

**C5 - 00****SPECIAL REPORT FOR SC C5  
(Electricity Markets and Regulation)**

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**Special Reporters**

**General Information**

- The **Pre-meeting** (for meeting with contributors/presenters):

**Tuesday**, 28th August 2018

Room: 364 (3rd Floor)

Time: 9 AM – 12 Noon

- **Group Discussion Meeting / Paper Session**

**Wednesday**, 29th August 2018

Room: Havane Room

Time: 8:30 AM – 6 PM

- Deadline for contributors to send their formal contributions is **30th June**<sup>1</sup>

- **Introduction**

Study Committee C5 focuses on the analysis of 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 C5 scope also includes the role of competition and regulation in improving end-to-end efficiency of the electric power system.

The 2018 Discussion Session Preferential Subjects center on three aspects of the drivers for changes in Electricity Markets and the Markets' responses to those drivers:

PS 1 - *The need to change business and regulatory models driven by increase in distributed resources, storage and demand response*

PS 2 - *The Impact of Climate Policy on Electricity Markets*

PS 3 - *Localized Markets or Microgrids Interacting with Wholesale Markets*

- **2018 Group Discussion Session**

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## **2.1. PS 1 - The need to change business and regulatory models driven by increase in distributed resources, storage and demand response**

- Evolution of regulatory models given reduction in revenue and negative load growth.
- Evolution of regulatory models to accommodate distributed and / or renewable resources in a challenging economic situation.
- Optimal evolution of markets at all levels.

### **Preferential Subject 1: Paper Summaries**

#### **SC 5 101: Regulatory model to accommodate distributed and renewable resources in a challenging economic situation: Brazilian experience**

A review of the (ambitious) targets for distributed generation in Brazil. The paper highlights a number of barriers to entry for renewable technologies within the existing rules and how these are being removed.

The paper notes distributed generation will play a major part in future electricity systems. A comprehensive suite of objectives, legislative, commercial and technical changes is described and is valuable for that reason, albeit the details are inevitably those needed for Brazil. There is note of the role of the promotion of changes for distributed generation as instrument of social policy.

An interesting feature of the arrangements is that behind the meter production (from rooftop PV) is exported in to distribution company and returned in kind, there is no payment or FIT but the timing of return must consider different tariff levels. Access arrangements require connecting renewable gens to pay for metering but any impact on network is the responsibility of the distributor.

Reviewers note: a system of 'return in kind' is obviously simple but runs the risk of misalignment of value. How material – depends on the details of the prevailing tariff and the accuracy with which energy can in practice be returned at similar value. The comprehensive nature of amendments is impressive.

#### **SC5 5-103: The estimation of the value of lost load (VoLL)**

This paper presents a wide-ranging review of the role of VoLL, its different forms, its link to Market Price Caps, how it is measured and how it is used in a number of market designs with emphasis on the Italian market. The paper notes that the VoLL is used in similar ways in different markets but there is no common definition or approach to measurement

The paper describes four (well known) approaches to measurement of VoLL:

- Revealed preferences: whereby the behaviours of market customers are observed (for example holding standby generation plant in an industrial complex) and implying the customers' VoLL from their actions;
- Stated preferences: based on surveys of willingness to pay (WTP) for additional level of reliability or willingness to avoid (WTA) reduction in reliability of supply;

- Proxy measurement; whereby indirect measures such as cost of loss of production are used to define the VoLL;
- Case studies; where the cost to the community and economy of particular events is assessed after an event where customer demand has been reduced.

The paper notes the four approaches each have advantages and disadvantages but does not suggest one is better than the other(s).

The application and importance of the VoLL in a number of areas of the electricity industry (e.g. generation, transmission) and in different countries (e.g. UK, Italy and also tables showing the wide range of values for the VoLL. The paper also highlights the distinction between investment (or adequacy) and operational security noting the connection between VoLL and ancillary services, an area that is not always well handled.

Interesting details of the Italian capacity mechanism are provided including the construction of demand curve and market price cap and correlation of LoLE (measured as hours at risk) and VoLL.

The paper concludes by noting the importance of a ‘coherent’ application of VoLL and the role of regulators in ensuring this occurs.

#### **SC 5-104 Imbalance Pricing in the context of the third and fourth energy packages – The new balancing market arrangements in Ireland and Northern Ireland**

This paper presents a good overview of changes to the market design for Ireland and Northern Ireland. Note is made of the need to work within a number of objectives including alignment with other European markets and response to changing technology mix as the percentage of distributed and intermittent resources. Note is also made of the relatively weak correlation between wind and solar output and current demand and the efforts to shift the profile of demand closer to that of available generating capacity by empowering demand (response).

The new markets arrangements are to comprise a capacity market, day ahead market, intra-day market and a sophisticated 5-minute balancing market with a price set to the marginal cost of meeting demand. The design of the day ahead and intra-day markets is linked to similar markets in Europe and Great Britain. System services play a prominent role in creating market mechanisms to maintain reliability of supply in the presence of significant percentage of intermittent and asynchronous generation. The weak correlation of intermittent generation and demand is leading to a relatively heavy de-rating of intermittent capacity in the capacity market.

The paper includes a description of the arrangements developed to ensure balancing prices and volumes are accurate reflections of participant imbalance and are separated from system security constraints. This is a challenging task in any design and note is made of the trade-off between complexity and accuracy appropriate for the Ireland and Northern Ireland networks and generation mix showing yet again the need to recognise local conditions and circumstances to ensure a fit for purpose design.

### **SC 5-105: Electricity Tariff Structure Review in Iran (Identifying and analyzing the most influenced factors)**

This paper provides a detailed analysis of the structure of electricity pricing in Iran and benchmarks Iran's tariff against a number of other countries. The benchmarking analysis is based on the American Process Classification Framework (APCF) and provides detailed statistical comparisons. The paper notes the significant influence of social objectives in the formation of tariffs but as a consequence that tariffs do not recover the costs of the industry it also distinguishes between overall subsidy and cross-subsidies within the industry.

Most of the other papers in this preferential subject are discussing changes to business models and integration of distributed resources, storage and demand response from the perspective of changes needed to respond to changing technology. These changes are often designed to overcome distortions or approximations that are now out of date.

Paper SC-105, on the other hand presents a first principles analysis of tariffs in an industry where revenues are, by design, well below cost and therefore unable to provide price signals for efficient decisions. However, it would appear there is an opportunity for tariff reform that moves directly to an efficient structure for pricing of emerging technologies.

### **SC 5- 106: The impact of shorter intraday market gate closure on regulation reserves**

The paper focusses on the gate closure period in the Portuguese electricity market within the context of Iberian electricity market comprising Portugal and Spain. The paper provides a description of the key features of the market design and policy initiatives of government and the European Commission. Note is made of the need for change to gate closure in light of increasing ramp rates of solar-PV.

A notable feature of the market design is the current multi layered gate closures involved in day-ahead and intra-day trading. The paper describes a hybrid arrangement which integrates aspects of the Portuguese and broader European market arrangements.

The paper reports on quantitative analysis of the impact on cost of reserves and discusses the potential to significantly reduce gate-closure times and also notes there is an open question as to whether to retain the current 6 intra-day trading periods or to increase the number. The quantitative results show increasing cost of reserves are likely for increasing time of delivery and a meaningful reduction in cost if gate closure is shortened. However, the paper also expresses a note of caution around pricing outcomes related to the pay at bid design for out of merit dispatch.

Overall the paper highlights the level of attention needed to ensure robust outcomes from interactions between technical operation to maintain security of supply and commercial operation across market and international borders as technology and policy shifts.

### **SC 5-107: Indian Electricity Market – Data Analysis of a Decade of Experience**

The paper provides a description of the design of the Indian electricity market. It traces the evolution of the design as a precursor to discussion of recent changes prompted, at least in part, by changing characteristics of generating plant as the level of renewable generation grows. Key features noted include the use of decentralised scheduling and dispatch based on contract schedules as the basis for operation with voluntary participation in the Spot Market. The market has arrangements for congestion management, contract balancing payments and ancillary services,

In addition to a review of the overall market the paper notes a number of established initiatives related to use of renewable resources including Renewable Energy Certificate scheme which creates obligations for purchase of certificates. A national platform for trading RECs has been established. An Energy Efficiency regime was established in 2012 along with a mechanism to trade the certificates.

More recent developments to facilitate additional renewable technologies noted include:

- Point of Connection Transmission pricing which dynamically prices transmission access as a function of distance, direction and power flow. Note of initial volatility in the price is noted and the subsequent shift to averages, which appears to be successful. A similar approach is used for losses. Values for both are approved by the Regulator; and
- Another area of development in response to increasing levels of renewables relates to 5-minute markets for a number of ancillary services to manage high ramp rates and reduce the level of reserves that need to be scheduled. (Interestingly managing the amount of reserve is an objective of gate-closure changes in the Portuguese market discussed in paper SC 5-106 achieved through somewhat different mechanism.)

### **SC 5 – 108: Towards a Common Target Regulatory Framework. Harmonising Technical Rules for the Mediterranean Power Systems from a TSO perspective**

Paper 108 deals with technical components of a wide-ranging project to harmonise the market arrangements in Mediterranean power systems aiming to enhance security of supply, manage prices for electricity and also facilitate growing levels of distributed, storage and demand response facilities. The paper is therefore describing how the impact of these new technologies is influencing the design of new arrangements without being the sole reason for new arrangements as it is in other cases.

66 technical issues have been selected for inclusion in the Common Target Regulatory Framework and much of the paper describes these issues which are driven by the objective for harmonisation. The paper includes note of which issues are to move to a common approach and which are to remain matters for local control from details of communication protocols through to frequency control and fault ride-through standards. Particular attention is paid to the benefit of a high level of harmonisation of technical rules in light of the renewable plant.

Overall the range of matters included in the project and noted in the paper is extensive and provides a useful reference for similar work elsewhere and also notes how local conditions have influenced the outcomes.

### **SC 5-109: Exploring multi-services business cases for a storage unit in various grid schemes**

This paper presents details of a multi period, mixed integer DC OPF based analysis of the economic application of storage to managing congestion with particular reference to optimising renewable energy resources. The analysis is based on a representative network configuration with renewable resource connected via single radial line although there is note of issues to allow the approach to be applied to meshed networks. The construction of constraints and detailed results are presented.

Much of the paper is devoted to presentation of detailed case studies but it has particular relevance to the preferential subject because it presents an analytical technique to undertake cost benefit analyses of storage size and number of facilities, network congestion and the trade-off between additional storage and curtailment of renewable resources. Note is made of the potential for storage to allow temporary deferral of network augmentation and evaluation of renewable investment behind potentially congested parts of a network.

### **SC 5-110. Network tariff design in evolving electricity markets**

This paper deals with the impact of renewable resources on network tariffs. It reviews the changes in the role of networks as connection of embedded and intermittent generation resources has grown and highlights the technical and commercial implications on TSOs in particular issues around tariff design. Data from the French network is presented to illustrate.

The paper then suggests principles for design of tariffs including:

- Cost Recovery
- Non discriminatory
- Economic Efficiency
- Simplicity
- Stability
- Feasibility
- Acceptability

The paper then briefly considers a number of issues involved in meeting these principles including: capacity versus volumetric charging, generator charges, whether prices should reflect volatility (of use of a network) and understanding of price elasticity.

The paper has relevance to the preferential subject as tariffs, designed for different technologies and a different era are often a barrier to deployment of newer technologies in particular storage where facilities frequently switch between demand and supply sides of the industry and therefore averaging features of existing tariffs are distorted.

## Preferential Subject 1: Questions

- 1.1 Many of the papers submitted noted that, in part, the reason for many recent changes to rules is a desire to lower emissions or simply to increase use of renewable technologies driven by external policy requirements and mandates. This question addresses the impact on cost-benefit analyses of these external influences. Traditionally, cost-benefit analyses considered internal costs such as construction and fuel and (sometimes) elasticity of customer demand. However, wider policy and social impacts are now material.
- a. Are approaches to cost-benefit approaches responding to increasing uncertainty?
  - b. To what extent do techniques and rules need to be amended to factor in broader social and policy factors – how can this reliably be done?
- 1.2 As the papers for this subject are showing, development of distributed resources, storage and demand response are requiring changes to existing, but often mature, regulatory models.
- c. What is the view about whether regulatory models can cost-effectively price even more complex and interlinked operating characteristics (including very fast response, inertia and system strength)? Or, will there need to be greater reliance on technical performance standards?
- 1.3 Typically market designs focus on optimising across an entire market or power system but many of the developments in technology, such as micro-grids and computing power that facilitates peer to peer trading, are implemented locally.
- d. Is there a need to rethink the market wide optimisation philosophy – for example for rules to focus on cooperating local sub-markets.
  - e. To what extent will there be a need to make distribution system operators central facilitators of future markets?
- 1.4 Paper C5-103 looks at techniques to assess VoLL and notes that a VoLL appropriate to investment may be different to the VoLL for operational risks as the impact of operational risks (generally managed through technical standards within rules and codes) are quite different to those for inadequate investment.
- f. What are the views of C5 panels as to whether there is a need for separate consideration of VoLL for operational management of power systems?
  - g. Are there examples where operational standards have been set considering economic impacts of operational disturbances (system black in the extreme)?

1.5 Storage can contribute to the efficiency of investment and operational costs in supply, demand and in networks. Paper 109 provides analysis of the benefits in each sector on a representative network.

- h. Do C5 panels consider that market rules will allow these contributions to be achieved simultaneously in practice and accordingly there is generally a need to amend rules to achieve the full economic benefit of storage?
- i. Are there examples where such amendments have been (or are being) made?



## 2.2 PS 2 - **The Impact of Climate Policy on Electricity**

- Methods to adapt electricity markets given the trend to zero marginal cost resources and feasibility of such evolution.
- Market response to public policy driven intervention and methods by which markets can be utilized to implement public policy.
- Market design or regulatory changes that can be considered to make markets more resilient to such intervention.

### **Preferential Subject 2: Paper Summaries**

#### **SC5–201: Electricity Network Codes: A success story?**

This paper has demonstrated the complexity of drafting a full set of legally binding principles to establish and underpin the internal electricity market and the scale of resource devoted by a broad variety of different stakeholders in European power market. Despite of that, the progress of market integration in Europe over the last 15 years has been remarkable. While steps are still needed to formally complete and while progress may have been slower than policy makers may have hoped, Europe has the most integrated electricity market anywhere in the world and consumers are seeing benefits from that. The ENC's (Electricity National Codes) have certainly played a role in driving market integration and in converging standards and practices, particularly in areas where this had not developed on a voluntary basis. The areas covered by ENC's are: i) Connection Network Codes; ii) Market related Network Codes; and iii) System Operation Network Codes.

#### **SC5–202: “Implications of the Integration of Renewable Energies into the Electricity Market of Greece”**

This paper proposes an investigation of the Greek electricity production and transmission system with a focus on the integration of renewable energy sources. The paper includes the effects of an increasing electricity demand on the electricity production with respect to solar/PV and wind power capacities, the imports, the age structure of the power plant and the CO<sub>2</sub> emissions. The paper uses a techno-economic model of the Continental European electricity sector called ATLANTIS to analyse the Greek power system. The national development strategy of Greece until 2027 has been chosen for the simulation. The results show an increase in electricity imports from some neighbouring countries, a high increase in renewable energies production and a reduction of the CO<sub>2</sub> emissions in the Greek power system. The paper notes that the shorter technical lifetime of the renewable energies has to be considered in the future development strategies and concludes that the future expansion of renewable energies technologies after 2017 imply a further grid expansion.

#### **C5-203 - Revenue Stacking for Battery Storage Projects from a Technical and Risk Perspective in the UK**

In this paper, the author points out that the adoption of utility scale energy storage projects is at an early stage, which ends up exposing their stakeholders to high levels of technical, commercial and regulatory uncertainties. Thus, to come up with a contribution to such stakeholders, the article presents a qualitative view on which revenue streams are accessible

to battery storage projects and explores the risks when stacking different revenue streams together. Services that are considered in this paper are: (i) Ancillary services to the Transmission system operator (TSO); (ii) Participation in the capacity market; (iii) Flexibility to electricity suppliers; (iv) Network support services to the local Distribution Network Operator (DNO); (v) Energy capture in constrained areas to benefit co-located generators. Some services impose large uncertainties to providers, such as triad avoidance, which can subject the company to material liabilities in case of impossibility to deliver. Regulation has been under review, since unintended and inefficient outcomes have been achieved because battery technology came after most of the regulation had been written. Nevertheless, the article concludes that it is possible to operate battery sites to access multiple revenue streams simultaneously through the year.

#### **SC5-204: “Analysis of the Current Carbon Tax Implementation in the Chilean Electric Market and Future Regulatory Developments to Allow Effective CO2 Reduction”**

This paper analysis some scenarios of carbon tax applied per ton of carbon dioxide (tCO<sub>2</sub>) emitted by stationary plants of a least 50 megawatts (MW) in the Chilean electric market starting in 2017. These scenarios are selected to help understand the main underlying relationships, transition points in the generation mix, and broad types of policy effects. The authors developed a unimodal optimization model for the expansion of the energy mix assuming that investments in generation take place in a centralized way. The paper uses Ose2000 model to determine the operation of the generation fleet as it exists and as it evolves according to results from the expansion planning results. The paper presents three different changes to current regulations: Emissions from i) “no tax scenario” ii) “tax not included in variable cost” iii) “tax included in variable cost”. The paper concludes that the current approach is not consistent with the sustainability of the electricity sector. The tax inclusion in the variable costs will lead to more efficient utilization of the existing fleet.

#### **SC5-205: Revision of the French capacity market**

This paper describes the recent implementation and enhancements of capacity market in France in order to better ensure the security of local supply and in European framework as a whole. The French capacity market has been revised to match European Commission requests. Some original features have been kept unchanged from original market design, such as the opening to all potential types of capacity providers and its market-based framework. Evolutions of the French capacity market are concentrated in to competition improvements; long term signals for investment in new capacities; cross-border participation. These capacity market revisions have been investigated in other marketplaces in Europe to reach a better coordination of national schemes.

#### **SC5-206: Challenges and Measures to Integrate Renewable Energy Sources and Storage Means in the Brazilian Power System and Electricity Market**

This paper presents the challenges that are emerging in the Brazilian electrical system with the considerable increase of intermittent sources and alternatives to implementing storage resources. The characteristics of variability and uncertainty of wind generation cause immediate and strategic consequences: raise planning resource adequacy for long and short

terms, providing adequate transmission facilities to incorporate these sources, managing increased system reserve and ancillary service requirements among others. The challenges faced in the Brazilian system in resource adequacy assessment, system planning and operations, and market performance, are also described. This paper addresses some benefits that the storage can provide to improve the performance of wind generation, for example, and proposes some ways to implement it in the power grid.

### **SC5-207: Mexican Energy Reforms: Mexico's Path to a Clean Economy**

The paper presents the recent Mexican energy reforms to reach a rapid evolution to a competitive market place. The expansion of power generation capacity has been accelerated based on long-term auctions. A remarkable growth in renewables has been observed based on the long-term auctions, which were designed to meet new government mandates of large share renewable generators by 2024 in Mexican power matrix. A market for a Clean Energy Certificate - CEL will provide an additional revenue stream flow for new renewable projects. The market reforms also include other features to become more competitive and the investors are confident on system developments on this new framework. Enhancements on power market pricing are under development, and besides a critical issue to be solved is to increase market participation.

### **SC5-208: The Design and Modelling of China's Electricity Market Mechanism of Renewable Energy**

The paper discusses some issues related to China's renewable energy power generation. The rapid growth of renewables has been substantial, which becomes wind and solar power a relevant share of generation in China, and even worldwide. Recent developments are focused on large-scale power generation remote from load centers, which are creating transmission constraints on existing network and will require more transmission capacity. Market mechanisms must be able to accommodate renewable energy consumption on network. This paper simulates the patterns of trans-provincial/trans-regional power generation rights trade and direct power trading, which are the main patterns that renewable energy participates in power market. The results show through trans-provincial trading of renewable energy, the income of renewable producers and grid utilities have increased, while the revenue of thermal power generation enterprises of receiving province is reduced. This solution is consistent with the renewable development targets.

### **SC5-209: "Solar Parks to Ramp up Solar Projects in India: The Recent Downward Trends in Tariff"**

This paper reviews the evolution of solar projects in India leveraged by the incentives provided through Solar Parks, a central public sector enterprise on behalf of Government of India (GOI). According to the paper, solar power projects can be set up anywhere in India. However, individual projects of smaller capacity incur significant expenses in site development, drawing separate transmission lines to the nearest substation, procuring water and building other necessary infrastructure, as well as acquiring land and other permissions. To overcome these challenges, Solar Parks were created as flagship facilities to encourage

project developers and investors through concentrated zones for development of solar power generation projects, providing entrepreneurs an area with proper infrastructure and access to amenities, reducing the number of required approvals, saving time and minimizing projects' risks. By these measures, the Government of India expect to prompt additional projects of similar nature, triggering economies of scale for cost-reductions, technical improvements and achieving large-scale reductions in greenhouse gas emissions. The paper concludes showing success cases of solar industry and recent downward trends in solar tariff boosted by the Solar Parks.

### **SC5 – 210: “Evolutions of Japanese Markets to Realize Stable and Low-Cost Power Supply Satisfying Environmental Targets”**

The paper presents the Electricity Sector Reform that has being carried out in Japan to ensure energy security by facilitating power interchange between regions, to reduce cost by introducing fully competitive environment, to expand consumers' option of retailers, and to expand business opportunities, among various measures to enforce its effectiveness. The situation of the power industry in Japan is drastically changing, such as weakened demand growth and significant increase of renewables. The predictability of cost recovery of generation facility is expected to deteriorate and therefore the establishment of measures to secure required supply capability is a priority issue. It is a big challenge to rationalize investments and at the same time secure system reliability and fulfil the environmental target.

A large set of measures has been implementing and undergoing, such as: (i) the transmission capacity allocation rule of interties will be changed to implicit auction, which shall also contribute in achieving nationwide merit order dispatch and increase market liquidity; (ii) segregation the values which the generation facilities provide and establish respective markets, namely, capacity market, balancing market, and non-fossil fuel value market, in which the role of existing and new generation shall change, and the entities will be compensated accordingly to the values they provided through the respective markets; (iii) promotion of Demand Response transaction is discussed which is useful for diversification of energy source and optimizing the capacity / reserve to secure; and also (iv) environmental targets to enforce renewables integration, introducing some new facilities, such as: purchase obligation to TSOs; installation of grid-scale battery storages; grid congestion management to enhance RES integration; utilizing interties for regulation reserve transactions.

## **Preferential Subject 2:      Questions**

- 2.1    What regulatory methods or market governance procedures are best suited to allow regulatory rules and market designs to more rapidly evolve to accommodate the accelerated pace of government policy changes and technology advancements?
  
- 2.2    The participation of the renewable energies in the breakdown of the total produced electricity is going to increase worldwide, as described in many papers. Should some type of market-based penalties or limits to renewable expansion be considered to reflect restrictions on system operations?
  
- 2.3    What is driving the current situation of insufficient reliable revenue streams for financing new storage projects? Are regulatory improvements necessary? If so what are the benefits of storage technologies that should be considered in developing market-based mechanisms or incentive regulations?
  
- 2.4    What are the impacts on the energy prices or tariffs including a carbon tax? What are preferred methods of pricing environmental policies and/or desired emission characteristics through competitive markets?
  
- 2.5    What are the main effects and incentives that can be accomplished by capacity markets? What are the main barriers to fully implement capacity markets in various jurisdictions?
  
- 2.6    What are the recommended power market reforms to motivate further expansion of renewables on distribution networks? How are market features to better accommodate the development of new renewables to reflect network limitations and security of supply issues?

### 2.3 PS 3 - **Localized Markets or Microgrids Interacting with Wholesale Markets**

- Methods to leverage markets for localized resources to provide system services.
- Market signals and schemes that can be utilized to harmonize and coordinate resources across transmission / distribution interface.
- Market design changes that can be considered at wholesale and retail level to manage localized resource interactions.

### **Preferential Subject 3: Paper Summaries**

#### **C5-301 - The New Market Paradigm of the Brazilian Power System considering Thermal Base Generation for Supporting the Renewable Source Expansion**

Localized infrastructure coupled with climatic conditions has impacted Brazilian power system reliability options.

This paper proposes a cost-effective modification that recognizes the fuel related benefits of traditional power resources while improving Brazil's reliability services needed to cope with Brazil's expanding intermittent energy resources.

#### **C5-302 - The evolution of embedded networks and localised markets in Australia**

The successful expansion of Australia's *embedded networks* (aka microgrids) has spawned a new industry of intermediaries (e.g. service providers between customers and power industry, or between embedded networks and the power industry) as well as new regulatory and market challenges.

The paper documents the ongoing evolution of these embedded networks in Australia, the emerging new services and opportunities being afforded to both entrepreneurs and to customers, and describes the transition of a start-up industry being exempted from regulations to a potentially complete industry capable needing its own set of regulations.

#### **C5-303 – Exploring the Market Value of Smart Grids and Interactions with Wholesale (TSO) and Distribution (DSO) markets**

CIGRE Working Group C5.24 documents and analyzes the market-value of various international Smart Grid Accounting methodologies.

The paper evaluates an Australian Program by analyzing various program technologies (i.e. Active Volt-VAR Control; Fault detection and restoration; dynamic tariffs, Substation monitoring; Solar PV Battery Storage).. The French program is reviewed independently by capacity (MW) and Energy (MWh) for Ancillary Services, Balancing Markets, Wholesale Markets and Within Portfolio. Three Portuguese initiatives are evaluated: InovGrid; PDIRD/distribution investment plan and PDIRT/transmission investment plan). The benefits

of California (USA) programs on Demand Response, DER Integration, Electric Vehicle Integration ; Energy Storage and Cybersecurity are documented in this paper.

#### **C5-304 – Economic assessment of smart grid flexibilities**

This paper provides an in-depth documentation and analysis of the evolution of Smart Grid activities in France. The paper includes discussions of the values attributed to Smart Grids (re: global emissions; France; TSO; DSO; consumers et al).

The impacts of individual technologies (e.g. Storage; Residential Demand response; Industrial DR; Wind controllability ; ) are also analyzed.

#### **C5-305 – Efficient Participation by Customers in an Electricity Market Using a Receding-Horizon Optimization**

Papers C5-305 – C5-307 & C5-309 are a series of presentations on a pan-European Smart Grid project entitled SmartNet. The papers include alternative initiatives and analysis of 5 countries and a pilot project in one of them.

In C5-305 the authors present a quantitative analysis of a wholesale market structure (Receding Horizon Optimization) for local control of distributed storage.

The authors posit that distributed resources will eventually overwhelm system operators and that a market design to address aggregators of deferred demand will be necessary. The 4 Case Study-analysis demonstrates that a simple market design with distributed storage controlled by aggregators is feasible and efficient.

#### **C5-306 – TSO-DSO coordination and market architectures for an integrated ancillary services acquisition: the view of the SmartNet project**

Paper C5-306 describes the platform utilized to conduct the SmartNet Market Model studies.

The project identified five market coordination schemes (A Centralized Ancillary Service model; a Local AS Model; Shared Balancing Responsibility Model; Common TSO-DSO AS Market Model; and an Integrated Flexibility Market Model).

#### **C5-307 – Smart TSO-DSO interaction schemes and ICT solutions for the integration of ancillary services from distributed generation**

This paper presents findings associated with an Italian demonstration project to evaluate coordination requirements between a TSO and a DSO.

The project provides insight into expanding ancillary services (e.g. voltage regulation; reactive power reserves) from renewable resources.

**C5-308 – A comparative analysis of existing and prospective market organisations at the retail level: role modelling and regulatory choices**

The authors provide a comprehensive view of the future of electric power. The paper offers analysis of the cause and effects of alternative models to the traditional markets. The paper discusses and evaluates the possible new players as well as drivers for the respective new players.

The consequences of the expansion of renewable supplies (which requires power system flexibility) vs. the expansion of demand management (which provides power system flexibility) is addressed as well as the consequences of society's acceptance of autonomous devices decision. The authors summarize their analysis into two high-level models based on the concepts of Active prosumers and Passive consumers.

**C5-309 – Exploiting flexibility of radio base stations in local DSO markets for congestion management with shared balancing responsibility between TSO and DSO**

This paper documents the results associated with a Spanish demonstration project to evaluate balancing coordination requirements between a TSO and a DSO in Barcelona.

The pilot project (Shared Balancing Responsibility Model) transfers balancing responsibility from the TSO to the DSO (in the role of Local Market Operator). The paper documents the LMO responsibilities and processes used to do provide the balancing service.

**C5-310 – Key Guidelines to New Market Design to Ancillary Services in Latin American Power Systems with High Levels of Wind and Solar Energy: Practices Experiences from North America ISOs and European TSOs**

The authors document system conditions in three Latin American countries (Brazil, Chile and Peru) resulting from growing levels of intermittent generation in hydro-electric based systems.

The authors describe the short-falls of traditional ancillary service in addressing their situation. The paper provides analysis of international ancillary services markets and how those markets operate (acquisition, Timing, Pricing, and Information). The authors discuss potential new ancillary services to address their changing environment.



### **Preferential Subject 3: Questions**

- 3.1 Proposed “local” market solutions are shown to be efficient as viewed from the perspective of the major actors, what are the efficiencies obtained from the consumer?
- 3.2 The papers show benefits of Micogrids / embedded networks within the current Market structures. To the extent that these Microgrids fill a current need created by public policy (i.e. emission reduction initiatives) Microgrids are easily incorporated into current market designs, what added value does the bulk power markets to compensate for the level of Microgrid growth as their (the Bulk power markets’) share of the customers is reduced?
- 3.3 Are the tools used to evaluate local market design impacts sufficient to address the reliability on the bulk power system? Do traditional tools used for well-defined assets and locations apply to aggregators and distributed resources and the even less-well defined consumer impacts?
- 3.4 Are the positive evaluations of Microgrids vis-à-vis the current power system state providing a valid insight into the future? Or are the analyses undervaluing the impacts of the “uberization” of the power markets?