DISCUSSION MEETING

SUMMARY

Study Committee C5

Electricity Markets and Regulation

September 2, 2022

Chairman: **Alex Cruickshank**

Secretary: **Yannick Phulpin**

Technical Committee Chair: **Kankar Bhattacharya**

Special Reporters: **J. Wright (PS3), Samir C. Saxena (PS2), Anant Venkateswaran (PS3)**

1. INTRODUCTION

The 2022 discussion meeting of Study Committee C5 was held on September 2nd, in room Havane at the Palais des Congrès in a morning and afternoon session.

The scope of Study Committee C5 focuses on the impacts on the planning and operation of electric power systems of different market approaches and solutions; and of new structures, institutions, actors and stakeholders. The Study Committee C5 also addresses the role of competition and regulation in improving end-to-end efficiency of the electric power system.

The Preferential Subjects of the 2022 CIGRE Session attracted papers that cover 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. SC C5 had 40 papers from 20 countries.

2. RUNNING OF THE MEETING

The Discussion Group Meeting was chaired by the Study Committee Chairman, *Alex Cruickshank*, with *Kankar Bhattacharya, Samir C. Saxena, and A. Venkateswaran* as Special Reporters and *Yannick Phulpin* as SC C5 Secretary.

3. CONTRIBUTIONS TO PREFERENTIAL SUBJECT 1

Twelve (12) papers were accepted from ten (10) countries [4 from Europe, 4 from Asia & Australia, 3 from Americas, 1 Africa] under PS1 where the following sub-topics were identified:

- Market design developments to facilitate the integration of new participants and renewable resources.
- The role of retail electricity markets in the promotion of behind the meter technologies.
- Innovative contracts/services between market participants and with customers/distributed energy resource owners.

Based on the above sub-topics and the papers accepted, the Special Report summarized the following main themes that were of key importance and focus:

- Evolution of the electricity market to integrate DERs in the power system.
- Opportunities of DERs for transition to more efficient and resilient energy markets.
- Experience of five-minute metering and market settlement, intra-day market auctions and binding dispatch.
- Wind farm earnings from frequency regulation markets.
- Electricity markets and cross-border interconnections.
- Impact of market constraints on integrated energy businesses.
- Applications of blockchain technologies to energy markets.

In total there were nine (9) prepared contributions and several spontaneous questions and comments from the floor, as well as via the SparkUp tool. Overall it was a very lively and interactive session.

The Special Report summarized each PS1 paper and poses the following seven questions to invite contributions for the Group Discussion Meeting (GDM). Alongside each question, the submitted contributions are also summarized to provide a complete overview of the deliberations at the GDM.

Q1. What are the biggest challenges and lessons learnt when considering market reforms in your jurisdiction (with specific reference to the integration of DERs)?

Prepared Contributions:

- Vatee Laoharojanaphand, Thailand

The biggest challenge when considering market reforms in Thailand regarding integration of DERs is government policy. Despite Thailand's gradual shift away from the enhanced single buyer scheme towards third-party access and energy market, the recent National Energy Policy Committee's resolution still allows the bidding for the small and very small power producers (SPP/VSPP) to sell the energy to electric utilities on a bilateral basis.

The Thai electricity supply industry need to reform to energy market, the new energy policy should prioritize an energy market over bilateral trades and significantly reduce bidding quotas for bilateral trade.

- Greg Thorpe, Australia

The new roles for DER providers in terms of new services are orchestrated DER dispatch, procurement of network services, managing demand response programs and virtual power plants, manage community batteries and integrate microgrids.

Technical Challenges: Voltage variations, power losses, grid congestion, lower grid reliability, cybersecurity.
Economic Challenges: Lower revenues, customers off-grid, higher O&M costs, higher non-technical losses, cross subsidies, lower energy affordability, penalties from regulator.

- Saulo Cisneiros, Brazil

The integration of DERs connected directly to the customers' end or in the distribution grid on a large-scale, will require a reformulation of the regulation rules and grid code of the electricity sector as well in the business model and modus operandi of Distribution Companies with the involvement of the regulator, system operator and especially, the Distribution Companies. The Market Rules define that the Distribution Company is responsible for the power flow in the connection between the distribution and transmission system. In this context it is necessary to change this definition of the Market Rules in order to define the responsibility for that and not penalize the Distribution Company.

Spontaneous Contributions:

Arjen Jongepier (The Netherlands): The (perceived?) increase of non-technical losses by DERs despite the extended measurements (especially in DSO grids) may be because of the assumption that former distribution loss models were (almost) perfect as the flows seemed to be predictable. However, I am of the opinion that new models have to developed, and to some extent already are. I would be delighted to make contact with one of our asset management guys who personally developed such a model. Additionally, DERs do not decrease but increase distribution losses as flows are reversed, are more volatile, and the assets are operated more to their nominal and thermal limits. And we all know that losses increase quadratically with current. And finally, local measurements, with higher observability from smart meters and distribution transformer metering, higher sampling frequency (to sub-second level) and good data science methods have high potential to detect and localize real energy theft. Again, I would be delighted to match interested people to my colleagues working on this.

Rimnesh Shah (Saudi Arabia): The non-technical losses should not increase but rather decrease with optimum planning/placement of DERs and transition to DSO because:

- The integration of smart meters helps the distribution system reduce non-technical losses by pinpointing theft, vandalism, and unmetered activities.
- With large-scale DER implementation, better power system models and improved loss models are required.
- The overall impact on lower revenues can be offset by the reduced technical losses by correct placement of the DERs and potentially the right tariff setting in addition to the flat capacity charge to pay for the lower customer energy import due to DER.

Q2. Have similar (or other) hardware deployment challenges been seen in other jurisdictions as increasing variable renewable energy is deployed and system operations/market operations needs to move closer to real-time? How crucial are metering infrastructure/enhancements (at utility-scale and distributed scale)?

Prepared Contribution:

- Saulo Cisneiros, Brazil

Energy storage systems are important options for providing flexibility of system operations in both transmission and distribution. Implementing energy storage in distribution and transmission grids should consider the expansion of the power grid to eliminate bottlenecks for variable generation; evaluate the investments required for each option.

Q3. Are other market-based approaches to the non-firm integration of generation capacity being applied elsewhere and what direct/indirect costs/benefits are included? What experience has been gained from these approaches?

Prepared Contributions: None
Spontaneous Contributions: None

The following two questions were taken up for discussions together as they touched upon similar issues.

Q4. Are there any concerns around scalability of blockchain applications in energy markets that could limit further blockchain deployments?

Q5. Should sustainability be a built-in design feature of potentially scaled applications of blockchain technologies in energy markets (and/or more broadly)? How so?

Prepared Contributions:

- Vladislav Berezovsky, Russia

In most cases, the concerns around the scalability of blockchain applications relate to public blockchain networks, such as Bitcoin or Ethereum. Anybody can join the public network, that's why they are more reliable but slower. The private blockchain frameworks are closed, only approved users can participate in the network and make changes to the blockchain (add new data, etc.). These networks are less decentralized but faster and more scalable. In the energy sector, private blockchain strengths are needed for the market actors for electricity trading (retail markets or microgrids), smart metering, billing, tracking certificates of energy origin, etc. Using non-fungible tokens as unique certificates can provide transparency and double-spending problem solution while reducing transaction costs. Market

actors can participate in a blockchain platform to observe that the system operates correctly with the respect to a grid specification.

- David Bowker, Australia

There are two aspect in sustainability and blockchain, they allow efficient, novel processes which are not possible without blockchain, but may consume significant energy resources in facilitating them. The novel processes can help sustainability by management of decentralized energy grids, supply chain transparency, facilitate EVs find charging stations, use of on-demand drivers without a gig economy, facilitating peer-to-peer energy transactions.

Among the novel processes, Peer-to-Peer (P2P) investments as a Security Token Offering on the blockchain can bring much-needed immediate capital to sustainable energy projects. Blockchain technology has significant potential to improve sustainability – the challenge is constructive progress in its use and reducing energy intensiveness.

The following two questions were taken up for discussions together as they touched upon similar issues.

Q6: Are other jurisdictions experimenting with the potential for wind and solar (including distributed PV) providing ancillary services directly or via aggregators?

Q7: How far behind are DER market-based approaches or regulations behind those for utility-scale resources?

Prepared Contributions:

- Ben Vandervaal, Australia

Inverter-connected wind plants can provide frequency control services in accordance with requirements of the (Australian) Market Ancillary Service Specification. Viability of hybrid models utilizing Battery Energy Storage Systems (BESS) to operate in the Frequency Control Ancillary Services (FCAS) market. Wind and solar/battery hybrid generators provide both regulation and contingency FCAS. Trial outcomes have noted the commercial and economic benefits of including inverter connected sources in ancillary services market participation. There are now numerous wind and solar aggregators providing ancillary services in the Australian National Energy Markey (NEM). Now in every jurisdiction of the NEM either wind plant or solar aggregators are registered to operate in the FCAS market.

- Saulo Cisneiros, Brazil

There are wind and solar plants installed in the transmission and distribution grid of the Brazilian power system. Wind plants are normally installed in centralized plants and solar PV plants are installed in centralized plants as well as in micro and mini distributed generation.

- J. Mello, Brazil

In Brazil, the growth of utility-scale renewables has been consolidated with stable regulations and competitive prices. The growth of DERs has been fast due to the attractive regulatory incentives combined with higher avoided costs (full tariff) and competitive CAPEX. In the context of utility-scale DERs, naturally, there is no market and limitations in transmission infrastructure for potential projects in the coming years will result in an intense competition. Renewables are unbeatable in the context of energy price. A large set of projects (off-shore mainly) will be dedicated to “green hydrogen” production. In the context of DERs, large-scale expansion will be expected in commercial and residential users (currently 77% share). Solar PV currently represents 98% of total capacity of DERs in Australia – remote sites and on-shelter. Distribution utilities must be prepared to operate the large volume of DERs, modernizations are expected. Efficient production and regulatory incentives are the main “drivers” to consolidate renewables.

4. CONTRIBUTIONS TO PREFERENTIAL SUBJECT 2

The subject "The Evolution of Market Design and Regulation to Integrate Distributed Energy Sources" covered the following sub-topics:

- The lessons for markets and regulation from major system disturbances and social disruptions.
- Market designs for reliability and resilience in systems with high penetration of asynchronous and low inertia connected facilities.
- Markets to co-ordinate resources that are not responsive to demand or price.

Fifteen (15) papers from twelve countries (Australia, Brazil, China, Columbia, Greece, Ireland, Japan, Netherlands, Oman, Russia, Slovenia and USA) are selected which discussing following main themes:

(a) Evolving metrics for resource adequacy assessment, energy crisis and fuel adequacy
(b) Reserves assessment, capacity market and imbalance market design.
(c) Market monitoring methodologies.
(d) Transmission network expansion and regulatory mechanisms.
(e) Frameworks to ensure reliable operations in view of declining system strength
(f) Joint economic despatch over multiple regions.
(g) Challenges and resilience in dealing with Covid-19 pandemic.
(h) Curtailment of renewable generation for reliability and compensation thereof.

The Special Report summarised the PS2 papers and posed the following questions.

1. How are short, shallow, and frequent events distinguished from long, deep, and rare (low prob- ability high impact) events and factored in the resource adequacy studies? How are fuel adequacy, fuel transportation and transmission issues factored in the resource adequacy studies? Considering the large amount of data associated with resource adequacy studies, how are visualization and stakeholder communication challenges handled?
2. Individual components of renewable forecast error, load forecast error, schedule changes and unforeseen load changes are used in the formulation for assessment of reserves (e.g. in Greece). Area Control Error (ACE), which combines these is another approach. How do the methodologies compare? What risks arise from the implementation of "coincidence factor" leading to overlapping of the procured reserves in interconnected systems with multiple jurisdictions and can these be mitigated in real time operations?
3. What changes to capacity market design are required to assist in achieving carbon neutrality and to effectively prioritise renewable energy generation in a multi-source or hybrid procurement. Is this a the role of capacity markets? Is there a possibility of using a double-sided auction in the capacity market where multiple buyers and multiple sellers bid simultaneously? What is the possible market design in such a case including price discovery?
4. With increasing penetration of DERs, balancing is becoming increasingly challenging. Will a differentiation between the generation and consumption in imbalance settlement create incentives for BRPs to take actions for better balancing their systems? Is location also a factor in determining the imbalance pricing e.g., a congested zone? Should imbalance pricing be linked to frequency, as in some jurisdictions like ENTSOE, South Africa and India?
5. How is the implementation of the three-stage process of market monitoring (behavioural, structural, and economic) carried out in practice and how are cross-border transactions considered? How is monitoring possible for the positions taken by participants in the fuel market (in that it is linked with the electricity market?
6. What are the possible cost sharing mechanisms for the proposed cross-border interconnections, such as those which extend to Europe, North Africa and South Asia? How are despatch mechanisms coordinated? What are the challenges faced in applying the RPI-X regulation; in particular, the incentives (or lack of incentives) in the development of transmission system? What method is used to determine 'X' factor and how are uncontrollable costs considered? How does this compare with other incentive-based regulation methods?
7. What is the mechanism for declaring the largest credible contingency considering generation contingency and network contingency? How is the next alternate contingency decided and on what basis?

8. Inverter based resources (IBRs) utilizing the grid following technology need a certain level of system strength to maintain stable operation and, *per se*, do not contribute to system strength. Whose responsibility should it be to provide enough system strength services to ensure stable operations– transmission service provider or the generators? If the latter, then how does the generator provide this and how are costs recovered? Does making the generator responsible for system strength requirements create an entry barrier for renewable generators?
9. What are the lessons learned during COVID-19 induced crisis that can be applied for the improvement of the market designs to be more flexible and prepared for prompt reaction in such or similar large market disturbances? Recovery from COVID-19 pandemic has also resulted in an energy crisis being faced by many countries across the globe. What steps can be taken in short-term and medium/long term horizons?

In response to the questions above, 12 prepared contributions have been received from Brazil (2), Australia (3), Russia (2), Japan (2), Netherlands (1) and Ireland (2) have been received. A summary of the contributions received is as follows.

Prepared Contributions:

Question 1 dealt with evolving metrics, fuel adequacy, data visualization and stakeholder communication for resource adequacy (RA) assessment in the changing energy resource mix. The following contributions were received:

- J. Mello, Brazil: Contribution presented the methodology adopted in Brazil, where hydro generation is the major source of generation and variability of inflows needs to be considered in the resource adequacy assessment. The hydro inflow sequences are collected since 30́ s and large set of variations are considered in resource adequacy studies to define the best balance of supply, for short, mid and long-term applications. Concerning visualization and stakeholder communication of resource adequacy studies, all of important criteria and results for planning and operations are submitted to public hearing.

- B. Vanderwaal, Australia: Contribution presented multi-period resource adequacy assessment ranging from short-term, medium-term to investment time horizon. Integrated system plan including least cost generation study, transmission expansion and operational & security aspects is also mentioned. The nature of unserved energy events are forecast to remain as a mix of high impact low probability (HILP) and more frequent shallow supply shortfall risks. With the benefit of planning, consultation and publication of the modelling the market is seeking stronger contribution from the demand side, identifying opportunities for both shallow and deeper long duration storage, and valuing the beneficial aspects of transmission network investment. A number of key visualisations are provided in the accompanying contribution presentation.

Question 2 dealt with reserves assessment methodologies and following contribution was received.

- Tomohiro Inoue, Japan: Contribution describes the inadequacy of the reserves during the recent energy crisis with high prices primarily resulting from fuel shortage (LNG). Maintenance of adequate reserves through effective management of the fuel supply & associated logistics is mentioned. The allocation & recovery of costs of such reserves is also provided.

Question 3 dealt with capacity market design to achieve carbon neutrality and the following contributions were received.

- A. Downey, Ireland: Contribution presented that Ireland and Northern Ireland have a Capacity Market based on centralised auctions of reliability options. Capacity providers including conventional thermal, hydro, interconnectors, batteries, wind, solar all compete alongside each other to provide reliable capacity to the power system. The approach taken in Ireland and Northern Ireland is to design the market for energy, capacity

and system services around the needs of the power system, which in the case of a Capacity Market is reliability, rather than basing the design on any one technology required to meet those needs. Capacity markets form part of the revenue stream for renewables insofar as they contribute to reliability and are also needed to provide for the capacity that is needed to meet the net demand – in a longer term zero carbon world this is demand response, storage, interconnection and flexible hydrogen / biogas fired turbines. Results of the capacity auction for 2025/26 are also presented.

Question 4 dealt with balancing and imbalance pricing design and the following contributions were received.

- H. Sakai, Japan: Current capacity markets assess supply capacity only for a "year" after four years, long-term revenue projections and consequently, investments are difficult. It is necessary to support the establishment of new power sources by ensuring the predictability of fixed cost recovery. Mechanisms for ensuring investment in renewable sources including future energy sources like ammonia & hydrogen was mentioned. In the short run, LNG is also targeted to meet the electricity demand.

- F. Nobel / D. Klaar, Netherlands: The impact of integration of increasing volumes of energy from variable renewable sources in three European countries is presented and discussed. The impact on the balancing energy and capacity demands of the TSOs are explained by imbalance pricing methodologies. Three country specific examples are presented in the paper where introduction of, or strengthening of imbalance price incentives to BRPs were followed by a gradual decrease in their TSOs' Balancing Energy demand, over a few years. The relative 'strength' of imbalance price incentives to BRPs is reflected in the spread between the average imbalance price for short BRPs, when system is short, and the average imbalance price for long BRPs when system is long

Question 5 dealt with market monitoring including behavioural, structural, and economic aspects and covering different market segments. Following contribution was received.

- M. Dolmatova, Russia: The three stages of market monitoring were presented. In the first stage, bids submitted by market participants for the day-ahead electricity auction are monitored on the daily basis before the market is cleared. Second stage monitoring process deals with market outcomes and is fulfilled on the daily, weekly, monthly, quarterly, and yearly basis. The third stage includes typical competition measures as well as adjusted Residual Supply Index and Parameters Dependent Index.

Question 6 dealt with cost-sharing mechanisms among multiple parties involved in cross-border interconnection projects and the following contribution was received.

- M. Needham, Ireland: There has been a history of 16+ years of successful cooperation and cost-sharing between the two system operators in Ireland Both system operators have licence obligations to confer and cooperate with each other in order to plan their respect grids on an economic and efficient basis. The two system operators are registered separately as part of the Inter TSO Compensational scheme although cost of losses tend to be similar.

Question 7 dealt with assessing largest credible contingency, next alternate contingency in the context of inertia assessment in systems with high variable renewable energy penetration and no contribution was received.

Question 8 dealt with system strength services in systems with high inverter based resources (IBRs) penetration, responsibility thereof and cost sharing mechanism. The following contribution was received.

- D. Bones, Australia: Contribution mentioned that often the transmission network service providers is better placed to identify and implement efficient system strength solutions. In these situations it may be more cost effective for the network service provider to determine the appropriate remediation options and implement

those options. Appropriate allocation of costs is also important which should recognise the various factors driving the system strength requirement.

- G. Thorpe, Australia: Under the Australian National Electricity Rules, Transmission Network Service providers (TNSPs) must plan to provide the suitable system strength to support inverter-based resources (IBR) connections that are forecasted by AEMO. New access standards also require generators, loads and market network service providers to guarantee the demand for system strength. Generators and large loads may choose between paying for using the system strength services provided by TNSPs or build their own system strength.

Question 9 dealt with lessons learned during COVID-19 pandemic in terms of market design issues and improvements thereof and the following contribution was received.

- Andrey Sviridov: The contribution mentioned about the impact of COVID-19 on the prices & volumes in Russia during 2019, 2020 and 2021.

Spontaneous / Floor Contributions:

The discussions were very interactive with the participants showing keen interest in the papers & contributions under PS2. Participants from the audience made extensive observations/remarks and posed questions for the contributors covering the following related themes:

- Methodologies for resource adequacy assessment, visualization, and communication challenges
- Fuel adequacy for ensuring resource adequacy and use of alternate fuels in case of fuel shortage in dual fired generators.
- Prioritising technology options in Capacity Markets in the procurement process to meet clean energy objectives.
- Imbalance pricing methodologies including differentiated imbalance pricing across different actors.
- Derating of generation from different technologies in capacity markets which need to evolve to get the kind of generation fleet while at the same time ensuring reliability of supply.
- Market monitoring techniques (behavioural, aggregated market based and thirdly, integrated with economic parameters) to prevent market abuse and market power.
- Framework for system strength in systems with high penetration of IBR resources, obligation to provide system strength services, responsibility for the associated costs during new generator interconnection process.
- Lessons learnt from the impact of extreme events like COVID-19 pandemic on the electricity market.

5. CONTRIBUTIONS TO PREFERENTIAL SUBJECT 3

The subject "WORKING WITH INNOVATION AND DISRUPTION— PREPARING FOR THE FUTURE" covered the following subjects:

- Innovative approaches to markets and regulation to achieve energy policy targets and to include edge-of-grid activities.
- The design and structure of retail and wholesale electricity markets to support capital-intensive investments.
- Sector regulation and tariff design in the face of technological disruption, e.g. vehicle to grid, hydrogen and new forms of storage.

Fourteen (14) papers from ten countries were selected selected which discussing following main themes:

(i) Does the carbon pricing have full effectiveness for power sector?
(j) Electric vehicles and the urgent issues for their widespread introduction is the development of electric charging infrastructure in the country
(k) Energy Management System for Multi-region Digital Power Supply targeting to Carbon Neutrality.
(l) Ireland and Northern Ireland having and managing one of the highest levels of variable renewable generation on a synchronous power system in the world.
(m) The Greek demonstration of the CoordiNet project focused on providing ancillary services from Distributed Energy Resources (DERs) located in the distribution grid.
(n) Seeking a smooth transition in the Australian National Electricity Market
(o) National Electricity Market of Singapore (NEMS): Transition Experience
(p) Fair and efficient management with compensating losses
(q) Evaluation of imbalance reduction by battery utilization and aggregation
(r) Market Structure for a Decarbonized New York Electricity Market
(s) Synergic network and the Synergic network model

The Special Report summarised the PS3 papers and posed the following questions.

Decarbonization is a focus of many governments. How can we value carbon pricing and what models would be recommended to realize the value offered by flexibility from innovative technologies like DER's (including BESS and EV's) ?
Mr Joao Mello – Talked about carbon policies in Brazil. Asked if the carbon pricing have full effectiveness of power sector especially with the growing participation of non-synchronous intermittent sources with retirement of dispatchable creates a worrying vicous cycle. As a result, price for end customer increases, dispatchability issues happens. He proposed an idea to move from the Vicious to Virtuous cycle. Key takeaways are that past policies seem to not hit the issue, climate change events show no unique solution. Suggestions are to incorporate power system stability and decarbonization of projects carried out in existing power plants

What policies are driving innovation across different jurisdictions when it comes to tariffs, DERs, EVs etc., in markets and how can they be enhanced to drive more adoption across the board.
Mrs Remizova (presented by Mr Andre) - When it comes to electric vehicles, one of the urgent issues for their widespread introduction is the development of electric charging infrastructure in the country (along with its own production of electric vehicles and subsidizing their purchase). That is why in the directions of state policy in France, Germany, China, designed to stimulate the transition to electric vehicles, you can also see the development of charging infrastructure. Plans by countries and companies to develop charging infrastructure was also presented.

Are other jurisdictions offering or considering offering wind and solar PV (distributed), BESS and EVs in providing ancillary services directly or via aggregators? Are there existing business cases for this and is hybridization a viable option? What are the biggest challenges faced with the changing mix of generation, new responses to the providing ancillary services and innovative generation connection proposals?
Mr Tomoyuki - To address these problems of lack of space near consumption sites and unstable power supply due to renewable energy resources, this paper proposes a new concept called "Multi-region energy management". This will allow companies to achieve each site's decarbonization target while optimizing energy supply and demand at multiple sites by exchanging renewable energy outputs using existing power grids.

Mrs Delaney - Ireland and Northern Ireland have one of the highest levels of variable renewable generation on a synchronous power system in the world. It is now operational policy for the power system on the island to accommodate up to 75% System Non-Synchronous Penetration (SNSP). SNSP is a metric which measures the non-synchronous generation on the island systems at an instant in time and therefore quantifies the level of demand that is met by generation resources other than synchronous units (i.e. wind and PV renewables and HVDC imports). The current focus for Ireland and Northern Ireland is to develop a set of future arrangements for system services which procure system services primarily through short term auctions.

Mr Voumvoulakis - The Greek demonstration of the CoordiNet project focused on providing ancillary services from Distributed Energy Resources (DERs) located in the distribution grid. More specifically, the services that were examined were congestion management and voltage control of both transmission and distribution network. The project outcomes show that for these types of services the bid location is required due to distribution network radiality.

Mr Thorpe (NEM) - Seeking a smooth transition in the Australian National Electricity Market. The Australian National Electricity Market NEM is in transition from one which was highly dependent on coal fired power stations for the provision on energy, capacity and system services to a decarbonised market. The transition has been progressing over the last decade which has seen strong growth of wind and solar generation at utility scale and distributed rooftop solar. The NEM has reached instantaneous levels of variable renewable generation in excess of 60% at times with instantaneous levels in excess of 140% in the South Australian region. The growth of variable renewable resources has lowered emissions and lowered spot market prices in many dispatch periods. The transition has not, however, always been smooth and there have been negative impacts at times on incumbent generators, new generators, and customers.

Mr Kosakada – The contribution covered the evaluation of imbalance reduction by battery utilization and aggregation. A simulation was conducted by using data from 102 resources in 7 areas. It was confirmed that the imbalance of renewable energy generation can be reduced by the optimal charge / discharge control of the storage battery, and by increasing the scale of BG by the aggregator.

What is the impact of the current energy transition on reliability and cost? What market structures should be put in place to ensure a smoother transition to the market of the future to support a fully decarbonised grid?
Mr Thorpe (Singapore) - Singapore has limited renewable energy potential due to space limitations. They also have gas-fired generation. Today the the energy transition impact on Singapore's power system reliability is minimal. The Singapore grid continues to be one of the most reliable in the world. Other energy sources are being considered in the mix. Expert Committee deemed is realistic for Singapore's power sector to aspire to achieve net-zero emissions by 2050, even though it will be challenging due to uncertainties in geopolitical trends and technological advancements in the energy space.Recommended strategies include pursuing the adoption of electricity imports, using more ESS to manage solar intermittency and shape end user consumption patterns to optimize the power system.

Mr Goutaland - low-carbon pathways foster the design of alternative energy systems. But energy justice scholars have shown that energy systems generate unfair situation and they call for alternative decision making. The research project, led by French TSO RTE and the Center for Management Science at MINES Paris PSL, aims studying the links between the design of electric networks and fairness issues. In order to model them, we consider norms as designed object having the functions to enable efficient action and propose fair allocation. The special report stresses practical blinspot of the research program we proposed in the article raising the following question: how to implement fairness logis and who is to responsible for them ? I partially answer this question using a case study given by the critical European electric shortage situation for Autumn 2022 and Winter 2023. A distinct allocation authority is still to be designed to account for the heterogeneous benefits of preserving electric network’s integrity.

Mr. Nascimento - In response to the question, Mr. Nascimento of Brazil, introduced a synergic network leveraging data transmission using the fiber optic infrastructure with a detailed synergic network model. The conclusion was that such a network was more secure, less subject to vandalism, has a higher performance, higher availability.

What are the lessons learned from dynamic pricing pilots and what regulatory support structure is needed to get them implemented? What can the international community learn from the real-time market implementations in different jurisdictions including India in the context of innovations like DER's and renewables?
What type of equipment, if any, are the consumers using for control of their price response (Automatic or manual type of control)? Is a finer granularity of smart metering required to improve baseline estimation? What baselining methods, including measuring load shifting before and after the peak-price period are used.

In response to the questions above, 11 prepared contributions have been received. A summary of the contributions received is as follows.

Spontaneous / Floor Contributions:

The discussions were very interactive with the participants showing keen interest in the papers & contributions under PS3. Participants from the audience made extensive observations/remarks and posed questions for the contributors covering the following related themes covering the first four questions.

Questions with no prepared or spontaneous contribution:

Question 5 dealt with the lessons learned from dynamic pricing pilots and what regulatory support structure is needed to get them implemented? What can the international community learn from the realtime market implementations in different jurisdictions including India in the context of innovations like DER's and renewables?

Question 6 dealt with the type of equipment, if any, are the consumers using for control of their price response (Automatic or manual type of control)? Is a finer granularity of smart metering required to improve baseline estimation? What baselining methods, including measuring load shifting before and after the peak-price period are used.

6. CONCLUSION

The SC Chair thanked all contributors and participants for their inputs.