by an inappropriate setting of this parameter. The article clearly describes that without sufficient incentives in voluntary regulatory systems, regulatory objectives cannot be achieved.

Paper 11882: Comparing the Co-Optimized and Market-Based Allocation of Cross-Zonal Capacity for the Exchange of Balancing Capacity

The European electricity market is divided into market zones with limited transmission capacity for import and exports, which is allocated to electricity exchanges for market coupling. To additionally enable cross-zonal exchange of balancing capacity, i.e. Frequency Containment Reserve and Replacement Reserve, the cross-zonal transmission capacity needs to be shared for both purposes, cross-zonal spot trading and balancing capacity exchange. Two approaches are evaluated, the co-optimization, i.e. joint matching of spot and balancing markets, as well as market-based allocation, i.e. allocation of capacity for the balancing market using a best estimate for the subsequent spot market.

Compared with today's approach, i.e. no cross-zonal balancing capacity exchange, the co-optimization reduces generation costs by 4.3 bn. EUR/year, mainly in dispatch at spot market. 2.4 bn. EUR/year out of it results from introduction of cross-zonal exchange of balancing capacity, the rest from the joint optimization of both markets. Applying the market-based allocation method, leads to minor savings of about 0.3 bn. EUR/year.

Note: This is an NGN Showcase paper and will be presented during the General Discussion Meeting.

Questions for PS 1

1. What are the biggest challenges and lessons learnt when applying price caps on electricity in your jurisdiction to cope with high price volatility, especially following the Ukraine war?
2. Have strategic fuel reserves, e.g. natural gas, been required in your markets to ensure energy security? What are the experiences with such fuel reserves?
3. To what extent can better integration of different market segments, e.g. ancillary services and trading of scheduled energy, provide not only higher efficiency, but also higher resilience to markets?
4. To what extent are regulatory incentives in your markets expected to better integrate industrial Demand-Side-Management? What is the role of industrial DSM in your country? Does this additional flexibility effectively contribute to market resilience?
5. What incentive schemes, e.g. financial incentives, or prestigious awards, are available in your country to improve operational performance? How much does this contribute to resilience of markets?
6. What regulatory measures are taken in your country to cope with non-technical losses? What are the experiences with these measures? Do they lead to higher market resilience?

PREFERENTIAL SUBJECT 2

PREPARING FOR THE FUTURE WITH MOVING TARGETS

Special Reporter: Samir C. Saxena

The Preferential Subject 2 on “Preparing for the future with moving targets” covers the following themes:

- Innovative approaches to markets and regulation to achieve climate and energy policy targets.
- The design and structure of electricity markets to support capital-intensive, climate neutral investments.
- Market and regulatory arrangements for supply, demand and storage that function across transmission, distribution and behind the meter resources.

A total of thirty-three (33) papers have been selected from twenty (20) countries under the Preferential Subject PS2. The papers discuss the following broad areas:

- a) Electricity markets in conjunction with carbon markets.
- b) Electricity market simulations.
- c) Market coupling, transmission capacity allocation methodologies in the market.
- d) Distributed energy resources (DERs) and grid services.
- e) Grid connection (firm and non-firm), permitting.
- f) TSO-DSO interactions.
- g) Reserves, Ancillary Services (frequency control).
- h) Flexibility, balancing, guidelines and regulatory framework.
- i) Demand side participation in markets.
- j) Resource adequacy, Capacity markets, use of de-rating factors in capacity markets.
- k) Renewable integration including offshore wind integration.
- l) Virtual power purchase agreements, dedicated market segments for green energy.
- m) Energy storage systems and integration into markets.
- n) Artificial intelligence, data repository, data lake, forecasting techniques.

PS 2 Paper Summaries

Paper 10242: Conjectural Variation Equilibria in Electricity-Carbon Coupling Markets: A MILP Formulation

The paper discusses the need for coupling the electricity market with the carbon-emission market, forming electricity-carbon coupling markets. It mentions the gaps that presently exist viz. that all agents are price takers in the current electricity market and carbon-emission trading is not considered in current electricity market equilibrium models. The paper analyses the interactions analyse the interaction between the electricity market and the carbon-emission market. The paper proposes a conjectural variation (CV) equilibrium model for electricity-carbon coupling markets. To consider the strategic behavior of agents, it introduces the CV coefficient and extends the CV equilibrium model used to study oligopolistic markets to the electricity market. Numerical results from different cases in two test systems are used to validate the feasibility of the proposed model in different market environments and demonstrate the impact of competition modes, transmission congestion, and carbon-emissions cap on the market equilibrium.

Paper 10389: Study on the effects of the flow-based approach in the Italian bidding zones capacity calculation

Italy is amongst the few countries (including Sweden, Norway and Denmark) in Europe which are internally divided into bidding zones. Presently, a Coordinated Net Transmission Capacity approach

(CNTC) is employed at these internal borders. Whereas this methodology performs well when the bidding zones are radially connected or connected solely by DC links (as in the current Italian Bidding Zone configuration), it may not be optimal for more complex topologies. The paper proposes a new methodology based on the flow-based methodology for capacity calculations on the internal borders. A base case is simulated using a specific Italian grid to simulate the two proposed approaches. Results show that the flow-based capacity calculation approach is more complex than the current used, but with the advantage of being more flexible in representing grid constraints.

Paper 10466: Structuring the Coordination Across Transmission and Distribution to Support Value Stacking Scenarios Combining Multiple DER-Provided Grid Services

The paper explores the new coordination needs between the distribution utility, the wholesale market operator, and the individual or aggregated DER providing grid services. Total DSO and dual participation coordination frameworks are compared on various attributes. The proposed approach follows a hierarchical structure composed of three levels –stages, steps and functions– to describe the coordination needs between the ISO, DSO, and DER (individual or aggregated) providing grid services. The end-result is a series of coordination diagrams presented in this paper, which are detailed enough to convey coordination needs at the functional level, but flexible enough to serve as a starting point to a range of implementation approaches.

Paper 10467: Dynamic Procurement of Reserves in New York Electricity Markets

This paper discusses the implementation of dynamic reserves, a concept critical to the management of New York's evolving electric grid. This approach includes dynamically adjusting the New York Control Area (NYCA) Operating Reserve requirements in response to the largest source contingencies, thus ensuring a more responsive and efficient grid management system. Additionally, the development of dynamic locational reserve requirements is emphasized, aiming to ensure that post-contingency transmission flows adhere to established reliability criteria.

Paper 10468: Optimizing Combined-Cycle Generators in PJM's Wholesale Electricity Markets Using a Hybrid Multiple Configuration Resource Model for Enhanced Flexibility

The paper discusses the simulations to quantify the market and computational performance impacts of the Multiple Configuration Resources (MCR) model on PJM's wholesale energy markets. The MCR approach is specifically relevant for gas-based generation with a number of gas turbines and steam turbines where different configurations are possible. A prototype full-scale MCR model has been developed and implemented in the PROBE Day-Ahead (PROBE DA) market clearing software, which is currently a critical component of PJM's Day-Ahead Market (DAM) clearing process. Results clearly demonstrate significant potential bid production cost savings per year with a very modest increase in solution time.

Paper 10469: Finding Flexibility in Large Flexible Loads: Making Demand Equivalent to Generation in Wholesale Markets

Increased levels of variable renewable energy will require more flexibility from all resources on the grid including generation, storage, and demand. The paper provides thoughts on pricing and market participation arrangements that have the potential to enlist certain types of customers that have both generation and load behind a point of interconnection and the ability to moderate (at least a material level) of both their consumption and generation (i.e. their net position) in the real-time operation of the electricity system and by doing so provide real-time and planning timeframe benefits to the market. Exposing loads to price signals also provides incentives for flexible consumption.

Paper 10896: Novel Settlement Mechanism for Encouraging Flexibility in the Balancing Markets

The paper discusses the security constrained economic despatch (Real Time Despatch) in the Single Electricity Market in Ireland and Northern Ireland. In the present system, deviations are allocated to the generators with respect to their submitted final physical notifications, and the imbalance settlement price will be paid to the providers based on uniform pricing. Generation unit internal technical constraints

typically increase the total cost of objective function and contribute to the general imbalance of the system, which is likely to lead to higher electricity prices for end users. The authors discuss a methodology of evaluating the contribution of the generators internal constraints in the total allocated power and proposes a reduced payment rate. The main idea is to differentiate the price the volume associated to unit technical constraints are settled. These volumes will be settled at a lower price (unit variable cost) than the clearing price, incentivizing more flexible technologies and reducing costs for the overall system.

Paper 10897: The Idea of Fed-Balancing Energy Market, a Smart Use of Balancing Capacity Auction Results

The paper discusses conceptually how the outcomes of the balancing capacity auctions can be used to minimize the required displacements in the balancing market. Unconstrained daily auctions are being conducted for competitive procurement of reserves in Ireland. Due to the system constraints that need to be considered in the balancing market (BM) scheduling process, the actual real-time providers might differ from those that have won in the daily auctions. To manage these mismatches more efficiently, this paper introduces the idea of a Fed-BM to adjust the BM input data to (i) minimize the required energy position displacement in the BM, (ii) avoid costly changes in the mechanics of the already established BM because of the introduction of daily balancing capacity auctions, and (iii) reduce the total cost of the BM.

Paper 10914: Transforming the power system for future generations – the role of dynamic capacity markets and de-rating factors

The paper focuses on the role that dynamic capacity markets can play in supporting the transformation of the power system to low carbon technologies while maintaining reliability. In particular, the paper discusses the importance of how de-rating factors -- that apply to different technologies in line with their contribution to reliability – evolve over time in response to the changing portfolio. The paper discusses several emergent effects including a net demand effect, a saturation effect and capacity effects including an availability effect, a size effect, and an energy limit effect.

Paper 10958: Analysis on the integration of new technology in the Brazilian electricity market – Offshore wind case

The paper presents the potential, opportunities, and challenges for offshore wind deployment in Brazil. It also discusses the regulatory and technical aspects associated with offshore wind and the capital cost trajectories in the future. For the implementation of a new technology, six essential aspects are highlighted: i) the cost and competitiveness of technology; ii) environmental and socio-economic impacts; iii) energy security and existing sources; iv) the demand for the contracting of electricity; v) investors interest; and vi) the country's planning vision, considering the organization of power systems, particularly the transmission infrastructure for the flow of the energy generated.

Paper 10975: Connection products in electricity grids

The paper presents the concept of standardized connection products. Today's standard grid connections have firm rights entirely. Connection with non-firm rights have restrictions that introduces a risk for curtailment, that is, a flexibility response. Approaches for accessing flexibility can be based on connection properties, marketplaces, bilateral contracts, regular grid tariffs, regulations, and rules. Connection properties, regulations, and rules provide good reliability in terms of accessing flexibility, especially due to the approaches' long-term predictability. The authors discuss the current connection problem, the increasing time it takes for grid users to be connected after ordering grid connections and resultant long grid connections queues for, among others, 1500 gigawatts of advanced stage renewable energy projects in 12 countries combined. The paper brings out a novel approach about the connection products in selected markets and propose connections products, both firm and non-firm, for different types of entities based in several aspects.

Paper 11010: Forecasting Model of Electricity Production from Hydroelectric Sources with Long Short-Term Memory (LSTM) Networks

The paper presents the use of Long Short-Term Memory method (a recurrent neural network method widely used in deep learning) to forecast hydroelectric generation, with the purpose to improve the accuracy of forecasts for hydro generation. The results show a reduction in the RMSE errors.

Paper 11072: Implementation of Virtual Power Purchase Agreements to Support Carbon Neutral Investments in the Russian Electricity Market

The paper examines the role of virtual power purchase agreements (VPPAs) in supporting capital-intensive climate-neutral investments while mitigating price risks in electricity markets through a case study of the Russian energy market. It gives an analysis of the regulation of the Russian energy market in terms of the restrictions that the VPPA market may face and suggests legislative changes that could effectively eliminate these unnecessary restrictions. It also discusses the economic viability of VPPAs in the Russian energy market in the future.

Paper 11074: Impact of Carbon Pricing on Wholesale Electricity Prices and Energy Transition Scenarios in Russia

The paper presents a study of the impact of carbon pricing on Russian Energy Sector and wholesale electricity prices. The study assesses the ability of carbon pricing in Russia to drive the transition from conventional fuel-based technologies to environmentally friendly alternatives such as renewables. It also examines the potential impact of carbon pricing on wholesale electricity prices, considering the country's existing energy mix and emissions intensity, in addition, considered options to change the tax system to offset that impact.

Paper 11178: Connection agreements subject to limitations for renewable generation and storage facilities in Greece

Limited connection capacity or capacity subject to operational limitations an issue of utmost importance is the lack of available hosting capacity in transmission and distribution grids. Network congestion is prominent in many power systems, negatively affecting the prospect of installing RES plants. While RE targets have been specified by Greece just like other countries, grid integration of renewables is facing challenges in terms of interconnection capacity, grid expansion and operational limitations. The paper proposes methodologies for utilizing the existing grid infrastructure efficiently by imposing power evacuation limitations for the renewables. Establishing a framework for non-firm connection agreements (in addition to firm connection) is a valid solution towards tackling the long queues of RES producers anticipating grid connection terms. These limitations can be static or adaptive in nature with the former being simpler in design and implementation. The limitations provide signals for integrating more storage also.

Paper 11242: Not Drowning, Waving! Australia's Net Zero Ambitions – Enabled by multiple approaches? Or drowning in complexity?

The paper discusses the diverse state-based approaches that are evolving across Australian states in response to diverse resource availability, environmental, political, economic and community factors. A summary of various policies and targets for each state are presented. Given the federal structure, a harmonization of the federal and state approaches to decarbonization, challenges in transmission planning & evacuation of RE and Renewable Energy Zones approach are discussed.

Paper 11256: Mechanisms for Trading the Electrical Value of the Demand Side to Promote the Usage of Distributed Energy Resources

Increasing penetration of renewables specially DERs, bi-directional flows of electricity, congestion and supply demand mismatches create challenges. To promote demand side participation, the paper discusses the need for more market-based prices for the retail consumers. The paper proposes to introduce distribution locational marginal pricing (DLMP) in the 6.6 kV or lower grids as well for trading. With DLMP, the market price will reflect the electricity surplus/shortage and grid congestion

at each point, and provide opportunities for trading, such as selling electricity at the time when others are willing to buy it at higher prices, while also making use of DERs to deal with grid congestion in a fair and transparent manner.

Paper 11355: Electricity Market in India- Present and Future

The paper provides an overview of the Indian Electricity Market, its various segments, policy and regulatory interventions in the recent past. National Open Access Registry (NOAR) has been implemented as a single window portal for administration of the short-term electricity market transactions including Power Exchange transactions. The paper mentions about the new Indian Electricity Grid Code and the mechanism of Transmission Access implemented with effect from October 2023. Future roadmap for the electricity market is also discussed.

Paper 11358: Introduction of the Operational Core Day-Ahead Flow-Based Capacity Calculation and Market Coupling through Active Constraints and Price Spread

The day ahead flow-based market coupling has gone live in the core region in Europe on 8th of June 2022 comprising of 14 bidding zones, 16 TSOs and 10 Nominated Electricity Market Operators (NEMOs). While one of the NEMOs acts as the principal market coupling agent, the other NEMOs act as the verifying agents. This paper provides an in-depth understanding of the flow-based market coupling. It also compares the flow-based coupling with the earlier NTC based method and provides the advantages of the flow-based method. The paper provides a comparison between NTC and FB MC results over a period of several months.

Paper 11372: Key Initiatives, Regulatory Framework & Challenges to attain ambitious target of 500 GW non-fossil fuel energy by 2030 in India

The paper elaborates the policy initiatives undertaken by the Ministry of Power, Government of India, and highlights the supportive regulatory framework established by the Central Electricity Regulatory Commission. The major challenges in attaining the ambitious target of 500 GW of RE and operational challenges with high renewable energy share in Grid are discussed.

Paper 11374: State Tariff Design using Regulatory Sandbox Approach for Enhancing Renewable Energy Demand

The paper describes a real-time pricing pilot conducted to evaluate the feasibility and potential benefits of implementing the dynamic pricing mechanism for identified consumers with time of use (ToU) pricing under a regulatory sandbox. Real time pricing introduced a dynamic pricing structure which varied based on the supply and demand conditions. The study aims to enhance grid efficiency, promote demand response, and encourage consumers to shift their energy consumption patterns to periods of lower demand. Shadow billing in parallel with utility billing was also carried out to bring out the financial implication for both the consumers and the utility.

Paper 11377: Initiatives to develop dedicated market segments for Green Energy in India

This paper presents the initiatives taken for developing dedicated market segments for renewable energy, viz. introduction Green Day Ahead Market (GDAM), Green Term Ahead Market (GTAM), pan India implementation of Green Energy Open Access. The experience gained and the regulatory changes are discussed.

Paper 11378: Initiatives to develop dedicated market segments for Green Energy in India

The paper outlines the developments in the Indian electricity market as it seeks to pursue energy transition. It highlights the interplay between market mechanisms and regulations in reshaping energy markets, emphasizing the integration of renewables into the national grid.

Paper 11501: Coal phase out in Chile: lessons from an ongoing process

The paper describes the policy & regulatory process adopted for phasing out coal-based generation in Chile to achieve the stated policy objectives for energy transition as per the Energy Policy 2050. Chile has a completely private energy sector. To achieve the phasing out of coal-based generation an

innovative voluntary public-private agreement has been put in place. The voluntary process also implies that the Government is not obligated to compensate the generators for phasing out the generating units. The paper also presents the challenges faced so far and those likely to be faced in the future.

Paper 11674: Advance Procurement of Reserves in Indian Electricity Market – Policy & Regulatory Intervention and Implementation Experience

The paper presents the policy, regulatory and operational aspects of reserve procurement in the Indian electricity system. Authors discuss the impact of policy and regulatory intervention for advance procurement of reserves. The cost allocation of reserves and funding is also discussed. The procurement of reserves in the coordinated multi-lateral scheduling system has helped in accessing the reserves at interstate and intrastate levels. The operational aspects and impact on the grid are also presented.

Paper 11678: Implementation of Market Based Ancillary Services in the Indian Power System

The paper presents the implementation of Market Based Ancillary Services, where day-ahead and real time (hour ahead) procurement of reserves is envisaged. Regulatory framework and implementation aspects in terms of reserve estimation, challenges and in-house software developed is described. Market design aspects such as bid specifications, market clearing, integration with energy market for transport of residual supply bids to ancillary market, timelines, scheduling and dispatch and clearing and settlement are presented.

Paper 11708: Benchmarking Of Grid Connection Permit Process for RES Installations In Energy Community Contracting Parties – Key Findings And Recommendations

The paper analyses the grid connection procedures and the permit-granting processes to the Energy Community Contracting Parties (CPs) in EU countries of Albania, Bosnia and Herzegovina, Georgia, Kosovo, North Macedonia, Moldova, Montenegro, Serbia, and Ukraine. The paper identifies the grid connection process (key process steps, cost of grid connection, barriers related to the grid infrastructure, requirements to publish hosting capacity for RES integration, measures to deal with scarce capacity, provision of information, digitalization of the permitting process and eased procedures for self-consumption and small-scale projects), barriers and provides recommendations to enhance grid permission procedures and considered possible regulatory reforms/adjustments.

Paper 11766: The Colombian Energy Market Information System. A Modern Approach

The paper presents SIMEM, the first Colombian open data portal for wholesale energy market and power system operation information. Using Data Lake technology, it provides a central data management system that allows both machine and human readable access to the data. It serves as an open-data reference in the electricity sector, collecting relevant information from various entities, e.g. the Energy Market Operator (EMO), the Independent System Operator (ISO), derivatives marketplaces, and energy market traders. SIMEM uses agile methodologies and scalable infrastructure.

Paper 11767: Analysis of Colombia Energy Market Exposure during El Niño Phenomenon

The paper presents the market exposure in the Colombian electricity sector and its correlation with water reservoir levels, price patterns and the influence of the El Niño phenomenon. Relevant market variables such as System Reservoir Levels, Spot Prices, Oceanic Niño Index and Regulated and Non-regulated Contract Prices are studied to find their influence on the market exposure. Measures to hedge the market against exposure and avoid an alarming systemic risk are deliberated. Mitigation measures available to market participants, such as energy derivatives and power purchase agreements (PPAs), are presented.

Paper 11770: New electricity market design for storage technologies participation in Colombia

The paper presents the market design for integration battery energy storage systems (BESS) into the Colombian grid at transmission/distribution level and the electricity market. One of the motivations to integrate BESS is the delays in transmission/distribution system augmentation and the need to maintain reliable operations meeting the security criteria. Business opportunities for BESS in terms of multiple services that it can provide, and corresponding revenue streams are discussed. Cost implications for end consumer are also mentioned.

Paper 11771: Lessons Learned from Electricity Pricing in Colombia 2015 – 2022

The paper presents the formation of prices for remuneration of generation, transmission, distribution, and retail in Colombia. It analyses the tariff design, evolution of tariff/pricing conceptually detailing the tariff model of each element of the chain of formation of the cost of electric energy services. Methodology for factoring restrictions/congestion and losses is also presented. Importance of periodic tariff monitoring and control is mentioned.

Paper 11823: Peer-to-Peer Energy Trading via Automated Matching with Public Profit-Sharing Algorithms: A Case Study for ERC Sandbox in Thailand

The paper outlines a blockchain approach for P2P trading using a profit-sharing algorithm to match bids and offers in a way that is shown to result in a better price for both bidders and sellers. Results show that a greater volume of decentralised energy production is cleared for use in the grid as compared to a general energy market matching algorithm. Various market design aspects such as participant eligibility, transaction matching, grid balancing, market oversight, regulations, etc. are discussed. Details of pilot performed under a regulatory sandbox approach are mentioned.

Paper 11878: Research on Market Mechanism in Electricity-Carbon Coupling System: The Practice of CSG

The paper presents work on the Electricity Market – Carbon Market Coupling (ECC) and the relevant technologies that have been emerging in China to reduce carbon emissions in recent years. In this context, the state-of-the-art of market mechanism research of China Southern Power Grid (CSG) in the ECC System is reviewed for the first time. The ECC research covers accounting & monitoring of carbon emission, assessment and certification of carbon emissions and green power, analysis of market mechanism, bidding behaviour and equilibrium. Key issues and further areas of potential research are identified.

Note: This is an NGN Showcase paper and will be presented during the General Discussion Meeting.

Questions for PS2:

1. Do electricity market designs need to be modified to accommodate a carbon price? If so, what changes are needed?
2. How do the Coordinated Net Transmission Capacity (CNTC) and Flow Based (FB) methodologies compare? especially in highly meshed networks?
3. What are the key differences in approaches for TSO-DSO coordination to facilitate effective participation by DERs in electricity markets. Does any approach facilitate inclusion of essential grid services / reliability services by DER? How can markets/regulation value the flexibility needed to face: i) uncertainty on transmission/distribution constraints, or ii) sudden frequency excursions?
4. With increasing penetration of renewables, the frequency excursions are increasing. Exposing loads to real-time prices makes zero marginal prices an opportunity rather than a problem to be solved. Can frequency linked real time pricing including imbalance handling pricing help provide signals to demand for flexible consumption?
Further, can such linkage of the price signal also reduce balancing costs?
5. How can reliable data from market participants be ensured for fair calculation of costs?
6. How can interconnections, storage duration and flexibility be considered in capacity markets?
7. What are the key regulatory, technical and implementation challenges in using non-firm grid interconnections in different jurisdictions across the world, and how do they apply to facilities with energy storage systems?
8. How intraday markets and rescheduling are developed to cope with massive integration of renewables and demand-side management? How dynamic reserve procurement facilitate management of network congestion on account increasing RE penetration.
9. Should the growing number of large price sensitive loads (Such as Data Centres, Electrolysers, Industrial loads, crypto mining, etc.) be obliged to offer flexibility? How should price-responsive loads be modelled in the resource adequacy framework?

PREFERENTIAL SUBJECT 3
EMERGING MARKETS AND FORMS OF MARKETS

Special Reporter: Anant Venkateswaran

Seventeen (17) papers are accepted for PS3 with four papers from the US, three papers each from Colombia, two from Brazil, two papers from Russia, two from Georgia, one each from Canada, Germany, Bosnia, Croatia, Italy, Kingdom of Saudi Arabia, and Thailand.

They cover several topics with respect to resilient markets:

- a) Markets and regulations addressing the attributes of electricity that customers are seeking from the industry.
- b) Market based approaches to integrate community and distributed resources.
- c) New market approaches to overcome the barriers and limitations on current market designs.

PS3 Paper Summaries

Paper 10470: Automated Market Bidding for Battery Energy Storage Systems

The stochastic vs deterministic argument is not new to the industry. For over four decades, several papers and lot of research has been done in this space, including my own.

The paper provides reasoning and examples to indicate the benefit of using a stochastic approach to bidding the output of a combined VRES and BESS generation/storage facility as compared to a deterministic approach. A general approach to optimal trading on multiple markets for hybrid wind farms and battery systems.

The paper provides an interesting and useful discussion of stochastic vs deterministic bidding approaches. The issue is not whether the stochastic approach is better than the deterministic approach for these types of plants operating in markets with increasing amount of variable renewable energy generation, but rather how to develop the information needed to make the stochastic approach as good as possible.

The analysis demonstrates that in the presence of uncertainty weighted scenario analysis is better whereas deterministic analysis is better future prices are known more accurately. This paper compares the results using a deterministic approach with the realized prices (ground truth) with the stochastic model using a different set of quantiles of a forecast. The difference on how many of the forecast quantiles should be considered and how this impacts the results is discussed.

Finally, my questions for the authors would be a) what is unique about the analysis, b) for automated bidding and how the system operator deals with it under the eventuality that they cannot accept it.

Paper 10471: New Market Rules to Meter Behind-the-Meter DERs Participating in Wholesale Electricity Markets: Overcoming Technical Limitations and Economic Barriers

This paper outlines different meter configurations under consideration for measuring the impact of DERs in NY State under FERC 2222 and for each option, the pros and cons are discussed in view of the evolving smart metering initiative across the state.

The paper also provides a clear explanation of the three options being considered in New York state for metering the services that DER (including DR) can provide to the wholesale and distribution network portions of the electricity supply chain. It points out that the need for the ability to measure these contributions are being driven by regulation, and identifies that while there are solutions for two types of DER (i.e., front-of-meter DER and DR, though not an entirely satisfying solution in the case of the latter), there is not a workable approach for behind-the-meter DER, which is the fastest growing and potentially largest source of DER service provision.

Finally, this paper may be useful for jurisdictions in which the adoption of behind-the-meter DER is still quite low (but is expected to grow) and the use of interval metering and AMI has not yet been

implemented, as it can point out issues that can help may decisions about metering arrangements more fit for purpose.

My question for the authors would be (a) detail how DER services are currently measured and compensated in New York and (b) provide whatever information or thoughts it can on the difficulties confronting the dedicated sub-meter approach -- particularly the changes that will be needed to AMI to allow the meter reconciliation.

Paper 10566: Evaluating the Quality of Probabilistic Forecast for Energy and Ancillary Service Trading

This paper provides an overview of the limitations of deterministic forecasts and the associated advantages and challenges of probabilistic/quantile forecasts. The paper outlines forecasting methods and notes the appropriate measures for assessing the quality of probabilistic methods.

Paper 10834: Enhancing Power Consumption Efficiency: A Comprehensive Analysis of Demand Response and Tariff-Based Mechanisms

This paper examines the different DR mechanisms in the Russian federation with adjacencies. The focus is on economic DR programs with tariffs designed to incentivize customers to participate and manage their consumption in exchange for benefits. This paper compares the C&I (industrial) and residential customers. This paper goes into the architecture of an energy management system architecture that can among other things incorporate algorithms on the demand side for DR.

This paper also explores the details of the demand response (DR) mechanisms, appropriate incentives and eventual application into an EMS (Energy Management System). An example of a mining application of the proposed DR mechanisms is shown to demonstrate how effective DR signals can reduce capacity requirements and associated costs.

A significant aspect highlighted is the payment for generating capacity, which can constitute up to 40% of the final cost of electricity. This payment is fixed during each working day, lasting merely one hour – approximately 3% of the total time in a year. The paper also underscores the dilemma faced by consumers in choosing between tariff mechanisms and DR programs to minimize electricity bills. Additionally, the paper conducts a statistical analysis of consumption patterns among industrial and residential consumers. This analysis includes an examination of the overlap between these consumption patterns and PLHs in regional power systems. Furthermore, the authors also propose an energy management system (EMS) architecture aimed at implementing more effective control algorithms on the demand-side.

Paper 10839: Financing model for the construction of solar power plants on prosumer facilities provided by Public Supplier

Affordability, reliability, sustainability and equity are the goals of a just energy transition.

The topic of the just energy transition within the confines of broader socio-economic construct and energy policy is very important, timely and interesting. A program of household solar would not only benefit the consumer but the power supplier and other stakeholders as well. This is a very interesting solution.

This paper explores a just energy transition case for the vulnerable/energy poor household consumers with the addition of government subsidized roof top solar installations and associated household tariff mechanism. Additionally, this solar power and household pricing structure can allow the power supplier to avoid some revenue losses due to price level set for household tariffs that are currently lower than power supply prices due to social and economic policy.

Paper 10959: Certification of the electricity used to produce hydrogen

This paper reports on the work of a Joint Working Group (C5/C1) on this topic and is a valuable contribution to the evolving role of hydrogen in the transition to low emissions. As energy transition is in full swing, green hydrogen is a contributor to low emissions within regions/countries and also tradeable and has many parallels with renewable energy certificates. Certification is therefore an

important means to enhance credibility and provide guarantees that claimed emissions are what they are claimed to be.

The paper provides a set of recommendations, based on an initial consideration of 34 schemes and detailed consideration of 14, regarding the structure and content of the components that should be included any scheme seeking to certify the GHG emissions associated with the production and delivery of any batch of hydrogen. Given the level of interest in hydrogen as a potentially clean fuel and the nascent level of development of schemes that seek to identify the relative level of emissions associated with its production and delivery, this paper should provide a template for harmonising the schemes put in place in various jurisdictions and thereby facilitate the international trade of hydrogen.

Paper 11071: Facilitating Efficiency of LMP-based Electricity Markets Through Distributed Demand Response

This paper showcases how to optimally allocate DR auctions factoring in issues like day-ahead market and other parameters. A real-life nodal day-ahead electricity market with over 7000 nodes is discussed and it identifies regions for targeted DR deployment and compares market performance for three different approaches: the proposed optimal one, the naive and the allocation of DR resources close to actual one on the Russian day-ahead market.

The average market effect for different months is studied. Different months have shown different characteristics. For example, in February and October, base and optimal local are higher than the native and native local. However, some other cases, base is lower than the native and native local. As DR volume changes in each month, it is difficult to evaluate that economic efficiency for each month. Authors mentioned that on average optimal approach is 45% more economically efficient than base approach. It is beneficial to provide the efficiency value for each month and compare that with average value of 45%.

The results are potentially very beneficial for developing mechanisms to better allocate DR in Russia that could result in a more efficient and sustainable electricity system.

Paper 11348: Enabling Behind the Meter DER Participation to Provide Bulk and Distribution Grid Services

A multi-level hierarchical control of DER's for their participation in bulk power markets is very well addressed in this paper. The paper also addresses how that architecture would operate in response to the requirements of a day-ahead market. Assuming the technologies described can actually do what they are described as doing, it would seem that this architecture would almost be self-evident.

The use of three tiers of resource aggregation helps to simplify the role of each entity in the methodology, outlining a methodology for addressing one of the two major challenges for utilizing DERs in the operations of the bulk power system and markets. The three-tiered approach closely approximates methods in use in some locations.

Paper 11588: Energy Scheduling & Imbalance Settlement between GCC Interconnection System and an External System

The paper describes status and a roadmap for future development of energy trade between six Gulf states (Abu Dhabi, Kuwait, Qatar, Oman and Saudi Arabia, called the GCC region). A study has shown that increased trade between these countries can give benefit of more 100 million USD a year. Today, exchange is mainly limited by regulatory differences both at the regional and national level. The paper describes a roadmap for how the regulatory issues can be gradually adapted to increase trade between counties.

The paper summarizes and discusses the current and future envisaged situation in establishing an electricity market around the GCCIA interconnector. It describes a road-map in three stages. It should be noted that the relevance of the paper is supported by the fact that the existing literature on the region of the world remains scarce.

Paper 11722: The Implementation of Intraday Auctions and Its Impact on The Electricity Market from Local and Regional Perspective

The paper describes the Intra-day auctions in the Croatia market with details. It discusses the move towards intra-day market auctions/coupling on the pan-European level and the methodology to price cross-border capacities and the impact on the Croatian electricity market.

The paper also details the reason for the creation of these auctions, the implementation chronology, the infrastructure that is being developed for it (with its modules), information with their times for each of the three auctions, the tests that are being carried out and the benefits they will provide.

The concept discussed in this paper is very relevant to the evolution of electricity markets and the integration of variable energy sources, who are inherently less predictable/introduce uncertainty to the system. The introduction of intraday markets is one piece in the puzzle to integrate renewables more efficiently and to send the right price signals. The authors also demonstrate the level of testing required prior to the implementation of the Intraday implicit market auctions and the level of coordination required between the TSOs and the NEMOs.

The benefits of this approach are well-articulated. The topic is also very relevant to the ongoing energy transition, i.e., the integration of renewables into the system as well as regional cooperation.

Paper 11768: The Implementation of Intraday Auctions and Its Impact on The Electricity Market from Local and Regional Perspective

This paper outlines the progress in energy transition in Columbia leading to the establishment of regulation and policies to promote both small scale generation at customer location (prosumer) and distributed generation. Each case is handled separately. The national government, policy and regulatory bodies as well as the market operators are constantly reviewing the integration of these technologies and their impact both on the operation and on the energy market, since the progress of the energy transition depends on the result of a correct integration that makes the operational and financial performance of the actors that participate in this market sustainable. Lessons learned, experiences and enablers, barriers and required support structures are discussed.

For this purpose, DERs have been divided into two groups: small-scale self-generation (AGPE) and distributed generation (GD). Then tariffs of some are regulated, and some are fixed as per the price of exchange. The participation of these types of generation has increased dramatically in the energy market from 33 in 2018 to 6082 in 2023.

This paper builds on the status of the Columbian energy market from the last CIGRE event. It lays out systematically the advances across regulation, policy, mandates and others that are driving energy transition in Columbia. While the penetration of DER's in the Columbian system is only about 3% attempts are being made to expand its presence This paper also discusses reasons for the low penetration of DER's, primarily solar in the Columbian system.

Paper 11769: Use of Blockchain Technology for the Issuance and administration of Bank Guarantees in the Colombian Energy Market

Market settlement is one of the main areas where blockchain technology can add value. This paper examines the application of blockchain technology to market settlement in Columbia. The main features of blockchain - immutability, trust, data tracking and tracing etc., are highlighted. The ROI was also demonstrated.

The paper presents a new system for the issuance and administration of bank guarantees in the Colombian Energy Market based on blockchain technology. This greatly speeds up the process of issuance, administration, approval, submission and release of bank guarantees, leading to improved efficiency, security, and reduced costs to all market participants. The system was designed based on blockchain, defining each electronic guarantee as a unique digital asset, traceable and with high integrity.

A cost-benefit analysis was also presented.

Paper 11798: Designing balancing Products for the Georgian Power Grid under the liberalized Market Model

The paper discusses the approaches taken in Georgia to develop necessary ancillary services to allow a European style of market to operate. The paper brings an interesting assessment of how Georgia power market has been coupled with the EU power market, with the creation of day-ahead market, intraday market, balancing market, and forward market. The new model comes with trading on forecasts and not on factual values, including imbalance settlements every hour at the end of the month. The paper focus on the development of balancing products, due to the peculiarities of the Georgian power grid balancing products.

The paper sets out the challenges facing the Georgian Power market/system. Lack of incentive for participants to provide Frequency Containment Reserves (FCR), particularly as it is a free service, so participants are not incentivised to earn additional funds if they operate FCR ancillary service.

It also discusses the lack of incentive for participants to participation the automatic frequency restoration reserves. The paper evidences the lack of participation by noting that only 2 hydro units have qualified. The authors notes that a market-based approach should be used, which would improve liquidity.

Paper 11799: Designing balancing Products for the Georgian Power Grid under the liberalized Market Model

Georgia's electricity market is going through reforms to improve, among other things, the efficiency and transparency. The paper analyses the current state of the metering system within the Georgia's electricity market and makes recommendations for efficient functioning of the energy markets. Among some of the issues identified are poor energy infrastructure, faulty meters, lack of meters within some metering nodes, lack of control meters between Georgia and its neighbours, and scattered communication between data centres. To address these challenges, the paper proposes the installation of smart meters with improved data collection techniques, improved SCADA system, implementing data hub to create centralized communication system for effective energy data management.

This paper outlines the move to a competitive market in Georgia and the important role of accurate metering. The paper notes the mechanisms being used to mitigate the imperfect penetration of meters. The paper also notes that the use of a data hub is proposed to optimise the data. The paper, thus, highlights the importance of smart metering in ensuring access to real-time information to make market decisions and establish trust.

Paper 11822: ASEAN Cross-Border Electricity Trading Lessons From the LTM-PIP and LTMS-PIP: The Proposed GMS Regional Renewable Energy Market

The paper explores cross-border electricity trading within ASEAN through two initiatives, highlighting opportunities and challenges. The proposed electricity trading platform aims to bolster ASEAN's global energy trading role, addressing diverse renewable energy capacities and demands across member countries. The paper includes a brief description of the ASEAN electricity system including existing and possible future interconnections. Key obstacles include dependency on seasonal renewable energy sources, emphasizing the need for diversified energy sources and integrating countries with robust renewable energy potentials.

This paper documents experiences from two cross border trading projects that involves Laos, PDR, Thailand, Malaysia and Singapore. The main purpose is transport of excess renewable hydro in Laos to Singapore. Experience from the projects show that in dry seasons there is no exchange, but it also shows that regulatory issues and differences can hinder exchange between the countries. The last part of the paper proposes how energy trading in ASEAN can be further developed with creation of a trading platform with clear roles for buyers, sellers and transit countries.

The paper also stresses the importance of collaboration, harmonized regulations and standardized protocols for efficient management of cross-border electricity trade.

Paper 11833: Challenges and Opportunities for Ancillary Services on the Energy Transition in Colombia

The story of the Colombian market resembles many of the markets across the world that are still in development. Yes, they want to integrate DER's but do not have the tools to manage the flexibility and hence need more services to be developed and market design to be modernized. This paper is well written and is reflective of the nascent state of this market. However, this is important for other nations in similar state to see, collaborate and learn.

The paper clearly addressed the challenges that will come with the perspective of integrating 9 GW of solar into the Colombian electrical system, such as the trend towards the need for increased inertia, load following, and voltage control. It also clearly laid out the proposals that have already been implemented as well as those that are in progress in the creation of an ancillary services market and the necessary steps, such as day-ahead, intra-day, and real-time negotiations. It also clearly presents the perspective on the need for different ancillary service products and the necessary regulatory roadmap for their implementation.

Colombia is experiencing similar issues to many other systems. It presents the task to be tackled.

Paper 11862: Metering Aggregation: An Approach to Enhance Market Design – A Case Study

This paper discussed the role of smart metering in the Brazilian market. The paper presents a comparison of the organization of metering services in 4 markets and discusses their learnings in view of market opening in Brazil. Metering aggregation and net metering are important topics for future markets.

Note: This is an NGN Showcase paper and will be presented on Friday during the Retail Competition workshop.

Questions for PS 3

1. What regulatory evolution is taking place in your country/region to support emerging and new types of markets? Please highlight the drivers and barriers and the incentive structures being provided in your region to help overcome the barriers and drive adoption.
2. In the context of energy transition where renewable penetration and electrification with sector cross-coupling increase; how do we design future electricity markets to ensure reliable operations and drive ongoing investments (Context - Marginal cost of renewables is not same as fossil resources)
3. How are interactions between the new emerging markets and the existing systems/markets in place managed? What service requests from the market operator, TSO, DSO or a third party are handled by this new system/ market? For example., active or reactive power, maximum power limit, ramp rate, voltage or frequency regulation etc.
4. What types of operational information should TSOs, market operators, and market participants be required to provide in real or near-real time to other parts of the electricity supply chain, regulators or the government? How are AI applications used to exploit this information?