WORLD SMART GRID
FORUM 2013
Berlin, 24-25 September 2013

Results and Recommendations
29 September 2013
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Organizers:
IEC International Electrotechnical Commission
SGCC State Grid Corporation of China (CN)
VDE Association for Electrical, Electronic & Information Technologies (DE)
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EXECUTIVE SUMMARY

The IEC (International Electrotechnical Commission), the State Grid Corporation of China (SGCC) and VDE, the Association for Electrical, Electronic & Information Technologies in Germany organized the World Smart Grid Forum 2013 in Berlin from 23 to 25 Sept. 2013. The current document presents the Forum’s results, conclusions and recommendations.

It has been produced immediately after the Forum, so that its conclusions for decision-makers, management and experts should be as timely, relevant and useful as possible. Its primary audience is the Forum’s attendees themselves, followed by Smart Grid communities the world over who may also find the results of use.

The Forum was designed as A business, regulatory and technical executive perspective because it is important to the organizing institutions to capture not only the technical challenges, but in particular the decision-making aspects of roll-out of Smart Grids. In the words of the Programme,

"Today, most Smart Grid projects fail to move into large-scale implementation. ... The Forum [will] analyze and crystallize key Smart Grid success factors; develop the decision matrix that will bring projects to broad implementation; and outline a clear path forward."

Two parallel tracks were offered, comprising a series of complementary sessions that covered topics of core importance (the Forum’s programme is enclosed in the Annex). This approach provided participants with a highly condensed understanding which can serve as a foundation for real-life solutions.

Track A: Future Electricity Grid Supporting a Low-Carbon Energy Supply

Track A with its four sessions explored required interactions to support a low-carbon energy supply and assess the realistic potential for mass integration of renewable energy generation. How do transmission, distribution and electrical grids need to interconnect to increase overall performance and resilience?

Track B: Smart Energy – Visions for the Smart Grid Evolving Towards Smart Customers and Smart Markets

Track B and its four sessions defined what is needed to develop smart and sustainable communities or cities that offer quality jobs and living conditions. Beyond technology and design, what gaps need to be filled to bridge from vision to reality?

After the Forum’s recommendations to all actors, session-by-session syntheses and conclusions follow. The complex texture of difficulties, challenges and achievements involved in the Smart Grid have meant that the subjects are interwoven and common aspects arise in the different sessions. The fact that their conclusions converge shows that a better understanding of the overall problem is emerging, which coincides with the Forum’s goals and is a source of satisfaction to the organizing institutions.

We wish you pleasant and instructive reading.
RECOMMENDATIONS

The Forum recommends:

1. immediate discussions in each region with a view to clarity on the respective roles and responsibilities of TSOs and DSOs (transmission & distribution system operators) in the control and stability of the grid.

2. much more cross-border exchange of experiences in applying technical solutions and designing markets, no matter how different the circumstances and constraints of each national player, so as to be able to learn and profit to the maximum from international experience. This should include regulators.

3. significant research & development effort to be devoted to analytics and forecasting, to improve their flexibility, regularity & reliability.

4. DSOs and TSOs to devote serious effort to integrating the best possible forecasts into their control strategies for the grid.

5. information exchange among grid players to be greatly extended, introducing much more transparency and flexibility than exists today.

6. the energy market and the services market to be organized and valued separately, given that the value of many services such as flexibility is greater than the low rates per kilowatt-hour charged for normal energy.

7. that producers, consumers, prosumers and other stakeholders should all be involved in the design of and negotiations in energy markets and services markets.

8. retailers to place great emphasis on informing and training of customers, which is key to increased customer participation in the market and the success of demand response.

9. all stakeholders to find the best mix of national, continental and global standards, binding grid codes and legislation to promote security of supply, competition and sustainability.

10. governments and regulators to frame rules in such a way as to allow markets to function and provide all players, especially TSOs and DSOs, with the funds needed for investment.

11. that, recognizing the availability or advancing development of most of the necessary technology, the authorities should create the legal and regulatory framework to allow the technology to be acquired and installed cost-effectively.
KEYNOTE SPEECHES

The World Smart Grid Forum 2013 was officially opened by Dr Klaus Wucherer, President of the IEC. In his address, Dr Wucherer gave a warm welcome to all the participants and expressed a high-level view of what he saw as necessary for Smart Grids and Smart Cities. He suggested that complex, interconnected and interdependent systems like these needed not only technology innovation, but also the ability to analyze and crystallize proven success factors, so that the many small-scale projects can evolve into broad-scale reality. In addition to appropriate technology, Smart Grids need technology-independent decision processes, innovative business models and well-designed policies.

In the first keynote speech, Mr Zhenya Liu, Chairman of State Grid Corporation of China, illustrated how to develop strong and smart grids for safe, clean and efficient energy development. He pointed out that being reliable, efficient and clean constitutes the strategic path for energy development. To address this issue, a “grand energy vision” should be established, which represents a global and sustainable perception and will give rise to strategic initiatives and innovative technologies. Every effort must be put into transforming the direction of energy development, as well as planning for a coordinated development of the economy, society and the environment. The high-carbon energy structure must be shifted to a low-carbon one, extensive energy consumption changed to intensive energy consumption, local energy allocation extended to a global scale, and one-way energy supply upgraded to smart, interactive services. The goal of the global modern energy security system is the provision of reliable, clean and efficient energy. In this new century, it has become an important trend to replace coal and oil by electricity. As a secondary energy source, electricity is clean, efficient and of excellent quality. The power grid is a fundamental vehicle for electrical transmission, resource allocation, market transactions and customer services. To reach the goal, a key necessity is to reinforce the role of electricity as the centre of a diversified energy mix, displaying the full play of the power grid’s fundamental function. Only then can sustainable development of energy be achieved.

The strong and smart grid, Mr Liu emphasized, is a powerful platform for energy conversion, efficient allocation and interactive services. It is a modern grid with both a strong grid backbone and a smart control system, which includes generation, transmission, transformation, distribution, consumption and dispatching. The development of the strong and smart grid has great economic, social and environmental value, and is a strategic choice to achieve sustainable energy development. It will provide cleaner and more reliable electricity, more efficiently, to support socio-economic advances.

Mr Liu then introduced the achievements of State Grid Corporation of China in the area of the strong and smart grid. He expressed the wish to work with international peers in an open, innovative, cooperative and win-win spirit, pour in all the wisdom and power to promote the grid’s upgrade and improvement, and contribute further to the sustainable development of the economy, society and the environment.

The second keynote speech, Smart Grid: Horizons–Visions–Challenges–Tasks, was delivered by Mr Joachim Schneider of RWE Deutschland AG, President of VDE. He believed that the future will be a smart “world of electricity” which will require transitioning from classical energy systems to innovative solutions that are sustainable, secure, environmentally compatible – and affordable. Mr Schneider explored the possibilities from the perspective of Germany’s “Energy Transformation” and the views from VDE. He concluded that Smart Grids cannot be built on a significant scale without instituting major changes in the current framework conditions. These necessary changes will be accelerated and best accomplished by intensifying international cooperation in standardization and research efforts.
In the third keynote speech, *Large Utilities Making Smart Energy a Reality*, Jean-François Faugeras, Research Director for Renewables Integration in EDF, first addressed the key features of the international context regarding Smart Grids, and gave a brief overview of the challenges for the EDF Group as an example of a large utility. He then explained EDF’s specific involvement in Smart Energy and Smart Cities. Mr Faugeras concluded that large utilities need to devote their energy to:

- Creating a long-term, sustainable, low-carbon generation mix: safety, performance and extended operating lifetime of power plants, emergence of new and promising photovoltaic technologies (e.g. thin film), integration of renewable energies into systems, carbon capture and storage, etc.;
- Helping customers actively manage their energy consumption: energy efficiency, distributed renewable generation, smart grids, electric mobility, and involvement in the planning of smart cities; and
- Promoting Smart Grids that can integrate renewable energies on a large scale and help manage the supply-demand balance.

As the fourth keynote speaker, Dr George Arnold, Director of Standards Coordination Office and formerly National Coordinator for Smart Grid Interoperability at the US National Institute of Standards and Technology (NIST), described the progress and results of Smart Grid deployment in the US. He observed that from its beginning with Thomas Edison’s electricity generating station in New York in 1882, the US grid has evolved into a very large system accounting for over 20 % of the world’s consumption and supply of electricity. The system is owned and operated by over 3 200 electric utility companies, most of which are private-sector entities. The system serves over 140 million customers. Modernization of the US grid is driven by three needs. The first is to achieve greater system efficiency. It is estimated that US$1.5-US$2 trillion will need to be invested over the next twenty years to replace aging assets; Smart Grid technologies that allow the system to operate more efficiently will reduce the investment needed. The second need is increasing the reliability of the system. Power outages cost the US economy around US$80 billion per year. The third need is to make the system more sustainable and reduce its impact on the environment. Renewable portfolio standards in 29 of the 50 US states, the rapidly falling cost of solar PV and other factors have resulted in increasing deployment of variable renewable and distributed generation resources, and the Smart Grid is needed to support the integration of these resources in the grid.

Policy direction for modernization of the US grid to achieve a Smart Grid was established by the US Congress in legislation adopted in 2007. The US Administration published a more detailed policy framework for the 21st century grid in 2011. The American Reinvestment and Recovery Act of 2009 provided US$4.5 billion in federal funds to accelerate the development and deployment of smart grid technologies. Of this amount, US$3.4 billion was allocated to Smart Grid Investment Grants. With matching funds, this represents US$7.8 billion supporting more than 180 deployment projects. About ⅔ of these funds support the deployment of smart meters, about ¼ support the deployment of distribution automation assets, and the remainder support the deployment of nearly 1 000 networked phasor measurement units. As of June 30, 2013, between ⅔ and ¾ of these assets have already been operationally deployed.

The US Department of Energy has recently issued a series of reports that evaluate the economic impact of these Smart Grid investments and operational impacts. The reports are available on the internet at: http://smartgrid.gov. Significant benefits have been quantified. For example, selected examples of projects involving smart meters, customer systems, and new pricing plans have shown reductions in peak demand of 25 %-37 %. Reliability improvements from automated feeder switching have resulted in reductions of up to 22 % in duration and frequency of outages. Calculation of economic benefits shows that for every US$1 invested, US$2.5 in economic benefits were achieved.
Interoperability standards are an essential enabler for the Smart Grid to be realized. The US Congress directed NIST to coordinate the development of standards for the US Smart Grid, working with the private sector, standardization bodies and government agencies. The NIST Smart Grid framework, first published in 2010 and updated since, has provided important input to standardization work in the IEC and other international bodies, as well as to national and regional efforts in other parts of the world. The coordination of the standards work is now being carried on by the Smart Grid Interoperability Panel (SGIP), an independent, not-for-profit organization led by the private sector with government participation. One example of the broad impact that a good standard can have is the “Green Button”, which enables consumers to access their energy usage information through the world wide web, or connect the data to any of over 60 third-party applications that help consumers be more efficient and save money. The Green Button capability is based on a well-defined set of data standards, which has allowed it to be rapidly implemented and deployed. Utilities serving 27 million of the 140 million electricity consumers in the US (nearly 20 %) have either already made this capability available to their customers or have committed to do so in 2013.

Ensuring cybersecurity in the smart grid is an urgent priority. Significant progress has been made in developing guidelines for cybersecurity and a risk management process for electricity sector cybersecurity. NIST is also engaged in developing a framework for improving cybersecurity of critical infrastructure in accordance with the President’s February 2013 Executive Order.

In closing, Dr Arnold stressed the great importance of international collaboration and sharing of knowledge as each country develops its smart grid.

The final keynote speech, Smart Grid Standardization in Japan, was given by Mr Yuko Yasunaga, Deputy Director-General for Industrial Science and Technology and Environment, Ministry of Economy, Trade and Industry (METI), Japan. He first talked about Japan’s energy situation and the necessity of a Smart Grid for Japan’s energy policy. Then he presented Smart Grid demonstration projects in Japan, including the Yokohama Smart City and Keihan Eco City Projects, the Toyota City Low-carbon Society Verification Project, the Kitakyushu Smart Community Project, Smart Communities for Resilience of Tohoku and the Next-Generation Energy Technology demonstration project. Finally, Mr Yasunaga introduced Smart Grid standardization activities in Japan, especially the recent topics in IEC Technical Committee 120 on electrical energy storage systems.
SESSION SYNTHESES AND CONCLUSIONS

Session A1: Smart Generation and Integration

There is tremendous movement in power systems around the world, in order to reduce CO₂ emissions. Most countries are implementing ambitious energy policies aimed at developing renewable energy resources (RES). The consequent changes in the generation mix imply new challenges and issues for ensuring secure and cost-effective power system management.

Grid integration of new renewable energy sources – especially intermittent ones such as solar and wind power generation – is one of the most critical points.

Transmission and distribution networks have in the past been designed mostly in a centralized way for reasons of technical and economic efficiency. Electricity was produced by large, centralized generating plants to match consumers’ needs. The resulting power system was very successful in ensuring the quality and security of the electricity supply.

However, its flexibility seems to be limited in a rapidly changing environment, characterized among other things by:

- high penetration of distributed generation (particularly renewable energy sources), demand-side management and energy efficiency measures;
- difficulties in the construction of new grid components, particularly overhead transmission lines;
- opening of markets, which separates and multiplies actors and leads to frequently divergent interests and more complexity in operating the system;
- aging of infrastructures whose replacement requires major investment, but which also presents an opportunity for modernization; and
- the development of information and communication technologies (ICT), power electronics, energy storage and production from RES and co-generation.

A more advanced power system is needed in order to integrate, on the one hand, large onshore and offshore wind farms and solar plants, primarily into the transmission network, and on the other hand distributed generation plants – PV, micro-turbines and so on – into the distribution network.

The Smart Generation and Integration session addressed the main issues and challenges for smart integration of large-scale, distributed renewables into the transmission and distribution grids.

New intelligent electrical networks and systems have to cope mainly with:

- technical barriers
- economic issues
- design of new rules and grid codes, to integrate diverse new players
- architectures and planning, to integrate renewable generation flexibly
- control and operation of the networks, dynamically coordinating transmission and distribution.
These key issues for smart integration of generation were at the heart of the session, focusing on the following topics:

- What technical issues are the most critical? How may they be resolved?
- What methods and solutions can be implemented today? Tomorrow? What results and performance can be expected?
- What legal and regulatory frameworks can be proposed to ensure security of supply and cost-effective power system management?
- What is the correct balance between clear and firm legal frameworks, requirements for conformity to technical standards, and open markets where players can develop their business?
- How to ensure an efficient control and dispatch of renewable energy sources coping with the objective of a secure power system management?
- What architectures could maximize the integration of intermittent generation and flexibility of the whole power system management?

In the first presentation, Yao Liangzhong, Vice President Renewable Energy and Smart Grid Technologies of China EPRI, illustrated how China is planning and implementing large renewable energy sources.

He listed the various technical issues and challenges resulting from grid integration of such a plan. He highlighted the critical issues for both transmission and distribution networks: voltage and frequency control, overload risks, short-circuit currents, protection schemes, harmonics and so on. Issues related to large renewable generation outage and curtailment were also described.

Technical solutions were proposed, including network reinforcement, reactive power control at the point of common coupling with the generator, real-time control of the on-load tap changer (OLTC) reference voltage at the HV/MV (high/medium voltage) substation, generation curtailment, and storage. Best practices for efficiently operating the power system were outlined. Mr Yao also weighed the potential advantages and disadvantages of various solutions to technical T&D network issues and to the cost-effectiveness of the whole power system.

In the second speech, Axel Strang, Green Technologies Policy Adviser, French Ministry of Ecology Sustainable Development and Energy, underlined the importance of the legal and regulatory framework for transitioning towards an efficient new energy supply system.

He pointed out what he saw as the main drivers and challenges of regulatory change consistent with the technical issues and with the emerging new technologies and businesses in the energy sector: grid codes, demand-side management, metering data management, privacy protection, cybersecurity and so on.

In the context of increasing penetration of renewable and intermittent generation, he highlighted how critical the design of a new legal and regulatory framework was, seeking to meet the objectives of security of supply and cost-effectiveness for the benefit of the customers. In his view it was key to take the different implementation time scales into account in order to anticipate the changes in the power system successfully. Concretely, the main challenges were new interactions among energy market players, grid operators, consumers and local stakeholders.

In the third presentation, Kim Behnke, Head of R&D and Smart Grid in Energinet.dk, illustrated various topologies and architectures of T&D (transmission & distribution) networks to maximize integration of intermittent generation and guarantee flexible management of the power system. Current Danish experience, used as an example, provides some reliable lessons.
He described various control and dispatch strategies for intermittent generation to serve fluctuating loads, and compared their cost-effectiveness taking the whole power system into account. There are ways for transmission & distribution system planning to ensure flexibility for both generation and load, and the ENTSO-E grid codes also influence planning and management in certain ways.

Finally, Mr Behnke provided his vision of the coordination needed among the different players (TSOs, DSOs, generators, suppliers, aggregators, …) for the integration of renewable generation, with a focus on the specific coordination between TSO and DSO.

In the fourth and final presentation, Lee Jung-Ho, General Manager of the Smart Grid Department in KEPCO (Korea Electric Power Corporation), sketched technical decision methods for integrating distributed energy resources (DER) into distribution systems. He described the main features needed in the grid code and in technical guidelines for DER interconnection. KEPCO applies a specific technical methodology for DER estimation, including steps for evaluation and determination. He presented the technical estimation programme, based on distribution automation, which helps decide whether DG (distributed generation) will be accepted for integration into the distribution network.

**Discussions and conclusions**

A common view emerged among participants from different countries on the major technical challenges to the integration of renewables into transmission and distribution grids: voltage control, dynamic stability, grid capacity, protection plan. However, the severity of these challenges can vary greatly from country to country. Many technical solutions are either already available or in development and testing (more accurate renewable generation forecasting, for instance, or new coordinated reactive power and voltage control strategies). But the approaches to solving the technical issues can be different in each country, according to local conditions. One key point to be considered, greatly affecting quality of supply, is the level of inertia of the whole power system resulting from the degree of penetration of renewables.

In the regulatory challenges identified, a critical one is to find a balance between mandatory requirements and open market access in a realistic and progressive way, i.e. mainly based on facts and data. Market design is a key to favouring innovation and investment, but can also provoke perverse effects. Some types of heavy regulation can strangle investment, and others – strong incentives for installation of renewable generation, for example, if the corresponding new transmission lines cannot be built rapidly – can lead to stranded investments.

The session therefore tended to conclude that policies with subsidies, and those which support production without accounting for demand, are not sustainable. Policies and changes in the legal and regulatory framework should take into account appropriate timelines for the different stakeholders, such as the delays for a new law, a new power plant or a new very-high-voltage line. Different regulations across borders can create unfair competition, and thus hinder the setting up of an interconnected supraregional grid where one is needed.

Two issues were discussed but remained open. Depending on what business model is used, a cost-benefit analysis can yield widely varying results (positive vs negative). A social business model (such as one assessing benefits in terms of energy savings resulting from changes in consumer behaviour) usually shows high benefits, while a purely economic business model leads to lower benefits. And it is not clear how to bundle the value created by the various services offered to the different players in the power system, including prosumers. As an example, storage serves several purposes, such as balancing seasonal or weekly fluctuations in demand and supply or coupling with demand-side management, and its costs and value may be variously apportioned.
It further remains to clarify the roles and responsibilities between transmission grid operators (HV & UHV, [ultra-]high voltage) and distribution grid operators (mainly MV & LV, medium & low voltage) for ensuring security and stability. Current regulations require transmission operators to guarantee this for the whole power system, but simultaneously large investments are needed in the MV & LV networks, especially in Europe. Coordination across regions and countries is needed to ensure stability and security of supply and avoid a domino effect. Finally, questions were raised on how to benefit from demonstration projects. How can one compare results and performance between pilots? By what means can the lessons to be drawn be identified? How may they be replicated and scaled up? What avenues are there to promote a philosophy of interoperability and create a common “plug-and-play” logic?
Session A2: Network Stability in Design and Operation

The transmission system is already quite smart, but network stability continues to be a big challenge, witness various large disturbances (e.g. India 2012, Europe 2003 and 2006, US 2003). Other sessions addressed how ongoing large changes in energy mix, climate protection and relative costs of generation technologies lead to an absolute requirement to integrate RES and distributed system resources into reliable operations. This session concentrated on how networks can be designed and operated so that stability is maintained.

Design issues address the voltage levels to be used for continental-scale power flows that result from RES and market integration. They also concern the best mix and use of DC and AC, and flexible AC transmission system (FACTS) technology to best control the stability of the overall system.

Operations issues address the growing complexity of managing the many degrees of freedom within and across control areas. They also involve the growing sophistication of on-line dynamic stability analyses and cascading event tracking, intelligent alarming and global sharing, on-line identification of low-frequency oscillation, and phasor measurement units. Finally, they concern the interaction of transmission and distribution systems with standardized use cases and market designs.

What is common to both sets of issues is the need for coordination and cooperation on a continental scale, and this is addressed through institutions such as NERC (North American Electric Reliability Corporation) in the USA, State Grid Corporation of China (SGCC) with its own standards, and the European Network Transmission System Operators for Electricity (ENTSO-E) and ACER in Europe. This formalized cooperation is important both for continental-scale system planning and for clear and binding rules for connection, operations and markets.

As was also heard in other sessions, standards help a great deal. But grid codes which often have the power of laws also contribute substantially. In Europe, ENTSO-E drafts network codes which through ACER become European laws on connection conditions, markets and system operations.

It is one of our challenges to find the best mix of national, continental and global standards, binding grid codes and actual laws to drive the electricity system towards ever better security of supply, competitiveness and sustainability.

The first presentation was given by Alf Henryk Wulf, Alstom Deutschland AG Chairman, VDE Vice-President, on How to Ensure Network Stability with High Share of Remote, Volatile Generation. He gave an overview of volatility effects in the grid due to growing in-feed of renewable energies in general and in a few countries as examples. Frequency stability, its variance and speed of changes play a major role here, specifically when handling large wind-farms. The number of dispatches and manual interventions is growing steadily, and the amount and availability of flexible loads and flexibility of thermal power plants has a great influence. He described the differences between current technology and targets for further development in the thermal sector.

He then outlined the technological measures which can already be applied now and in the near future, in terms of the different methods of compensation, very precise forecasts and real-time measurements, as well as in the design of a future digital substation.

The second subject in the session, Stabilizing Power Systems with a Hybrid AC-DC Transmission Infrastructure, was covered by Xin Yaozhong, Deputy Director of National Electric Power Dispatching and Communication Centre of SGCC, China, with the following aspects:
• Benefits of combining AC and DC in a transmission system;
• Experience with existing hybrid installations;
• Outlook: stabilizing large interconnected power systems with an HVDC overlay grid.

The third subject was Consequences of Distributed Generation for Distribution Networks, presented by Andreas Breuer, Vice President New Technologies/Projects of RWE, Germany. Even today requirements resulting from the energy transition are posing major challenges to distribution system operators (DSO), and vary according to region with regard to size and the ability to find a technical solution. Distribution grid operators have already implemented a multitude of projects as a means of modifying the grid on a technological level, and through these have gained important insights. The presentation highlighted the key importance of IT for the optimum economic and technical integration of intermittent generation and flexible customer behaviour with regard to loads.

Changing political framework conditions (e.g. RE act rates) are leading to progressively vaster processing costs. Regulation must provide prerequisites for grid operators of sufficient size to be capable of investment and innovation. Also, regulation must induce a paradigm shift from a maximum to an optimum overall system.

**Discussions and conclusions**

• The impact of remote, volatile generation on system stability creates greater challenges.
• DC lines embedded in the AC grid are becoming an important design feature.
• Large operators do not necessarily have the most experience with wind, while smaller operators with higher penetration have valuable insights.
• Comparison of voltage control options from the points of view of cost, losses and variability: the perspectives are that daily step operations may be sufficient for certain needs and carry a significant cost advantage.
• Reactive power provided by a rotating phase-shifter: technical solutions exist which increase line capacity, integrate well into existing substations, are adaptable in response to remote power generation (e.g. off-shore wind), and constitute a very competitive system design to comply with customers’ needs.
• Some operational features such as dynamic line rating can extract extra capacity from transmission lines.
• The comparison between AC, DC and AC-DC hybrid power grids shows advantages and disadvantages for each system. By using UHV AC interconnection and DC transmission, the benefits of AC mutual support and DC modulation can be exploited and the reliability of a hybrid power grid can be improved.
• In order to improve the stability of an AC-DC hybrid grid, the following measures are needed:
  o optimizing SPS (special protection scheme) control strategy;
  o implementing smart grid operation and control;
  o building a strong as well as smart power grid.
• Even today, the requirements resulting from the energy transition are posing major challenges to distribution system operators (DSOs) and vary according to region with regard to size and the ability to find a technical solution:
  o Generation is becoming more decentralised;
  o Major renewable energy (RE) producers are concentrated a large distance away;
- Generation will increase and become more volatile.
- Smart grids can contribute to deferring new distribution-line investment (e.g. through voltage control – new technologies for voltage control to be further developed). This can be a major benefit of smart grids, contributing to a positive cost/benefit ratio and enabling demand response.
- Keeping local distribution grids in balance through good use of data brings benefits.
- Use of superconducting cables is an option in urban areas.
- Smart regulation is a pressing need.
- An optimum overall system requires limitation of network costs by controlling access to the grid:
  - Unlimited provision of grid capacity would lead to extremely high grid costs in rural electricity distribution grids in certain situations. In light of this, the system operator should have the opportunity to control both decentralized generation and certain consumers – particularly e-Mobility charging stations, heat, cooling energy, industrial processes and storage units – by setting definite limits on quantities;
  - Corresponding initiatives by legislators and regulators should be initiated.
Session A3: New Developments for Smart Transmission Grids

Many changes needed to make future power systems smart concern the downstream aspects: distribution, marketing and demand management/response. Other changes are clearly needed in the source of the electricity sent downstream, i.e. generation (whether central or distributed), and perhaps most of all in the information and communications that connect all the components. These were covered in other sessions. Session A3 concerned the upstream part of the grid, transmission, perhaps the most investment-critical element, and one which simultaneously presents unique problems and has already experienced a number of smart developments in design, operation and maintenance.

Most of the challenges transmission currently faces are linked to an absolute need to make the grid smarter. Even a superficial summary of these challenges goes beyond what could be covered in one session, but is useful as introduction.

- Because new bulk renewable generation is often a long distance from load centres, ever larger quantities of electricity must be transmitted over longer distances, so as to tap the available power with as little loss as possible.
- Larger and more tightly interconnected systems improve the efficiency of the power systems, but they increase the risk of large disturbances.
- The changes needed in transmission for smartening the whole grid demand robust equipment in an excellent operational condition. This requires substantial investment, especially after many years of deregulation in an environment of stable networks which operated satisfactorily even when maintenance and renewal were inadequate.
- New transmission infrastructures are less well accepted. This results in operating the assets nearer their limit and, in the worst cases, in a deficit of capacity which calls for real-time monitoring of the load conditions at system level, specific protection schemes and reduction in down time for maintenance.
- Renewables are intermittent, and their growth confronts the power system with new requirements, especially in terms of system stability and reliability.

The four presentations sketched some of the techniques which can be used to face the challenges, describing experience of what has worked, experience of less successful approaches, what action seems to be indicated today, and where this action is likely to lead us in the future. Since it was impossible to cover all the possible responses in a limited set of presentations, it was fascinating to see what unsolved problems came out most strongly in discussions during the session and at other moments during the Forum, and so what other responses beyond those mentioned by our speakers will need our immediate attention.

The first presentation was given by Liu Zehong, Director General of the DC Transmission Department of the State Grid Corporation of China, on the Latest record breakthroughs in HV and UHV transmission networks. Both DC and AC transmission at much higher voltages and over much longer distances is helping to deliver remotely generated electricity to consumer centres, without extreme losses. However, safety at the megavolt levels used, construction of the tall towers and a series of other challenges must be met. Using State Grid's experience as a leading UHV pioneer, Mr Liu covered the history of AC/DC voltage development in China, citing the power levels and transmission distances involved. Milestones and the timeline were highlighted.

He then presented the state of the art in HV and UHV technologies in China, for both AC and DC transmission. The FACTS and power stability control technologies used were described and their current scale put in context. Mr Liu further illustrated the challenges and R&D progress for the
further development of UHV AC/DC transmission technology, such as higher capacity UHV AC equipment and ±1100 kV DC. In these areas he pointed out critical issues and achievements. Finally he described the vision for the UHV transmission network of the future in China.

The second subject, Worldwide industrial efforts for the transmission grid of the future, was covered by Magnus Callavik, who is in charge of grid systems technology for ABB. He reviewed the speed of technology development over the last 15 years and extrapolated to what can be expected – and what is less likely – in the future, thus sketching a scenario for the next 15 years.

The market for high-voltage direct current (HVDC) has grown significantly in recent years. The first commercial HVDC project in 1954 was a subsea connection to the island of Gotland, using the classic or Line Commutated Converter (LCC) technology. Since then many more applications have been explored in parallel to an ever-increasing capacity for coping with higher power levels per line, at present above 7 GW per link over more than 2000 km. The introduction of Voltage Source Converter (VSC) HVDC in the late 1990s has also enabled GW-sized offshore wind connection. Use of the VSC technology enables HVDC stations to take a much more active role in the AC grid, such as providing reactive/voltage support.

The presentation showed how HVDC is increasingly becoming an integral part of the AC grid and not only a means for remote bulk transfer and long subsea connections. Examples of some of the more recent projects under construction and commissioning were shown. In addition, the vision of the future grid represented by several ambitious joint projects along the whole value chain was summarized. These include the Desertec Industrial Initiative, Medgrid, Friends of the Supergrid and the German electric grid development plan.

Industrial leaders have announced recent developments in the areas of some of the key components to enable the development of future HVDC transmission technology:

- power semiconductors such as thyristor and IGBT types, the heart of the AC-DC power converter;
- HVDC cables for underground and subsea use;
- HVDC breakers to be used for fast dynamic isolation of a converter station or any faulty part of the future HVDC grid;
- the design of VSC and classic HVDC converter stations; and
- real-time digital simulation of HVDC power systems.

These and other foreseeable developments were used to discuss how steps taken now will influence the future grid.

The third subject in the session was Specific control and protection challenges and achievements, covered by Hans-Joachim Herrmann of Siemens's smart grid infrastructure sector. Safety, stability and controllability in a smart grid environment requires new consideration of many topics influencing protection and control. After a short introduction to protection four topics were addressed, with solutions as well as new challenges.

- Large distances between generation and load centres need new solutions for energy transport, an Ultranet with AC and DC transmission on the same tower. One protection challenge is intersystem faults (between AC and DC) for which additional investigation is necessary. Another is voltage stability problems from the transmission of a large amount of power via an overhead line, which demands a certain amount of reactive power. The required reactive power support can be provided by rotating machines, MSCDN, VSC and others. Additionally, there is a need for supervision. An application of phasor measurement technique (PMU) can monitor the PU-curve (voltage as a function of reactive power) and generate an alarm in critical cases.

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1 Mechanically Switched Capacitor with Damping Network
• **Increased renewable energy contribution to generation** leads to converter stations. Their power electronic components cannot transmit large short-circuit currents, so that the supplied fault current is close to the rated current. This influences the protection concept (selected principles as well as settings). With an asymmetrical fault, due to the design of the control software, there may be no fault current at all. In such cases the control software must be revised. A negative sequence current is required.

• **Changed network topology.** Offshore wind platforms are connected to the power system (e.g. HVDC stations) by parallel sea cables, where due to the large capacitances shunt reactors are necessary. Transient simulations have shown that the current can have a DC offset and an AC current without zero crossing. That means stress for circuit breakers if they operate (after tripping of a protection), so intelligent control of the circuit breakers is required. The Energy Line Extinction Act in Germany requires a combination of overhead lines and short cable sections, which is a new situation for protection needing new concepts. However, present technology can cope with the main challenge, which is a safe power supply for protection devices, using redundancy.

• **Unpredictable load flow due to fluctuating generation.** Various factors such as distant generation or energy trading can lead to temporary overload of transmission lines, which affects protection settings and behaviour. Distance protection in particular needs improvement, but a solution requires research and will probably involve adaptive characteristics.

The final presentation was *Smart utilization and upgrading of existing transmission assets* by Alessandro Clerici, Honorary Chairman of WEC Italy and Vice-President of IEC Italy. On the basis of his experience in generation and T&D, he first reviewed the global energy situation and its key drivers and concluded that a true smart grid approach is needed for the complete electrical system, from generation to final consumers. “Smart” implies not only ICT but robust physical infrastructures for reliable and economic energy flow from any generating plant to any load. ICT is an asset but cannot control the flow of electrons without adequate “hardware” assets such as transmission lines (TLs) and substations; conversely, there is no optimum utilization of power system components without ICT.

Opposition and delays for new TLs are constantly increasing; in the EU, a few dozen km of TL take 10-15 years to commission (as against 4 years in China for a 2000 km line). The second part of the presentation stressed the consequent need for fast implementation of smart grid concepts in the transmission area, including smart utilization of existing assets; this in Mr Clerici’s view should have priority with respect to distribution, which currently tends to dominate the discussion. Application of FACTS or Battery Storage Systems or in some cases new underground cables can alleviate bottlenecks, but it does not increase the inherent power transfer limits of TLs or transformers.

With reference to the upgrading of existing AC TL corridors, the various alternatives were analyzed with some practical examples:

- **“reconductoring”** (replacing existing conductors with new ones with higher current capacity for the same weight/diameter),
- voltage upgrading,
- transformation of an AC line into DC making maximum use of existing conductors and towers, and
- changing an existing AC line in the same corridor for a new “compact” one at a higher voltage, or for a DC line.

Summer and winter limits in standards and local codes for TLs and interconnecting transformers are based on extreme weather conditions which are very rare in real life, so improvements through “dynamic loading” based on actual conditions may be practicable. This would alleviate N-1 situations and increase transfer capacity for much of the time, but requires new technologies and of course the revision of standards and operating procedures.
Discussions and conclusions

Following the presentations it became clear that the technology was by-and-large ready and available to cope with the transmission challenges identified, with only some of the protection techniques needing more research. Principally it was investment in installations and infrastructures which presented the greatest task. Several questions addressed items of technology such as VSC and UHV and other technical possibilities such as deep-sea cable, all of which seemed ready – if installed – to transfer safely and efficiently the vast amounts of power and energy needed.

The following is a summary of the conclusions suggested by transmission discussions in this as well as other sessions.

- For a truly Smart Grid, transmission is just as important as other aspects which often receive more attention (distribution, communications, demand response, markets, ...).
- A Smart Grid is a smart power system in its entirety, including every element from the beginning of the chain to the end (where “chain” is value chain, power chain and energy chain).
- The technical challenges worldwide are all roughly of the same type, but differ in their constraints & circumstances (per country, region or continent).
  - In China, the principal emphasis is to transfer more and more power over very long distances, against a background of linked but not unified grids and generation potential located very far away from load centres.
  - In Europe, there is already a single grid, but reinforcing it is difficult (especially using overhead lines). An overlay grid is planned, with a meshed DC system superimposed on the AC grid, and new transmission links with North Africa.
  - In the USA, coordination of the solutions applied across state and regional boundaries is key.
- Protection and control are a problem in two separate phases, needing to be treated as such:
  - for the system as a whole, and
  - for equipment, including maintenance and condition monitoring.
- Technical solutions exist to most of the problems presented by the Smart Grid, and the conditions must now be created to allow them to be acquired and installed cost-effectively.
Session A4: Evolution of the Distribution Grid

A dynamic of transition for energy systems as a whole is engaged in many regions of the world. The share of production of electricity from renewable and intermittent generation is increasing in many regions. By 2012, more than 280 GW of wind power and 100 GW of PV were installed worldwide. The IEA (International Energy Agency) forecasts that the evolution will continue with the installation of a further 230 GW of wind power and 210 GW of PV by 2017.

Many governments encourage the development of sustainable transport (trains, buses, trams) and car manufacturers are now offering a wide range of plug-in electric / hybrid vehicles (by Dec 2012 180 000+ plug-in EV were on the roads – source IEA). Last but not least consumers are changing their behaviour towards energy savings. The massive roll-out of electric Smart Meters will permit the development of energy conservation services (more than 80 million smart meters were already deployed worldwide by Dec 2012).

DSOs (Distribution System Operators) are playing a central role in the electric system. Being in charge of reliable operations on the distribution grid, DSOs should act as enablers and facilitators of the market in order (with others) to

- Ensure uniform and harmonized deployment of Smart Energy
- Enable the deployment of new services
- Contribute to the operation and control of new flexibilities (storage, peak shaving programmes, management of capacities (production and demand), dynamic tariffs, ...)
- Provide data to the customers, suppliers and other market players and ensure its security, legibility and usability.

Smart grids have different drivers requiring different solutions in the regions. In this session, the speakers presented and discussed drivers and successful examples for increasing reliability and security of supply in North America, South America, Europe, the Middle East and Japan. Whereas the previous presentations had mainly grid connection in mind, this session includes the transition from grid connection to islanding operation in case of black-outs. Further, in this session the focus was on convergence of operation and information systems with big data analytics in smart grids.

The first speaker, Gary Rackliffe, Vice President Smart Grids North America at ABB, covered Increasing the intelligence of the distribution grid. He explained drivers for smart grids in North America. Utilities are implementing distribution grid management, increasing integration of distributed resources, adapting transmission grid management and using utility analytics. The goal is to improve operational performance and condition-based maintenance for better asset life-cycle management. He showed examples of drastic improvement by distributing the intelligence within a system architecture.

The presentation described how operations technology (OT) and IT are merged. OT is the control, operation, engineering of the grid and IT is the utility enterprise-level information systems such as a customer information system, a geographic information system, mobile workforce management, work and asset management, meter data management, and business intelligence. The intelligent grid leverages energy information from smart meters and distribution sensors to allow advanced operations and maintenance of the grid through real-time grid monitoring, event detection and locating, and automated switching. The more significant change to utility operations will come when we can leverage advanced data analytics and grid diagnostics to predict and avoid disruptive events. Together these improvements will modernize the grid to support the competitive electric marketplace.
The second speaker, Ricardo Klatovsky, Vice President Global Energy and Utilities Industry at IBM, focused on *Data Analytics for Increased Intelligence of Distribution Grid*. He explained Big Data characteristics and examples and showed how to manage all data from new devices and combine electrical distribution and communications. Examples were given of such analytics for preventive maintenance and sharper operation planning. One example is the Pacific Northwest Smart Regional demonstration. It is the largest Smart Grid demonstration project in the USA and will create the future of distributed control for electrical grids. The Transactive Energy Management System is a distributed software and communications environment that logically overlays the electricity grid. It deploys thousands (even millions) of software control agents to manage all responsive assets in the system. Agents communicate with each other through incentive and feedback signals.

Big data significantly changes behaviour and the way utilities operate. Mr Klatovsky showed examples from various utilities where big data management is in place.

The third presentation, *Microgrid Operation in Sendai and the Massive Earthquake in 2011 - Experience and Deductions for the General Design of Microgrids*, was given by Keiichi Hirose, R&D headquarters of NTT Facilities Inc., Tokyo. He showed how the Sendai Microgrid developed, focusing on project design and experiences during the big March 2011 earthquake. He provided insight into the technical configuration at several quality levels and measurement results. The Sendai Microgrid continued to supply power despite the devastating damage to the power delivery system in the Tohoku area due to the earthquake.

The lessons learned from this experience have many implications for the future design, siting and construction of microgrids. These were examined as regards the importance of microgrids in times of disaster, diversity of power sources, backup equipment and comprehensive operations and training. In his presentation, he talked about Sendai City efforts to build operational bases in an emergency through small and medium-scale microgrids.

The fourth presentation, entitled *Smart distribution grids: different local conditions affect the priorities*, was from Matteo Codazzi, Chief Executive Officer of CESI. Focusing on Smart Grid for distribution, four key elements can be identified: Smart Meter, Network Automation, Home/Building Automation and Distributed Network Management. Worldwide, the Smart Grid landscape is rapidly changing with different approaches, strategies, agenda priorities, adoption propensity, investment policies and financial availability within and among countries. He presented Europe’s 20-20-20 targets with a focus on Italy, and then showed Middle East and South American characteristics.

Lessons learned:

1. Investments in embedded intelligent solutions (hardware and software) will enable utilities to improve reliability and efficiency today, while also laying the foundation to meet future energy demands and requirements (i.e. energy storage, e-vehicles and distributed RES require local intelligence to rapidly respond to changing system conditions).

2. A new paradigm with customers living at the core of the systems as trader of electricity, feeder of storage, self-producer, and provider of electricity to other customers. Utilities have to re-think their business models; regulators have to set incentive schemes and create a stable environment for both private and public investments; DSOs have to develop supervision centres dedicated to managing huge amount of data.

3. Interoperability is the key as a multitude of technologies, systems and devices need to securely and effectively talk to each other.

4. Adding sensitive information and communications technology to the grid require cybersecurity standards and must ensure customers’ privacy.
Discussions and conclusions

Worldwide there is a real challenge for electrical systems and a paradigm shift for distribution networks. In view of the issues – distributed energy resources, electric vehicles and so on – Smart Grids are not an option, they are a necessity. Intelligent solutions are needed locally to ensure the security and reliability of the networks.

Convergence of IT/operations technology (OT) and data management is the key to taking full advantage of new technologies and developing more reactive & efficient networks, with high levels of security and cybersecurity. Areas involved are forecasting of production and consumption, operational management of the network (supervision, remote control, self-healing), and providing data to all actors in the electrical system (customers, storage providers, EV fleet managers, ...).

The savings expected from Smart Grids are large and spread across the value chain. The most important condition for ultimately achieving these savings is that consumers change their behaviour, accepting to become prosumers, to shift their consumption or to consume differently. Thus, since Smart Grids are a complex topic, explaining their benefits to consumers is vital, and the solutions proposed to them must be as simple as possible.

Data management is naturally handled by utilities, given their core mission and activities. In countries with a few, large DSOs, these can easily manage the data, but it is more difficult for DSOs in countries with a scattered municipal DSO landscape. In most European countries DSOs are in charge of metering, and most of them therefore manage data. Synergies are thus expected between these traditional activities and new tasks: DSOs will take advantage of the metering infrastructure to operate the network. Detailed information, such as load curves, voltage quality and status, will be used to ensure the stability of the grid and integrate new uses.

Distribution networks are designed to face extremely complex situations involving demand or production peaks, based on long-term scenarios. Operational management systems can handle incidents and limit the impact on consumers. In this context, microgrids may be considered as a complementary solution. However, islanding of a microgrid is a temporary situation and corresponds to a downgraded mode of functioning, and thus is relevant to maintaining local provision of energy only in the case of a major incident on the network.

Self-consumption could be of benefit to the electrical system by limiting the investment needed to reinforce the network – it reduces the peak level of production on the network by synchronizing consumption with local production (“wash with the wind”, recharging EV, storage of hot water, ...). There is however a prerequisite: regulation must evolve, in particular to guarantee a certain income for the DSO so as to cover network costs.

DSOs play a central role in the electrical system and should act as enablers for the market. Smarter networks will require significant investments in coming decades with the deployment of smart meters and smart grids, and for these investments to be made the regulatory framework needs to change. Roles and responsibilities in the market must be defined, a fair rate of return on investments ensured, and in Europe network codes and standards adjusted to support cost-effective development.

Standards are required for interoperability between equipment and systems, so as to allow new functions to be deployed. The application areas involved are peak demand, flexible load, power quality, electric vehicle charging and distributed energy resources. They require both electrical standards and information technology standards and involve several organizations.

In summary, international cooperation among the stakeholders of Smart Grids is a key success factor. They must disseminate best practices and tackle the technical challenges through multidisciplinary consortia and standardization. Only through this can the learning curve and the time to market of industrial solutions be reduced.
Session B1: Smart Energy Market Design

In order to de-carbonize the electricity supply, the power system is undergoing a tremendous transition which affects all its parts: power generation, transmission and distribution systems, power consumption, storage as well as electricity markets. The session Smart Energy Market Design addressed the features required of a future market that can fulfil its role even though the framework will have changed. Electricity markets have to match the amounts of energy generated with those consumed or stored, to advertise fair prices for energy and other system service products (capacity, flexibility etc.), to protect the interests of society, and finally to ensure an appropriate level of security of supply, system security and system stability. Smart electricity market designs have to address and to cope with the following changes to the framework:

- A limited number of fossil or nuclear power plants will be replaced by innumerable generation units using renewable energy sources (RES), mainly wind turbines and PV plants. The number of participants in wholesale electricity markets may increase significantly.
- Dispatchable thermal power plants operating at different variable costs will be replaced by non-dispatchable generation units using RES operating at zero variable costs. This will affect market clearance, merit order and market prices.
- RES-based generation units show a volatile generation pattern which also imposes volatility on energy markets.
- Because RES-based generation units are often connected to distribution systems, limitations to the commitment of these generation units may be set by the technical capabilities of distribution systems rather than transmission systems, and this may interfere with market results.
- RES-based generation units do not contribute substantially to the adequacy of system capacity.
- RES-based generation units connected to distribution systems will offer system services (e.g. on system services markets) to the transmission system and to distribution systems.
- Energy management systems governing the electrical applications of consumers will provide new flexibility to the power system and enable demand response.
- Smart meter technology allows for better integration of millions of consumers and prosumers into the energy and system services markets.
- Storage, e.g. based on new technologies such as decentralized battery storage (mobile or stationary), will play a major role in electricity markets and therefore lead to stronger intertemporal dependencies in the markets.

The key issues for future smart electricity market design were discussed by the presentations in this session, each of them focusing on different topics:

- As long as there is still a need for RES support, what are the appropriate support mechanisms to allow smooth market integration of RES-based generation units into smart energy markets?
- How can adequate investments in generation capacity be ensured? Are capacity support mechanisms the right approach to ensure adequacy of system capacity?
- How do we cope with the mass of decentralized market participants, i.e. consumers, prosumers and RES-based generation units, when integrating them into wholesale markets?
- How do we properly integrate consumers’ flexibility into smart energy and system services markets?
- What are appropriate mechanisms to generate price signals on the available grid capacity? In case pricing zones are used, what is the correct layout for these zones?
In the first talk, without slides, Marc Oliver Bettzüge, Director of the Institute of Energy Economics at Cologne University, highlighted the role that price signals need to play in order to efficiently achieve the desired de-carbonization of European electricity production. In this context, he looked at the interplay of alternative RES support mechanisms and European and national electricity markets, as well as the European CO₂ mechanism. Here, he also pointed out the role of import/export opportunities in accommodating high national shares of RES.

This first contribution also attempted to disentangle the “myths” and the “truths” about the need for capacity adequacy mechanisms, in particular in situations with increasing shares of wind and solar electricity production. The author challenged some of the usual arguments for the need for capacity support mechanisms, stressing in particular the role of increased system flexibility and long-term demand elasticity, as well as discussing the questions of the “when” and “how” of potential capacity mechanisms. In this context, he specifically addressed the question of correct pricing zones, both horizontally within Europe as well as vertically between the TSO and DSO levels.

In the second presentation, Knud Pedersen, Vice-President of DONG Energy Distribution, presented the Danish example, which targets a 100 % RES share for electricity and heat by 2035. He described the roles and responsibilities of system operators, commercial players and private players in Denmark. Focus was also placed on the interaction of electricity, district heating and natural gas systems.

He suggested helpful conclusions based on his practical experience using Denmark as an example. He believes that in Denmark all the basic components for developing an effective Smart Energy Market System are already in place or will be by 2020. Political commitment to developing the basic framework is crucial, e.g. rollout of remote metering. (In this respect, he made the point that the “smart” in “smart metering” was limited to the new ability to measure consumption remotely at given time intervals – experience showed that hourly was sufficient – and did not imply any other intelligence or control.) The key success factor for a market-based system is that it attracts players on both the demand side and the supply side. He believes that weak price incentives for flexibility products are the major barrier to rapid development of smart energy markets.

In the third contribution, Jessica Strömbäck, Executive Director of the Smart Energy Demand Coalition, illustrated system benefits, consumer benefits and increased market efficiencies resulting from demand response. She focused on both demand response in energy markets and demand response in system services markets. Her fundamental premise is that demand response should have comparable opportunities in the market to those of generation.

Her roadmap to successfully integrating consumers consists of four steps. In step one, in order to involve consumers, a key success factor is for independent aggregators to put themselves in the place of consumers and offer them simple-to-use products with clear benefits. The creation of viable products should allow, in step two, demand and supply to compete on an equal footing. The development of measurement and verification requirements in step three includes contractual and communication arrangements, as well as well-defined and appropriate measurement and verification protocols that enable smooth and cost-effective market coordination. In step four, to ensure fair payment and investment stability, it is essential to create market structures which reward and maximize flexibility and capacity resources, in a manner which provides investment stability. Capacity markets especially have to be open to demand-side resources.

In the final presentation, Dirk Biermann, Managing Director at 50Hertz, one of four German TSOs, looked into the changes mentioned from the transmission system perspective. He contributed the 50Hertz experience with a system which today already shows a 35 % renewable energy penetration. The main focus was on system operation and how the system has to be developed to cope with a vast number of small generators in the distribution networks. These generators have a strong impact on the transmission system, but are neither connected to the transmission grid nor individually under the control of any central entity. A major challenge for secure system operations is the volatility and unpredictability of feed-in of renewables; this was illustrated and analyzed with respect to actions for improvement and risk mitigation.
He also explained that distributed generation can and will have to deliver its share of ancillary services, that today’s design of balancing service products will have to be further developed, and that properly functioning intraday markets are key for RES market integration. A conclusion was that online data exchange between distributed generators and the system operator is urgently required, including the possibility of selective curtailment of RES generators. DSOs also have an eminent role in this interaction, and smart technologies in distribution networks can facilitate fulfilling the new requirements.

**Discussions and conclusions**

- **Proper market design is crucial**
  - All participants (all types of customers & suppliers) must be involved
  - The energy market and the flexibility market should be distinct
  - The intraday market should be greatly enhanced and become international (e.g. to cope with forecast errors)
  - Carbon pricing is an integral part of pricing
  - Correct design of bidding zones is needed to prevent bottlenecks
- **Regulations should avoid influencing markets in such a way as to negate the advantage of a market**
  - The advantage of a market derives from the fact that it is the way of determining prices so that they correctly reflect the scarcity of resources
  - Concerned are feed-in tariffs, capacity support and other subsidies
  - Retailers & BRPs (Balance Responsible Parties) must be protected from forced losses in energy sales resulting from flexibility contracts with 3rd parties (caused by regulations or rigid contractual or market conditions)
- **Consumers should be integrated in the markets (energy, ancillary services)**
  - Their flexibility should belong to them, so as to be best used for the benefit of all
- **35% + of RES is technically and operationally feasible**
  - Existence proofs: Denmark, 50Hertz Transmission (Germany)
- **Transparency, exchange & reliability of information among market players must be enhanced**
  - Forecasting must be vastly improved and refined (with respect to its flexibility, regularity & reliability) and taken seriously
  - Some information hitherto considered competition-sensitive should now become transparent (e.g. among TSOs), to allow smooth operation of the markets and secure operation of the grid.
Session B2: Smart Grid Communication (Information Technology)

Control of electric power delivery systems is undergoing significant change, following emerging trends that are being driven by public policy. In particular, electric utilities are seeing increasing penetration of distributed generation (especially of Variable Energy Resources such as wind and solar), roaming loads such as electric vehicles, responsive loads (including demand response and local energy balance), microgrids and local energy networks, and the incorporation of market-like mechanisms directly into grid control loops (sometimes inadvertently). The trends have much value but also have the effect of destabilizing the power grid, and this has become a significant risk management issue for the grid operators.

What are the issues that grid operators must face when contemplating the communications architecture that must be implemented to address these challenges? What sort of attributes must such a communications architecture incorporate – both for functionality and security today, but also to remain future-proof for several decades?

The session Smart Grid Communication (Information Technology) addressed the main issues and challenges for producers and consumers alike, on both sides of the meter, in terms of the IT and communication infrastructure necessary to support the various value propositions of a smart grid implementation.

These key issues for smart grid communications were at the heart of the three presentations in the session, each of them focusing on some of the following topics:

- Communication architectures, software services, protocols, etc.
- Big data and managing IT
- Various and conflicting international standards and interoperability
- Cybersecurity and consumer privacy
- Home, neighbourhood, and wide-area networks
- Advanced Metering Infrastructure (AMI) communications and management
- Reliability, availability, robustness, fault-tolerance, and self-healing
- Quality-of-service provisioning
- Support for renewable energy generation, microgrids, and storage
- Electric vehicle, plug-in or battery system and network
- Wireless sensor network applications.

In the first talk, Henry Bailey, Global Vice President of Utilities Industry Business Unit for SAP, gave an overview of Europe’s vision of energy and smart grids from 2020 through 2050, based on the Energy Roadmap 2050. This focuses on decarbonization as well as increased use of renewables. Given that by 2035 IEA predicts that demand will increase by 36 %, Mr Bailey says the only way to manage consumers’ increased demand is by measuring in real time their consumption, which will lead to a tsunami of data that needs to be gathered, transmitted and managed.

He listed the diverse locations, sizes and other characteristics defining consumers of the future, emphasizing changes from today (or business as usual), such as the set of users with specialized mobility requirements for plug-in hybrid and pure electric vehicles. These users need mobility interfaces with quality and security of supply of electricity. Similarly, energy prosumers are
consumers who are also providers, with the additional role of self-provided (owned) electricity generation and storage for private, daily life needs, comfort and SME business needs.

Mr Bailey posited that the energy sector is similar to the telecom sector 10 years ago, and now energy and telecom consumer management are converging to flexible, real time management of huge volumes of data and value added products and services that are becoming more and more competitive. In addition to faster communications, which now approach real time, he talked of cutting-edge technologies for high-speed data transactional and analytics performance, so-called In-Memory Technology.

The session illustrated an end-to-end story with these examples: vision, Smart Grid requirements, challenges, description of the new technologies and conclusion of what will change.

In the second presentation, Larsh Johnson, Head of Technology & Innovation/CTO of eMeter, focused on the consumer. He discussed some of the primary value propositions for consumers, the challenges of the connected home, and privacy-related obstacles. He pointed out the regional variations in smart grid initiatives around the world, and showed how these regional differences all have the consumer in common, with expanded consumer choice as a key objective. In spite of the regional differences, these new energy offerings generally include some form of consumer engagement and are beginning to include smart home applications.

He then showed how these offerings raise many issues for the providers, not all of which are energy suppliers, with networking, security and privacy at the top of the list.

Jeff Taft, Cisco Connected Energy Network, Distinguished Engineer and Chief Architect, gave the last presentation and discussed newer technologies that have emerged to assist grid operators. They include the transition from centralized to distributed control, pervasive use of IPv6 digital communications, and use of optimization tools for developing grid control and distributed control coordination approaches that address several major concerns.

He described why, in the new world of grid modernization, it has become clear that traditional grid communications and control systems are not adequate, with new systems needed to provide flexibility and resilience in real-time operations. Finally he discussed emerging technologies and architectures for communication and control to meet these needs.

Discussions and conclusions

In the course of the presentations, it was shown that we are now able to process big data in real time, which is a very big shift from previous data collection usage. How to collect big data while empowering consumers was explained, generating many consumer-oriented questions, and the audience saw the big-picture view of changes from the ‘old’ grid to the ‘new’ grid, meaning a grid that is more dynamic, more decentralized and stochastic.

There were two main conclusions of the session. First was the importance of forecasting to smart grid deployments, where good forecasting sets expectations and targets. Focusing on good forecasts allows for efficiency in how to achieve those expectations and targets. The second theme taken from the presentations was that Smart Grids optimize the energy value chain for all the stakeholders.

Less certain, on the basis of information from the session, is the control and stability of the grid as we transition from the old grid to the new grid. The physics of electricity rules the grid, shaped by grid connectivity; neither business models nor software can change this. Using the analogy of replacing a plane’s engine in mid-flight, typical grid control tools can be seen as increasingly insufficient to address the emerging technological issues faced. Grid control must become more flexible to accommodate changing conditions so that the grid does not become “unstable by
“evolution”. This means we started the grid in a certain manner, but the assumptions and modes have now changed. For example, the use of distributed PV changed the equation, but we haven’t changed the regulation or the operating procedure, hence instability by evolution. And what are the needs of communication to meet that?

The second development with an uncertain outcome is complexity in data. As there are many stakeholders and the complexity of the data is overwhelming, questions on how to make it meaningful while adding value for the stakeholders need to be answered. Somehow energy information has become sensitive with more availability and transparency of usage data to customers, who therefore need to know what the companies are doing with the information they collect. Many companies now offer innovative pricing and packaging programmes, including demand response. While they indicate that they are ready for customer engagement, the question was posed as to who the customer on the grid actually was and whether he was ready. It was acknowledged that there are two tiers of customers on the grid, the end user and the utility itself. Also pointed out was that developing regions have different needs and the utilities are in a different position to supply those needs, and there is not just one standard or one solution.

A common theme from this session was data privacy. From a consumer perspective, it is a big unanswered question; and it is yet to be determined what the norms are and how to deal with privacy, as compared to what is done in other industries.

Lastly, what do the emerging trends in Power Systems mean for security as the span of connectivity increases? This larger “attack surface” has more edge devices connected to grid communications networks, which will spur the need for more complex threat analysis and place even greater emphasis on proper security measures and processes.
Session B3: Smart Customer

The advent of the Smart Grid is enabling a more direct utility-customer interaction, which is transforming the customers from passive consumers of electricity who are only concerned with their electricity bills, to more active players, who manage their electricity consumption patterns in response to incentives, or event signals, or price signals.

Smart Grid technologies in the customer domain include smart building/home, EV (electric vehicle) charging/discharging, distributed energy resources (DER)/microgrid/CCHP (combined heat & power), and demand response.

Demand response (DR) is an effective means of building a reactive relationship between customers and power grids. Event or price-responsive DR helps make the power system operate more efficiently and reliably while reducing the overall cost of the electricity service. This active customer engagement in managing consumption is the fundamental basis of DR, but the social or psychological problems and an appropriate market mechanism are main issues to be resolved.

Electric Vehicles (EVs), either plug-in hybrid type or pure-electric type, are another novel development whose further deployment is being made possible by the smart grid. EVs are expected to exert significant impact on power generation and consumption patterns. Further penetration of EVs, depending on the prevailing charging patterns, is expected to directly impact how supply-side generation will be dispatched. Increased EV penetration will impact Transmission and Distribution (T&D) infrastructures, consumption of primary fuel used in power generation, and also the levels of environmental and greenhouse gas (GHG) emissions. Smart scheduling of EV charging in response to incentives or dynamic pricing can be considered a DR service. In the future, adoption of Vehicle-To-Grid (V2G) technology has the potential to make EV batteries act as DERs and play an important role as ancillary service/operating reserve providers.

A smart building/home integrates major building/home systems onto a common network and shares information and functionality between systems in order to improve building operations and home energy consumption. A smart building/home has the following benefits: improved energy efficiency, enhanced operational effectiveness and increased tenant satisfaction. A smart building/home can also be regarded as a DR resource. Customer-scale DERs are components of a smart building/home and are expected to become an important component of the power grid, either as ancillary service providers or by giving opportunities for energy arbitrage (buying power at low prices and selling power at high prices). DERs are expected to function as resources that can help mitigate the impact of higher integration of intermittent renewable resources in the future grid. It should be noted that DER can also be categorized as a DR resource.

The first presentation was given by Ahmad Faruqui, Principal, The Brattle Group, on Smart Rates to Engage Consumers. He explained the concept of dynamic pricing that reflects the dynamic changes in the supply-demand balance. Examples include critical peak pricing, variable peak pricing and real-time pricing. Dynamic pricing provides lower customer bills, less pollution, higher reliability and integration of renewable energy resources with the grid.

He then explained how dynamic prices can be designed and gave an overview of the response of customers to dynamic pricing in several pilots from seven countries. A survey of developments from around the globe was also given.

The second subject, New Energy Customer, was covered by Joost Brinkman, Senior Manager in Accenture’s Sustainability Practice. He described the 4th ‘New Energy Customer’ research project conducted by Accenture in 2013. Over 40 000 consumers from 21 countries and 2 000 SMEs from nine countries took part in the research programme. Governmental regulations, technology developments, sustainability and shifting consumer preferences are creating a challenging new environment for utilities. Where a “consumer” used to be a simple address of a bill payer,
consumers are now evolving into prosumers with solar panels and small-scale wind turbines, and EV drivers charging not only at home.

With declining volume and bigger competition, energy providers are squeezed to increase their customer intimacy by segmentation and innovation. To speed up innovation and develop stronger partnerships, utilities should be at the forefront of new energy eco-systems like Smart Cities. Some key outcomes and learning from the Amsterdam Smart City programme was shared.

The third subject in the session was Electric Vehicle Technology and Strategy from a Utility’s View, presented by Hiroyuki Aoki, senior manager of mobility technology, TEPCO (Tokyo Electric Power Company) R&D Centre. His presentation covered competing models related to battery swap versus charging. A wider range of technologies are being proposed by the car industry beyond just battery swapping or AC/DC charging: fuel cell and wireless charging technologies have already been proposed to the IEC and ISO standardization community. All new technologies require new types of energy infrastructure. Making the business model for such infrastructure is not easy, but it has been recognized that the connection to the grid could enhance financial viability.

The second part of the presentation addressed two questions, whether EVs could provide storage to the grid and, if so, what kind, and whether electricity storage developments are triggering the EV market, or the other way around.

The fourth presentation was by Thomas Goette, CEO GreenPocket, on Smart Home and the Smart Customer – Insights from the Digital Natives’ Generation. In order to explore the drivers and inhibitors of the smart home technology, GreenPocket in cooperation with the University of Applied Sciences Bonn-Rhein-Sieg conducted a market research study focusing on the digital natives’ generation – the generation which most probably will stand at the forefront of the diffusion of smart home technology into the market. Examining product awareness, consumer expectations, feature portfolio and propensity to pay, the study produced results offering insights into what the young generation demands of smart home software. Online affinity, especially for social media, high purchasing power, mobility, individuality, a need to stay ahead and the notion of speed characterize this generation and therefore set parameters for the development of a software solution suited to this target market. The subjects covered were: the lessons to be derived from the study; whether a case could be made for one particular use case or whether an all-in-one solution was preferable; the features that product development should focus on; and the question of whether consumers were willing to pay for smart home services and, if yes, what business models would be accepted by the market.

**Discussions and conclusions**

The presentations in this session focused on the evolution of the smart consumer. There is a need to educate, communicate and overcome any psychological challenges to smart technology to enable the smart customer.

Smart meters are being rolled out rapidly throughout the globe, as part of smart grid deployment. But there was a consensus that smart meters by themselves will not lead consumers to make smart energy decisions unless they are also accompanied by smart prices and smart in-home technologies.

The results from 163 pricing treatments including traditional time-of-use rates and dynamic pricing rates such as critical-peak pricing and peak-time rebates were reviewed. They show conclusively that consumers respond to prices by lowering peak usage and that the magnitude of response is related to the ratio of peak to off-peak prices. Enabling technologies such as in-home displays and smart thermostats, as well as home energy controllers that control multiple devices, boost price responsiveness. In other words, experimentation has shown conclusively that demand response works. The time has arrived to modify market designs to include demand response. This is likely to
lower customer costs by improving system load factors and reliability, and to lead to a cleaner environment.

Newer forms of demand response can be used to integrate renewable energy resources into the grid. These tend to be variable and intermittent. Thus the type of demand response that would work best in grid integration will need to have a real-time character. The combination of real-time pricing and home energy automation needs to be further piloted and tested.

Another factor that was discussed in the session is the emergence of a new norm when it comes to load growth. In many markets around the globe, including those in North America, the EU, Asia and Australia, load growth has fallen by half. This has created an issue for transmission and distribution utilities whose rates tend to recover revenue in proportion to the sale of electricity. However, the costs for these utilities are essentially fixed. Moving forwards, tariffs will need to be redesigned to reflect this reality. The best option is to introduce two-part tariffs where the first part functions as a grid access fee and the second part functions as a dynamic volumetric charge which could be based on either time-of-use or dynamic pricing rates. Such a rate design would also eliminate inter-customer subsidies that often cause non-optimal investments to be made in renewable technologies.

There is a need to better engage with customers, look at how social media have helped other sectors and harness this power to engage customers. A pilot in Amsterdam (Smart City Project) has shown how some of these activities can be achieved

The options around battery swap versus charging of EVs were reviewed. Will electrical storage development trigger the EV market, or the other way around? There is an instinctive hesitation in EV drivers to voluntarily keep the state of charge of battery low. For using EV as grid storage, a set of good incentives and technology will have to be provided.

Market research in Germany on what a new consumer generation knows about smart homes shows that consumers do want smart homes. Associated with the term “smart home” is appliance control in view of energy savings, security concerns for the protection of the home from burglaries, and increased quality of living through home automation. Willingness to pay for equipment and software is high. Software applications should be optimized for smartphone/tablet usage.
Session B4: Smart City Infrastructure – Lessons Learned

The first reason why smart cities are needed across the world is the changes in the external environment surrounding people: response to climate change, depletion of resources and similar issues faced by cities. These changes require among other things that we achieve a low-carbon society; that we save natural resources; that we downsize cities to address population concentrations in emerging countries as well as declining populations in developed countries; and that we develop transport to accommodate the growing elderly population.

The second reason for smart cities is the change in people’s inner motivations – the change in the sense of value placed on life. That is, people are focusing more on activities than on objects of consumption. This change is seen more in matured developed countries but a similar phenomenon may also become obvious in emerging countries in the future.

The third reason is the changing nature of cities, with the consequence that further development requires continuous effort and appropriate planning. Some cities may be going through a growing phase where the development of infrastructure cannot keep up with expansion. Others may be in a mature phase where improvement of aging infrastructure and higher value-added services for residents are required. It is therefore important to see cities from the standpoint of their lifecycle to properly manage their development in a long-term perspective.

If we now look at the components of a smart city, we note that our daily life is supported by a variety of infrastructures: service infrastructure, public infrastructure (urban and national), and urban management infrastructure. Smart cities are expected to contribute to solving coming challenges in urban environments and provide more efficient solutions.

One concept is that a smart city is one which combines information and control and uses an urban management system. Fusion of information and control systems creates a smooth and smart society. This allows us to automate operations, balance supply and demand, and support people’s activities. Connecting our lives with infrastructure allows us to achieve comfortable, convenient, safe, environmentally friendly cities. Community infrastructures and economic growth are essential and effective in solving societal problems such as poverty, pollution or public hygiene, where fundamental community infrastructures including energy, water, transportation, waste-management and ICT are in turn needed to achieve economic growth. Hence we need harmonized and transparent metrics for evaluating the smartness of community infrastructures.

These key issues for integration of smart generation were at the heart of the three presentations in the session, each of them focusing on some of the following topics:

- What is ‘smartness’ like in the smart city?
- Which types of infrastructure will we focus on in the smart city?
- How can we measure ‘smartness’ comprehensively?
- Business targets for Smart Cities: main motivations for smart city projects
- Standardization efforts from IEC and ISO
- Big data in the Smart City: analysis, storage, security and communication of a massively increasing amount of data
- Convergence of technologies and communication supports new integrating business models or new value streams.
In the first presentation, Richard Schomberg of EDF and the Smart City Council talked about *Defining the Smart City*, one using ICT to enhance livability, workability and sustainability. The smartness of a city may come from pervasive development of connectivity for people and technology. But the smartness can also originate in the use of modelling and simulation for long-term planning, taking history into account. True smartness is achieved by integrating different departments to achieve synergies and cost savings. The core activities of a smart city are collecting data about the city's conditions; communicating that data to where it is needed; and analyzing the data to create insights and operational efficiencies. He presented examples of efficient analytics and forecasting solutions. With the help of standards and interoperability, taking the systems approach will accelerate deployments, while triggering a gigantic market. He introduced the Smart Cities Council framework, providing guidance and metrics for the essential functions a city must perform 24 hours a day. He explained that smart cities are “systems of systems”. In order to master the complexity, the critical challenge is to break out into enough but not too many subsystems, in order to maximize the number of interactions within the subsystems, and minimize the interactions between them.

The second talk was given by Yoshiaki Ichikawa, Senior Chief Engineer in Hitachi, on *Smart City Infrastructures*. He introduced the activity in ISO related to smart city standardization. ISO TC (Technical Committee) 268 writes standards for “Sustainable development in communities” that will include requirements, guidance and supporting techniques and tools to help all kinds of communities. He introduced standards for smart community infrastructures, including basic concepts to define and describe them as scalable and integral systems, harmonized metrics for benchmarking, applying the metrics to different types of community and specifications for measurement, reporting and verification. He showed the goal of harmonized and transparent standards with metrics for evaluating the smartness and the system aspects of community infrastructures.

In the third presentation, Jianming Liu, Deputy Director, Science and Technology Department of State Grid Corporation of China, illustrated how the Smart Grid supports Smart Cities and data management strategies for them. He highlighted achievements in China in order to explain how the Smart Grid helps to ensure electrical safety, promote greener (cleaner) growth, upgrade urban communication capacity, stimulate growth of relevant industries and enrich urban services. It is important to analyze the massive amounts of data available in order to give advice on energy conservation and emission reduction, public policy-making, urban planning and urban security.

The fourth talk was by Victor Rumyantsev, Vice-President of JSC Energostroy-M.N. in Russia, and discussed the creation of an effective power cluster in the Northern Caucasus region. The key points were development of the Smart City in Russia, presenting new construction and modernization of an existing infrastructure, particularly in Russia’s Northern Caucasus Federal District. He explained how to balance the various constraints in order to strategically evaluate chances and problems for the Smart City and considered state-of-the-art Russian and global technologies for efficient and innovative solutions.

**Discussions and conclusions**

The session showed that there are already many things going on in smart cities that use the Smart Grid – the basis for smart energy – as a foundation for projects around the world. The first presentation’s messages were that there is a need for a global, systemic approach to smart cities, using ICT to enhance information will allow for a better understanding and predictability for customer services, and modelling and simulation make long-term planning possible. The second talk recognized a need to create harmonized and transparent metrics for evaluating the smartness of community infrastructures, and this work is taking place in ISO/TC 268. Our third presentation takeaway highlighted that there are 219 cities in China which are proposed as smart cities, furthering a discussion on big data and how it can be used by the utilities and customers. In the
final presentation, a highly efficient energy infrastructure in the territory of the North Caucasus Federal District in Russia was shown. Each of the Republics in the region has its own problems and its own approach to development, and hence its own version of a “smart” city philosophy, so that the technological solution design for each area became unique and specific.

Everyone wants a written definition of what is a smart city and what is not a smart city. The session came to an agreement that we may not be able to define it in words. This is exactly what happened with Smart Grids when people tried to find the right language to define them. A Smart Grid is already a highly complex system of systems, and a smart city is unprecedentedly even more so. So as with the Smart Grid it seems almost impossible to find a unique definition of “Smart City”, but organizations have started to work on them and eventually their work will help to explain what it really is even without a definition.

The same approach should be considered for what parts of a smart city should be looked at first. In this initial effort it may seem simpler to ignore available documents worked out by existing groups in order to avoid controversies over details, but the result may be to add more complexity to an already complex task. In most cases it is accepted that Smart Grids and Smart Energy are initial steps and investments leading towards Smart Cities.

Smart City approaches strongly focus on technology and often rely on sophisticated applications. Badly understood or poorly implemented, they may be pursued for their own sake and divert cities from real issues (employment, education, crime, etc.). Ideally, Smart City projects should be carried out only if they help cities to meet their needs, with a quantifiable added value.

There are established actors and frameworks already in place, but how do we change the complexity to get different elements working together? Is it accomplished by tackling one system at a time, or does it need to take place as a wholesale task? Standards organizations such as the IEC, ISO, ITU and consortia such as the Smart Cities Council are well aware of the smart city issues at hand; however, there is no one organization or entity that can handle all the different aspects of smart cities by itself.

Accordingly, the session did not come up with a blueprint from lessons learned in smart cities, but agreed on the interactions that need to take place.
RESULTS OF GENERAL DISCUSSIONS

Two sessions in the forum were designed as horizontal approaches to all the areas important for the Smart Grid:

- the **Interactive Session**, in which attendees were invited to express their views in answer to cross-cutting questions on opportunities and challenges, and
- the **Future Forum**, a round table of co-chairs from each of the eight sessions designed to derive the best recommendations for the next steps towards a universal Smart Grid.

The Interactive Session aimed to “crowdsource” the responses of all the expert attendees to twelve questions concerning significant opportunities and challenges for the future Smart Grid. The results were displayed in real time to the voting public and commented upon by moderators Melinda Crane and Richard Schomberg. They are shown below.

**Question 1:** What are customers’ priorities?

A Maslow-type hierarchy (basic needs first) is important, whereas more abstract characteristics seem less relevant.
Question 2: More than 20% of private households will participate in dynamic energy markets by ... 

The functionality will probably be ready by 2020, but more people think that the desire to participate will take longer to reach the level targeted. 10% of customers will probably be participating in time-of-use programmes by 2020. But a true effect on peak shaving will likely be through direct load control, to which perhaps half the customers may sign up by 2030. These results show the probable scale of the change needed.
The long delay foreseen is understandable, since people are not convinced the infrastructures can be put in place quickly or that the commitments announced by many governments in terms of target numbers by 2020 are realistic. However, fleet programmes such as that in France, where government agencies and the top 10 companies have committed to renew 50% of their vehicle fleet by 2020, seem to be effective. It is already an optimistic result that only a minority have marked “never”. We have not yet reached the stage of working out business models which suit consumers and adapting the technology and infrastructure to those; today business models developed on the basis of the technology and policy decisions are being promoted to consumers, with limited success.
Question 4: EV's will be used for reverse energy supply from battery to grid (V2G) by ...

The technology has been demonstrated in many projects. In Asia in particular there is a strong push, due to market needs for Uninterruptible Power Supply (UPS) systems. As presented in session B3 by TEPCO, Japan is planning to deploy 2 Million EVs by 2020. Assuming 50 KWh per EV, the energy potentially available by aggregating their batteries is not very large, but the power available could reach 20 GW, equal to that of renewable generation (i.e. about 10 % of the 220 GW total generation capacity).

For most observers, the evolution of storage technology will have a key impact on the energy transition. The Tesla battery for a 426 Km range can provide 85 KWh, supplying eight homes for perhaps 2½ h, but still costs around 100 K€.

Most EVs will be parked for 95 % to 98 % of the time, so they are suitable for vehicle-to-home use. But owners may not be ready to risk wear & tear caused by limited charge/discharge cycling.

Many experts believe that a completely new, disruptive storage technology may emerge by 2030. It is also possible that fuel cell technology, currently on the back burner, will finally become viable.
Question 5: Renewables’ share of worldwide electrical energy supply will reach 50 % by ...

In some countries it is already the case from time to time, with on occasion even more than 50 %, with negative prices. Many experts believe that wind will continue to develop strongly. Geothermal energy is often mentioned as it is not intermittent, but drilling pits is very expensive and piping must be highly resistant to corrosion. Much hope is still placed in PV development as well.

However, the majority response here is for 2060 or never, which probably reflects a general fear about the current financial situation and uncertain subsidies.
Question 6: The share of decentralized power supply in 2030 will amount to ...

This confirms the general trend towards and interest in distributed renewable energy together with micro-grids and self-consumption. But there are still many issues with regulations and business models. One cannot expect that the grid will be so strong and stable that it can routinely cope 24 hours a day with large blocks of generation or consumption switched on and off without a forecast available to the DSO, especially if these users do not pay their share of the extra costs for the operation and maintenance of the grid.
Question 7: New energy business opportunities

The prominent place given to green energy is not entirely consistent with the preference for security of supply and affordability expressed in question 1.

10% of the energy business will likely evolve with service packages, and another 10% may be handled by building-management players. Telecom providers are in contact with customers and may very well play a major role in handling complex energy invoicing by 2030; however, consumers may have reservations about data protection. New entrants may come after 2030, or never.
Question 8: Please rate each of the following areas according to whether you believe it is mature enough for investment

These results are broadly consistent with responses to previous questions. HVDC, shown by presentations in the Forum to be well-advanced, may be a more promising investment area than these responses suggest.
Question 9: Risk of black-outs will increase due to ...

Volutility and cyber-attacks, as negatively phrased possible causes of blackouts, were perhaps favoured by the way the question was put. The last three bars show that there is a relatively high level of confidence in technical solutions, and the main risks in the first three bars are due to new interactions and electrical system management situations. This indicates that the technology, even though apparently safe in itself, will need much intelligence to face the new situations in which it must be managed, and that there is a need for a rapid and massive development of analytics and forecasting solutions.
Question 10: Reliability and security of supply will increase due to...

Several previous questions had not thoroughly dealt with automation or information technology, but this question shows clearly that they are the direction to go according to this audience. The present result is consistent with answers to the previous question. Surprisingly, demand response does not appear very promising (nor risky, for that matter). This is strange, as major efforts have already been made, especially in the US, to demonstrate and start to deploy demand response.
Regulators, perhaps not very well represented at this Interactive Session, might disagree at the “first” place given to legislation and regulation. It is also clear that more work is needed on standards, but increasing the involvement of consumers may be more important than shown in this exercise. Consumer acceptance may very likely be a major roadblock.
Question 12: Of the following 12 sectors and/or actors, which will be the main drivers of smart grid/smart energy deployment in the next 10 years? (Who will make the business? Who will set the market rules?)

The results are consistent with others, and show that the three elements required simultaneously are technology, regulations and business models. The car industry, which may control a large part of the charging infrastructure, may have been underestimated. What is really needed is the involvement of all the stakeholders, as none can make it happen alone.
The Future Forum brought together summaries of the conclusions to be drawn from each of the eight sessions; notes on these are given in the box below.

A number of cross-cutting themes, mainly in the form of questions, were derived from the Forum.

- Great regional differences exist, but so does the possibility of learning from each other.
- How far will standards get us? How far should standards be pushed?
- How can existing structures (old grids, existing cities, ...) be grouped differently so as to facilitate the migration?
- What small, incremental steps are on offer which would allow progress without too great a risk or an impossibly large investment?
- What are the conditions needed to allow the different players to cooperate successfully, to get all stakeholders on board?
A1  Smart Generation and Integration

There’s agreement on the technical challenges (voltage control etc.), but their intensity is different from country to country. The technical solutions are also the subject of agreement, but again vary in their relevance from country to country. Local circumstances are fundamentally different in different places, which has a profound influence on how a Smart Grid can be developed. In all cases the right balance needs to be found between mandatory requirements and free market mechanisms, and this balance may be a radically different from one environment to another. Depending on the business model used, the return on Smart Grid investments varies widely, from positive to negative. The respective roles of TSOs and DSOs must be clarified, e.g. responsibility for providing stability. A way of comparing results of demonstration projects is needed, and how to replicate them & learn from them.

A2  Network Stability in Design and Operation

In order to deliver market value of long-distance transmission (e.g. of renewables), hybrid AC-DC techniques are needed. On-line analysis and information sharing are required for control of stability, as well as advanced operations strategies and intelligent electronic control equipment. Controversies have not really been identified, but the ways of supporting Smart Grid development are radically different in different economies. A major unanswered question is how in Europe to reconcile national decision-making and investment funding subsystems, and to minimize the interactions between the subsystems. A permanent open question, almost everywhere, remains where the financing for investments will come from.

A3  New Developments for Smart Transmission Grids

Manufacturers will be able to face successfully the technical challenges involved in developing the Smart Grid. This remains true in spite of the fact that different continents have historically adopted different solutions—no higher than 500 kV in Europe, 1000 kV in China, or DC being point-to-point in China but planned as a multi-terminal overlaid mesh in Europe. A major unanswered question is how in Europe to reconcile national decision-making and investment funding with the international nature of the overlay DC mesh and its needs for investment.

A4  Evolution of the Distribution Grid

Smart Grids and EV are not options, but necessities. Data production & supply is crucial to this. The savings expected from Smart Grids are large, but spread over the value chain, which makes them complex to communicate and to plan for. Data management is naturally handled by DSOs, but it is controversial how far they should be able to use the data for their own purposes, as well as how the data may be used for control of the overall grid. Decentralized generation and self-consumption may be a part solution, but they need an evolution in regulations. They also need proper business models which can finance operation and maintenance of the distribution grid—supposed to achieve balancing whatever happens—even when large amounts of generation and load become much less controlled. DSOs need further changes in the regulatory framework if they are to fulfil their natural role of coordinators of grid control and data management.

B1  Smart Energy Market Design

35 % and more of renewables is feasible in a Smart Grid when its markets are being designed. Regulations should not negate the advantages of a market (whether energy market or services market—they should be distinct). Consumers of all kinds must be involved in market design and negotiations. Transparency between TSOs and with DSOs is needed, which links to the data management issue raised in A4.

B2  Smart Grid Communication (Information Technology)

Good forecasting is essential, and computation is approaching the threshold of real-time calculations of forecasts. The new grid is more stochastic and dynamic, and as such needs different handling. The new instability, arising through the evolution of the existing grid, requires faster communications for effective balancing control. Communications with (from) customers are also a need, and simultaneously an issue, as concerns privacy for example. Stepwise improvements towards the benefits of Smart Grids should be feasible, rather than having to make the whole investment up front before being able to realize any benefits.

B3  Smart Customer

Customers have practically no knowledge of electricity as a commodity in a potentially flexible market, so it is much more a question of informing customers than making them “smart”. Pilots have shown that customers automatically become “smart” when they are knowingly involved in and informed about an environment where they are free to take “smart” decisions. The problem of migrating to a situation where there are no longer any artificial rates for consumers, some in effect subsidized and some actually subsidizing others, but instead rates which allow all players to generate funds for investment and obtain returns, gave rise to different, competing suggestions. One solution might be to migrate over a period of 3 to 5 years.

B4  Smart City Infrastructure – Lessons Learned

To achieve smart cities, the required investments will be very large, and standards will be essential, including coordination among the standards organizations. There are some first, very compelling examples of analytics deployed to present information, perfect operations and predict conditions. A Smart Grid encompassing all aspects of energy is a precondition for a smart city, but the smart city introduces vastly greater complexity. The critical challenge is to break out the overall system into enough but not too many subsystems, in order to maximize the number of interactions within the subsystems, and to minimize the interactions between the subsystems.
## Annex – Programme

### Committees

#### General Chairs

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<tr>
<th>Name</th>
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<td>Klaus Wucherer</td>
<td>President</td>
<td>IEC</td>
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<td>Zhenya Liu</td>
<td>Chairman</td>
<td>State Grid Corporation of China</td>
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<tr>
<td>Joachim Schneider</td>
<td>President</td>
<td>VDE, RWE Deutschland AG</td>
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#### Steering Committee

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<tr>
<td>Frans Vreeswijk</td>
<td>General Secretary &amp; CEO</td>
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<td>Yinbiao Shu</td>
<td>President</td>
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<tr>
<td>Helmut Klausing</td>
<td>Deputy CEO</td>
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#### Chair of Technical Programme Committee

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<tr>
<td>Richard Schomberg</td>
<td>IEC</td>
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#### Secretary of Technical Programme Committee

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<tr>
<td>Johannes Stein</td>
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#### Technical Programme Committee Members

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<td>Mengrong Cheng</td>
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<td>Jochen Kreusel</td>
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#### Session Chairs

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#### B.N. Sharma
Government of India, Ministry of Power

#### Konstantin Staschus
ENTSO-E, Secretary General

#### Rahul Tongia
India Smart Grid Forum, Advisor, Carnegie Mellon University

#### Xiaoxin Zhou
CEPRI, Honorary President

#### Yonghua Song
Executive Vice-President of Zhejiang University, Vice-President of Chinese Society for Electrical Engineering (CSEE)

#### Session Secretaries

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<td>Gabriel Barta</td>
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<td>David Hanlon</td>
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<td>Peter Lanctot</td>
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Opening

Klaus Wucherer
President, IEC

Monday, September 23, 2013

19:00 ROOM BERLIN
Opening of the exhibition
Get together in the Exhibition Area

Programme

The Forum offers two parallel tracks which comprise a series of well-prepared, complementary sessions that cover topics of core importance. This approach provides participants with highly condensed understanding that can serve as a foundation for real-life solutions.

Track A: Future Electricity Grid Supporting a Low-Carbon Energy Supply

Track A and its four sessions will explore required interactions to support a low-carbon energy supply and assess the realistic potential for mass integration of renewable energy generation. How do transmission, distribution and electrical grids need to interconnect to increase overall performance and resilience?

Track B: Smart Energy – Visions for the Smart Grid Evolving Towards Smart Customers and Smart Markets

Track B and its four sessions will define what is needed to develop smart and sustainable communities/cities that offer quality jobs and living conditions. Beyond technology and design: what are the gaps that need to be filled to bridge from vision to reality?

Keynote Speakers

Zhenya Liu
Chairman, State Grid Corporation of China

Joachim Schneider
President, VDE, RWE Deutschland AG

Bernard Salha
Group Senior Executive VP, CEO R&D, EDF

George Arnold
Director of Standards Coordination Office, NIST

Yuko Yasunaga
Deputy Director-General for Industrial Science and Technology and Environment, Ministry of Economy, Trade and Industry (METI)
Tuesday, September 24, 2013

08:30 – 09:00  Morning Coffee

09:00 – 11:30 ROOM MARITIM
Opening and Keynotes

Welcome
Klaus Wucherer
President, IEC

To develop strong and smart Grids for safe, clean and efficient Energy Development
Zhenya Liu
Chairman, State Grid Corporation of China

Smart Grid HorizonsVisions – Challenges – Tasks
Joachim Schneider
President, VDE, RWE Deutschland AG

Large Utilities making Smart Energy a reality - From Smart Grid and Smart Customers towards Smart Cities
Bernard Salha
Group Senior Executive VP, CEO R&D, EDF

Smart Grid in the U.S.: Progress and Results
George Arnold
Director of Standards Coordination Office, NIST

Smart Grid Standardization in Japan
Yuko Yasunaga
Deputy Director-General for Industrial Sciences and Technology and Environment, Ministry of Economy, Trade and Industry (METI)

Moderation: Melinda Crane
DW’s Chief Political Correspondent

11:30 – 13:15 Lunch, Exhibition and Poster Session

13:15 – 15:30 ROOM MARITIM
Session A1: Smart Generation and Integration

Chairs: B.N. Sharma
Government of India, Ministry of Power, Joint Secretary
Jean-François Faugeras
EDF, Research Director for Renewables Integration
Session Secretary: David Hanlon, IEC

A1.1 High Capacity Renewable Energy Generation and Integration
Liangzhong Yao
CEPRI, Vice President Renewable Energy and Smart Grid Technologies

- Examples of largest MW, MWh, % of integrated renewable energy achieved in the energy mix (Denmark, Germany, Iceland, China, etc…)
- Records of worst issues raised by solar and wind (volts, vars, etc…)
- Potential limits to maximum % of intermittent generation to integrate and limiting factors that have to be overcome

A1.2 Regulatory Framework for a new Energy Supply System
Karl Axel Strang
Green Technologies Policy Advisor, French Ministry of Ecology, Sustainable Development and Energy

- Behind the technical developments and new products the legislative and regulatory framework is a key factor for a new energy landscape
- Cyber security, active participation by customers and grid codes for flexible integration of renewables are the main drivers of regulatory changes
- Where is the right balance between a firm legislative framework, a liberalised market design, and technical standardization? Where to keep freedom for innovation and where to ensure new business models through sound regulatory conditions?

Poster Session in Room Berlin Section D

The technical programme is complemented by an associated poster session which can be visited in Section D of room Berlin. To acknowledge the excellence of the submissions, the Technical Programme Committee has decided to make a Poster Award. The authors of the best two posters will be honoured as part of the World Smart Grid Evening.
A1.3  
Flexible Generation Coordinated with the Smart Grid  
Kim Behnke  
Energinet.dk, Head of R&D and Smart Grid  
- Various topologies and architectures of networks to maximize integration of intermittent generation and flexibility  
- Various Control & Dispatch strategies for intermittent generation to serve fluctuating loads  
- Transmission System Planning for flexibility of both generation and load as well as the influence of the ENTSO-E grid codes

A1.4  
Method of Technical Decision to integrate Distributed Energy Resources into Distribution System  
Jung-Ho Lee  
General Manager, Smart Grid Department, KEPCO  
- Grid code and technical guideline for DER interconnection into distribution system  
- Technical methodology applied for DER interconnection estimation process which includes both the evaluation and determination  
- Technical estimation program based on distribution automation system to decide whether distributed generation (DG) will be accepted or not to integrate into distribution networks

Poster Presentations  
Presentation of selected Posters by the Session Chair in Room Maritim

13:15 – 15:30 ROOM BERLIN  
Session B1: Smart Energy Market Design  

B1.1  
Introduction: Requirements for a Market Design Supporting Smart Energy  
Marc Oliver Bettzüge  
University of Cologne, Institute of Energy Economics, Professor  
- Market integration of (distributed) generation with zero marginal costs – is there a need for capacity markets?  
- Market integration of highly distributed resources, storage and backup power plants  
- Using customers and their flexibility patterns in demand and generation for market processes

B1.2  
Integration of Distributed Generation into an unbundled Market - the Danish Example  
Knud Pedersen  
DONG Energy Sales & Distribution, Vice President  
- Market setup  
- New market role aggregator  
- Practical experiences
B1.3
Use of Customer Flexibility in fully unbundled Retail Markets
Jessica Stromback
Smart Energy Demand Coalition (SEDC), Executive Director
- Smart Grid and Smart Market - what infrastructure is required to enable customer participation? Do we need new markets like real time markets, local markets, and neighborhood negotiations?
- Success factors for flexibility offerings
- Differences between unbundled and integrated distribution markets

B1.4
Market and system integration of distributed generation – a TSO perspective
Dirk Biermann
Chief Markets & System Operations Officer (CMO), 50Hz Transmission
- Challenges from fast development of renewable energy in Germany
- Strategies for successful system integration of renewable energy. How to keep system security?
- How should the market develop for increasing distributed generation? Which new products and processes are needed?

16:00 – 17:50 ROOM MARITIM
Session A2: Network Stability in Design and Operation
Chairs: Konstantin Staschus
ENTSO-E, Secretary General
Yonghua Song
Executive Vice-President of Zhejiang University, Vice-President of Chinese Society for Electrical Engineering (CSEE)
Session Secretary: Rémy Baillif, IEC

A2.1
Introduction: How to Ensure Network Stability with High Share of Remote, Volatile Generation?
Alf Henryk Wulf
Alstom Deutschland AG, Chairman, VDE Vice-President
- Impact of remote, volatile generation on system stability
- Technical options for stabilizing the system
- Experiences in Germany during winter 2011 and 2012

A2.2
Stabilizing Power Systems with a Hybrid AC-DC Transmission Infrastructure
Xin Yaozhong
National Power Dispatching & Communication Center, Deputy Director General
- Benefits of combining AC and DC in a transmission system
- Experiences with existing hybrid installation
- Outlook: Stabilizing large interconnected power systems with a HVDC overlay grid

A2.3
Consequences of Distributed Generation for Distribution Networks
Andreas Breuer
RWE Germany, Vice President New Technologies/Projects
- Voltage stability and protection schemes
- Local balancing of load and generation
- Field experiences (e.g. RWE’s Smart Country project)

Poster Presentations
Presentation of selected Posters by the Session Chair in Room Berlin
15:30 – 16:00 Coffee Break
16:00 – 17:50 ROOM BERLIN
Session B2: Smart Grid Communication

(Information Technology)

Chairs: Rahul Tongia
India Smart Grid Forum, Advisor, Carnegie Mellon University,
Adjunct Professor
Scott Henneberry
Schneider Electric, Vice President Smart Grid Strategy

Session Secretary: Peter Lanctot, IEC

B2.1
New Business Opportunities Leveraging big Data from the Real World – Examples, Trends and next Steps

Henry Bailey
SAP, Global Vice President, Utilities Industry Business Solutions

- 3 real examples of new value extracted from a large amount of consumer data: e.g. enabling advice to customers based on analysis of behaviour and past browsing
- Challenges: Managing big data and finding consumers’ data algorithms
- What will happen? When? Who?

B2.2
Network-based Smart Home Apps – how are we doing?

Larsh Johnson
eMeter, Head of Technology & Innovation/CTO

- Smart grid application intersection with the home
- Home/in-building networking challenges
- Balancing privacy and consumer value

B2.3
Emerging Trends in Power Systems and the Implications for Communications and Control

Jeff Tant
Cisco Connected Energy Network, Distinguished Engineer and Chief Architect

- Power automation: from central to decentralized, open, and autonomous control? What are the challenges of distributed energy resources (DER), demand response with more and more participating customers, and an active distribution grid?
- Recent design trends for future-proof investments in networks, control and communication: Flexibility, self-organization, real-time operations, cloud computing, structural scalability, decentralized cyber-physical systems
- Security implications: Reliability, resilience and privacy by design while integrating new devices and customers into the power automation system

Poster Presentations
Presentation of selected Posters by the Session Chair in Room Berlin

19:00 – 23:00 DEUTSCHES TECHNIKMUSEUM
World Smart Grid Evening

The conference dinner will be held at “Deutsches Technikmuseum” which has been developed since 1982 in Berlin’s old and new centre. A cultural history of technology in historical buildings.

The museum continues the tradition of the reputable museums of technology to which Berlin had been home until World War II. The Gleisdreieck location is also of historical importance: this is where Anhalter freight station, the rail depot with two circular locomotive sheds and the factory buildings of a company specialising in markets and cold stores were located. This historical ensemble of buildings is also the most valuable “object” of the museum. On completion of all development phases, the building will cover an exhibition area of over 50,000 square metres and will be one of the largest technical museums in the world. 14 departments currently exhibit just one quarter of their treasures on 20,000 square metres: old-timers, locomotives and planes, new nautical collection, looms, household appliances and machine tools, computers, radios and cameras, Diesel engines, steam engines, scientific instruments, paper machines, printing presses and much more.

Buses will leave at 18:15 – 18:30 and 18:45 from the Maritim Hotel Berlin. Participation at this event is included for WSGF delegates.
19:00 – 23:00 DEUTSCHES TECHNIKMUSEUM
World Smart Grid Evening

19:30 Welcome
Klaus Wucherer
President, IEC
Melinda Crane
Moderation
H. E. Shi Mingde
Ambassador of the People’s Republic of China to Germany
Klaus Dieter Rennert
Chief Executive for Europe of Hitachi, Ltd.
Brad Gammons
General Manager of IBM Global Energy & Utilities Industry
Dong Zengping
President of Sifang Electric Co., Ltd.
Zhang Weifeng
Chairman of Beijing Sifang Automation Co., Ltd.

20:20 Opening of the dinner
Dinner and Entertainment

21:00 Honour of the Poster Award Winners
Dinner and Entertainment

23:00 Bus shuttle to Maritim Hotel

Wednesday, September 25, 2013

08:30 – 10:45 ROOM MARITIM
Session A3: New Developments for Smart Transmission Grids

Chairs: Xiaoxin Zhou
CEPRI, Honorary President, Professor
Jean Kowal
MEDGRID S.A. Executive Vice President
Session Secretary: Gabriel Barta, IEC

A3.1
Latest Record Breakthroughs of HV and UHV Transmission Networks
Zehong Liu
State Grid Corporation of China, Director General of DC Transmission Department
- Examples of highest voltage, power and distance achieved, and corresponding realization timelines
- What are the remaining obstacles to further progress?
- Influence of DC transmission networks: next steps and visions for the future

A3.2
Worldwide Industrial Efforts for Transmission Grid of the Future
Magnus Callavik
ABB, CTO Grid Systems
- Projects currently under consideration worldwide: desertec, medgrid, tresamigas, DC overlay grid etc...
- Power electronics, materials, modelling & simulation, etc.
- Options pursued by world industrial leaders
A3.3 Specific Control and Protection Challenges and Achievements
Hans-Joachim Herrmann
Siemens, Principal Key Expert Protection

- Specific control & protection issues
- Control & protection schemes and strategies
- Modelling & simulation, smart technology to provide solutions

A3.4 Smart utilization/upgrading of existing transmission assets
Alessandro Clerici
WEC Italy, Honorary Chairman and IEC Italy Vice President

- Review of the critical effects of bottle necks in existing transmission grids
- Some examples of AC/DC upgrading of existing overhead transmission lines (OHTL) which are the critical issue of transmission systems’ operation and development
- Dynamic loading of transmission systems assets such as OHTL’s and interconnecting transformers and general remarks of key position of transmission in a real global approach to smart electrical systems

Poster Presentations
Presentation of selected Posters by the Session Chair in Room Maritim

08:30 – 10:45 ROOM BERLIN
Session B3: Smart Customer
Chairs: Like Wang
Vice President CEPRI
Simon Hill
Opower, Vice-President of Regulatory Affairs (EMEA)
Session Secretary: Rémy Baillif, IEC

B3.1 Smart Rates to Engage Consumers
Ahmad Faruqui
The Brattle Group

- Results of worldwide pilots: What customers accept (by region) and what makes them react?
- What is the potential of rates to which customers can react, with and without the help of technology?
- How to design smart rates (dos & don’ts), and how to introduce them?

B3.2 Insights from the global New Energy Consumer research project
Joost Brinkman
Accenture

- Insights from the global New Energy Consumer research project
- A major example: Engagement of energy consumers in the Netherlands and Amsterdam Smart City context

B3.3 Electric Vehicle Technology and Strategy from a Utility’s View
Hiroyuki Aoki
TEPCO, R&D Center, senior manager of mobility technology

- Competing models: battery swap versus charging
- Can EVs provide storage to the grid and, if so, what kind?
- Will electrical storage development trigger the EV market, or the other way around?
B3.4
Smart Home and the Smart Customer – insights from the Digital Natives Generation
Thomas Goette
CEO, GreenPocket
- Report from a market research study – covering questions like: Consumer needs – what do the digital natives need from a smart home?
- Product feature analysis – which features inspire consumers, which put them off?
- Propensity to pay – do consumers want to pay for smart home services?

Poster Presentations
Presentation of selected Posters by the Session Chair in Room Berlin

10:45 – 11:15 Coffee Break

11:15 – 12:15 ROOM MARITIM
Interactive Session

The interactive forum will use questions out of the sessions for discussion with the audience.
You can participate actively in the discussion and vote online about urgent Smart Grid questions. You as an expert and decision-maker can react to session topics and signal trends based on your experience. The results will be made available immediately and will influence further discussions.

Please bring your smart phone or iPad for the voting. More detailed information will be shown by APP LINK (page 45)

12:15 – 13:15 Lunch

13:15 – 15:30 ROOM MARITIM
Session A4: Evolution of the Distribution Grid

Chairs: Britta Buchholz
ABB, Head of Business Development Smart Grids
Marc Boillot
ERDF, SVP Strategy & Major Initiatives
Session Secretary: David Hanlon, IEC

A4.1
Increasing the Intelligence of the Distribution Grid
Gary Rackliffe
ABB, Head of Smart Grids North America
- Examples of drastic improvement by distributing the intelligence within a system architecture
- Modelling & simulation faster than real time coupled with operations in order to prevent events – or help find the best course of action to face events
- Can the system be fully automated and what would be the technical conditions and implications, or should the system only guide operators?

A4.2
Data Analytics for Increased Intelligence of Distribution Grid
Ricardo Klatovsky
IBM, Vice President Global Energy and Utilities Industry
- Managing and making sense of all the data from all the new devices in a smart grid and combining electrical distribution and communications are significant challenges for utilities
- Examples of analytics for preventive maintenance, and sharper operation planning
- Too much data: overwhelming rather than helpful? How to prevent this?
A4.3
Microgrid Operation in Sendai and the Massive Earthquake in 2011 - Experience and Deductions for the General Design of Microgrids
Keiichi Hirose
NTT Facilities Inc., R&D Headquarters, Senior Research Engineer
- Sendai Microgrid: Project design, experience in the project and during the 3.11 big earthquake
- Sendai City’s efforts to build operational bases in an emergency (small/medium-scaled Microgrids)
- Consequences and recommendations for a future design of Microgrids considering technical questions and business models as well as integration into an overall design

A4.4
Smart distribution grids: different local conditions affect the priorities
Matteo Codazzi
CEO, CESI
- Review of main subsystems / functions involved in smart distribution grids
- Some few examples of priorities / approaches in different countries: some practical cases
- Lessons learnt and proposal

13:15 – 15:30 ROOM BERLIN
Session B4: Smart City Infrastructure - Lessons learned
Chairs: Jochen Kreusel
ABB
Hiroshi Kuniyoshi
NEDO, Executive Director, JSCA, General Secretary
Session Secretary: Peter Lanctot, IEC

B4.1
Defining the Smart City
Richard Schomberg
EDF, Smart City Council, IEC SG 3 Smart Grid and IEC TC 8 Chairman, Chair of the Technical programme committee of the World Smart Grid Forum
- What is ‘smartness’ like in the smart city?
- What kind of infrastructure will we focus on in the Smart City? E.g. electricity, water, transportation, ICT…
- What is the evaluation index for ‘smartness’ with which we should make a comprehensive evaluation?

B4.2
Smart City Infrastructures
Yoshiaki Ichikawa
Hitachi, Senior Chief Engineer, ISO/TC 268/SC 1, Chair
- Definition of Smart City - Main technology areas and infrastructures
- Business targets for Smart Cities: Main motivation for Smart Cities projects
- Standardization efforts from IEC and ISO

Poster Presentations
Presentation of selected Posters by the Session Chair in Room Maritim
B4.3
Smart Grid Supporting Smart City
Jianming Liu
Deputy director, Science and Technology Department of State Grid Corporation of China
- Big data in the Smart City: Analysing, storage, security and communication of a massively increasing amount of data. Can the increasing complexity be managed?
- Centralized vs. distributed data management? Pros & cons?
- Convergence of technologies and communication supports new integrating business models or new value streams

B4.4
Smart City Pilot Project in Russia
Victor Rumyantsev
JSC Energostroy-M.N., Vice-President
- Smart City: new construction and modernization of existing infrastructure, Peculiarities in Russia
- Actual Russian and World technologies are considered to be implemented
- Problematic issues we faced with
- Smart City background in Russia, looking for the World partners with efficient innovative solutions

Poster Presentations
Presentation of selected Posters by the Session Chair in Room Berlin

16:00 – 17:00 ROOM MARITIM
Future Forum Smart Grid

We are looking forward to Smart Grid fireworks at the Future Forum. This panel discussion will be led by the well-known moderator Melinda Crane. As chief political correspondent at Deutsche Welle (DW) TV and international affairs consultant to the Sabine Christiansen discussion programme, she is practiced in bringing out complex relationships and will help participants to bring the World Smart Grid’s future clearly into focus.

17:00 End of Event
Contact information:

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