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The Secretariat

Office of the Co-ordinator of OSCE Economic and Environmental Activities

OSCE Expert Workshop
"Sharing Best Practices to Protect Electricity Networks from Natural Disasters"

Vienna, July 2, 2014

Summary Report

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1. Overview

The Organization for Security and Co-operation in Europe (OSCE) is increasingly focusing on energy as an emerging and important security-related topic[1]. In December 2013 in Kyiv, the Ministerial Council adopted two decisions related to energy and the environment[2]: one on "Improving the environmental footprint of energy-related activities" (MC.DEC/5/13) and another on "Protecting Energy Networks from Natural and Man-made Disasters" (MC.DEC/6/13). Protection of energy networks refers to such activities as functionality, continuity and integrity of networks, which allow determination, mitigation and neutralization of risks, threats and vulnerability. In the context of MC.DEC/6/13, the term "energy networks" does not refer to nuclear energy installations, gas and oil infrastructure.

The OSCE as the world's largest regional security organization has already contributed to the protection of non-nuclear critical energy infrastructure through a number of capacity building events, which resulted i.a. in the 2013 publication of the "Good Practices Guide on Non-Nuclear Critical Energy Infrastructure Protection from Terrorist Attacks Focusing on Threats Emanating from Cyberspace".

Following MC.DEC/6/13 the OSCE Ministerial Council mandated the Office of the Co-ordinator of OSCE Economic and Environmental Activities (OCCEA) to expand its activities focusing on the protection of energy networks from natural and man-made disasters.

Paragraph 6 of the Decision "Tasks the Office of the Co-ordinator of OSCE Economic and Environmental Activities to identify opportunities for co-operation with international organizations and regional organizations and agencies in the field of protection of energy networks against natural and man-made disasters and to facilitate discussions on possible areas for co-operation".

Paragraph 7, "Tasks the Office of the Co-ordinator of OSCE Economic and Environmental Activities to facilitate the exchange of good practices, technological innovations and the sharing of information on effective preparedness for, and responses to, disaster risks to energy networks without duplicating activities already carried out by other relevant international organizations."

[1] OSCE commitments to energy are reflected in the following documents: the 1975 Helsinki Final Act, the OSCE Strategy Document for the Economic and Environmental Dimension adopted at the Maastricht Meeting of the Ministerial Council in 2003, Ministerial Council Decision No. 12/06 on energy security dialogue in the OSCE, Ministerial Council Decision No. 6/07 on protecting critical energy infrastructure from terrorist attack, Ministerial Council Decision No. 6/09 on strengthening dialogue and co-operation on energy security in the OSCE area and the 2010 Astana Commemorative Declaration.

[2] Other relevant documents are: Madrid Declaration on Environment and Security (MC.DOC/4/07), which underlines the linkages between environmental risks, and natural and man-made disasters and security in the OSCE region and the Permanent Council Decision No. 1088 for the Twenty-Second Economic and Environmental Forum "Responding to environmental cooperation and security in the OSCE area", with a particular focus on preparedness, emergency response and recovery related to environmental challenges.

Initial planned OSCE activities to implement these assignments include the organization of an Expert Workshop followed by the publication of a Handbook on "Best Practices to Protect Electricity Networks from Natural Disasters".

The workshop took place in Vienna on 2 July 2014. Its objective was to contribute to enhancing the capacities of OSCE participating States to fulfill their commitment with regard to MC.DEC/6/13 by raising awareness of and facilitating the dialogue and knowledge sharing on the protection of electricity networks from natural disasters. The focus of the workshop was to discuss the state of the art and other existing best-practices for protecting electricity networks from natural disasters.

The workshop brought together participating States and Partners for Co-operation, as well as representatives of international organizations and institutions, specialized agencies, the business sector (including Transmission Systems Operators), and academia. In line with MC.DEC/6/13 the scope of the workshop was limited to electricity networks, and did not address nuclear, gas and oil infrastructure.

The following natural disasters, relevant to electricity networks, were discussed: geophysical disasters such as earthquakes, volcanoes and landslides as well as hydrological (floods, landslides, avalanches), meteorological (storms) and climatological (extreme temperatures, droughts) disasters.

The workshop provided insights on good practices, knowledge and experience from different countries and stakeholders across the entire process of protecting electricity networks from natural disasters, including risk assessment (to identify threats, to assess vulnerabilities, to identify and quantify potential losses); risk preparedness, prevention and mitigation (including technical and physical protection measures and planning as well as organizational measures, capacity building, early warning and internal controls); risk management (disaster management); recondition (back-up supply and provisional repair); and risk recovery (reconstruction, financing, repairing and restoring).

2. Main conclusions and recommendations

Discussions during the workshop on the protection of electricity networks from natural disasters resulted in concrete recommendations for the OSCE's future engagement:

Mobilizing Political Support

An outage in the energy infrastructure in one country or region can trigger a cascade effect resulting in outages in other countries' infrastructure or even global malfunctions. Because of these cascade effects, non-nuclear critical energy infrastructure protection requires internationally coordinated prevention and crisis management measures.

According to workshop participants, the OSCE could consider identifying a set of areas directing their future engagement to protect non-nuclear critical energy infrastructure from natural disasters:

1. Support the development and implementation of strategies, policy and regulatory frameworks at all levels of governance, from local to national, to prevent the adverse impacts of natural disasters on energy networks' integrity;
2. Apply a holistic governance approach that covers the entire energy networks protection process, including risk management, mitigation, management and recovery;
3. Foster trans-boundary co-operation, inter alia, through supporting relevant international and regional legal instruments and protocols related to the protection of non-nuclear critical energy infrastructure;
4. Facilitate the implementation of existing agreements to enable internationally coordinated prevention and crisis management measures;
5. Promote the creation of information exchange structures, mechanisms and protocols to share results of risk assessments, and existing best-practices as well as data to increase the level of security of energy networks.

Promoting Co-operation

It is through complementary co-operation among various stakeholders, including governments, international, regional and non-governmental organizations, civil society, the business community, academia, development agencies and financial institutions that the goal of protecting electricity networks from natural disasters can eventually be achieved. Acknowledging the positive track record of the OSCE as an effective platform for dialogue and co-operation workshop participants recommended that the OSCE should:

1. Enhance its role as a platform for a broad dialogue, co-operation, exchange of information and sharing of best practices and experience in the area of the protection of non-nuclear infrastructures, and include civil society and all other relevant stakeholders of participating States and Partners for Co-operation in the debate;
2. Address cross-dimensional aspects related to the protection of non-nuclear critical energy infrastructure including with respect to natural and man-made disasters or disruptions;

3. Make use of the expertise and knowledge of the OSCE's executive structures, in particular its field operations, as key assets to foster transboundary co-operation and extend the reach of information-sharing.

Enhancing Capacities

To better understand the current energy and environmental challenges in the OSCE area, and to identify how these challenges can be more efficiently addressed, the OSCE should:

1. Keep abreast of on-going efforts of different stakeholders working on the protection of energy networks in order to synergize efforts and develop activities based on respective mandates and capabilities;
2. Continue enhancing analytical capacities related to energy networks protection, especially from natural disasters in the context of climate change, while taking into account the expertise of other organizations and agencies that operate in the field of energy and environment;
3. Compile good practices to facilitate information exchange and disseminate best practices and lessons learned on the link between environment and energy-related activities and security at all levels of society;
4. Proceed, as a first step, with the development of a Handbook of best practices to protect electricity networks from natural disasters (see specific suggestions in the next chapter);
5. Organize training and other capacity-building activities i.a. for government representatives, and for public and private owners and operators of electricity networks, to raise awareness, and disseminate best practices and lessons learned on non-nuclear critical energy infrastructure protection and the management of crisis related to natural disasters.

Involving Civil Society, Gender Mainstreaming

Energy security and environmental issues pose an ever growing challenge and all relevant stakeholders, including civil society, have a role to play in responding to it. To further advance the confidence building potential in this area the OSCE should:

1. Promote the empowerment of civil society organizations and multi-stakeholder networks to actively participate in the elaboration of policy recommendations as well as the design, implementation and evaluation of activities related to the protection of electricity networks from natural disasters;
2. Advocate and support the mainstreaming of a gender perspective in the elaboration and implementation of projects and policies for the energy sector.

3. Suggestions for the development of a Handbook of best practices to protect electricity networks from natural disasters

In addition to the recommendations listed above, more specific suggestions were made regarding the development of a Handbook of best practices to protect electricity networks from natural disasters.

The publication should serve as a reference document for government policy makers, state authorities, regulators, public and private owners and operators of energy networks.

To achieve this, the development of the Handbook should include collecting information from various stakeholders, in particular national governments, international organizations, academic institutions, Transmission and Distribution Systems Operators (TSOs) and civil society organizations.

The contributions, presentations and statements made during the workshop suggested the following elements that could be included in the Handbook:

- impacts of climate change and implications for the security of electricity networks;
- vulnerability assessment of electricity networks;
- overview of methods for risk assessment of electricity networks;
- existing risk mitigation measures in protecting electricity networks;
- barriers for implementation of these mitigation measures;
- practical experiences, case studies and lessons learned of countries dealing with natural disasters which resulted in electricity blackouts;
- multiple perspectives of resilience of electricity networks;
- governance, social, economic, technological and human factors which are relevant for the protection of electricity networks.

Participants identified the following best practices and risk-assessment tools as reference for the Handbook:

- natural hazards risk and multi-risk assessments such as stress tests, electrical power network models, Virtual City;
- experiences of TSOs such as generic models to enable exchange of information and collaboration frameworks for mutual assistance;
- best practices to address cascading events in risk management and restoration phases such as “Defense” and “Restoration” plans as well as special security packages;
- good practices from other sectors such as “near-misses”, relevant in the aviation industry.

4. Donors' contribution

The OSCE Project "Sharing Best Practices to Protect Electricity Networks from Natural Disasters" consists of two main activities:

This Expert Workshop, which was made possible thanks to the generous extra-budgetary contributions from the Governments of Austria, Slovakia and the United States.

The second activity is to compile and publish the proceedings of the Workshop, together with some additional inputs from selected experts, in a Handbook of best practices to protect electricity networks from natural disasters (exact title and scope to be determined).

5. Session reports

5.1. Session 1 – Opening session

Moderator: **Dr. Halil Yurdakul Yigitgüden**, Co-ordinator of OSCE Economic and Environmental Activities

The Secretary General of the OSCE H.E. Lamberto Zannier in his opening statement addressed the importance of protecting electricity networks from disruptions and damages caused by natural hazards. Recent examples of such extreme weather events affected lives of millions of people this year: In February, ice storms and falling trees damaged electricity poles and pylons and left almost 25% of households in Slovenia without electricity; later this year, dramatic floods in Serbia, Bosnia and Herzegovina and Croatia disrupted power supply. For some years now, the OSCE has increasingly been focusing on energy as a critical security-related topic. In December last year in Kyiv the Ministerial Council adopted two decisions on energy and environment, "Protecting Energy Networks from Natural and Man-made Disasters" was one of them. This theme also connects with the 2014 OSCE Chairmanship's priority on natural disasters and risk reduction. Therefore, the OSCE is well placed to provide a platform for international co-operation and sharing of best practices. The planned Handbook on protecting electricity networks will help to raise awareness, encourage further discussion and identify opportunities for co-operation.

Ms. Andrea Rauber Saxer, Minister, Deputy Head of the Swiss Delegation on behalf of the Swiss OSCE Chairmanship 2014 welcomed the process, which was opened by this expert workshop, towards the protection of electricity networks. She mentioned that the wide use of the planned best practices Handbook could contribute significantly to the security in the OSCE region. The Handbook will be a step forward in the disaster risk reduction and management process, which can have positive effects not only by eliminating threats but also as a confidence building measure between nations and local communities. The issue of protecting energy networks from natural hazards corresponds to priorities of the Ukrainian and the Swiss Chairmanships as the main focus in the Economic and Environmental Dimension of the 2013 Ukrainian Chairmanship was on energy and environment, and the main focus of the Swiss Chairmanship this year is on environmental challenges and natural disasters.

The Secretary General of the Energy Charter Secretariat, Ambassador Urban Rusnák addressed the critical importance of electricity networks infrastructure for security of energy supply and such sectors as transportation, health, businesses and households when disruption of complex and interconnected energy transmission infrastructure can affect millions of people, lead to multiple environmental impacts and a cascade of interlinked economic losses. As a response to the previous energy supply crisis with regard to transit through Ukraine in 2006 and in 2009, the Energy Charter established the Energy Security Contact Group as a neutral platform to gather and exchange reliable information. The Group developed the proposal of an Early Warning Mechanism, which is currently discussed within the Trade and Transit Group of the Energy Charter. The Early Warning Mechanism can be similar to the political mechanism for conflict prevention and emergency situations established in the OSCE. It can be based on multilateral and voluntary contributions and could facilitate consultations, exchange of information, verification and monitoring. The major aim is to develop a universal instrument to be applied for all types of energy. Ambassador Rusnák thanked the OSCE for its support and participation in the Energy Charter Forum in Bratislava on "Securing Energy Supply – How to better protect energy networks from disruptions", to be held on 10 October 2014. The forum will complement the on-going activities of the OSCE and can provide valuable inputs for the Handbook.

5.2. Session 2 – Morning session: Risk assessment and identification of vulnerabilities

Moderator: **Ms. Viktoriia Kuvshynnykova**, Counsellor, Permanent Mission of Ukraine to the OSCE, 2013 OSCE Chairmanship

Rapporteur: **Dr. Wei Liu**, Executive Director, NGO 'Human and Environment Linkage Programme', the USA

The first morning session discussed the questions of existing single and multi-risk assessments for critical infrastructure, such as electricity networks, and estimations of probabilities of natural hazards, developed and existing in science and applied by Transmission Systems Operators and national civil protection platforms. It also included experience with risk assessment and stress testing in the Nordic and Mediterranean regions.

Dr. Nadejda Komendatova from the International Institute for Applied Systems Analysis spoke about the need for a new governance approach to protect electricity networks from natural hazards. The new risk governance approach shall take into consideration the current conditions of electricity transmission and distribution networks as well as cross-border interconnectors, which include aging infrastructure, and difficulties in siting new transmission grids due to regulatory processes and public acceptance issues. The new risk governance approach shall also include changing requirements for grid architecture caused by diversification of electricity supply from intermittent renewable energy sources located in different areas. At the same time protection of electricity networks requires consideration of cascading effects among different natural hazards and risks affecting different elements of the grid. Thus, protecting electricity networks will not only require technical and economic capacities but also understanding of complex processes including decision-making, institutional structures, public acceptance and risks perceptions of different stakeholders.

Dr. Kevin Fleming from the GFZ German Research Centre for Geosciences focused on risk assessment and the need to address multi-type interactions of hazards and the dynamic of hazards and their impacts on physical, social and economic vulnerability and exposure. There are two best practices of multi-risk assessment, developed in the framework of the EU-project MATRIX. These are the Matrix-City IT Platform and the Virtual City, which were tested in three cities, Naples (Italy), Guadeloupe (French West Indies) and Cologne (Germany), and showed effects from multi-type interactions on critical infrastructure such as water, hospitals, electricity and road networks.

Mr. Kurt Misak from the Grid Security Department of the Austrian Power Grid AG, which is a member of the European Network of Transmission Service Operators – Electricity (ENTSO-e), addressed the need to identify the most serious meteorological risks for electricity grids in interdependency with man-made risks such as intrusions and raids. There is also a need to understand impacts from natural hazards on different components of the grid, such as electricity transmission towers. One of the best practices in an emergency situation can be the use of special security packages, allowing fast repairs through the deployment of standardized components.

Dr. Farrokh Nadim from the Norwegian Geotechnical Institute spoke about the experience of the Nordic region and recent developments in risk assessment for electricity networks. The special feature of the Nordic electricity grid is that it is highly interconnected and operates increasingly as a single entity. The natural disaster of 2003 and the storm Dagmar in 2011 showed that extreme natural hazards, climate and demographic changes pose a serious threat to the reliability of Nordic grids. Therefore, risk assessments should address all these factors and there are examples of best practices for such assessments. One is the electrical power network model developed in the EU supported project SYNER-G. Another one is a stress test, which shall be based on a scenario of exogenous shocks and model overall and specific impacts from these shocks on the object.

Dr. Khadidja Guenachi from the Laboratory for Industrial, Technological and Environmental Risks at the University of Oran, Algeria spoke about the need of a scientific-global-systemic approach to address risks for critical infrastructure, such as electricity networks. She explained the holistic approach existing in Algeria for risk assessments for such natural hazards as earthquakes, floods, lightning, violent winds and snowstorms. This approach starts from risk assessment for territories and infrastructures, for industrial activities and natural hazards, and includes legal, technical and human barriers for the implementation of risk mitigation measures.

5.3. Session 3 – Afternoon session: Risk mitigation and resilience of electricity network systems

Moderator: **Ms. Desiree Schweitzer**, Deputy Co-ordinator/Head, Environmental Activities, Office of the Co-ordinator of OSCE Economic and Environmental Activities

Rapporteur: **Mr. Thomas Schinko**, Wegener Centre, University of Graz

The afternoon session discussed risk management issues, including resilience of electricity network systems to single and multiple natural hazards. It included climate change adaptation policy processes geared to protecting critical infrastructure, as well as physical and non-physical resilience factors (organizational, social and economic). The social factors included human failures and errors in decision-making processes.

Mr. Martin König from the Environment Agency Austria spoke about the need to address energy generation and transmission issues from the point of view not only of climate change mitigation but also of climate change adaptation. This need is caused by direct physical impacts and damages to transmission and distribution grids caused by extreme weather events, adverse impacts on conventional supply facilities caused by extreme weather periods, indirect impacts via accelerated demand on transmission infrastructure and adverse effects of higher temperatures on all three components of the energy system:

generation, transmission and distribution. The adaptation of electricity networks should include four major targets: ensuring safety of supply and distribution in a changing climate, safeguarding climate-proofed energy supply, handling the seasonal demand peaks threatening supply and transmission, and developing further storage capacities. These are all crucial buffers for the European energy markets to allow a higher share of renewable energy. The adaptation of electricity networks should also take into consideration regional disparities: For example, Southern Europe will be mostly affected by heat waves and droughts, leading to water cooling problems that could result in a growing number of black-outs; and Southern, Western and Eastern Europe will be affected by shrinking hydro-power potentials.

Dr. Wei Liu from the Human and Environment Linkage Programme, the USA, addressed the need to include multiple perspectives of resilience of electricity networks. Currently resilience of electricity networks is mainly framed within two major paradigms: engineering resilience, which focuses on efficiency, constancy, predictability; and ecological resilience, which is defined as the capacity of a system to absorb disturbance and reorganize itself while undergoing change. Resilience of electricity networks can be outlined with four Rs: robustness (the ability to withstand a shock); redundancy (functional diversity); resourcefulness (the ability to mobilize when threatened), and rapidity (the ability to contain losses and recover in a timely manner). The 2008 Wenchuan earthquake showed the need to address the four Rs and to integrate electricity networks into a broader socio-ecological systems context.

Mr. Hubert Lemmens from GO15 - Reliable and Sustainable Power Grids, which is a voluntary initiative of the 16 largest grid operators, representing more than 70% of the world’s electricity demand and providing electricity to 3.4 billion end-use consumers, followed up on the topic of resilience. For TSOs resilience means the ability to absorb shocks and keep operating. Resourcefulness during an event is the ability to manage a disruption as it unfolds. Rapid recovery is the ability to get back to normal state as quickly as possible, and adaptability is the ability to absorb new lessons after disasters. Resilience is affected by natural hazards but also by failures in decision-making processes. High-impact low frequency events, such as hurricane Sandy, showed the need to improve grid resilience. Also human failures, forecast errors and other failures in planning shall be addressed in order to increase the short-term reliability of power system. The generic model to enable exchange of experience and benchmarking in the area, which is marked by the absence of common standards and differences in boundary conditions of different power systems, is a best practice to address resilience. The Collaboration Framework for Mutual Assistance, a pre-agreed contractual framework for members to provide services and equipment to a member experiencing a major disruption, is another best practice showing that exchange of experience is extremely important in case of low probability high impact events. This assistance also provides members with a quick access to specialized resources around the world, shared documents on past events, including root cause analysis and recommended actions, and contributes to an exchange of best practices and efficient communication in the case of a major event. The best practices to address cascading events, such as a simultaneous occurrence of multiple threats, in the risk management and restoration phases are the “Defence Plan” to return to stable state and the “Restoration Plan” to repower lost load.

Mr. Lubomir Tomik from the Center for Energy Systems CESys, Slovakia spoke about the need to address the safety of critical infrastructure by focusing on the human factor, as human errors and unsafe behavior are causing around 80% of all accidents. Human behavior results from several factors such as culture but also norms, values, assumptions of reality, which altogether form a safety culture. There are different best practices to estimate human performance: Attitude Meter, Twin-Model or Human Performance Toolbox as well as different error prevention tools.

Dr. Oscar van Vliet from ETH Swiss Federal Institute of Technology stressed the need to address multiple aspects to achieve resilience of electricity networks. These aspects include the concepts of redundant links, isolating outages, restoring services, and repairing and rebuilding infrastructure. The concept of redundant links means multiple ways of getting to each destination and includes such questions as how many separate links will be needed and where. The concept of isolating outages means "sacrificing a part in order to save the whole". This is needed to avoid natural hazards turning into cascade failures. Mainly it can be addressed via special measures such as construction of back-to-back connections. However, this might also lead to the question about how many such new transmission lines will be needed and who will be paying for expensive back-to-back interconnections. The concepts of restoring services as well as repairing and rebuilding infrastructure, includes getting electricity flowing again as soon as possible.

5.4. Session 4 – Panel discussion

Moderator: **Dr. Halil Yurdakul Yigitgüden**, Co-ordinator of OSCE Economic and Environmental Activities

Rapporteur: **Dr. Nadejda Komendantova**, Senior Research Scholar, International Institute for Applied Systems Analysis (IIASA)

Dr. Halil Yurdakul Yigitgüden, Co-ordinator of OSCE Economic and Environmental Activities, summarized discussions from the morning and afternoon sessions, which focused on topics such as vulnerability of electricity networks and impacts of natural hazards, existing risk assessment tools and practices, resilience and safety of electricity networks, forms of governance needed and experience from Nordic and Mediterranean regions.

Mr. Mario d'Agostini, Head of the Secretariat Electricity Unit at the State Secretariat for Economic Affairs of Switzerland, is a member of the Industrial Resources and Communications Services Group. He spoke about the role of NATO, which has a special group dealing with security issues for critical infrastructure. Protection of electricity networks requires a holistic approach to bring together the broad range of topics discussed in the two previous sessions. The planned Handbook should include a review of efforts of different stakeholders to protect electricity networks and should be a document which will help end-users such as governments, the private sector and civil society organizations.

Dr. Johannes Reichl from the Energy Institute at the Johannes Kepler University of Linz suggested including knowledge of Transmission Systems Operators about best practices into the Handbook. The Handbook should also give advice on existing best practices and on new governance structures, which are required to support systems operators to implement existing security measures. This governance framework is also needed to address the different levels and interpretations of security available across countries.

Prof. Friedemann Wenzel from the Karlsruhe Institute of Technology in Germany pointed to the role of science in order to provide methodologies to determine the resilience of energy systems. Four points have to be developed as a best practice. The first one is a stress testing system, used by the financial sector and nuclear industry. Here the scientific community can provide a methodology to assess the complexity of the topic. The second one is the development of an early warning mechanism for slow and fast developments and infrequent events. The third one is near-misses as a best practice used by nuclear and aviation industries, which should be done in the framework of interactions with stakeholders. The fourth one is the establishment of instruments to measure the process of implementation of best practices and improvements in practice.

Ms. Milka Mumovic from the Energy Community addressed the need to understand the legislative framework, in which industries are operating, and the responsibilities of different stakeholders as security requirements are usually defined by regulations and then a regulator can incentivize for better standards. However, security is a matter of social acceptance of costs as higher security requirements can also lead to higher costs for implementing countries. Therefore, the Handbook could address questions such as what is the current level of security requirements and is this level sufficient or should it be increased. Another question concerns probabilities of disasters and the role of science in an increase of protection standards. The third question is about quality of existing security standards and should include experience of the Energy Community with heavy snows, which affected several kilometers of networks, and experience of Transmission Systems Operators with floods and the reasons for inefficiencies in disaster risk management. Finally, the Handbook should involve end-users and stakeholders as contributors.

The discussion following the presentations focused mainly on four topics: near-misses, the need for clarification of terminology, quantification of economic impacts from outages and the experience of individual countries.

The “near-miss” system requires data about operations. It also requires trust within the specific organization involved otherwise stakeholders will not report about human failures and therefore the organizations have to introduce an atmosphere of trust, in which people are encouraged and rewarded to provide essential safety-related information. The Transmission Systems Operators do not have such a culture of trust yet as only very few cases of human failure are reported and it is much easier to say that it was a failure of equipment. At the same time, there are still no standards on how to analyze near-miss events and what actually counts as a near-miss. Aviation authorities have good expertise of how to investigate near-miss accidents. One of the possibilities to investigate near-misses could be to raise awareness about the issue through the establishment of a platform for education and training.

In terms of methodology, the need for further clarification regarding the term “natural disasters” was raised. Because of their impacts on people natural hazards and natural phenomena can become disasters; therefore the term “natural hazard” might be more appropriate than “natural disaster” which moves the responsibility away from stakeholders in charge. However, according to the Ministerial Council decision MC.DEC/6/13, the language used in the workshop and future related OSCE activities will reflect the terminology as contained in this decision.

It was argued that in terms of quantification of impacts from electricity blackouts a cost-benefit analysis might be the appropriate tool to understand the economic implications due to loss of service. Resilience is important to reduce immediate impacts but recovery will have short and long-term impacts as it involves expensive risk mitigation measures, which can be justified only with quantitative economic statistics. Economic simulation tools such as the blackout simulator[3] could be a best practice for cost-benefit analysis. However, the implementation of this tool is complicated because of the lack of data required to run the simulator. The European competence on modeling power systems in real time has to be built up.

During the debate it was stressed that the Handbook should also contain experiences of individual countries. Slovenia shared its experience of dealing with multiple disasters, and mentioned its comprehensive system of protection when it comes to complex cross-border challenges. In 2014 Slovenia faced a disaster that resulted in the collapse of the electricity infrastructure, and it left 10% of the population for five days without electricity and affected over 3000 km of electrical grids. The damages were estimated at about 400 million Euros. Recovery was only possible with additional resources and assistance through civil protection mechanisms, 172 generators from 11 countries were provided. The lessons learned from this disaster show that the electrical system should be better organized, additional reserves of power generators are not cost effective and too expensive for bigger users, critical infrastructure should have its own back-ups and international co-operation should be strengthened to cope with disasters and should include creating synergies among national, EU and OSCE activities. It was also suggested that the Handbook should include analyses of different outages in Western and Eastern Europe linked to boundary conditions.

[3] The Blackout Simulator software tool is available at http://www.blackout-simulator.com/

ANNEX 1. Annotated agenda

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09.00 – 10.30 **Opening Session**

H.E. Lamberto Zannier, OSCE Secretary General
Ms. Andrea Rauber Saxer, Minister, Deputy Head of Swiss Delegation, 2014 OSCE Chairmanship
Amb. Urban Rusnák, Secretary General of the Energy Charter Secretariat

Moderator: **Dr. Halil Yurdakul Yigitgüden**, Co-ordinator of OSCE Economic and Environmental Activities

Statements by Delegations / Discussion

10.30 – 11.00 **Coffee Break**

11.00 – 12.30 **Morning Session: Risk assessment and identification of vulnerabilities**

Moderator: **Ms. Viktoriia Kuvshynnykova**, Counsellor, Permanent Mission of Ukraine to the OSCE, 2013 OSCE Chairmanship

Rapporteur: **Dr. Wei Liu**, Executive Director, NGO 'Human and Environment Linkage Programme', USA

Selected topics:

- Single risk versus multi-risk assessment
- Implementation and communication of risk assessment
- Perspective of the private sector
- Experience of Nordic and Mediterranean regions

Speakers:

- **Dr. Nadejda Komendantova**, Senior Research Scholar, International Institute for Applied Systems Analysis (IIASA)
- **Dr. Kevin Fleming**, Project Manager and Senior Researcher, GFZ German Research Centre for Geosciences, Germany
- **Mr. Kurt Misak**, Head, Grid Security Department, Austrian Power Grid AG, (Member of the European Network of Transmission System Operators – Electricity (ENTSO-e)
- **Dr. Farrokh Nadim**, Technical Director, Norwegian Geotechnical Institute
- **Dr. Khadidja Guenachi**, Director, Laboratory for Industrial, Technological and Environmental Risks, University of Oran, Algeria

Discussion

12.30 – 14.00 **Buffet Lunch**

14.00 – 15.30 **Afternoon Session: Risk mitigation and resilience of electricity network systems**

Moderator: **Ms. Desiree Schweitzer**, Deputy Coordinator of OSCE Economic and Environmental Activities

Rapporteur: **Mr. Thomas Schinko**, Wegener Centre, University of Graz

Selected topics:

- Climate change adaptation policy process in relation to electricity networks
- Resilience of electricity networks
- Risk mitigation mechanisms

Speakers:

- **Mr. Martin König**, Project Manager, Environmental Impact Assessment and Climate Change, Environment Agency Austria
- **Dr. Wei Liu**, Executive Director, NGO 'Human and Environment Linkage Programme', USA
- **Mr. Hubert Lemmens**, Senior Advisor at Elia Group and Member of 'GO15 - Reliable and Sustainable Power Grids'
- **Mr. Lubomír Tomík**, Director, Center for Energy Systems CESys, Slovakia
- **Dr. Oscar van Vliet**, Senior Researcher, Department of Environmental Systems Science, ETH Swiss Federal Institute of Technology

15.30 – 16.00 **Coffee Break**

16.00 – 17.30 **Closing Session: Panel discussion**

Moderator: **Dr. Halil Yurdakul Yigitgüden**, Co-ordinator of OSCE Economic and Environmental Activities

Rapporteur: **Dr. Nadejda Komendantova**, Senior Research Scholar, International Institute for Applied Systems Analysis (IIASA)

Panelists:

- **Prof. Friedemann Wenzel**, Karlsruhe Institute of Technology (KIT)
- **Dr. Johannes Reichl**, Project Manager, Energy Institute at the Johannes Kepler University Linz
- **Ms. Milka Mumovic**, Electricity expert, Energy Community
- **Mr. Mario d'Agostini**, Head of the Electricity Unit, Federal Department of Economic Affairs, Switzerland

Statements by Delegations / Discussion

ANNEX 2. Background paper

SEC.GAL/103/14
27 June 2014
OSCE+
ENGLISH only

Background paper

Expert Workshop on

"Sharing Best Practices to Protect Electricity Networks from Natural Disasters"

Vienna, July 2nd 2014

The MC Decision on "Protection of Energy Networks from Natural and Man-made Disasters" (MC.DEC/6/13) adopted in Kyiv last year, i.a. "Tasks the Office of the Co-ordinator of OSCE Economic and Environmental Activities to identify opportunities for co-operation with international organizations and regional organizations and agencies in the field of protection of energy networks against natural and man-made disasters and to facilitate discussions on possible areas for co-operation".

The expert workshop to implement this tasking has the objective to contribute to enhancing the capacities of OSCE participating States to fulfil their commitment with regard to MC.DEC/6/13 by raising awareness of and facilitating the dialogue and knowledge sharing on the protection of electricity networks from natural disasters. It will bring together participating States and Partners for Cooperation, and representatives of international organizations and institutions, specialized agencies, the business sector (including Transmission Systems Operators) as well as academia.

The workshop will explore the state of the art and existing best-practices for protecting electricity networks from natural disasters. During this workshop the questions of vulnerability and resilience of electricity networks to single and multiple risks of natural hazards will be discussed. This will include all phases of the resilience design process such as risk assessment, risk communication and implementation of risk mitigation measures. Resilience refers to the capability of a system, in this case the electricity transmission network, to recover its functionality after the occurrence of a disruptive event. Looking at the vulnerability of electricity networks, the entire disturbance process, from prevention of risks and mitigation of possible negative consequences to the response and recovery in the acute crisis phase, will be discussed.

In line with the above referenced MC decision and to allow a more focused debate, the scope of the workshop will be limited to electricity networks - leaving aside nuclear, gas and oil infrastructure - and their vulnerabilities to natural disasters.

The natural disasters which will be discussed and which are relevant to electricity networks are the following: geophysical disasters such as earthquakes, volcanoes and landslides as well as climate-related disasters such as hydrological (floods, landslides, avalanches), meteorological (storms) and climatological (extreme temperatures, droughts).

The discussion will not only include risk assessments but also risk mitigation and management and therefore relevant operational and technological risks such as emergency preparedness and operations, interconnection reliability operations and coordination, planning and internal control as well as grid integration of renewable energy, capacity allocation and congestion management.

The workshop will provide insights on good practices, knowledge and experience from different countries and stakeholders across the entire process of protecting electricity networks, which includes the following elements:

- Risk assessment to identify threats, to assess vulnerabilities, to identify and quantify potential losses
- Risk preparedness and prevention including technical and physical protection measures and planning
- Risk preparation such as organizational measures, capacity building and internal controls
- Risk response, including intervention such as early warning and monitoring mechanisms, and recondition such as back-up supply and provisional repair
- Risk recovery which is connected with reconstruction, financing, repairing and restoring

Background:

The energy sector, in general, and the electrical power transmission systems in particular, are essential to the national economies and well-being of modern societies. These systems consist of three parts: generation, transmission and distribution; all these components are inter-connected through transmission lines arranged within a high dimensional network, including large amount of edges and nodes.

Security of energy supply is influenced by reliability of these systems. Their vulnerability can have implications for national security. Around 59% of all power system blackouts in the United States and Canada, for example, are caused by natural hazards[4]. The risk of natural disasters such as floods, droughts, earthquakes, tsunami, make these networks extremely vulnerable.

[4] Task-Force, "Final report on the august 14, 2003 blackout in the United States and Canada: Causes and recommendations," U.S.–Canada Power System Outage Task Force, Technical Report, April 2004.

Disruption or damage to electricity networks, especially today when they have become complex and interconnected, may affect millions of people, causing loss of life, multiple environmental impacts and a cascade of interlinked economic losses. Examples of accidents caused by natural disasters indicate that the scale and long-term consequences can go far beyond national borders. Earthquakes and related tsunamis as well as climate-related disasters such as hurricanes, floods, landslides or hail storms, most of the time, result in a serious physical damage to critical infrastructure making it almost impossible for a single country to cope[5]. The societal impacts of blackouts are determined in terms of power outage, number of days, weather conditions, nature of affected area, size and density of population, housing characteristics, industrial and economic activities. Therefore, discussion about vulnerability and resilience of critical components becomes essential in regions with significant natural hazards.

The issue of protecting electricity networks is additionally influenced by new emerging requirements for the grid infrastructure needed for on-going energy transition which is driven by concerns of climate change and energy security. The European climate policy goals, for example, require a reduction of at least 80% of all CO2 emissions by 2050, eventually leading to the full decarbonisation of the power sector[6]. At the same time, price volatility and competition on global markets for energy sources create additional incentives for national governments to develop available renewable energy resources.

To continue with the example of Europe: it is a fact that the existing electricity grid architecture has to be adapted to cope with increasing volumes of renewable electricity[7]. The generation of renewable power is generally concentrated in European regions with relatively low load, and then needs to be transmitted to high load and storage sites, sometimes over distances of several hundred kilometers. The majority of the European transmission systems is 30-40 years old, and needs to be replaced, upgraded and even expanded which makes them more vulnerable to natural hazards[8]. In some regions, grids are already pushed to the limits of their capacities due to rapid expansion of electricity from wind generation[9]. Around 42,000 km of transmissions lines need to be upgraded or constructed to secure market integration, security of supply and to accommodate the renewable expansion planned for 2020[10].

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[5] The largest blackouts in history such as 2012 in India (670 mio people affected), 2005 in Indonesia (100 mio), 1999 in Brazil (97 mio), 2009 in Brazil and Paraguay (87 mio), 2003 in US and Canada (55 mio), 2003 in Italy, Switzerland, Austria, Slovenia and Croatia (55 mio) show the need to protect electricity networks from natural disasters.

[6] European Commission, 2010. Energy 2020. A strategy for competitive, sustainable and secure energy. COM(2010) 639 final, Brussels, November, 2010.

[7] IEA, 2002. Security of Supply in electricity markets. Evidence and Policy Issues. Paris: International Energy Agency (IEA) / Organisation for Economic Cooperation and Development (OECD).

[8] Ecofys, 2008. Study on the comparative merits of overhead electricity transmission lines versus underground cables. Study for the Department of Communications, Energy and Natural Resources, Ireland, May 2008.

[9] EWEA, 2005. Large Scale integration of wind energy in the European power supply: analysis, issues and recommendations. European Wind Energy Association (EWEA) Brussels.

[10] Entso-E, 2010. Ten-year network development plan 2010-2020. European Network of Transmission System Operators for Electricity (ENTSO-E), Brussels.

The new requirements on electricity transmission infrastructure as well as an increasing interconnection on the electricity markets and growing volumes of transmitted electricity impact vulnerability of electricity grids. Additionally, a higher share of renewable energy generation can lead to more exposure to climate risks, with the potential of increasing dependency from solar radiation, wind velocities and river run-offs regimes. New forms of electricity networks architecture, such as smart grids to balance intermittency of renewable energy sources, and super grids to transfer large volumes of electricity over long distances, raise additional questions about the vulnerability of electricity grids to climate change, and how to make the changing electricity networks more resilient.