CIGRE 2014

# C2-00

## SPECIAL REPORT FOR SC C2
## (System Operation and Control)

**Susana de Almeida de Graaff, Paulo Gomes**

**Special Reporters**

## 1. Introduction

CIGRÉ Study Committee C2 deals with the technical functionalities, structures and competence needed to operate integrated power systems in compliance with the social requirements for security and quality of electricity supply.

The field of activities of SC C2 includes securing the physical integrity of power systems, management of strained systems and capacity shortage situations with controlled risks, restoration strategies, functionalities and reliability of Control Centre and training of System Operators.

SC C2 needs to understand, use and integrate results from studies in other Committees to assure that the technical concepts can be applicable in real time in various contexts and implemented by the System Operators. The SC C2, therefore, embraces a wide range of competence areas and interfaces with other disciplines.

## 2. Group Discussion Meeting Session 2014

For the Group Discussion Meeting, SC C2 has invited written contributions to provide discussion materials pertaining to two specified Preferential Subjects. As a result of this invitation a total of 36 papers have been accepted, categorized into the Preferential Subjects:

<u>Preferential Subject No 1:</u>

Managing new challenges in operational planning and real-time operation of Electric Power Systems (24 papers)
Special Reporter: Susana de Almeida de Graaff (The Netherlands)

<u>Preferential Subject No 2:</u>

Emerging Operational Issues for Transmission and Distribution interaction (12 papers)
Special Reporter: Paulo Gomes (Brasil)

Susana.de.graaff@tennet.eu, pgomes@ons.org.br

**Preferential Subject 1**
**Managing new challenges in operational planning and real-time operation of Electric Power Systems.**

- **Stability analysis, monitoring and control (i.e. voltage and frequency control, phase angle stability)**
- **Use of line loadability and dynamic ratings**
- **Ancillary services, including operational reserves**

System Operators are constantly being confronted by an evolving power system, demanding a focus on operational security assessment, new methods, paradigms and more flexible, closer to real-time and coordinated approaches for operating the power system. New Challenges, such as for instance the integration of renewable energy sources (RES), the integration of new technologies and the increasing volatility of market-driven generation, place the system closer or constrained by its stability limits. In all the papers, these challenges are addressed giving a clear sign that System Operators are constantly facing them and attentively preparing the future, implementing solutions such as Dynamic Security Assessment (DSA), Phasor Measurement Units (PMUs) and Wide Area Monitoring Systems (WAMS), Dynamic Line Rating (DLR), Risk Management and Assessment, among others.

**<u>Papers for PS 1</u>**

Paper C2-101 proposes a mixed state estimation strategy for power systems, combining a hierarchical and a distributed structure. Local estimations can be taken from PMU measurements. This estimation scheme was tested in the 500kV network of the Colombian power system.

Paper C2-102 describes the experiences gained with the application of DLR in the Transmission System of Australia and New Zealand, addressing operational and market issues. The thermal model, the validation tests results and future plans are presented. This paper shows the approaches of different network operators in the two countries.

Paper C2-103 focuses on how to effectively integrate DLR in the processes of the network operators and maximize the usage of the network. This paper highlights the experience of the Belgian TSO, regarding the usability of forecasting of DLR to increase the flexibility of using the network when determining capacity to the market or accommodating RES.

Paper C2-104 presents the development of a parallel computational tool designed to perform static and dynamic security assessment of large scale power systems both for real-time and off-line studies. This tool is being tested with the Brazilian Interconnected Power System.

Paper C2-105 provides an overview of the French TSO operational voltage control framework illustrated with experienced situations, description of methodologies and tools, operational processes and automatisms, and main benefits.

Paper C2-106 outlines the intraday studies performed by CORESO since July 2013 within a coordinated process that also involves TSC, including TSOs from both Central Western and Central Eastern Europe.

Paper C2-107 focuses on voltage stability assessment. A comparison between an advanced generation unit model and a conventional model is made using the P/V analysis to determine the margins to different critical system states, as defined in ENTSO-E Operation Handbook.

Paper C2-108 describes the challenges to compute TTC in the fast growing Indian transmission system with still a large expansion foreseen, where the delicate balance between network security and market facilitation has to be dealt in a transparent manner.

Paper C2-109 summarises the experiences of the Power System Operation Corporation in India, using synchrophasor data for several purposes both online, offline, and for improving the performance of the grid. In this paper several events are presented.

Paper C2-110 presents a model for Stability monitoring and control of generation based on the synchronized measurements in nodes of its connection. The model can be used in calculating the limits on the power output of each generator in the network for the steady state, quasi-steady-, and post emergency mode.

Paper C2-111 outlines the AGREGA Project held in Spain, aiming the preparation of the electric system to the introduction of a market player "the aggregator" with a coordination role to facilitate the implementation of demand response products in end consumers, in this case medium size industry.

Paper C2-112 presents the application of dynamic rating to Italian overhead lines. The algorithm combines the CIGRE thermal model of conductors and complex multi-span mechanical model of the line, increasing the completeness of the model. The operational benefits for the Italian TSO are shared.

Paper C2-113 outlines the work of the Regional Security Coordination Initiatives (RSCI) in Europe to maintain operational security and to comply with the legal framework. This works includes developing and implementing common strategies, coordinated procedures and long-term methods.

Paper C2-114 describes a new approach to assess the aggregated inertial contribution from wind generation in the Great Britain power system under time varying wind speeds on an hourly basis and across the regions, and also as a result of turbulence and wind speed variation across wind farms.

Paper C2-115 illustrates the analysis of four events, power system oscillations, captured by synchrophasor measurements in the Western Electricity Coordinating Council in the Western United States.

Paper C2-116 presents a new simulation platform developed in USA that combines electromechanical transient stability with the effect of protection relays, allowing a complete analysis of system dynamics and the design of wide-area control and protection algorithms, including cascading events.

Paper C2-117 outlines an "Integrated Stability Control" system used in Nagano region in Japan for the operation of a long-distance transmission system and shares actual operational experiences. Such platform allows operating in a more complex operational environment.

Paper C2-118 describes the system used in Mexico to perform online security assessment. The system is designed for steady-state voltage security assessment, calculating PV curves and defining power transfer limits and reactive power margins. Remedial actions are also considered. To the worst cases, a transient stability assessment is performed.

Paper C2-119 studies the potential of implementing dynamic control of voltages, active and reactive power flows in Qatar Transmission System, considering conventional practices with mid-term solutions, as the usage of FACTS. Optimisation techniques and optimal power flow are studied.

Paper C2-120 provides insight on the activities in the United Arab Emirates power sector concerning dispatching and regulatory aspects due to the integration of renewable energy sources, which are amendments recommended into the grid code.

Paper C2-121 presents the synchrophasor system of the power transmission grids of Ireland. The application of PMUs and its advantages to power system operational challenges is outlined, such as Special Protection Schemes, network models improvement, evaluation of control systems, disturbance analysis, and synchronisation of islands, among others.

Paper C2-122 discusses the possibility to use coordinated Q-V controllers (CQVC) to perform secondary voltage control at the power plant level and elaborates on studies related to the application of several coordinated controllers in the power system. CQVC can also be used to pricing reactive power production costs.

Paper C2-123 describes how the Italian TSO defines, evaluates and tests its restoration strategy in coordination with the neighbouring TSOs, in particular with Swissgrid, minimising the switching actions and restoration time. A very complete preparation is performed, including operational procedures, DTS training for operators and static and dynamic network analysis.

Paper C2-124 presents the development of a wide area monitoring and control (WAMAC) system in the Korean system for a two-step load shedding scheme due to voltage stability issues, reducing the amount of load shedding for most of the cases. This SPS was tested successfully with an RTDS.

The questions for PS1 are aggregated according to topics, which means that several questions can be related to each paper.

**Questions for PS 1**

**Question 1.1:** Paper C2-101 discusses a new scheme for Power System's State Estimation.

**The authors presented a test case of one day in a specific part of the Colombian power system. What are the plans for further tests? How do the authors propose to integrate the results of state estimation at TSO level and perform the comparison with a current state estimation in terms of e.g. accuracy and computational burden? Are there other examples operational or being developed of new methods for state estimation in a transmission system, including PMU based state estimation, and which advantages are identified?**

**Question 1.2:** Papers C2-102, C2-103 and C2-112 address the usage of dynamic line rating.

**Dynamic Line Rating application can increase the line capacity to a level that may conflict with the stability limit. Is dynamic security assessment performed by the network operators that have implemented dynamic line rating to guarantee network security and to cope with the operation of the system closer to its limits? Is this assessment performed in real-time or regularly off-line, or only in case of special situation such as planned outages? Is there any experience/examples of limiting the usage of dynamic rating due to network stability issues?**

**The possibility to adapt and curtail generation to ensure network security is referred in the papers. How is the decision process organised, interface between TSO and market players? Is redispatch as remedial action fast enough for real-time operation using the thermal time constant of the congested line, avoiding costs and without violating constraints (as mentioned in C2-112)? What is the gain in capacity and accuracy between the new model presented in C2-112 and the traditional method? Does it compensate the development and implementation of a more complex model? Are there other TSOs/ISOs developing similar solutions?**

**The different approaches regarding the usage of dynamic line rating by neighbouring TSOs in a synchronous interconnected AC system demands the need for coordination, regarding different ratings in different operational timeframes for the same network elements. In addition, combining DLR with controllable assets, such as PSTs or HVDCs, may impact the neighbouring TSOs' network. How is this coordination and impact assessment organised? How to ensure that we are neither reducing our network security level when applying DLR nor the needed flexibility for real-time operation, especially when combining it with controllable sources on a regional level not only during real-time operation (as mentioned in C2-103)? How to cope with DLR forecast errors in this context? Are there other TSOs/ISOs with experience in using DLR for capacity calculation timeframes and off-line network security analysis?**

**<u>Question 1.3</u>:** Paper C2-104 focuses on the development of static and dynamic security assessment tools. Paper C2-116 presents the possibilities of combining dynamic assessment with protection systems' behaviour. Paper C2-117 presents a decision support tool with integrated SPSs. Paper C2-118 performs transient stability assessment to the worst cases resulting from a voltage security assessment.

**When performing analysis on large scale power system, it can occur that the online and offline network models are not compatible, e.g. different asset names and different levels of detail. This becomes even more complex, if several disciplines and departments have to perform coordinated analysis (e.g. system operations and network planning) or if the models of several utilities have to be merged and then jointly analysed. How can the compatibility of network models be guaranteed (both EMS and offline and also steady-state and dynamic models) in order to have comparable results? Are there experiences of TSO/ISOs harmonising network models for integrated system planning and operation in this complex environment?**

**The starting point based on real-time information is often EMS snapshots. Normally EMS network models lack information to perform e.g. stability calculations, how is this issue handled? How do the authors of C2-116 and C2-118 foresee the integration of this platform in the control room? Are there other examples under development or operational in TSOs/ISOs regarding the integration of EMS system and network security tools (especially including DSA)? Can other TSOs/ISOs share the experience of having DSA in the control room? Especially when introducing the DSA in the control room for online simulations to support operator's decision, the quality of the dynamic model is crucial. How can control operators be confident that the calculated results represent reality? How are the results of dynamic security assessment shown to operators? Can the operator interpret the results or is decision support part of such a tool?**

**What is the computational time of the presented solutions? The possibility to integrate protection system behaviour and the simulation of system dynamics and cascading events becomes essential in a highly stressed and more complex operational environment not only during operational planning but also closer to real time. Do other TSOs/ISOs have simulation of cascading events in their operational processes? Could this platform be used in combination with an optimization algorithm for remedial actions providing decision support in operational timeframes, e.g. ID?**

**<u>Question 1.4</u>:** Both high and low voltage phenomena are part of TSOs daily operation, Paper C2-105, C2-107 and C2-118 focus on how to operate the network dealing with voltage phenomena. C2-124 presents WAMAC to handle voltage stability issues. C2-122 describes a CQVC for voltage control.

**Paper C2-105 presents solutions that start with long-term dynamic studies, the computation of dynamic consumption limits towards more operational timeframes, considering the uncertainty of forecast processes and implementing a risk management approach for voltage control, with the possibility to apply control measures. Paper C2-107 proposes to integrate voltage-dependent reactive power limits into the power flow algorithm, providing more realistic results for voltage stability assessment, including cascading events. How can such tools be integrated in the control room and how do control room operators react upon the analysis results? How do operators prepare remedial actions to increase the margin to the critical system states? Is decision support expected to be part of such a tool, e.g. optimisation of remedial actions?**

**Can you give insight on PMU based indices, such as in C2-124, Voltage Stability Index and dynamic Flow voltage curves? How many substations are monitored by these indices?**

**Do other TSOs/ISOs have different models or methodologies to evaluate and control voltage phenomena, e.g. risk assessment methodologies? Do other TSOs/ISOs have experience with dynamic security assessment closer to real-time and for congestion forecast timeframes? How are European projects such as Umbrella, iTesla and GARPUR or any other research initiative**

**developing risk assessment, probabilistic methodologies and optimisation algorithms to improve network security?**

**In a context that the number of conventional synchronous units operating in the network is decreasing, secondary voltage control becomes even more crucial. Would it be possible to implement CQVC as presented in C2-122 on the network level (or area of network), instead of power plant level? Would it be possible to extend this solution to different types of controllers? Such a CQVC needs close link and interaction with system and market operator, how do you foresee the required organisation level between parties?**

**<u>Question 1.5</u>:** Both Papers C2-106 and C2-113 outline activities performed by RSCIs, namely CORESO and TSC. Paper C2-104 is also addressed in the question due to forecast files improvement.

**To perform network security analysis in timeframes closer to real-time, such as intraday (ID), is crucial to prepare remedial actions in a coordinated way, to guarantee system security. How is the coordination between different RSCIs performed? If different issues are encountered by different RSCI, how do players ensure that all issues are properly solved/mitigated without conflicting solutions jeopardising the network security of neighbouring TSOs? How is the interaction between the RSCI and the individual TSOs? In C2-106 optimal remedial actions for wide influence phenomena is stated. How is the optimal remedial action defined? How is the analysis ex-ante-usage/reservation versus availability of remedial actions for real-time constraints performed? *"Overall, the operational goal of regional security coordination is to prevent disturbances or blackouts by intensive operational coordination between TSOs at all times."* Can RSCIs play a role in the coordination between different synchronous areas connect through DC-links, e.g. for congestion management?**

**Data quality and uncertainty are crucial issues for network security, and the improvement of forecast files is foreseen. RSCIs such as TSC, SSC and CORESO play a role in this network model improvement, which is crucial for an accurate analysis of the expected operating conditions. Can this task go beyond the compliance check of the RGCE data exchange format? For example coherence checks of network parameters according to RES forecasts? Is the quality of DA and ID congestion forecast files evaluated in comparison with actual operating conditions (snapshots), i.e. uncertainty measurement?**

**How is the experience of TSOs outside the Central European network? Are there other initiatives for coordination activities in other interconnected systems? How is the coordination of operational planning timeframes till close to real time performed?**

**<u>Question 1.6:</u>** Paper C2-108 describes the TTC computation issues in the Indian transmission system.

**In the paper it is stated that TTC is the minimum of thermal limit, stability limit and angular stability. Can you please elaborate on the stability studies that are performed for TTC computation? Closer to real-time TSOs have to face lower uncertainties and can assess better the available capacities to the market. Would it not be a strategy to decrease "longer"-term capacities and increasing the dynamic of closer to real-time market timeframes, e.g. in the ID market, decreasing the need for capacity curtailment or congestion management?**

**<u>Question 1.7:</u>** Paper C2-109, C2-115 and C2-121 present experiences and applications with PMUs in India, USA and Ireland. Paper C2-110 outlines a new model based on synchronised measurements to calculate the limits of power output of network generators. Paper C2-124 presents the development of a WAMAC system.

**With highly stressed networks and the integration of more control systems due to RES, FACTS and DC links (sophisticated fast-acting power electronics), poorly damped oscillations may occur more often. PMUs bring the possibility to TSOs to monitor system dynamics in real-time with**

**synchronised information. Based on the experience with PMU information and its integration in the control room, did it trigger any change of procedures in order to react on the PMU information, such as implementing proactively remedial actions or the development of new operational indicators?**

**The presented WAMAC in C2-124 will in the future develop to an on-line calculation of load shedding amounts. How do you foresee this computation? Are WACs (wide area control) being considered or applied by TSOs/ISOs (examples)? How did operators acquire the knowledge on how and what to do? Are there other TSOs/ISOs with experience on how to operate the system with PMU information? Are there other experiences of testing SPSs in RTDS simulators to be shared?**

**In a control room, several different systems may co-exist, such as SCADA/EMS, WAMS, DSA, among others. What are TSOs'/ISOs' future plans for the integration of the different systems? Or separate solutions are to be kept? Are there experiences of the usage and integration of different systems in the control room of other System Operators worldwide? In large interconnected networks, information sharing and joint coordinated activities play an important role in system operation, e.g. during the synchronisation of 2 stable islands or restoration. Are there examples of joint coordinated activities of recognised added value using PMU information among TSOs of different national, regional control centres or initiatives?**

**In C2-110 tests were performed in a relatively small system. How do you see the scalability issue? Would it be possible to implement this model in a larger system, such as the European interconnected system? What are the steps to be taken by this approach in order to make it available in real-time for control room operators? It is also mentioned the possibility of automatic control, how are these controls defined and how do you prevent interaction between the individual control systems? Would this be only possible in a system where synchronised measurements exist in all generation nodes? This is an example how to tackle system dynamics without a complete dynamic analysis, are there other examples in research institutes, universities or TSOs of similar approaches?**

**In C2-121 operators should act upon an oscillation with magnitude and damping thresholds. How was the definition of the thresholds and the tuning of the alarms (relevant phenomena) performed? How were the procedures regarding how to act developed?**

**<u>Question 1.8</u>:** Paper C2-111 deals with the integration of demand response in system operation.

**In the challenging environment of electrical systems, increased flexibility to operate is required. This paper focuses on reserves for load-frequency control that the TSO can use with a minimum response time of one hour, which falls into reserve replacement times. How are operational reserves expected to be developed, i.e. are there plans to go forward with this solution, and to expand it to secondary control or primary control times? To involve domestic consumers and how? How much time would be needed to develop such an approach on a national scale? Are there other experiences, solutions or visions worldwide on demand side response or on more flexible power reserves?**

**<u>Question 1.9</u>:** Paper C2-114 evaluates the wind inertial support to a power system with high wind penetration.

**Lower inertia operating points due to high RES penetration are a concern. Would this kind of studies help to define the minimum level of conventional generation available in the electrical system taking into account wind generation support? C2-114 states that wind if suitably controlled can deliver improvement in power system response. Can the authors please elaborate on the required control? How could this approach be integrated and bring benefit to the operational procedures in a TSO/ISO?**

**<u>Question 1.10</u>:** Paper C2-119 presents an evaluation of the voltage and power flow control using several FACTS (e.g. SVC combined with line up-rate, FSC, TCSC, GUPFC and STATCOM).

**With the current challenges faced by power systems, such as the increased difficulties of building overhead lines and the decrease of synchronous machines in the network, the usage of FACTS to control power flow and voltage is expected to increase. The authors state that cost and dynamic assessment still needs to be performed. Are there any operational challenges/impacts expected due to the integration of FACTS? Which? Is that taken into account in the final evaluation? Do other TSOs/ISOs have made a similar analysis and have decided to install such a solution? Which analyses were performed to support the final decision?**

**<u>Question 1.11</u>:** Paper C2-120 deals with requirements for RES integration.

**After the inclusion of the requirement into the grid code, which is undoubtedly crucial, how are the operational processes expected to be organised in terms of: operational agreements (including maintenance procedures, protection system coordination, …); integration of the information in the control room; operator's activities regarding RES; compliance check with network codes, etc? Are there other TSOs/ISOs able to share their experience regarding this topic?**

**<u>Question 1.12</u>:** Paper C2-123 focus on restoration strategy.

**What is the role of the neighbouring TSOs during the restoration test? How much faster can the restoration be due to coordination? How is the coordination performed, e.g. specific restoration strategy procedure, access to the same DTS? How are operators trained, only in DTS or do they also get the information of the static and dynamic analysis? How is the knowledge of operators regarding dynamic phenomena? PMUs are used for identification of blackout condition, how many PMUs are required and in how many locations? What is the frequency of updating such a restoration plan and of repetition of real restoration tests? Do other TSOs/ISOs have experience in coordinated restoration strategies worldwide? How is it organised?**

## Preferential Subject 2

## Emerging Operational Issues for Transmission and Distribution interaction

- **Transmission, distribution and consumers interfaces**
- **Control centres and market operator interfaces**
- **Education and training of operators**
- **Visibility and awareness of operation issues**
- **Modelling needs and data interchange**
- **Controllability of distributed generation**
- **Fault level management**
- **Demand response.**

The mission of a modern power system is to supply electric energy satisfying conflicting requirements such as reliability and security of supply, economy, environmental constraints and low tariffs.
More recently, society has begun to ask for reduction of CO2 emissions. This has led to the wide integration of Renewable Energy Sources (RES) and distributed Generation (DG) aiming at replacing coal and oil thermal plants in some countries. Another issue is related with the society's opposition to the use of nuclear power plants due to the risks involved, considering the last occurrence in Japan in 2011. These facts have been imposing the loss of some degree of power system controllability. This has led to the need for revisiting the current ways of thinking regarding all power system chain, with the introduction of higher intelligence and efficiency improvements. This preferential subject has twelve very interesting papers covering these topics.

**Papers for PS2**

Paper C2-201 focuses on large wind power outages verified in China and proposes a preventive strategy, which includes coordinative reactive power control among wind turbines and reactive power compensation devices together with the requirements of High Voltage Ride Through (HVRT) capabilities of wind turbines.

Paper C2-202 addresses the high development of electrical powered heating in France and its high thermo-sensitive demand. A new market mechanism (NEBEF) that has been designed to value explicit DSM is described

Paper C2-203 describes the German case where RES are reaching significant proportion on distribution grid levels and presents a new P-Q controller for distribution systems in order to control power flows in the points of connection with the transmission system, providing some degree of control and aggregating flexibility.

Paper C2-204 explains the challenges to be faced by the TSO in the future regarding more frequent alternatives of power flow as well as higher security constraints. An alternative suggested to be adopted to avoid costly network reinforcements or to minimize costs of generation re-dispatch is the implementation of phase-shifting transformers (PST).

Paper C2-205 describes modifications introduced in the regional SCADA system configuration, in Japan, that used to be provided at each control centre and developed an integrated regional SCADA system using a private IP network that can be used as a backup system when the control centre suffers from a disturbance.

Paper C2-206 shows examples of the coordinated function/methods between the transmission and distribution operation systems. Besides, it is presented the new functions capable of continuous stable power supply in the substantial connection with photovoltaic power generation.

Paper C2-207 describes that the introduction of RES on the distribution network in the South African System has provoked a number of changes regarding the responsibilities of the distribution control room and new information exchange requirements. Additionally the frameworks how RES have to be connected to the grid are presented.

Paper C2-208 discusses the integration of processes of the Dutch power system operator, presenting the complexity of its implementation in the light of the requirements, IT infrastructure and users´ needs. Emphasis is given to near-real-time processes for which the complexity is greater. Best practices from consumers' point of view and future developments are presented

Paper C2-209 presents the future DG/RES operational challenges, which are categorized under five headings: organizational (state of the art and future trends), operations (congestion in grids and voltage control), observability & controllability (system security and technical capabilities), technical capabilities and regulating commercial aspects.

Paper C2-210 describes some proposed health indices related to adequacy and power system security. Four indices are related to adequacy and four others to security. The paper considers three evaluation domains into health, margin and risk domains based on the reliability criteria and the results of interviews with experts in Korea.

Paper C2-211 presents an interactive method of network reconfiguration algorithm that combines Optimal Power Flow (OPF) and short-circuit analysis to split busbars in order to limit fault currents. The algorithm is to make decisions on where busbar splitting or line opening needs to be applied to reduce fault current level within the CB (Circuit Breaker) ratings.

Paper C2-212 presents a risk assessment methodology that has been implemented by the Portuguese TSO to allow a more efficient use of the network capacity. Results are shown and future developments and improvements are proposed.

**<u>Questions for PS2:</u>**

**<u>Question 2.1:</u>** Studies on prevention strategy of large wind power outages due to high voltage conditions to be answered by Paper C2-201

**What was the penetration degree of wind generation in 2012? What is the expected penetration degree for 2020? How has the certification process of wind turbines LVRT (Low Voltage Ride Through) been carried out? Have you considered the possibility of increasing the settings of overvoltage protections? The overvoltage levels presented in the paper (1.15 pu) are normally acceptable for a 330 kV transmission system, unless the voltage at the wind farm busbar level is much higher. Does anyone have additional comments?**

**<u>Question 2.2:</u>** Demand response mechanisms to be answered by Paper C2-202

**What is the current amount of contracts in MVA between the DCM operator and residential, commercial and industrial consumers? Why are EJP (Peak Days Curtailment) contracts no longer offered? Wouldn't these contracts increase the total amount of load shedding? Is there, in the contract, the possibility for the consumer not to perform the shedding of its load a day ahead? If so, does this compromise the purpose of the program in some cases? Has anyone ever faced this situation?**

**<u>Question 2.3</u>**: P-Q controller to provide some degree of power control and aggregate operational flexibility to be answered by Papers C2-203 and C2-204

**Paper C2-203 deals with renewable energy sources and therefore considers that there is a great variability in the output of these generators. At the same time, the distribution system equivalent should be calculated recursively so that it is possible to control P and Q. How can one calculate these equivalents efficiently and accurately so that the algorithm can be used in practice?**
**What is the proposal for commercial arrangements and financial compensation for the generators that have their P and Q changed by centralized control?**
**How is this control expected to interact with other existing distribution and embedded generation controls? Is there the possibility of conflicting objectives?**

**Paper C2- 204: The use of a reduced number of PSTs enables to find solutions for transmission constraints as well as to dispatch generators at lower costs. This practice has been adopted in some systems as a solution that lasts for some time intervals. Is this feasible in case it is necessary the use of several PSTs, especially considering successive tunings in a short period? Is there any additional experience to be reported as a solution for the mentioned problem?**

**<u>Question 2.4:</u>** Modifications introduced in the regional SCADA to be answered by Paper C2-205

**Have the modifications adopted in regional SCADA caused some sort of restrictions concerning critical data such as SOE or PMU? Have continuity tests of this SCADA framework been carried out periodically? If so, what is the number of tests performed in one year?**
**Has any other country adopted similar technical solutions in order to keep real time operation of central and regional centres even under severe disturbances?**

**<u>Question 2.5:</u>** Operational issue for transmission and distribution due to DG and RES to be answered by Papers C2-06, C2-207 and C2-209

**Paper C2-206: When you have substantial amount of energy provided by the photovoltaic generators connected to the distribution system it is possible that you have to turn off more plants connected to the transmission system. How do you manage to keep power system security? Is there a criterion to define the maximum PV penetration degree? Does anyone have additional comments on this? Assuming that the new features provided by the expansion of photovoltaic (generation are automatic and are included in the EMS): Is there a team in Control Centres to act in case of failure of these systems? What actions are necessary to train this team that will work in this new situation? What is the statistic of failures and correct operation of the referred automatic restoration systems? If the numbers are adequate, are you concerned about performance decrease in the new situation with the substantial presence of photovoltaic generation? Is this expected?**

**Paper C2-207: As the RPPs have the possibility to generate all the power they have to deliver and they will turn off in almost all system emergencies, how does the South African National Control Centre manage the system security? Is it possible to constrain the amount of power delivered by these RPPs? What are the criteria to decide the one to be reduced?**

**Paper C2-209: The article presents several aspects, which leads to a more integrated action between DNO and TSO/ISOs. Will this be sufficient? Isn't it time to reconsider all operational hierarchy frameworks? Observability and controllability are key elements, but stressing control rooms with large amount of data does not seem to be a good idea. What type of solution are DNOs and TSOs implementing to deal with this challenge? Has anyone developed smart and dedicated software to help real time operation teams?**

**Question 2.6**: From strategic planning to after-the-fact analysis to be answered by Paper C2- 208.

**How is the maintenance of "multi-users database" and the mounting of the base cases ("network model management") that feed the network models used in the various computational tools done? How and by what means is this data shared? How are the distribution systems and interconnections represented in the "national 150kV to 380kV grid model"? If so, what types of equivalents are used? How and when is the hourly load forecast informed by the agents checked for consistency? In which "grid forecasting processes" are dynamic studies performed? Who are the suppliers of this "power system analysis platform"?**

**Question 2.7**: Adequacy and security indices to evaluate power system performance to be answered by Paper C2-210 and Risk analysis methodology by Paper C2- 212

**What are the events considered by the authors of Paper C2-210 to calculate the amount of operative power reserve? Could the authors clarify the concepts of "Health Index" for SPS? Could the experience of other SOs be presented regarding the utilization of adequacy/security to evaluate power system performance?**
**Regarding Paper C2-212, what is the computational cost of the probabilistic methodology implemented by the Portuguese TSO, compared with the deterministic methodology? At the current stage, what is the frequency of updating the results of each method in the control room? Can the results of the probabilistic methodology be presented to operators as the same of those produced by the conventional method? Does it require any operators' additional skill to interpret the results? In the authors' point of view, what are the main challenges to extend the proposed probabilistic methodology for network planning models?**

**Question 2.8:** An iterative method of network reconfiguration algorithm that combines Optimal Power Flow (OPF) and short-circuit analysis to split busbars in order to limit fault currents, to be answered by Paper C2-211

**In the Korean system, there was a case where more than 20 remedial actions (RA) were necessary to accommodate the large number of fault current violations. In a situation like that, wouldn't the system reliability be overwhelmingly impaired? Shouldn't the authors, in the future, consider the utilization of a FCC-OPF (fault current constraint power flow) to better balance the solutions between adequacy and security? The authors mentioned that they have utilized Matpower, a Matlab-based software, for the OPF algorithm. What was the software used for the fault analysis computation? In Korea, can the same database be accessed by different applications as, for instance, the two utilized in this paper, i.e., the OPF and the fault analysis?**