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608540

Project acronym:
GARPUR

Project full title:
Generally Accepted Reliability Principle with Uncertainty modelling and through probabilistic Risk assessment

Collaborative project

FP7-ENERGY-2013-1

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D10.3d
Workshops proceedings and satisfaction questionnaires (all reporting periods)

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TECHNOFI

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Dissemination Level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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Deliverable short title:	Workshops proceedings and satisfaction questionnaires (all reporting periods)
Deliverable title:	Workshops proceedings and satisfaction questionnaire exploitation for all the yearly interactive workshops occurring in WP10 (T10.3, T10.4 and T10.10)
Work package:	WP10 Dissemination and exploitation
Lead participant:	TECHNOFI

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Date	**Revision**	**Author(s)**	**Comments**
2014-08-29	a	Sophie Dourlens-Quaranta	Initial version: proceedings of workshops held during the first year of the project
2015-07-07	b	Sophie Dourlens-Quaranta	Addition of the proceedings of workshops held during the second year
2016-08-30	c	Athanase Vafeas, Sophie Dourlens-Quaranta	Addition of the proceedings of workshops held during the third year
2017-10-25	d	Athanase Vafeas	Addition of the proceedings of workshops held during the fourth year

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EXECUTIVE SUMMARY

To reach the dissemination objectives of GARPUR, several workshops are planned during GARPUR project lifetime, each targeting a specific audience:

- Transmission System Operators (project task 10.3),
- Regulatory bodies and policy makers (task 10.4),
- Impacted stakeholders: Distribution System Operators, power generators and technology providers (task 10.10).

1. Workshops organized during the first year of the project

During the first year of GARPUR (September 2013 – August 2014), two workshops were organised:

- A workshop towards TSOs, on 7 April 2014 in Brussels (ENTSO-E premises),
- A workshop towards regulatory bodies, on 30 June 2014 in Ljubljana (ACER premises).

These workshops allowed GARPUR partners to present the project and very first deliverables. Both TSOs and regulators expressed interest in the project and asked for further exchanges, in particular when GARPUR partners are able to present more technical aspects of their activities. Proceedings of these workshops were the purpose of the deliverable D10.3a.

The presentations given at the two workshops can be found on the GARPUR website: http://www.garpur-project.eu/publications.

First workshop towards TSOs

The workshop was attended by 35 participants, including 13 people representing 11 TSOs non partners in GARPUR and ENTSO-E secretariat.

Six presentations were given and were followed by questions and answers sessions:

- "Opening introduction - the overarching goals of the GARPUR project" by STATNETT,
- "Overview and organization of the GARPUR project" by SINTEF,
- "Functional analysis of probabilistic reliability management" by the Scientific Advisor (ULG),
- "Current practices for reliability management in complex systems: a review of drivers and barriers for new reliability standards" by AALTO,
- "Shaping the GARPUR quantification platform" by KUL,
- "The role of reference group" by STATNETT.

A satisfaction questionnaire was distributed at the end of the workshop and provided positive feedback and interesting remarks that will be taken into account for the next workshops.

First workshop towards regulatory bodies

At GARPUR's instigation, this workshop was co-organized with iTesla and Umbrella projects. It was attended in total by 19 participants, including 3 ACER representatives and 4 NRAs representatives.

In conclusion for GARPUR, regulators demanded further exchange of views about the reliability criteria and the economic indicators. They asked the possibility to be involved in the discussions before new reliability criteria are finalized. They insisted that the next workshop (more technical) should be held as soon as possible. The next workshop towards regulators should therefore involve WP2 and WP3 partners and be held early 2015.

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2. Workshops organized during the second year of the project

During the second year of GARPUR (September 2014 – August 2015), three meetings were organised between GARPUR and the above-mentioned stakeholders:

- Presentation of GARPUR at the Pentalateral Energy Forum, on 23 September 2014 in Brussels (Benelux Secretariat premises),
- A workshop with DSOs, power generators and technology providers, on 7 October 2014 in Brussels (ENTSO-E premises),
- A workshop with TSOs, on 2 June 2015 in Brussels (ENTSO-E premises).

Proceedings of these meetings are the purpose of the present revision of the same deliverable (version D10.3b).

The presentations given at these various events can be found on the GARPUR website: http://www.garpur-project.eu/publications.

Meeting with the Pentalateral Energy Forum (PLEF)

The Pentalateral Energy Forum (PLEF) is the framework for regional cooperation in Central Western Europe. It was created in 2005 by Energy Ministers from Benelux countries, Austria, Germany and France (with Switzerland as a permanent observer) in order to promote collaboration on cross-border exchange of electricity.

Participants in PLEF support group meetings are representatives of Energy Ministries, regulators, TSOs, power generators, and when relevant power exchanges. From GARPUR WP10 tasks point of view, participation in PLEF meetings is therefore seen as a contribution to tasks 10.3, 10.4 and 10.10.

GARPUR was presented to PLEF Support Group 2 “Security of Supply” at the occasion of a meeting held at the Benelux Secretariat in Brussels on 23 September 2014.

Following this presentation, regulators and ministries representatives expressed interest in participating in future exchanges with GARPUR, in particular regarding the design of new reliability criteria.

First workshop with DSOs, power generators and technology providers

This workshop was held in ENTSO-E premises on 7 October 2014, the day before an EDSO Technology Committee meeting. Not only GARPUR was presented, but representatives of the three categories of targeted stakeholders were invited to present their point of view about reliability management.

Discussion mainly focused on the following aspects:

- Complexity of GARPUR and the communication towards external stakeholders,
- Data and scenarios,
- Impacts of GARPUR.

Responses to the evaluation questionnaire show that stakeholders are eager to know more about GARPUR and ask for more concrete examples, pictures or use cases illustrating the impacts of GARPUR on their own activities.

Second workshop with TSOs

This workshop was held in ENTSO-E premises on 2 June 2015, the day before an ENTSO-E RDC meeting. At this workshop, the GARPUR reliability management framework was introduced, with a focus on the development of new reliability criteria and the socio-economic assessment of reliability criteria; the current practices amongst European TSOs in terms of TSOs functional workflow of long-term, mid-term and short-term decision making processes was presented; and a focus was made on recent and upcoming project milestones.

Discussions during the workshop and responses to the evaluation questionnaire show that TSOs are interested in GARPUR and request more practical examples about the potential impacts of GARPUR approach.

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3. Workshops organized during the third year of the project

During the third year of GARPUR (September 2015 – August 2016), three meetings were organised between GARPUR and related projects and stakeholders:

- Bilateral meetings with iTesla and Umbrella projects on 25th January 2016 at ENTSO-E's in Brussels
- Meeting with regulatory bodies and policy makers in Iceland on 16 February 2016 in Reykjavik
- The second workshop with regulatory bodies and policy makers on 17 March 2016 in Brussels (jointly with iTesla project)
- The third workshop with TSOs on 3rd June 2015 in Nice
- The second workshop with DSO, power generators and technology providers on 24th August 2016 (jointly with iTesla project) in Paris

Bilateral meetings with iTesla and Umbrella projects

In order to ensure the coherence of GARPUR and iTesla/Umbrella toolboxes it was decided at the second GARPUR exploitation workshop on 8&9 June 2015 to organize bilateral meetings of Garpur with iTesla and Umbrella projects. Such meetings have been held on 25th January 2016 at ENTSO-E's with an attendance of 16 participants for the meeting with iTesla and 24 participants for the meeting with Umbrella. As a result, all projects agreed to further cooperate.

Meeting with regulatory bodies and policy makers in Iceland

The GARPUR project was presented to in Iceland to the National Energy Authority (Orkustofnun) and the Ministry of Industries and Innovation on 16 February 2016. The meeting was organized by Landsnet and included ministry and regulator representatives of Iceland as well as from the project Landsnet and the University of Reykjavik.

Second workshop with regulatory bodies and policy makers

This workshop was organized on 17 March 2016 in collaboration with the iTesla project. It was hosted at the Belgian Ministry in Brussels (Federal Public Service Economy, SMEs, Self-employed and Energy) the day after a meeting of the Pentalateral Energy Forum. The workshop was attended by 17 participants.

Third workshop with TSOs

This workshop was held in Nice on 3rd June 2015 with an important participation of TSOs. At this workshop, within the general GARPUR reliability management framework key concepts and draft results on long-term, mid-term and short-term decision making processes in TSOs were presented. In particular the Vision towards the use of the new RMAC in TSOs' processes was delivered in the three components, each dedicated to one key function of TSO: TSOs' system development processes, TSOs' asset management processes, TSOs' system operation processes.

Second workshop with DSOs, power generators and technology providers

The second workshop was organized jointly with the iTesla project by RTE and TECHNOFI in Paris on 24th August 2016. It was organized as a side event of the CIGRE session in Paris to take benefit of the presence of stakeholders in Paris. The attendance reached 47 participants and discussions showed a high interest to both complementary projects in the domain of reliability management for TSO in Europe. It should be noted that participation was international with several participants beyond European continent.

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4. Workshops and interactions organized during the fourth year of the project

Additional interactions with the regulatory world were ensured during the final reporting period.
They took the form of:

- Bilateral interactions for presentation of the project results and recommendations towards regulatory authorities or ministries: beyond the natural communication/monitoring channels at the national level by the GARPUR TSO, activity in WP9 enabled new series of contacts with regulatory authorities and ministries during the final year of the project.
- Participation to the session "benefits for society and possible barriers for implementation from a regulatory perspective" during the 2nd day of the Final Conference (18th October 2017).

The Third workshop on involvement of impacted stakeholders targeted mainly the scientific community.
It took place on 21 June 2017: A GARPUR Special session (SS12) in PowerTech Conference 2017 in Manchester under the leadership of ULg: "The GARPUR probabilistic reliability management approach & criteria". About 45 participants attended.

- GARPUR Special session (SS12) in PowerTech Conference 2017: "The GARPUR probabilistic reliability management approach & criteria
- About 45 participants with speakers from the project under the management of scientific advisor Louis Wehenkel, ULG.
- Speakers from GARPUR consortium included: SINTEF, STATNETT, ELIA, RTE, LANDSNET, KUL, ULg.

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1 INTRODUCTION

Dissemination activities are an important part of the GARPUR project. Objectives of dissemination activities are the following:

1. To convince the TSO community to implement a new reliability criteria to make the pan-European transmission network more flexible while keeping security at a socially acceptable level.
2. To convince policy makers and regulators to make the present pan-European transmission network reliability criteria evolve to increase its flexibility.
3. To involve other electricity market players (DSOs, generators, manufacturers) in the preparation of the future deployment of the project outputs.
4. To deliver the new project-based knowledge in a manner suited to meet the collected multi-stakeholder needs.
5. To stimulate the relevant players towards further demonstration activities to support the deployment of the new criteria according to an agreed road map.

Several workshops are planned during GARPUR project lifetime, each targeting a specific audience:

- Transmission System Operators (project task 10.3),
- Regulatory bodies and policy makers (task 10.4),
- Impacted stakeholders: Distribution System Operators, power generators and technology providers (task 10.10).

During the first year of the GARPUR project (September 2013 – August 2014), two workshops were organised:

- The first workshop towards TSOs, on 7 April 2014, in Brussels (ENTSO-E premises),
- The first workshop towards regulatory bodies, on 30 June 2014 in Ljubljana (ACER premises).

Proceedings of these workshops can be found in D10.3a "Workshops proceedings and satisfaction questionnaires (first year)", published in September 2014.

During the second year of GARPUR (September 2014 – August 2015), three meetings were organised between GARPUR and the above-mentioned stakeholders:

- A presentation of GARPUR at the Pentalateral Energy Forum, on 23 September 2014 in Brussels (Benelux Secretariat premises),
- The first workshop with DSOs, power generators and technology providers, on 7 October 2014 in Brussels (ENTSO-E premises),
- The second workshop with TSOs, on 2 June 2015 in Brussels (ENTSO-E premises).

Proceedings of these meetings can be found in D10.3b "Dissemination workshops proceedings (first and second years)", published in September 2015.

During the third year of GARPUR (September 2015 – August 2016), five meetings were organised between GARPUR and the above-mentioned stakeholders:

- Bilateral meetings with iTesla and Umbrella projects on 25 January 2016 in Brussels (ENTSO-E premises),
- Meeting with regulatory bodies and policy makers in Iceland on 16 February 2016,
- Second workshop with regulatory bodies and policy makers on 17 March 2016 in Brussels at the Belgian Federal Ministry for Economy,
- Third workshop with TSOs on 3 June 2015 in Nice (France),
- Second workshop with DSOs, power generators and technology providers on 24 August 2016 in Paris during the CIGRE session.

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Proceedings of these meetings are the purpose of the present revision of the same deliverable (version D10.3c).

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2 FIRST WORKSHOP TOWARDS TSOS

This workshop was held in ENTSO-E premises on 7 April 2014, the day before an ENTSO-E RDC meeting.

2.1 Attendees

The workshop was attended by 35 participants, including 13 people representing 11 TSOs non partners in GARPUR and ENTSO-E secretariat. The detailed attendance list is presented in Table 1.

Table 1 – Attendance list of the first workshop towards TSOs

Company name	Representative	email
TSOs non GARPUR partners		
AMPRION	Björn Wohlgemuth	bjoern.wohlgemuth@amprion.net
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REE	Vicente González López	vgonzalez@ree.es
REE	Carlos Llanos	cllanos@ree.es
SVENSKA KRAFTNÄT	GÖRAN ERICSSON	GORAN.N.ERICSSON@SVK.SE
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TENNET	Gert Aanhaanen	Gert.Aanhaanen@tennet.eu
TERNA	Antonio Iliceto	antonio.iliceto@terna.it
GARPUR partners		
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02_STATNETT	Lars Kristian Vormedal	lars.vormedal@statnett.no
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03_ELIA	Cindy Bastiaensen	cindy.Bastiaensen@elia.be
04_RTE	Stéphane Chatellier	stephane.chatellier@rte-france.com
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[1] System Operation Committee

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12_AALTO	Liisa Haarla	liisa.haarla@aalto.fi
17_TECHNOFI	Serge Galant	sgalant@symple.eu
17_TECHNOFI	Sophie Dourlens-Quaranta	sdourlens@symple.eu

2.2 Agenda

The workshop was held from 13:30 to 18:20, and was followed by a diner jointly organised with ENTSO-E. The detailed agenda is presented in Table 2.

Table 2 – Agenda of the first workshop towards TSOs

Time	Title	Responsible
13:30	Welcome of attendees	STATNETT (Gerard Doorman)
14:00	Opening introduction - the overarching goals of the GARPUR project	STATNETT (Gerard Doorman)
14:15	Overview and organization of the GARPUR project	SINTEF Energy Research (Einar Jordanger, acting coordinator)
14:30	Q/A	
14:45	Functional analysis of probabilistic reliability management	UNIVERSITY OF LIEGE (Louis Wehenkel, scientific advisor)
15:00	Q/A	
15:15	Coffee break	
15:30	Current practices for reliability management in complex systems: a review of drivers and barriers for new reliability standards	AALTO UNIVERSITY (Liisa Haarla)
15:50	Group discussion – "Drivers and barriers (for new reliability standards)"	AALTO UNIVERSITY (Liisa Haarla)
16:30	Coffee break	
16:45	Shaping the GARPUR quantification platform	KU LEUVEN (Dirk Van Hertem)
17:00	Discussion – Methods and Tools to be included in the Quantification Platform	KU LEUVEN (Dirk Van Hertem)
18:00	The role of reference group	STATNETT (Gerard Doorman)
18:15	Conclusions: the way forward with ENTSO-E members • TSOs in GARPUR • TSOs of the reference group • TSOs of ENTSO-E	STATNETT (Gerard Doorman)
18:20	End of meeting	
19:30	Joint dinner invited by TECHNOFI	

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2.3 Proceedings

The presentations can be found on the GARPUR website: http://www.garpur-project.eu/publications. The detailed minutes of the workshop can be found in Annex 1.

With the first presentation "Opening introduction - the overarching goals of the GARPUR project" (by STATNETT), the purpose of GARPUR, with the detailed scientific and technical objectives of the project, were presented to the audience. The relation with the N-1 rule was clarified.

With the second presentation "Overview and organization of the GARPUR project" (by SINTEF), GARPUR key figures, partners, work packages, timeline and milestones were presented.

Following the first two presentations, several participants suggested that new reliability criteria should be presented to ENTSO-E System and Development Committee (SDC) and System Operation Committee (SOC). The role of ENTSO-E was emphasized: GARPUR recommendations, if directed towards ENTSO-E, could be taken into account in future updates of the Network Codes.

With the third presentation "Functional analysis of probabilistic reliability management" (by the Scientific Advisor), the main ingredients of the generic functional analysis of reliability management proposed by GARPUR WP2 were presented. A focus was done on the short-term horizon of System Operation (coupling of real-time decision making with operational planning). A discussion followed with the audience, regarding the meaning of different terms (criticalities, mid-term vs. long-term…), the connection between reliability evaluation and economic evaluation, the relation with other projects as iTesla, Umbrella and eHighway2050, and the relation with ENTSO-E TYNDP.

With the fourth presentation "Current practices for reliability management in complex systems: a review of drivers and barriers for new reliability standards" (by AALTO), the work of GARPUR WP1 and the content of D1.1 and D1.2 were presented and discussed. The audience was invited to express on what they consider to be drivers or barriers to new reliability standards. A discussion followed about:

- The reliability criteria applied outside Europe,
- The need to involve regulators in the possible adoption of a risk-based approach (cost recovering),
- Data needed to adopt such approach,
- The customer point of view,
- Some differences between N-1 and probabilistic approaches (risk of black-out, the need to assess consequences of contingencies, the habits of the staff in real-time operation, the possibility to verify "by hand" that power flows are correct),

The fifth presentation "Shaping the GARPUR quantification platform" (by KUL) was accompanied by a more detailed document distributed to the audience and published on the website (http://www.garpur-project.eu/publications). A discussion followed about:

- The possible focus of the Quantification Platform on real-time,
- The scope and granularity of the model of the European network,
- Data standards (CIM),
- The training sessions with the GQP organized at the end of the project to convince the TSOs community of the performance of the new reliability criteria,
- The possible impact of new reliability criteria of Transmission Reliability Margins,
- Test cases for the GQP which could be proposed by SOC members.

The last presentation "The role of reference group" (by STATNETT) aimed at clarifying the role of the Reference Group and recruiting TSOs. Questions were raised about the exact role of Reference Group members and associated workload.

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2.4 Responses to satisfaction questionnaire

A satisfaction questionnaire was distributed at the end of the workshop, both to TSOs non partner of GARPUR and to GARPUR partners. It is copied in Annex 2 of this document. Responses were gathered as presented in Annex 3.

Seven questions called for a quantified answer, from 1 (in full disagreement) to 5 (fully agree). The average marks given by attendees are presented in Table 3.

Table 3 – Average marks to quantitative questions of the satisfaction questionnaire

#	Questions	Average marks
This meeting has helped you …		
1	… understanding the overreaching goal of the GARPUR project	4.7
2	… understanding the scientific challenges of the GARPUR project	4.1
3	… getting a clear picture of the drivers and barriers for using new reliability standards	4.1
4	… understanding the functioning and the role of the GQP	4.2
5	… understanding the role of the GARPUR Reference Group	3.9
You consider that…		
6	… enough time was dedicated to describing the key ambitions and challenges of GARPUR	4.6
7	… the R&D activities foreseen by the consortium are appropriate to meet the presented project ambitions	4.1

The following reasons were given to explain marks between 1 and 3:

- Question 2:
  - "Understanding the scientific challenges requires probably more than one working day for people not daily involved in reliability assessment".
  - "WP2 and WP3 need to be synchronized. There needs to be a balance between reliability criteria and social benefits".
- Question 4: "Still a bit high-level and abstract (but promising)".
- Question 5: "It would be a good thing to have the MoU ready for the workshop".
- Question 7: "Not enough overview about the research capacity - therefore hard to evaluate appropriateness of the activities".

Qualitative questions were raised and received the following answers:

9. How would you sum up in one sentence the main message of the meeting?

- "Nice challenge to hear different opinions of other TSOs".
- "GARPUR is ready to test conceptually different options for reliability criteria and to provide recommendation for next steps to evolve N-1".
- "The analysis of alternatives to N-1 approach is complex and controversial, because of all the impacts and consequences it would have on "Business as Usual" for the electricity sector and for all the society".
- "N-1 must not be always the right rule".
- "The GARPUR team is very interested in input from TSOs".

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- "TSOs have to find something that is more sophisticated than N-1 criteria in the field of network planning".
- "GARPUR is a European R&D project which involves all TSOs".

From GARPUR partners:

- "GARPUR will try to improve current reliability criteria, with participation of RD's and TSOs, looking at both technical and economic issues".
- "The TSOs show interest in the project".
- "GARPUR is going in the right direction".
- "Overview of the project ambitions, and need for feedback from non-consortium TSOs".
- "Very important to disseminate the findings to other TSOs (SOC, MC…) of ENTSO-E".
- "GARPUR will investigate the potential and realism of a probabilistic reliability criterion".
- "Can N-1 be replaced by probabilistic methods?"
- "Challenging R&D project. High risk project".
- "Inform TSOs of GARPUR and get feedback to some work already done in GARPUR".

10. Are there any important issues that you thought worth being discussed and were not addressed during the meeting? Or any topic you would have liked spending more time on?

- "Each country optimize its own grid, so what about the use of phase-shifter in a probabilistic planning?"
- "Not for this initial workshop, it has provided a very good and complete picture; for future workshops more time and details will be necessary".
- "Beside providing input information, how can TSOs help the project and what are the benefits of developing and using software like GQP?"

From GARPUR partners:

- "Goal of the Reference Group (not at the end of meeting!)".
- "What are the shortcomings of the current situation? (what we are going to 'repair')".
- "Influence of environmental issues".

11. What would you suggest to improve the agenda and organization of the next workshops with TSOs?

- "Some practical mean should be used to "force" all participants to the workshops to actively contribute".
- "Send material before the workshop / provide presentations in printed form at the workshop".

From GARPUR partners:

- "Another set-up of meeting room".
- "Present more initial results".
- "In next meetings, discussions on specific methodologies, test cases and previous experience should start".
- "Interactivity of "drivers and barriers" was good. More of that!"
- "TSOs should also present something".

12. Do you intend to join the GARPUR Reference Group?

- 3 "yes"
- 2 "no"
- 3 "maybe" (need to check available resources, depends on decision of management…)

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3 FIRST WORKSHOP TOWARDS REGULATORY BODIES

To organize this workshop, the contact was first established with one CEER member. Despite his interest in the subject, he considered it highly difficult to gather several representatives of regulators (NRAs, ACER) into one specific workshop dedicated to GARPUR. This was due to the high workload of regulators and the difficulty, in that context, to travel for an event which is not directly linked to their short-term duties. This difficulty was increased by the fact that the GARPUR project would be able, at this stage (June 2014), not to present results but only intentions.

It was therefore decided, instead of organizing a workshop in Brussels, that a small delegation would go to Ljubljana to meet ACER representatives, with the National Regulators involved by teleconference.

At GARPUR's instigation, this workshop was co-organised with iTESLA and UMBRELLA projects. The purpose was to give regulators a more complete presentation regarding European projects at the cutting-edge of research and innovation in power system reliability and control.

The workshop was held in ACER premises on 30 June 2014.

3.1 Attendees

The workshop was attended by 19 participants. The detailed attendance list is presented in Table 4.

Table 4 – Attendance list of the first workshop towards regulators

Company name	Representative	email	
Regulators			
ACER	Ernst Tremmel	Ernst.Tremmel@acer.europa.eu	
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CER (Ireland)	Robert O'Rourke		*by phone*
E-CONTROL (Austria)	Jakub Fijalkowski		*by phone*
EI (Sweden)	Lena Lange Jaakonantti		*by phone*
NCC (Lithuania)	Paulius Blažys		*by phone*
GARPUR partners			
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STATNETT	Gerard Doorman	gerard.doorman@statnett.no	
TECHNOFI	Sophie DOURLENS-QUARANTA	sdourlens@symple.eu	
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UMBRELLA partners			
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ETH Zurich	Thilo Krause	krause@eeh.ee.ethz.ch	*by phone*
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UDE	Klaus Köck	Klaus.Koeck@student.tugraz.at	*by phone*

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3.2 Agenda

The workshop was held from 14:30 to 17:00.

Table 5 - Agenda of the first workshop towards regulatory bodies

Time	Title	Responsible
14:30	Opening presentation	TECHNOFI (Sophie Dourlens-Quaranta)
14:45	Presentation of UMBRELLA project *+ Question and answers*	ELES (Jan Kostevc)
15:30	Presentation of iTESLA project *+ Question and answers*	RTE (Gabriel Bareux)
16:15	Presentation of GARPUR project *+ Question and answers*	STATNETT (Gerard Doorman)
17:00	End of meeting	

3.3 Proceedings

The presentations can be found on the GARPUR website: http://www.garpur-project.eu/publications.

A discussion occurred following the GARPUR presentation:

- Most questions were about WP2 and WP3 :
  - When will intermediate results be presented?
  - What is the exact meaning of "criteria"?
  - The definition of indicators would be very useful for the work of regulators and TSOs on network codes.
- Regulators also expressed interest in the GQP which may be very useful to them.
- Also regarding iTESLA and UMBRELLA, regulators are interested in concrete recommendations towards ENTSO-E for amending network codes, not in high-level, "vague" recommendations.

In conclusion for GARPUR, regulators demanded further exchange of views about the reliability criteria and the economic indicators. They asked the possibility to be involved in the discussions before new reliability criteria are finalized. They insisted that the next workshop (more technical) should be held as soon as possible. The next workshop towards regulators should therefore involve WP2 and WP3 partners and be held early 2015.

4 PRESENTATION AT THE PENTALATERAL ENERGY FORUM (PLEF)

This meeting was held at the Benelux Secretariat in Brussels on 23 September 2014, at the occasion of a meeting of the PLEF Support Group 2 "Security of supply".

4.1 About the Pentalateral Energy Forum

The Pentalateral Energy Forum (PLEF) is the framework for regional cooperation in Central Western Europe. It was created in 2005 by Energy Ministers from Benelux countries, Austria, Germany and France (with Switzerland as a permanent observer) in order to promote collaboration on cross-border exchange of electricity. It is a temporarily, intergovernmental initiative, which goal is to enhance the cooperation

The research leading to these results has received funding from the European Union
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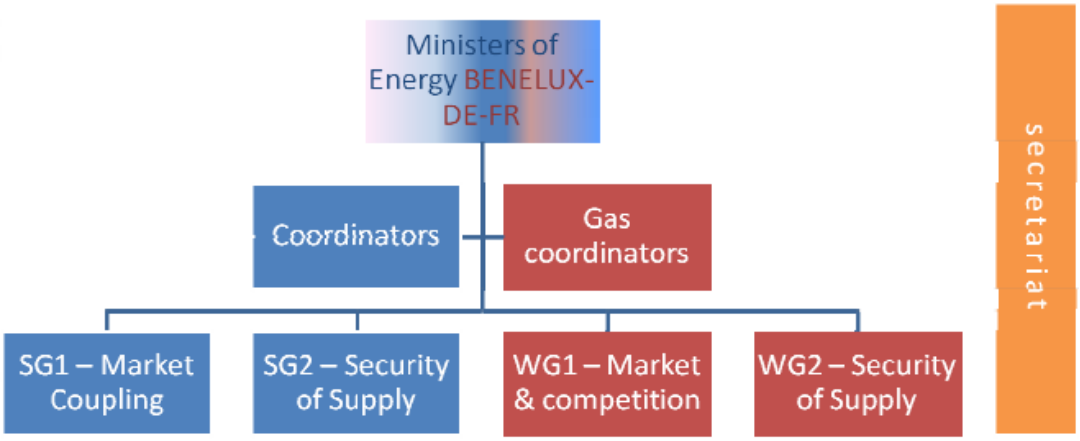
between all relevant parties in order to create a regional Northwest-European electricity market as an intermediate step towards one common European electricity market,… For electricity, two "support groups" are working on specific topics: Market Coupling (SG1) and Security of Supply (SG2), as depicted in Figure 1.

Participants in PLEF support group meetings are representatives of Energy Ministries, regulators, TSOs, power generators, and when relevant power exchanges. From GARPUR WP10 tasks point of view, participation in PLEF meetings is therefore seen as a contribution to tasks 10.3, 10.4 and 10.10.

Figure 1 - Pentalateral Energy Forum organization chart



Source: Benelux Secretariat

4.2 Participants in the SG2 meeting

The participants registered at the PLEF SG2 meeting on 23 September 2014 are listed in Table 6 below.

Table 6 – Participants registered at the PLEF SG2 meeting on 23 September 2014

Name	Organisation	email
COORDINATORS (Member States representatives)		
Jan HENSMANS	FOD Economie (BE)	jan.hensmans@economie.fgov.be
Pierre BOUTOT	Ministère de l'Ecologie (FR)	pierre.boutot@developpement-durable.gouv.fr
Benedikt GÜNTER	Bundesministerium für Wirtschaft & Technologie (DE)	benedikt.guenter@bmwi.bund.d
Steffen JENNER	Bundesministerium für Wirtschaft & Technologie (DE)	steffen.jenner@bmwi.bund.de
Ludwig DUVIGNEAU	Bundesministerium für Wirtschaft & Technologie (DE)	johann.duvigneau@bmwi.bund.
Nico HEINEMANN	Bundesministerium für Wirtschaft & Technologie (DE)	nico.heinemann@bmwi.bund.d
Gérard MEYER	Ministère de l'Economie (LU)	gerard.meyer@eco.etat.lu
Erik SIEDERS	Ministerie van Economische Zaken (NL)	h.sieders@minez.nl
Wieger WIERSEMA	Ministerie van Economische Zaken (NL)	w.j.wiersema@minez.nl

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REGULATORS		
Jakub FIJALKOWSKI	E-Control	jakubatarina.bauer@e-control.a
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OBSERVERS		
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Nicolas KUEN	Electrabel	nicolas.kuen@electrabel.com
GARPUR		
Sophie DOURLENS-QUARANTA	Technofi	sdourlens@symple.eu
CORESO		
Patrick DE LEENER	CORESO	patrick.deleener@coreso.eu
SECRETARIAT		
Frederik DELOOF	BENELUX Secretariat	f.deloof@benelux.int

4.3 Presentation of and discussion about GARPUR

The presentation can be found on the GARPUR website: http://www.garpur-project.eu/publications.

Elia and Technofi presented the GARPUR project at the SG2 PLEF meeting on 23 September 2014, in front of about 30 people representing Ministries, Regulators, TSOs and market parties from Belgium, Luxemburg, Netherlands, France, Germany, Switzerland and Austria.

The presentation fit well in this meeting since the UMBRELLA project was also presented, and CORESO did present their views on Regional Security Coordination Initiatives.

Both regulators and ministries representatives expressed interest in participating in future exchanges with GARPUR. They are in particular keen to participate in the design of new reliability criteria.

The research leading to these results has received funding from the European Union
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5 FIRST WORKSHOP WITH DSOS, POWER GENERATORS AND TECHNOLOGY PROVIDERS

This workshop was held in ENTSO-E premises on 7 October 2014, the day before an EDSO Technology Committee meeting.

5.1 Agenda

The workshop was held from 13:30 to 18:00. Not only GARPUR was presented, but representatives of the three categories of targeted stakeholders were invited to present their point of view about reliability management (session 2 of the agenda).

The detailed agenda is presented in Table 6 below.

Table 7 – Agenda of the first workshop with DSOs, power generators and technology providers

Time	Title	Responsible
13:30	*Welcome of attendees*	
SESSION 1: Insights from the GARPUR project		
13:45	Introduction to GARPUR and objectives of the workshop	Technofi (Sophie Dourlens-Quaranta)
14:00	Vision from TSOs: purpose of the GARPUR project	Statnett (Gerard Doorman)
14:20	Probabilistic reliability management: comparison with the N-1 approach	University of Liège (Louis Wehenkel)
15:00	State of the art in reliability assessment and management	SINTEF Energy Research (Gerd Kjølle)
15:30	*Coffee break*	
SESSION 2: Vision from impacted electricity stakeholders		
16:00	Reliability management from the DSOs' perspective	ErDF (Jacques Merley)
16:20	Reliability management from the Power Generators' perspective	Statkraft (Paul Giesbertz)
16:40	Reliability management from the Technology Providers' perspective	Alstom Grid (Jean-Louis Coullon)
SESSION 3: Roundtable discussion		
17:00	Probabilistic reliability management: pros and cons from the electricity system players	Technofi (Sophie Dourlens-Quaranta)
18:00	*End of meeting*	

5.2 Attendees

The workshop was attended by 19 participants, including representatives of the targeted stakeholders (DSOs, Power Generators and Technology Providers) as well as university representatives. The detailed attendance list is presented in Table 8.

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Table 8 – Attendance list of the first workshop with DSOs, power generators and technology providers

Company name	Representative	email
ALPHA TECHNOLOGIES	Emmanuel Orban de Xivry	eorban@alphatechnologies.be
ALPHA TECHNOLOGIES	Jean-Philippe Vanhulst	jpvanhulst@alphatechnologies.be
Alstom Grid	Jean-Louis Coullon	jean-louis.coullon@alstom.com
ELIA	Arnaud Attanasi	arnaud.attanasi@elia.be
ENTSO-E	Norela Constantinescu	Norela.Constantinescu@entsoe.eu
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EC DG Research	Patrick Van Hove	Patrick.van-hove@ec.europa.eu
Netze BW GmbH	Bettina Helbig	b.helbig@netze-bw.de
ORES	David Vangulick	david.vangulick@ores.net
SINTEF ENERGY RESEARCH	Gerd Kjølle	gerd.kjolle@sintef.no
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STATNETT	Gerard Doorman	gerard.doorman@statnett.no
TECHNOFI	Sophie Dourlens-Quaranta	sdourlens@symple.eu
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TU Delft (representing UMBRELLA project)	Rob Bootsman	r.j.bootsman@student.tudelft.nl
University of Technology - Eindhoven	Raoul Bernards	R.Bernards@tue.nl
University of Technology - Eindhoven	Michiel Nijhuis	M.Nijhuis@tue.nl
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ULG	Efthymios Karangelos	e.karangelos@ulg.ac.be

5.3 Proceedings

The presentations can be found on the GARPUR website: http://www.garpur-project.eu/publications.

Following ULg presentation

- Question: How would reliability management be modelled, through planning to operation or the other way around?
  - Response: Reliability management decisions will be modelled for the very short term horizon first, and the modelling of mid- and long-term horizons will be derived from that.
- Question: It seems you intend to solve an optimal control problem. How do you address the chain of decisions, the end of the game…?
  - Response: The multi-stage nature of the problem is currently investigated. The difficult part is how to formulate the optimization problem. Simplifications must be made, having in mind the risks of making the wrong simplifications and the risk of missing data. There is no guarantee that new reliability strategies are better than current practices, there is therefore a need for evaluating the new criteria (quantification platform).
- Question: How will you take into account the reactions from the different actors?
  - Response: WP3 works in two steps: in the absence of market response, and with market response. It is indeed difficult to study the dynamics, and TSOs will also adapt their behaviour.

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Following SINTEF presentation

- **Question**: TSOs already gather data on primary components: only network or also load and generation?
  - **Response**: Mainly generation
  - **Remark**: The loss of a big consumer (factory) may also create a disturbance.
- **Question**: How to evaluate the criticality of failure of each component? Is there a methodology commonly accepted to evaluate this on a per-component basis?
  - **Response**: Not really.
- **Question**: Have you noticed if the differences between TSOs (in voltage levels, in size) have impacts on the way they address reliability?
  - **Response**: Few.
- **Question**: You received inputs to your questionnaire from 9 TSOs. Are they representative from all TSOs, aren't we missing something important?
  - Response: Only 9 but covering both Nordic and continental systems. The TSOs represented at the TSO workshop in April 2014 (about 10 non-GARPUR TSOs) were also questioned during the workshop and their answers were very similar to the ones gathered by the questionnaire.
  - Remark: You should try to characterize the TSOs who have responded to the questionnaire (% of EU load…). Experiences outside EU may not be relevant.

Roundtable discussion

About the complexity of GARPUR and the communication towards external stakeholders

- **Remark**: Formulating the problem in a simple way is very challenging.
  - **Response**: GARPUR combines a bottom-up approach (WP4-5-6) and a top-down approach (WP2-3) to deal with this complexity.
- **Question**: How to deal with events whose probabilities are not independent?
  - **Response**: Modelling correlation between variables is challenging and needs more data. For example, there is a correlation between ageing of an equipment and its value to the system.
- **Remark**: The explainability of GARPUR is important. You should find a way to explain N-1 vs. probabilistic approach (costs and benefits) in a few minutes.
  - **Response**: Efforts will be made in that direction, however complexity may be necessary. GARPUR approach can be compared with the "complex" flow-based method which will replace the "simple" ATC method to make the most of existing infrastructures. In addition, it is the role of the GARPUR Quantification Platform to demonstrate the benefits of the proposed approach and make its complexity acceptable.

About data and scenarios

- **Remark**: There are "quick wins" in the field of DSOs-TSOs cooperation, regarding in particular the grid network information from DSOs to TSOs.
  - **Response**: There is also a need for data from generators to DSOs and TSOs.
  - **Remark**: This depends on countries: some have one main DSO, some have hundreds of DSOs… We need a framework for TSOs-DSOs data exchange.
- **Remark**: TSOs are ready to share with other TSOs data on failure statistics.
- **Remark**: A probabilistic approach will require more data than today: Cost to gather data → need to find the right balance between amount and precision); Lots of estimations needed → uncertainties of the input data into complex processes → how to take decisions? Who shall take this risk: DSOs, TSOs?

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- **Response**: If there is an issue for regulators (costs borne by TSOs or DSOs), this could be addressed at the next GARPUR workshop with regulators.

- **Remark**: DSOs asset data are not so important to TSOs. What is more important is where generation is located, where it is growing… You should concentrate on the main points since access to data is very expensive (which is exacerbated for very accurate data). You should know beforehand what kind of data we need to explore. For example, smart meters will provide huge amount of data, but not necessarily relevant for TSOs reliability management.
- **Question**: There are different scenarios for the development of the electricity system. Are probabilities associated to each scenario?
  - **Response**: No, but the impacts of new reliability criteria within different scenarios will be tested thanks to the GQP.
- The ErDF representative proposes to organize a meeting between GARPUR and DSOs associations (Eurelectric, EDSO, CEDEC and GEODE) to discuss a possible framework for TSOs-DSOs data exchange related to reliability management.

About the impacts of GARPUR

- **Remark**: Changing reliability criteria will require a learning process from TSOs.
- **Question**: Will GARPUR have impacts on the network codes currently under development?
  - **Response**: No, GARPUR is initiating a process which may lead to amending network codes in a few years (amendments to Network Codes are foreseen by the Regulation). Before that, pilot tests will be performed in the framework of GARPUR. Again, it can be compared with flow-based: this method has been discussed for at least 10 years before being adopted in Network Codes.
- The ALSTOM representative proposes to cooperate with GARPUR regarding the pilot tests.
- **Remark**: You should concentrate on cross-border impacts.

5.4 Responses to evaluation questionnaire

A satisfaction questionnaire was distributed at the end of the workshop to all participants. Six responses were collected.

The average marks and general comments given by respondents are presented in Table 9. Marks fall between 1 (in full disagreement) and 5 (fully agree).

Table 9 – Average marks to quantitative questions of the satisfaction questionnaire and qualitative comments expressed by respondents

#	Questions	Average marks
This meeting has helped you …		
1	… understanding the overarching goal of the GARPUR project	4.4
2	… understanding the scientific challenges of the GARPUR project	4.4
3	… getting a clear picture of the drivers and barriers for using new reliability standards	4.2
4	… getting an overview on how GARPUR results may impact your own activities	2.9
You consider that …		
5	… the choice of non-GARPUR speakers was appropriate	4.3

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6	… enough time was dedicated to describing the key ambitions and challenges of GARPUR	4.1
7	… the R&D activities foreseen by the consortium are appropriate to meet the presented project ambitions	3.8
8	… there is a need to reconvene periodically in the future to know about the project findings and interact with a representative set of stakeholders acting along the electricity value chain	4.4

Your comments to explain marks between 1 and 3 (if any)
For communication, it is important to highlight the concrete impact on the challenges that TSO/DSO cope with
Let's make the description of risks more precise and measurable
Too early to fully see the impact on DSO scope
In terms of understanding the scientific challenges, the workshop addressed only scientific topic in a very general way
Q4: I am very interested in the further research into the probabilistic analysis, but could not yet fully see how it will impact my research Q8: Probabilistic analysis may have benefits, but also adds uncertainty and complexity and it should be focused to keep the results clear and practical
Q4: on own activities the point of view of TSOs on reliability management were more interesting than actual results
How would you sum up in one sentence the main message of the meeting?
Huge challenge ahead!
There is a real need for a probabilistic approach
Whatever is developed, it will not be straightforward to move to deployment
Probabilistic reliability management is complex but necessary.
Will the new approach be a big qualitative and quantitative (€) positive move?
How to gain acceptance for a more probabilistic operating and infrastructure planning approach, and what drivers could be used for that
GARPUR: what is it?
Are there any important issues that you thought worth being discussed and were not addressed during the meeting? Or any topic you would have liked spending more time on?
The transition from indicators to decision
What is the long term vision of system? (share of DG…)
More examples in pictures (picture of a use case)
Drivers for change and what is required to bridge the gap
Effects on other stakeholders
The external stakeholders viewpoint on how they can be affected by the GARPUR outcomes
What would you suggest to improve the agenda and organization of future workshops with electricity stakeholders?

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Brainstorming mode is interesting. Can be run on more specific questions to help building your overall plan.
Maybe a meeting with DSOs: we can try to arrange it
At the beginning you should introduce the attendees
Maybe it could be specified a bit more clearly which part of the research is done and will be presented

6 SECOND WORKSHOP TOWARDS TSOS

This workshop was held in ENTSO-E premises on 2 June 2015, the day before an ENTSO-E RDC meeting.

6.1 Attendees

The workshop was attended by 20 participants, including 3 representatives of Reference Group members (Fingrid, Tennet, CORESO), 3 representatives of other TSOs (REN, Swissgrid, Svenska) and 2 representatives of ENTSO-E secretariat. The detailed attendance list is presented in Table 10.

Table 10 – Attendance list of the second workshop towards TSOs

Name	Company	email
Olli Mäkelä	Aalto	olli.makela@aalto.fi
Marián Belyuš	CEPS	Belyus@ceps.cz
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Thong Vu Van	ENTSO-E	thong.vu.van@entsoe.eu
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Ana Roxana Ciupuliga	TenneT	Ana.Ciupuliga@tennet.eu
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6.2 Agenda

The workshop was held from 13:00 to 17:30. The detailed agenda is presented in Table 11 below.

Table 11 – Agenda of the second workshop towards TSOs

13:00	**Presentation of the agenda and of dissemination activities** Sophie Dourlens-Quaranta, Technofi
13:05	**Presentation of GARPUR** Gerard Doorman, Statnett
SESSION 1: GENERAL INTRODUCTION TO THE GARPUR RELIABILITY MANAGEMENT FRAMEWORK	
13:15	**Development of new reliability criteria** Efthymios Karangelos, ULg
13:30	**Socio-economic assessment of reliability criteria** Julia Bellenbaum, UDE
	Questions and answers
SESSION 2: CURRENT PRACTICES AMONGST EUROPEAN TSOs, CHALLENGES AND OPPORTUNITIES MOVING FORWARD	
14:00	**Functional workflow of the system development decision making process** Cindy Bastiaensen, Elia
	Questions and answers
14:25	**Functional workflow of mid-term decision making processes** Rémy Clément, RTE
	Questions and answers
14:50	**Functional workflow of short-term and real-time decision making processes** Håkon Kile, Statnett
	Questions and answers
15:15	**Coffee break**
SESSION 3: PRESENTATION AND DISCUSSION OF RECENT AND UPCOMING PROJECT MILESTONES	
15:50	**Functional description of the GARPUR Quantification Platform** Dirk Van Hertem, KUL
16:30	**Pilot testing ambitions** Håkon Kile, Statnett
16:50	**Alternative reliability criteria to be studied** Louis Wehenkel, ULg
17:30	**End of meeting**

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6.3 Proceedings

The presentations can be found on the GARPUR website: http://www.garpur-project.eu/publications.

Following the presentation "Development of new reliability criteria" (Efthymios Karangelos, ULg)

It was discussed how the fact that the probability of certain contingencies varies across time was taken into account in the project. Regarding the events with long duration, they are considered in WP5 (mid-term process).

It was also remarked that the same network contingency may have different criticality level depending on the generation and demand level.

The connection of the reliability model in GARPUR with weather forecasts was questioned.

It was suggested to illustrate the possible outcome of the new reliability criteria, for example regarding the impact on transmission capacity available to the market, or other practical examples.

Following the presentation "Socio-economic assessment of reliability criteria" (Julia Bellenbaum, UDE)

It was questioned whether the proposed socio-economic assessment methodology is compatible with the ENTSO-E cost-benefit analysis (CBA) methodology for the TYNDP and eHighway2050. It was suggested not to develop competitive methodologies. The RealiseGrid project was also mentioned as a reference. It was highlighted that the CBA methodology for the TYNDP was developed for cross-border projects, while in GARPUR we need a global methodology to assess socio-economic impact of reliability management criteria (RMC) not only at cross-border level and not only for the network planning timeframe.

The notion of "TSO surplus" was questioned. It actually represents the difference between revenues and expenses of the TSO; the word surplus is being used for wording harmonization with "consumer surplus" and "generator surplus". It is remarked that over long period of time, the sum of the "TSO surplus" is expected to be zero.

The fact that TSOs (being natural monopolists) by nature do not behave socio-economic welfare (SEW) maximizing was discussed. This is related to regulatory frameworks. As an example, the N-1 rule is clearly not aimed at maximizing SEW. The optimal regulatory framework provides incentives that align TSO interests with social welfare maximization.

The absence of the congestion rent in the picture was remarked. The depiction presented referred to a single country, single TSO and single market zone, so that congestion rents do not arise. The balance presented was a general and stylized list of costs and benefits. The internal deliverable (ID3.2.1) contains more detailed balances for each time horizon. There, congestion rent is included. Similarly, for multiple market zones or multiple TSOs or multiple markets, congestion rent needs to be taken into account.

Following the presentation "Functional workflow of the system development decision making process" (Cindy Bastiaensen, Elia)

The compatibility of the functional workflow of the system development decision making process as described in D4.1 with the TYNDP CBA methodology was highlighted.

The origin of candidate projects was questioned: do the drivers for these projects include solving reliability issues? It was clarified that this was not the driver, but was taken into account in the design remedies (in case a project does not meet the applied reliability criterion).

It was remarked that the TSOs investment plans are based on the N-1 rule. This is indeed current practice, however the impact of new RMC in the functional workflow has been delimited.

The value of this work for ENTSO-E was highlighted.

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Following the presentation "Functional workflow of mid-term decision making processes" (Rémy Clément, RTE)

It was questioned whether situations in which planned outages had to be cancelled due to operational circumstances were considered. They actually are, in WP6 (system operation).

The data issue was particularly highlighted here. For example, data are needed not only during maintenance periods but also out of these periods to assess the components' health for conditional maintenance purposes.

It was remarked that if the health of components was better known, then TSOs would be able to "relax" in some sense the N-1 constraint.

Following the presentation "Functional description of the GARPUR Quantification Platform" (Dirk Van Hertem, KUL)

Considering that simulations would cover one year of operations, it was questioned how this would be applicable to long-term planning. It was clarified that the pilot tests would be focused on short-term aspects only.

In fact, two main applications of the GARPUR Quantification Platform (GQP) will be addressed by the project:

- Pilot testing, probably on French and Belgian systems;
- Extensive sensibility analysis of RMC.

It was remarked that we should not necessarily aim at increasing reliability: maybe a small decrease in reliability may lead to a huge decrease in costs.

To a question about the contingency list considered in the GQP (listing all the N-1 contingencies or only a subset), it was responded that the contingency list is independent from the RMC. The contingency list has however to be limited, e.g. to N-3 events. It was advised not to discard contingencies based only on probability but rather consider also the severity of impact.

Regarding the new RMC it was remarked that many people in TSOs operating rooms are happy with N-1. GARPUR should therefore not make things too complex to be applied. Actually it is the purpose of the GQP to evaluate the benefits of moving away from N-1, which may depend on the different situations in Europe. For example, N-0 can be relevant sometimes. The consequences of moving away from N-1 really need to be explored.

Following the presentation "Pilot testing ambitions" (Håkon Kile, Statnett)

It was questioned whether the GQP could link with iTesla and Umbrella. It was clarified that iTesla and Umbrella aim at delivering toolboxes able to perform detailed calculations, while GARPUR is more at conceptual level. The GQP will be made open, and at a later stage one of its module may be replaced by one of the iTesla or Umbrella tools.

Following the presentation "Alternative reliability criteria to be studied" (Louis Wehenkel, ULg)

It was questioned whether the non-acceptable events were considered. They actually are; for example a black-out at an aluminum melter site or big internet server would not be acceptable, while it could be acceptable in a residential area. The impact of such events on economy, employment etc. should be taken into account in the consumers' utility function.

The need for practical examples about the application of new RMC was again highlighted.

The research leading to these results has received funding from the European Union
Seventh Framework Programme under Grant Agreement No 608540.

6.4 Responses to evaluation questionnaire

A satisfaction questionnaire was distributed at the end of the workshop to all participants. Six responses were collected.

The average marks and general comments given by respondents are presented inTable 12. Marks fall between 1 (in full disagreement) and 5 (fully agree).

Table 12 – Average marks to quantitative questions of the satisfaction questionnaire and qualitative comments expressed by respondents

#	Questions	Average marks
SESSION 1		
1	Have you understood the main aspects of the new reliability management framework designed by GARPUR?	4.0
2	Do you support measuring the impacts of moving from deterministic to probabilistic reliability management?	4.2
3	Do you agree with the socio-economic assessment of the reliability criteria as designed within GARPUR?	3.7
SESSION 2		
4	Do you agree with how the functional workflow of the system development decision making process is described within GARPUR?	4.3
5	Do you agree with how the functional workflow of the mid-term decision making processes are described within GARPUR?	4.0
6	Do you agree with how the functional workflow of the short-term and real-time decision making processes are described within GARPUR?	3.8
SESSION 3		
7	Have you understood the purpose of the GARPUR Quantification Platform?	4.0
8	Do you consider the GARPUR Quantification Platform a useful tool to assess the performance of different reliability criteria?	3.8
9	Do you support the pilot testing ambitions of GARPUR?	4.2
10	Do you support the way the alternative reliability criteria to be studied have been defined?	4.0
ABOUT THE REFERENCE GROUP OF TSOs		
11	Have you understood the role of the GARPUR Reference Group?	4.0
12	If you are already member of the Reference Group: Would you be interested in being involved more closely in GARPUR activities?	3.0
13	If you are not a Reference Group member (nor a GARPUR partner): Would you be interested in receiving more information about the Reference Group, and possibly joining it?	3.0
GENERAL QUESTIONS		
14	Are you satisfied with the organization of the workshop?	4.2

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15	Do you consider that enough time was dedicated to questions and answers?	3.8
16	Do you consider that the R&D activities foreseen by the consortium are appropriate to meet the project ambitions?	4.4
YOUR COMMENTS		
Questions 3 and 10: real implementation not yet clear Question 6: in principle yes, not completely checked for usability Question 11: seems to be a still in definition Question 12: already under discussion Question 16: focus on real implementation in next phase		
Thank you for an interesting workshop. It would be nice to start the meeting earlier next time and provide a choice for the date of the meeting (like a doodle poll).		

7 BILATERAL MEETINGS WITH ITESLA AND UMBRELLA PROJECTS

At the second GARPUR exploitation workshop on 8&9 June 2015, the compatibility of GARPUR and iTesla/Umbrella toolboxes was identified as critical for the exploitation prospects of GARPUR. The question is not to design GARPUR in such a way that it is compatible with iTesla and/or Umbrella toolboxes. Rather, it is to make sure that compatibility is not hindered; the iTesla and Umbrella toolboxes are indeed designed to work in coherence with the current practices. It should be shown how they can work in coherence with the GARPUR approach.

iTesla and Umbrella coordinators have been contacted to that purpose and bilateral meetings at technical level have been organized to assess this compatibility. Such meetings have been held on 25 January 2016 at ENTSO-E's, the day before the last joint dissemination event of the iTesla and Umbrella projects.

7.1 Attendees

The meeting with iTesla was attended by 16 participants, and the one with UMBRELLA by 24 participants. The detailed attendance list is presented in Table 14.

Table 13 – Attendance list of the bilateral meetings with iTESLA and UMBRELLA consortia

Representative	Organisation	email
Meeting GARPUR - iTESLA		
Rémy Clément	RTE	remy.clement@rte-france.com
Sophie Dourlens-Quaranta	Technofi	sdourlens@technofi.eu
Pauline GAMBIER-MOREL	RTE	pauline.gambier-morel@rte-france.com
Oddbjørn Gjerde	SINTEF Energi AS	oddbjorn.gjerde@sintef.no
Martin Godemann	CORESO	martin.godemann@coreso.eu
Efthymios Karangelos	Université de Liège	e.karangelos@ulg.ac.be
Christian LEMAITRE	RTE	christian.lemaitre@rte-france.com
Manuel Marin	Université de Liège	mmarin@ulg.ac.be
Nicolas Omont	RTE	nicolas.omont@rte-france.com
Patrick Panciatici	RTE	Patrick.panciatici@rte-france.com
Eric Peirano	Technofi	epeirano@technofi.eu

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Samuel Perkin	Landsnet	samuelp@landsnet.is
Dirk Van Hertem	KUL	dirk.vanhertem@esat.kuleuven.be
Patrick Van Hove	EC DG R&I	patrick.van-hove@ec.europa.eu
Luigi Vanfretti	KTH Royal Institute of Technology / Statnett SF	luigiv@kth.se
Louis Wehenkel	Université de Liège	L.Wehenkel@ulg.ac.be
Meeting GARPUR - UMBRELLA		
Raik Becker	University of Duisburg-Essen	raik.becker@uni-due.de
Belen Benavent Rodriguez	TransnetBW	B.Rodriguez@transnetbw.de
Rémy Clément	RTE	remy.clement@rte-france.com
Sophie Dourlens-Quaranta	Technofi	sdourlens@technofi.eu
Wulf Engl	TenneT TSO GmbH	Wulf.engl@tennet.eu
Jonas Eickmann	RWTH Aachen	je@iaew.rwth-aachen.de
Germán Germán Morales	TUDelft	g.a.moralesespana@tudelft.nl
Oddbjørn Gjerde	SINTEF Energi AS	oddbjorn.gjerde@sintef.no
Efthymios Karangelos	Université de Liège	e.karangelos@ulg.ac.be
Simon Krahl	FGH e.V.	simon.krahl@fgh-ma.de
Manuel Marin	Université de Liège	mmarin@ulg.ac.be
Andreas Moormann	FGH e.V.	andreas.moormann@fgh-ma.de
Helmut Paeschke	TenneT TSO GmbH	helmut.paeschke@tennet.eu
Patrick Panciatici	RTE	Patrick.panciatici@rte-france.com
Samuel Perkin	Landsnet	samuelp@landsnet.is
Line Roald	ETH Zurich	roald@eeh.ee.ethz.ch
Michael Rogge	Amprion GmbH	michael.rogge@amprion.net
Oliver Scheufeld	FGH e.V.	oliver.scheufeld@fgh-ma.de
Petter Støa	SINTEF	Petter.Stoa@sintef.no
Dirk Van Hertem	KU Leuven	dirk.vanhertem@esat.kuleuven.be
Tobias van Leeuwen	RWTH	tl@iaew.rwth-aachen.de
Patrick Wajant	TransnetBW	P.Wajant@transnetbw.de
Louis Wehenkel	Université de Liège	L.Wehenkel@ulg.ac.be
Jaka Žvab	ELES	Jaka.zvab@eles.si

7.2 Agendas

The agendas of the two bilateral meetings were similar:

Table 14 – Agenda of the bilateral meetings with iTESLA and UMBRELLA projects

Meeting with iTESLA	
Time	**Topics and speakers**
13:30	Opening and roundtable (Sophie Dourlens-Quaranta, Technofi)
13:40	Presentation of iTESLA toolbox (Nicolas Omont, RTE)

Meeting with UMBRELLA	
Time	**Topics and speakers**
17:30	Opening and roundtable (Sophie Dourlens-Quaranta, Technofi)
17:40	Presentation of UMBRELLA toolbox (Helmut Paeschke and Dr. Wulf Engl,

The research leading to these results has received funding from the European Union Seventh Framework Programme under Grant Agreement No 608540.

			TenneT TSO GmbH; Raik Becker, University of Duisburg-Essen; Line Roald, ETH Zürich; Oliver Scheufeld, FGH; Patrick Wajant, TransnetBW GmbH; Jonas Eickmann, RWTH Aachen University)
14:20	Presentation of GARPUR approach (Oddbjørn Gjerde, SINTEF; Louis Wehenkel, ULg; Dirk Van Hertem, KUL; Samuel Perkin, Landsnet)	18:20	Presentation of GARPUR approach (Oddbjørn Gjerde, SINTEF; Louis Wehenkel, ULg; Dirk Van Hertem, KUL; Samuel Perkin, Landsnet)
15:00	Open discussion about the compatibility of GARPUR and iTESLA	19:00	Open discussion about the compatibility of GARPUR and UMBRELLA
15:50	Conclusions and next steps for cooperation	19:50	Conclusions and next steps for cooperation
16:00	End of meeting	20:00	End of meeting

7.3 Conclusions

The projects agreed to further cooperate.

Regarding iTESLA, such cooperation will be managed by RTE who takes part in the two project and in further developing the iTESLA platform. Data exchange and tool sharing is considered.

Regarding UMBRELLA, the project exploitation prospects will be dealt with by TSC. Possible future cooperation between GARPUR and UMBRELLA partners will be discussed with TSC which is already member of GARPUR Reference Group.

8 WORKSHOP WITH POLICY MAKERS AND REGULATORY AUTHORITY IN ICELAND

Complementing workshops organized with regulatory bodies and policy makers at European level, a meeting was organized by Landsnet at national level with ministry and regulator representatives on 16 February 2016. It consisted in a presentation of GARPUR projects in Iceland to the National Energy Authority (Orkustofnun) and the Ministry of Industries and Innovation. Event was attended by the GARPUR TSO in Iceland Landsnet and University of Reykjavik.

8.1 Agenda

Main point of the agenda was to introduce GARPUR objectives and draft results to these two key institutional stakeholders in Iceland.

8.2 Attendees

Those who attended on the 16th of February here at Landsnet were:

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Table 15 – Attendance list 16th February workshop in Iceland

Name	Company	email
Gudni A. Johannesson	National Energy Authority (Orkustofnun)	gudni.a.johannesson@os.is
Silja Rán Sigurdardottir	National Energy Authority (Orkustofnun)	silja.r.sigurdardottir@os.is
Rán Jónsdóttir	National Energy Authority (Orkustofnun)	ran.jonsdottir@os.is
Erla Björk Þorgeirsdóttir	National Energy Authority (Orkustofnun)	erla.bjork.thorgeirsdottir@os.is
Sigurður H. Magnússon	National Energy Authority (Orkustofnun)	sigurdur.h.magnusson@os.is
Helga Bardadóttir	Ministry of Industries and Innovation	helga.bardadottir@anr.is
Ingvi Már Pálsson	Ministry of Industries and Innovation	ingvi.mar.palsson@anr.is
Erla Sigrídur Gestsdóttir	Ministry of Industries and Innovation	erla.sigridur.gestsdottir@anr.is
Íris Baldursdóttir	Landsnet	iris@landsnet.is
Gudjon Hugberg Björnsson	Landsnet	gudjonh@landsnet.is
Gudlaugur Sigurgeirsson	Landsnet	gudlaugurs@landsnet.is
Magni Þór Pálsson	Landsnet	magnip@landsnet.is
Fridrik Már Baldursson	University of Reykjavik	fmb@ru.is

8.3 Proceedings

Four presentations were held during the meeting. The first one was an introduction to the GARPUR project. Then a presentation was given on the new probabilistic reliability management approach and criteria in relevance to short term scheduling and real time operation. After that a presentation on the socio-economic assessment was given and finally a short presentation on the plans for pilot testing.

The attendees from the NEA and Ministry showed interest in what was being presented and how a probabilistic methodology takes varying risk into account, for example the impact of weather. There were some questions about how the new reliability criterion would be defined in comparison to the transparent and simple N-1 criteria.

9 SECOND WORKSHOP TOWARDS REGULATORY BODIES AND POLICY MAKERS

This workshop was organized on 17 March 2016 in collaboration with the iTesla project. It was hosted at the Belgian Ministry in Brussels (Federal Public Service Economy, SMEs, Self-employed and Energy). The date was chosen in collaboration with the Pentalateral Energy Forum, since a meeting of their Security of Supply task force was held on 16 March 2016.

The research leading to these results has received funding from the European Union
Seventh Framework Programme under Grant Agreement No 608540.

9.1 Attendees

The workshop was attended by 17 participants. The detailed attendance list is presented in Table 16.

Table 16 – Attendance list of the second workshop towards regulators and policy makers

Representative	Organisation	Country	email
Regulators and policy makers representatives			
Patrick Van Hove	EC Dg Research & Innovation	Belgium	patrick.van-hove@ec.europa.eu
Frederik Deloof	Benelux Secretariat General	Belgium	f.deloof@benelux.int
Jan Hensmans	FOD Economy	Belgium	Jan.Hensmans@economie.fgov.be
Riccardo Vailatti	Italian Regulatory Authority	Italy	rvailati@autorita.energia.it
Gérard Meyer	Ministry of the Economy	Luxembourg	gerard.meyer@eco.etat.lu
Lars Andreas Eriksson	Norwegian Water and Energy Directorate	Norway	lae@nve.no
Christina Sepulveda	NVE	Norway	chs@nve.no
Sigrun Mindeberg	NVE	Norway	skmi@nve.no
Marko Bregar	Agency for Cooperation of Energy Regulators, ACER	Slovenia	Marko.Bregar@acer.europa.eu
GARPUR partners			
Efthymios Karangelos	University of Liege	Belgium	e.karangelos@ulg.ac.be
Mania Pavella	University of Liege	Belgium	m.pavella@ulg.ac.be
Manuel Marin	University of Liege	Belgium	m.marin@ulg.ac.be
Louis Wehenkel	Université de Liège	Belgium	L.Wehenkel@ulg.ac.be
Stijn De Sutter	ELIA	Belgium	Stijn.DeSutter@elia.be
Sophie Dourlens-Quaranta	TECHNOFI	France	sdourlens@technofi.eu
Oddbjørn Gjerde	SINTEF Energy Research	Norway	oddbjorn.gjerde@sintef.no
iTESLA partners			
Nicolas Omont	RTE	France	Nicolas.omont@rte-france.com

9.2 Agenda

The workshop was held from 8:30 to 12:45 and was followed by a networking lunch.

Table 17 – Agenda of the second workshop towards regulators and policy makers

Time	Title	Responsible
8:30	Opening	Sophie Dourlens-Quaranta, TECHNOFI
8:35	Welcome speech	Jan Hensmans, FOD Economy
8:40	Introduction to research and innovation projects about reliability management in transmission networks	Patrick Van Hove, European Commission, DG Research and Innovation
New reliability management approach from the GARPUR project		

The research leading to these results has received funding from the European Union Seventh Framework Programme under Grant Agreement No 608540.

8:45	General presentation of GARPUR	Oddbjørn Gjerde, GARPUR coordinator, SINTEF Energy Research
9:00	How can TSOs enhance the reliability assessment by risk-based approach	Stijn De Sutter, Head of Power System Planning, ELIA
9:20	Questions & answers	
9:40	The new reliability management approach and criteria (RMAC) developed by GARPUR	Louis Wehenkel, GARPUR scientific advisor, Université de Liège
10:20	Questions & answers	
10:45	Coffee break	
Operating electricity transmission networks closer to their physical limits with the iTesla toolbox		
11:00	Workflow of the iTesla toolbox	Nicolas Omont, iTesla industrialization project manager, RTE
11:30	Added-value of the toolbox for network operators	
12:00	Main conclusions for the regulators	
12:15	Questions and answers	
12:45	Lunch	

9.3 Proceedings

The presentations can be found on the GARPUR website: http://www.garpur-project.eu/publications.

In introduction to the workshop, Patrick Van Hove explained the importance of new software tools to be developed in complement to the hardware infrastructure reinforcement to make sure that interconnection capacities can be properly used. Research and Innovation projects are needed to prepare the future with high RES penetration, while quality and reliability aspects remain very important.

Following Stijn De Sutter's presentation, several questions were raised covering the following topics:

- Approaches similar to GARPUR for generation adequacy;
- Ex-post measurement of reliability through quality, outage indicators; ex-ante management and prediction of reliability with redispatch;
- Applicability of GARPUR approach to distribution networks;
- Assessment of the value of lost load.

Following Louis Wehenkel's presentation, the following topics were questioned:

- Input parameters to decisions for planning purposes: difficulty to have an objective measurement of something that never happens; difficulty in assessing of the value of lost load in several decades (different from today's value); need for data collection and further research;
- Comparison with N-1: optimum reliability is never at N-1, nut no answer yet about the average position of N-1 compared to optimal reliability target; it will also depends of the value of the parameter ε of the new RMAC; trade-off between reliability and costs will also be influenced by the evolution of technology (for instance cost of batteries).

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Seventh Framework Programme under Grant Agreement No 608540.

10 THIRD WORKSHOP TOWARDS TSOS

This workshop was held in Nice (France) on the 3rd of June 2016 under the coordination of WP10 Leader.

10.1 Attendees

The workshop was attended by 28 participants, including 4 representatives of Reference Group members (Elering AS, Fingrid Oyj, REE, TSCNET Services), 4 representatives of other TSOs (1 for APG, 1 for Svenska kraftnät, 2 for ELES) and 2 representatives of ENTSO-E secretariat.

The detailed attendance list is presented in the following table.

Table 18 – Attendance list of the second workshop towards TSOs

Name	Company	email
Stefan Höglinger	Austrian Power Grid	stefan.hoeglinger@apg.at
Marián Belyuš	ČEPS a.s.	belyus@ceps.cz
Mari Löper	ELERING A S	mari.loper@elering.ee
Klemen Dragas	ELES d.o.o.	jurij.klancnik@eles.si
Jurij Klancnik	ELES d.o.o.	Klemen.Dragas@eles.si
Bernard Campion	ELIA	bernard.campion@elia.be
Stig Holm Sørensen	Energinet	shs@energinet.dk
Carlos Castel	ENTSO-E	carlos.castelconesa@entsoe.eu
Alina Neagu	ENTSO-E	alina.neagu@entsoe.eu
Jussi Matilainen	Fingrid Oyj	jussi.matilainen@fingrid.fi
Dirk Van Hertem	KULeuven	Dirk.vanhertem@esat.kuleuven.be
Camille Hamon	Norwegian University of Science and Technology (NTNU)	camilleh@ntnu.no
MUSTAFA PEZIC	RED ELECTRICA DE ESPAÑA	MPEZIC@REE.ES
Fridrik Mar Baldursson	Reykjavik University	fmb@ru.is
Rémy CLEMENT	RTE	remy.clement@rte-france.com
Oddbjørn Gjerde	SINTEF Energy Research	oddbjorn.gjerde@sintef.no
Matthias Hofmann	STATNETT	matthias.hofmann@statnett.no
Simon Weizenegger	STATNETT	simon.weizenegger@statnett.no
Thomas Trötscher	STATNETT	thomas.trotscher@statnett.no
Øystein Rognes Solheim	STATNETT	oystein.solheim@statnett.no
Anders Danell	Svenska kraftnät	anders.danell@svk.se
Sophie Dourlens-Quaranta	TECHNOFI	sdourlens@technofi.eu
Athanase VAFEAS	TECHNOFI	avafeas@technofi.eu
Tin Bobetko	TSCNET Services	T.bobetko@tscnet.eu
Louis Wehenkel	University of Liege	L.Wehenkel@ulg.ac.be
Efthymios Karangelos	University of Liege	e.karangelos@ulg.ac.be
Swasti Khuntia	TU Delft	S.R.Khuntia@tudelft.nl

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Jose Rueda-Torres	TU Delft	j.l.ruedatorres@tudelft.nl

10.2 Agenda

The workshop was held from 9:00 to 16:45. The detailed agenda is presented below.

9:00 *Welcome and registration*

Introductory session

9:15 **Overall objectives of GARPUR**
Oddbjørn Gjerde, SINTEF (GARPUR coordinator)

9:30 **Main stakes for probabilistic approaches vs N-1 in reliability assessment and control**
Louis Wehenkel, University of Liège (GARPUR scientific advisor)

Session 1: Vision towards the use of the new RMAC in TSOs' processes

10:00 **Vision about the use of the new RMAC in TSOs' system development processes**
Presentation by Bernard Campion (Elia) followed by interactions with the audience

10:45 *Coffee break*

11:00 **Vision about the use of the new RMAC in TSOs' asset management processes**
Presentation by Rémy Clément (RTE) followed by interactions with the audience

11:45 **Vision about the use of the new RMAC in TSOs' system operation processes**
Presentation by Guðjón Hugberg Björnsson (Landsnet) followed by interactions with the audience

12:30 *Lunch break*

Session 2: Challenges and next steps

13:45 **The overall mathematical and algorithmic challenges for the new RMAC**
Efthymios Karangelos, University of Liège

14:30 **Pilot testing of the new RMAC in TSOs' environment**
Camille Hamon, NTNU

15:15 *Coffee break*

15:30 **The principles and software development ambitions to quantify the socio-economic impacts of the new RMAC**
Dirk Van Hertem, KU Leuven

16:00 **Conclusions and next steps**
Matthias Hofmann, Statnett

16:30 *End of meeting*

10.3 Proceedings

Highlights of the workshop are reminded in this section while the detailed minutes including the discussions are available in annex. The presentations can be found on the GARPUR website: http://www.garpur-project.eu/publications.

Introducing the session, project coordinator (Oddbjørn Gjerde, SINTEF) presented the ambitions and key figures of the Garpur project. This presentation was followed by a presentation of Louis Wehenkel, University of Liège (GARPUR scientific advisor) on the main stakes for probabilistic approaches vs N-1 in reliability assessment and control. After this introductory session, the Vision towards the use of the new RMAC in TSOs' processes was delivered in three components, each dedicated to one key function of TSO.

Each presentation was followed by interactions with the audience:

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- TSOs' system development processes by Bernard Campion, Elia
- TSOs' asset management processes Presentation by Rémy Clément, RTE
- TSOs' system operation processes, presentation prepared by Guðjón Hugberg Björnsson (Landsnet) and delivered by Camille Hamon, NTNU.

After the lunch break, the overall mathematical and algorithmic challenges for the new RMAC was presented by Efthymios Karangelos, University of Liège. Challenges of the pilot testing of the new RMAC in TSOs' environment were described by Camille Hamon, NTNU.
The principles and software development ambitions to quantify the socio-economic impacts of the new RMAC were explained by Dirk Van Hertem, KU Leuven
Finally, Matthias Hofmann, Statnett proposed a way to move forward based on the draft results achieved so far by the project.

Among the issues that were thoroughly discussed one should retain:

- The limitations of the N-1 criterion for operational security.
- The status reached so far by the project with an effective framework which will allow to make the risk visible with not necessary increase the risk level.
- Reliability Management appears as a multi-stage multi-level decision making under uncertainty.
- Future challenges including the modelling of the multi-stage decision making processes for reliability assessment and the design of related proxies to ensure realistic assessment, data availability both for the development and the future use of the methods.
- A prototype quantification platform is under way and a series of pilot tests have been designed
- The process of a progressive migration from N-1 towards such RMAC Migration as seen by the TSOs that was a central topic of discussion.
- In particular the future tentative transition roadmap to evolve from the current N-1 practices is expected to address the question on barriers as seen by the TSOs.

Interesting contributions have also been collected from TSOs beyond the traditional dissemination circles of GARPUR and the particular role of ENTSOE: TSOs that are not yet in these circles will be invited to join the next dissemination events or the Reference Group. The particular role of ENTSOE was also highlighted for the promotion of GARPUR results to all TSO members.

Detailed minutes are included in annex 4.

10.4 Evaluation

A satisfaction questionnaire was distributed in the form of an e-questionnaire to collect feedback from participants.

11 INVOLVEMENT OF IMPACTED STAKEHOLDERS: THE JOINT WORKSHOP GARPUR/ITESLA DURING THE CIGRE PARIS 2016 (FRANCE)

A workshop organized jointly by RTE and TECHNOFI, and with the iTesla consortium, took place on 24th August 2016 as a side meeting to the CIGRE Paris event (same location, during the same week) in order to benefit from the Cigré audience.

The research leading to these results has received funding from the European Union
Seventh Framework Programme under Grant Agreement No 608540.

11.1 Agenda

The event focused on "NEW APPROACHES FOR RELIABILITY MANAGEMENT IN TRANSMISSION NETWORKS: METHODS AND TOOLS" with two main objectives: dissemination of results to stakeholders and gathering of feedback from audience.

The draft agenda of the event was organized in two main stages, with three successive speakers for the Garpur component (by the WP 4, 5, 6 leaders).

Dedicated promotion campaign was made through emails and direct promotion via project and partners website as well via direct contacts. In addition, an agreement was reached with the Cigre in order to include a flyer in the information package. This ensured a wide visibility towards the Cigre participants (3,200 copies).

11.2 Attendees

The on-line registration process implemented prior to the workshop allowed to register 57 persons wishing to attend the event (not counting the speakers and organization team). In total 68 persons were expected to attend based on the registration forms and direct inscriptions. 7 additional registrations were made at the welcome desk of the event. One can consider that 75 people have shown interest to the event further to the mailing campaigns and the various promotion means deployed by RTE and TECHNOFI, and including Cigre support.

Actual presence at the joint workshop was in the end 47 participants, the no-show rate of 37% (28 out of 75) remains however limited and showing the interest to the event. A wide spectrum of stakeholders were

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represented as shown in the Table 20 below and including among other system operators, manufacturers, professional and academics.

Table 19 – Speakers and organizers of the 24th August joint iTesla/Garpur workshop in Paris

Role	Name	Organisation	email
Organization	Athanase Vafeas	TECHNOFI	avafeas@technofi.eu
Organization	Magali Huet	RTE	magali.huet@rte-france.com
Key note speaker	Olivier Grabette	RTE	olivier.grabette@rte-france.com
Speaker	Rémy Clément	RTE	remy.clement@rte-france.com
Speaker	Íris Baldursdóttir	LANDSNET	iris@landsnet.is
Speaker	Pauline Gambier-Morel	RTE	pauline.gambier-morel@rte-france.com
Speaker	Nicolas Omont	RTE	nicolas.omont@rte-france.com
Speaker	Louis Wehenkel	ULG	L.Wehenkel@ulg.ac.be

Table 20 – Attendance list 24th August joint iTesla/Garpur workshop in Paris

Name	Organisation	email
Andrea Villa	Enel SpA	andrea.villa2@enel.com
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YongHo Chung	LSIS Co. Ltd, Korea	yhchung@lsis.com
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Jonathan BAUDIER	RTE	jonathan.baudier@rte-france.com

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Thorarinn Bjarnason	Landsnet	thorarinn@landsnet.is

A second table is added below showing a second circle of interested stakeholders (registered but with no physical presence).

Table 21 – Second list of interested stakeholders by the 24th August joint iTesla/Garpur workshop in Paris (not participant)

Name	**Organisation**	**email**
Alina Neagu	ENTSO-E	alina.neagu@entsoe.eu
Antonio Iliceto	Terna	antonio.iliceto@terna.it
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Hongseok Choi	KPX Korea Power Exchange	hongseok1@kpx.or.kr
Johannes Thorleiksson	ARA Engineering	johannes@araengineering.is
Aidan Tuohy	EPRI	atuohy@epri.com

Material presented during the workshop will be communicated to all participant and registered persons through the project website. These lists will also be used in future GARPUR dissemination events.

11.3 Proceedings

The workshop was introduced by a key note speech by Olivier Grabette, deputy CEO of RTE, on the nature of uncertainties for the transmission system and its impact to transmission system operators. The text of the introduction is included in Annex 5. Mr Grabette recalled the ever increasing complexity of a continental transmission system. He mentioned in particular some drivers of such complexity: the general context of massive integration of renewable energy, the recent evolution of in the annual growth of electric demand, the decorrelation in the planning of generation and the planning of transmission, revolutionary features from the IT world such as HPC (high performance computing) opening the way to powerful tools for addressing system operations. Mr Grabette also highlighted the complementarity of the two projects iTesla and Garpur, as European answers to the challenge of reliability management in an uncertain context.

In a second stage, five presentations took place as mentioned in the agenda: two on iTesla results and three on the Garpur probabilistic framework. The two iTesla presentations introduced the iTesla tool as a powerful prototype tool allowing online and offline simulations possibly addressing three very challenging issues: dynamic simulations, which could range from local to EU-wide scope while including uncertainty modelling. Mr Nicolas Omont detailed the distinctive advantages of iTesla compared to the current tools on operations at TSO or Coreso. Most of today's tools are static and do not consider uncertainty.

Then Ms. Pauline Gambier-Morel gave a focus on a use case in South of France – the N-1 Tavel-Tamareau 400 kV line. In particular the generation of security rules associated with the contingency « N-1 Tavel Tamareau » for overloads was presented in a first stage. Then Pauline discussed the analysis results on forecasted situations. In conclusion the use case enabled the proof of concept for the iTesla toolbox and perspectives of the prototype iTesla tool in its route towards industrialization were presented. A key final message on iTesla was on the fact that partners are welcome for further development and experimentations (Link: http://www.itesla-pst.org/).

Afterwards, a series of three presentation on Garpur took place. Due to the concise form of the workshop (two hours) and to be practical and direct enough, it was decided to focus on the impact of Garpur on the three time scales of a transmission system: System Operations by Íris Baldursdóttir, Landsnet, Probabilistic

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reliability assessment of maintenance policies of transmission assets by Rémy CLEMENT, RTE and System Development. This final presentation was prepared by the WP4 leader Bernard Campion, Elia and presented by L. Wehenkel, Garpur scientific advisor.

Then a concluding debate took place between speakers and participants showing their interest to alternative approaches to reliability management.

Among the issues that were discussed in the concluding debate one should retain:

- The problem of data in transmission system in Europe for uncertainty models. Handling data with different identifiers raise important consistency problems for building such models (CIM format needed).
- In the context of the limitations of the N-1 criterion for operational security, the two routes explored and developed by the two projects appear complementary: on one side iTesla as a powerful tool with continent-wide dynamic simulations with uncertainty and on the other side Garpur as a general framework for reliability management.
- Particular needs/issues were proposed/raised by some participants with respect to safety assessment:
    - The need to consider all possible cascading faults in safety assessment in real time system operations;
    - The need to set up a database of geographically located contingencies in Europe.
    - The definition and scope of the term “contingency”, is it defined widely enough or only as faults on high voltage equipment leading to the reaction of protection devices (i.e. opening of line breaker). Shouldn’t changes in generation or load be seen as contingencies as well? A participant suggested to consider it at the largest extend (a contingency would then refer to any unexpected change)
    - The need to take into consideration the fact that the system models used to calculate the system response to contingencies might include some errors and not be 100% perfect, and therefore give wrong results
    - The issue of the applicability of the GARPUR method for estimating the resilience of the system, i.e. will the method include or take into consideration HILP (High Impact Low Probability faults)?
    - The need to take into consideration the quality of supply at a local level: optimizing security based on global indicators might penalize particular geographical areas and Garpur project should take care of such situations.
- The status reached by each project and their future perspective: iTesla has adopted an open approach towards industrialization (“you can join us to do more”) and some pre-announcement on events foreseen by Garpur in its final year of project deployment.
- Other challenging issues as the evolution of the role of dispatcher having such powerful simulation tools have not been thoroughly discussed but mentioned: they will have to be integrated in the progressive process of migration from N-1 towards such new reliability management framework. The future GARPUR transition roadmap to evolve from the current N-1 practices will detail such process as well as the legal background for departing from the N-1 criterion.

The workshop was moderated by Athanase Vafeas, TECHNOFI who was also involved in its organization jointly with Ms. Sophie Dourlens-Quaranta, TECHNOFI and Ms. Magali Huet from RTE.

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12 ADDITIONAL INTERACTIONS WITH REGULATORY BODIES DURING THE THIRD REPORTING PERIOD

Additional interactions with the regulatory world were ensured during the final reporting period. They took several forms:

- Bilateral interactions for presentation of the project results and recommendations towards regulatory authorities or ministries: beyond the natural communication/monitoring channels at the national level by the GARPUR TSO, activity in WP9 enabled new series of contacts with regulatory authorities and ministries during the final year of the project. In order to gather feedback from key stakeholders, project partners contacted NVE (Norwegian regulator), Bundesnetzagentur in Germany and the National Energy Authority in Iceland to consult them on a draft list of project recommendations.

- Participation to the session “benefits for society and possible barriers for implementation from a regulatory perspective” during the 2nd day of the Final Conference (18th October 2017). Panel discussion on the willingness of the regulators to embrace the probabilistic approach based on socio-economic principles. Panelists were:
    - Martin Queen, Senior Technical Adviser, Ofgem, United Kingdom
    - Vegard Willumsen, Head of Section Power Systems, NVE, Norway
    - Jakub Fijalkowski, Senior Adviser / Co-chair of ACER’s System Operation and Grid Connection Task Force, E-conrol, Austria
    - Alain Marien, Chief Adviser, CRED, Belgium.

13 INVOLVEMENT OF IMPACTED STAKEHOLDERS: TOWARDS THE SCIENTIFIC COMMUNITY

The Third workshop on impacted stakeholders took place on 21 June 2017: A GARPUR Special session (SS12) in PowerTech Conference 2017 in Manchester under the leadership of ULg: "The GARPUR probabilistic reliability management approach & criteria". About 45 participants attended.

- GARPUR Special session (SS12) in PowerTech Conference 2017: "The GARPUR probabilistic reliability management approach & criteria
- About 45 participants with speakers from the project under the management of scientific advisor Louis Wehenkel, ULG.
- Speakers from GARPUR consortium included: SINTEF, STATNETT, ELIA, RTE, LANDSNET, KUL, ULG.

It should also be noted that in addition non-TSO stakeholders have been consulted during WP9 process.

Endly during the final conference a dedicated session is planned to organize the debate with impacted non-TSO players.

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ANNEX 1: DETAILED MINUTES FO THE FIRST WORKSHOP TOWARDS TSOS

Following the presentation "Overview and organization of the GARPUR project" (SINTEF)

- **SVENSKA:** New reliability criteria should be presented to ENTSO-E System and Development Committee (SDC).
- **SWISSGRID/SOC:** New reliability criteria should be presented to ENTSO-E System Operation Committee (SOC) and possibly integrated into the Network Code. Risk management is a pivotal concept for GARPUR (which risk should we take, which risk are we ready to accept).
- **REE:** GARPUR is "only" an FP7 project: it does not replace ENTSO-E. GARPUR recommendations should be towards ENTSO-E rather than towards EC or ACER. ENTSO-E is the entity taking decisions regarding reliability management.

Following the presentation "Functional analysis of probabilistic reliability management" (Scientific Advisor)

- **TENNET:** Criticalities are not only service disruptions: for example, decreasing the reliability level implies occupying teams, stressing them…
- **FINGRID:** "mid-term" may be confusing. Does operational planning belongs to mid-term horizon?
    - ***Response from Scientific Advisor*:** long-term = possible changes in structure; short-term = no changes in structure; mid-term = possible changes like new PSTs…
- **ENERGINET:** What are the connections between reliability evaluation and economic evaluation?
- **TENNET:** N-1 takes into consideration events occurring once every 10 years as well as events occurring once every 10 minutes. GARPUR proposes a smarter way of applying N-1.
- **FINGRID:** What are the connections with other FP7 projects (iTesla, Umbrella, eHighway2050)? Will results of these projects be used by GARPUR to avoid duplication of work?
    - ***Response from Scientific Advisor*:** Yes, but GARPUR is the only one covering the 3 time horizons.
- **REE:** Will SEI be calculated consistently with the TYNDP?
    - ***Response from RU***: yes.

Following the presentation "Current practices for reliability management in complex systems: a review of drivers and barriers for new reliability standards" (AALTO)

- **REE:** Have you reviewed reliability criteria applied outside Europe? Response from Task 2.1 leader: worldwide literature has been reviewed, but the questionnaire was sent only to European TSOs.
- **REE:** It would be interesting to assess the SoS level performed by the TSOs having answered the questionnaire.
- **AMPRION:** Is the questionnaire representative for the planning criteria applied in the whole Europe?
    - ***Response from AALTO*:** The new criteria will not be based on the questionnaire; the purpose of the questionnaire is to assess where we are at the moment.
- **SVENSKA** asks for the slides presented at the workshop.
- **SWISSGRID/SOC:** If we want to adopt a risk-based approach, we need regulators around the table (example with the Swiss regulator who allocate to the TSO a fixed amount for redispatching purposes).
- **LANDSNET:** Iceland can't afford N-1. SoS and SEI need to be balanced.
- **STATNETT:** The problem is not the data itself, but the trust in data.
- **ENTSO-E:** From a customer point of view, SoS is needed whatever the reliability criteria are.
    - ***Response from AALTO*:** The N-1 criterion does not guarantee that there are no black-outs.

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- **REE:** With N-1 black-outs are limited. Large black-outs in Europe were due to a poor application of N-1.
    - ***Response from KUL*:** New, probabilistic reliability criteria do not necessarily imply to be less secure than N-1. Evaluating reliability is needed: some customers may be more secure, others less secure, just as today.
    - ***Response from Scientific Advisor*:** A possible comparison may be the speed limits on the highway: they depend on traffic and weather.
- **ENERGINET** remarks that with N-1 there is no need to quantify the consequences (since they are not accepted). With probabilistic approaches, need to assess consequences.
- **REE** mentions the habits of the staff in real-time operation.
- **STATNETT:** with N-1, it is possible to verify that power flows are correct "by hand", while with probabilistic approaches it is not possible.

Following the presentation "Shaping the GARPUR quantification platform" (KUL)

- **SVENSKA:** Why focusing first on real-time, while it is the most complicated?
- **AMPRION:** There are many challenges in performing these tests from a system development point of view. It will be very complex to get the complete Europe overview because lots of data will be needed (reference to TYNDP).
    - ***Response from KUL*:** The whole EU network will not be modelled. Only a few options will be tested. Existing software will be used (iTesla, Umbrella).
- **REE** would like to implement within the GQP their reference case by their own.
    - ***Response from SINTEF*:** This would be out of the scope of GARPUR.
- **STATNETT:** data standards (CIM) would be useful to GARPUR.
- **AMPRION:** For the high acceptance by the TSOs community, GARPUR should contact SDC and SOC.
    - ***Response from ELIA*:** Training sessions with the GQP are planned at the end of the project to convince the TSOs community of the performance of the new reliability criteria.
- **AMPRION:** GARPUR will deliver concepts, not operational tools. So what is the purpose of these training sessions?
    - ***Response from TECHNOFI*:** GARPUR will deliver a prototype tool, with capabilities linked with budget and scope of pilot tests (which may be improved thanks to the Reference Group). After the end of the GARPUR project, the prototype may be further developed and access to non-GARPUR stakeholders may be granted, just as what has been done with the OPTIMATE prototype.
- **REE:** Regulators could ask for a more efficient way to reach reliability requirement but would never accept losing "one gram" of reliability.
    - ***Response from KUL*:** Thanks to new reliability criteria, Transmission Reliability Margins (TRM) could be reduced with no loss in reliability.
- **SWISSGRID/SOC will ask SOC members to propose some test cases for the GQP.**
    - ***Response from STATNETT*:** Please don't limit yourself because of data: only the description of an interesting case would be of interest for the project.

Following the presentation "The role of reference group" (STATNETT)

- **AMPRION:** What is meant by "support role"?
    - ***Response from STATNETT*:** Active participation in workshops, validation that the project goes into the right direction.
- **FINGRID:** What would be the workload of RG members?

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ANNEX 2: SATISFACTION QUESTIONNAIRE DISTRIBUTED AT THE FIRST WORKSHOP TOWARDS TSOS

Generally Accepted Reliability Principle with Uncertainty modelling and through probabilistic Risk assessment

First GARPUR workshop towards ENTSO-E members

7 April 2014 - ENTSO-E premises

EVALUATION QUESTIONNAIRE

Participant name: _____ **Organization**: _____

For all the questions below, please rate with marks between 1 (in full disagreement) and 5 (fully agree).

This meeting has helped you …	mark
1. … understanding the overreaching goal of the GARPUR project	1 2 3 4 5
2. … understanding the scientific challenges of the GARPUR project	1 2 3 4 5
3. … getting a clear picture of the drivers and barriers for using new reliability standards	1 2 3 4 5
4. … understanding the functioning and the role of the GARPUR Quantification Platform	1 2 3 4 5
5. … understanding the role of the GARPUR Reference Group	1 2 3 4 5
You consider that …	
6. ... enough time was dedicated to describing the key ambitions and challenges of GARPUR	1 2 3 4 5
7. … the R&D activities foreseen by the consortium are appropriate to meet the presented project ambitions	1 2 3 4 5

8. Your comments to explain marks between 1 and 3 (if any):

9. How would you sum up in one sentence the main message of the meeting?

10. Are there any important issues that you thought worth being discussed and were not addressed during the meeting? Or any topic you would have liked spending more time on?

11. What would you suggest to improve the agenda and organization of the next workshops with TSOs?

12. Do you intend to join the GARPUR Reference Group?

Thank you for your participation!

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ANNEX 3: ANALYSIS OF RESPONSES TO THE SATISFACTION QUESTIONNAIRE DISTRIBUTED AT THE FIRST WORKSHOP TOWARDS TSOS

	Outside TSOs									
Please rate with marks between 1 (in full disagreement) and 5 (fully agree).	FINGRID	TERNA	TENNET	REE	REE	HOPS	ELERING	MAVIR	Anonymous	
	J. Matilainen	A. Iliceto	G. Aanhaanen	V. Gonzalez	C. Llanos	M. Lasic	A. Mazikas	P. Kovacs		
This meeting has helped you …										
1. … understanding the overreaching goal of the GARPUR project	5	5	4	5	5	4	4	5	4	
2. … understanding the scientific challenges of the GARPUR project	3	5	3	3	4	5	4	4	5	
3. … getting a clear picture of the drivers and barriers for using new	4	5	4	4	4	3	5	4	3	
4. … understanding the functioning and the role of the GQP	4	5	4	5	5	3	4	4	4	
5. … understanding the role of the GARPUR Reference Group	4	5	4	5		3	4	4	3	
You consider that …										
6. … enough time was dedicated to describing the key ambitions and	5	5	5	4	5	4	4	4	5	
7. … the R&D activities foreseen by the consortium are appropriate to meet the presented project ambitions	4	4	4	4	4	3	3	4	5	
8. Your comments to explain marks between 1 and 3 (if any)				Understanding the scientific challenges requires probably more than one working day for people not daily involved in reliability assessment			Not enough overview about the research capacity - therefore hard to evaluate appriopriarity of the activities		It would be a good thing to have the MoU ready for the workshop	
9. How would you sum up in one sentence the main message of the meeting?		Informative, focused	Nice challenge to hear different opinions of other TSOs	GARPUR is ready to test conceptually different options for reliability criteria and to provide recommendation for next steps to evolve N-1	The analysis fo alternatives to N-1 approach is complex and controversial, because of all the impacts and consequences it would have on "Business as Usual" for the electricity sector and for all the society	N-1 must not be always the right rule.	The GARPUR team is very interested in input from TSOs	TSOs have to find something that is more sophisticated than N-1 criteria in the filed of network planning	GARPUR is a european R&D project which involves all TSOs !	
10. Are there any important issues that you thought worth being discussed and were not addressed during the meeting? Or any topic you would have liked spending more time on?		No	Each country optimize its own grid, so what about the use of phase-shifter in a probabilistic planning?		Not for this initial workshop, it has provided a very good and complete pictyure; for future workshops more time and details will be necessary.		Beside providing input information, how can TSOs help the project and what are the benefits of developping and using software like GQP?			
11. What would you suggest to improve the agenda and organization of the next workshops with TSOs?		Some practical mean should be used to "force" all participants to the workshops to actively					The presentations could be provided in printed form at the workshop.	Please send material before the workshops !		
12. Do you intend to join the GARPUR Reference Group?	Yes	Yes	No, maybe my colleague Ana Cupuliga - TenneT)	We will see.	We have to check available resources.	Not for now.	Hard to tell, depends on the decision of management.	No		

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	GARPUR partners									
	ELIA	ESO	ESO	RTE	CEPS	ENERGINET	LANDSNET	STATNETT	AALTO	
Please rate with marks between 1 (in full disagreement) and 5 (fully agree).	Manuel & Cindy	K. Gerasimov	N. Gamov	R. Clément	M. Belyus	G. Bronno	G. Asmundsson	L. Vormedal	L. Haarla	
This meeting has helped you …										
1. … understanding the overreaching goal of the GARPUR project	NA	NA	5	5	5	NA	5	4	5	
2. … understanding the scientific challenges of the GARPUR project	NA	NA	5	4	5	4	3	4	5	
3. … getting a clear picture of the drivers and barriers for using new	4	NA	4	4	5	4	4	4	5	
4. … understanding the functioning and the role of the GOP	4	NA	5	4	5	3	4	4	5	
5. … understanding the role of the GARPUR Reference Group	1	NA	5	4	5	3	4	4	5	
You consider that …										
6. … enough time was dedicated to describing the key ambitions and	5	4	5	5	4	5		4	5	
7. … the R&D activities foreseen by the consortium are appropriate to meet the presented project ambitions	3	4	5	5	5	NA		4	5	
8. Your comments to explain marks between 1 and 3 (if any)	3: there was a good discussion on this with participation of TSOs not participating in GARPUR					4. Still a bit high-level and abstract (but promising)	WP2 and WP3 need to be synchronized. There needs to be a balance between reliability criteria and social benefits.	Challenging R&D project. High risk project.		Inform TSOs of GARPUR and get feedback to some work already done in GARPUR
9. How would you sum up in one sentence the main message of the meeting?	GARPUR will try to improve current reliability criteria, with participation of RD's and TSOs, looking at both technical and economical issues	The TSOs show interest in the project.	GARPUR is going in the right direction	Overview of the project ambitions, and need for feedback from non consortium TSOs	Very important to disseminate the findings to other TSOs (SOC, MC…) of ENTSO-E	GARPUR will investigate thepotential and realism of a probabilistic reliability criterion	Can N-1 be replaced by probabilistic methods?			
10. Are there any important issues that you thought worth being discussed and were not addressed during the meeting? Or any topic you would have liked spending more time on?	Goal of the Reference Group (not at the end of meeting!)	Not at this stage.				What are the shortcomings of the current situation? (that we are going to "repair")	Influence of environmental issues		No	
11. What would you suggest to improve the agenda and organization of the next workshops with TSOs?	Another set-up of meeting room. Present more initial results	In next meetings, discussions on specific methodologies, test cases and previous experience should start		Different shape of the meeting room	To send the presentations in advance	Interactivity of "drivers and barriers" was good. More of that :-)	Send out presentations before the meeting		TSOs should also present something	
12. Do you intend to join the GARPUR Reference Group?	NA		NA		NA	NA		NA	NA	

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ANNEX 4: DETAILED MINUTES OF THE THIRD DISSEMINATION WORKSHOP TOWARDS TSO

3rd June 2016, Nice (France)

Detailed minutes of Meeting

Attendance: 28 participants in the room (see attendance list)

9: 05 Introduction by Sophie Dourlens-Quaranta, TECHNOFI, WP10 leader

9:15 "Overall objectives of GARPUR" by Oddbjorn Gjerde, SINTEF, project coordinator
N-1 rule is the reference for operational security. It will continue to stay a corner stone of TSO reliability management. But it has its limitations. First it does not consider the probability of outages. Second, there is not distinctions in consequences between different situations. It is also impossible to handle the comprehensive uncertainties in a large interconnected system. Complexity of the pan-European system becomes more complex and we have also to consider the increased volatility caused by RES. Endly it is hard to handle new devices that enable fast corrective actions
The purpose of Garpur: to address these shortcomings with the definition of new classes of reliability criteria, the evaluation of the relevance of the criteria and to compare reliability management though comparison on social welfare.
Different time scales of TSO activities are considered with issues such as investment vs maintenance or maintenance vs redispatching. We aim to make our results and define a framework consistent across these different scales covering from system planning to operations.
Key note figures on Garpur are displayed.

9:30 "Main stakes for probabilistic approaches vs N-1 in reliability assessment and control" by Louis Wehenkel, Université de Liège, scientific advisor

Reliability assessment approaches in Garpur are presented starting with revisiting the N-1 criterion, the Garpur RMAC proposal and a progressive implementation in practice. More details will be presented in next sessions. The original rationale was based on the 2006 black out. Primary target was to ensure continuity of service of the power supply.
A socio-economic analysis of alternative reliability criteria is introduced. This cost function sums up two terms: the criticality risk and the operating costs. The socio-economic impact of covering more or less contingencies in real-time operation.
External conditions (such as harsh weather conditions) might change the optimum. For facing a sudden change in wind, N-1 is too pessimistic. Depending on conditions the N-1 is either too optimistic or too pessimistic.

How to adapt?
The N-1 criterion neglects the spatiotemporal variations of threats (all N-1 events are not equally likely at all times, some N-k events may be more likely at some moments than some N-1 events). The N-1 criterion assumes fully predictable contingency response and neglects socio-economic impacts of service interruptions.
To move forward we thus need to dynamically adapt playing with the discarding principle and the reliability target of the proposed GARPUR RMAC.

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Regarding the discarding principle a minimization of a function Operating Costs + Criticality Risk **(**OC+CR) over all contingencies is proposed. In practice the problem is simplified by focusing on a small subset of contingencies.
We then choose a set of contingencies (Cc) in a way that the difference between the costs CR is below a threshold given in advance (ΔE) and we discard all other contingencies (C\Cc)

> Discussion
> Q) Stefan Höglinger, APG: Why not using all contingencies in the optimization problem, since we need to assess CR(x_0,C,u)?
> A) We don't need to compute CR(x_0,C,u) to assess CR(x_0,C,u)-CR(x_0,C_c,u) $\leq \Delta E$, which is much easier in terms of computation time.

We then introduce a set of constraints in the form of reliability targets we want to be satisfied at any time Prob (acceptable behavior) to be not lower than a probability threshold (1-ε).
The combination of the discarding principle and reliability target define the GARPUR Real-Time-RMAC, up to the specification of its 3 meta-parameters (ΔE, the notion of "acceptable behavior", and ε). An example is given for RT operations.

How to proceed with a migration from N-1 towards such RMAC Migration?
This can only be done progressively, as data becomes available and algorithms become mature and it must be motivated by a sound and comprehensive study of the resulting socio-economic impacts for all stakeholders. This is of course part of GARPUR methodology.
For each context we will have to specifically define a set of ingredients: the time horizons, exogenous scenarios and their probabilities, the types of candidate decisions available to the TSO, the socio-economic objective function, the reliability target (acceptable behavior and a quantification of the tolerance level), the discarding relaxation principles and their threshold.
We also need to ensure coherency among different contexts.

In next sessions colleagues will present the specific context of grid development, asset management and short term operations. As an introduction in grid development we have basically two problems according to the time horizon (long term or mid-term):

- Assessment of main system weaknesses
- Ranking of grid expansion projects

In asset management we are considering:

- Outage scheduling (on a mid-term horizon - few months to few years)
- Maintenance budgeting (on a long horizon - 20 years or more)

In short term operations issues are:

- Real-time operation (over the next hours)
- Operation planning (over the next days or weeks).

10:05 "Vision about the use of the new RMAC in TSO system development processes" by Bernard Campion, ELIA, WP4 leader
The context & objectives of system development (SD) is introduced then the question of what should we change in current practices is discussed.
We need to analyse a much broader set of operating points since worst case scenarios are not always the ones we expect anymore and a worst case approach does not allow to quantify how often a problem arises and how much it costs to solve it. Another issue is to develop a method to quantify / monetize the consequences of an outage (the "costs of the measures" to ensure reliability in shorter term horizons). We

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would need also to build the links between the different time horizons. Finally we need to manage the contingency list in a more dynamic and smarter way.
The approach followed in WP4 is then presented starting with the description of current practices, the development of a new methodology for SD assessment. Then the modalities on how to work with the tool, the validation and the migration of approach will be considered as fully part of the work.
The simplification of the theoretical formulation of the RMAC for SD is needed. We focus on assessment instead of optimization, Monte-Carlo approach with macro/micro scenarios for exogenous uncertainties is proposed, interactions between market analysis and grid analysis are analyzed. Endly, the future behaviour of the TSO in all the encapsulated shorter-term problems is modelled with proxies.
Two proxies are proposed in the methodology: one for outage scheduling and a second one for short-term and real time system operations.
The approach for SD is presented in details, in some aspects it is similar to the eHighway2050 WP8 innovative approach on transmission expansion planning for the pan-European system at long-term time horizon). It includes several modules.
First it is needed to define credible operating states:

- Generation of credible operating states for input to market analysis
- Market analysis
- « Translation » from zonal to nodal data.

Then a "complexity reduction stage" is required followed by the Network & reliability analysis stage.
The flexibility of the approach including the potential iterations is then presented. The iterations allow to build an expansion plan toward a target topology.

Data and modelling challenges are detailed by Bernard: the first challenge is to generate the Monte Carlo years taking into account the climatic parameters and intermodal correlations. Here the use of the eHighway2050 methodology is considered. The 2nd challenge relates to the failure rate and repair times (in cooperation with WP5). The 3rd deals with the definitions of proxies (in cooperation with WP5 and WP6). The 4th challenge consists in the Translation from zonal to nodal & interactions between market & grid analysis.

Bernard concludes with the next steps: testing of the methodology on a small test-case, testing of some aspects of the methodology on a near real-life test case (WP8) and the migration.

> Discussion:
> Q) Stefan Höglinger, APG: For the TYNDP process there are several parts that are almost the same. What is if you compare your methodology with the TYNDP process. Here you have more states, which is not taken into account in TYNDP?
> A) They don't really quantify the cost for operating the system in the coming years. Robustness of the candidate decisions or projects, flexibility is not quantified. It is a more qualitative approach. How much does it cost in operation to solve the overloading problem not addressed.
> Other points of differences: a better modelling and the spatial correlation, the approach at the zonal level is also different. A third point is to try to take better into account the real situations that the operators will face in 20 years.
> Q) Jussi Matilainen, Fingrid: In continuation of the eHighway2050 project, are you aware of the project results?
> A) For generation they did a good job, the main thing they don't do in eHighway2050 is to perform a reliability analysis. They use an OPF at zonal level. The simplified model with equivalent, at 400kV could be improved. The method is a good starting point, we could improve the nodal level. Contacts have been established with the eHighway2050 project.

10:45/11:15 Coffee break

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11:20 Vision about the use of the new RMAC in TSO asset management processes, by Remy Clement, RTE, WP5 leader

We need to wisely schedule outages due to asset management. There is a compromise between the maintenance requests on the operational needs. There is also a relation between the maintenance efforts and the failure rates. The probabilities of contingencies are an input to evaluate the reliability level of the whole system. Asset management helps keeping the assets in good health but costs money.
TSO's Asset Management concerns for the next 10+years is presented followed by the objectives of WP5 and an overview of the approach.

Some characteristics are detailed: again, focus is made on three main issues:

- assessment instead of optimization (too many hidden parameters cannot be included inside an optimization module and people might be afraid of black-boxes pushing for a more progressive way)
- screening of many possible future based on a Monte-Carlo approach with macro/micro scenarios for exogenous uncertainties
- the (future) behaviour of the TSO is emulated when assessing the future socio-economic consequences.

The two targeted problems are detailed. The first problem maintenance policy assessment is a long term problem (20 years). The simulation of the impact of given maintenance policies allows determining the resulting costs of O&M and the impact on system reliability and component health-status over the years.

The second problem is outage schedule assessment. Over a horizon of (say) 1 year, we want to simulate the impact of given outage schedules to determine the resulting costs of maintenance and operation, as well as the impact on system reliability.

RMAC for the outage scheduling are possible with different acceptability constraints at the overall system, at the sub-region system, and for each time-step (week), over the year. We can also define the notion of acceptable outage schedule via a chance-constraints formulation with an explicit tolerance that the schedule may not be robust anytime, for any scenario, against all N-1.

A methodology for a manual optimization based on probabilistic assessment is then detailed: Identifying the time steps when there are weak areas (through a color code representation), evaluating then the robustness of an outage schedule. In addition to operational use, such tool could be helpful to challenge the habits or perform sensitivity analyses.
The core novelty is the evaluation of reliability and costs through proxies.

For the (long term) maintenance policy assessment problem the outage scheduling proxy is presented.
We will adopt a scenario approach (macro – yearly variations and micro-daily variations scenarios) to take into account different possible trajectories for exogenous scenarios. We have also developed an innovative multi-scale approach to consider in the modelling (proxies) the progressive unveiled information as time progresses.
Data and modelling challenges include models of component ageing and failure rates with a tentative model to link the component state with a failure rate.
Remy concludes with a presentation of next steps which include the replacement of the N-1 proxies with the new GARPUR ST RMAC, the validation, improvement and fastening of the proxies and the migration. For that final step it is reminded that it would be needed to move away from current practices step by step and to address in a better way the data and modelling issues.

> Discussion:
> Q) Tin Bobetko, TSCNET: I like the detailed approach. On your slide 15 regarding the initial phase could you use PTDF factors instead of geographical factors?

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A) We have assessment and optimisation. Today we have not yet taken into account the market constraint. This is planned in the next step. We will make a proxy to represent the capacity allocation of TSO prior to the day ahead. We will do it step by step.
Q) Thomas Trötscher, Statnett: do you have a feedback between corrective actions and maintenance? If you have a failure you don't start the maintenance. Where is it taken into account in your proxies?
A) It is not represented. In case of postponing you should be able to see in the colored planning the possibility to reschedule directly from the graph.

12h05 "Vision about the use of the new RMAC in TSO's system operation processes" by Camille Hamon, NTNU

The presentation is made by Camille Hamon replacing Guðjón Hugberg Björnsson, Landsnet, WP6 leader

The scope of short term and real time is first defined: short-term operational planning (D-1, D-2, W-1) and real-time execution (15-60 min).

We want to have System Operations to be made situation aware. This is why we want to switch to more data: situation aware methods and situation aware data. From the question *"will the system state by N-1 secure"* we shall move to *"is there a high probability that the system state will be acceptable".*

In other words, we want to make the risk visible by using more data.

The N-1 method has some shortcomings and does not capture the risk. Here we don't take more risk but we will make it more visible. Some examples on plant outages, when the ST operation planner has to make a decision on outage is today based on his experience. Using more data that are situation aware will ease this process.

About the general vision of implementation. Within the next 10 years we expect that we will refine these methods. We envision that we will have to continue collecting data, refining methods and running multi TSO pilot tests. But what happens if different TSOs use different risk management approaches?

There are plenty of available models needing adaptations. If we want to quantify the risk in the system it is not enough to simulate what happens after the contingency but all the series of events that could appear in the system. We do recognize that we need better models to simulate all these events.

The vision for real-time and short term operations is given by Camille. Let's take an image. In the coming 10 years we expect that Garpur will be like a passenger in a car. The car is driven by TSO and GARPUR methods are run in parallel so that TSOs can get accustomed to and gain confidence in them, while still operating the system according to their own practices. Trade-off between the cost of these actions vs the impact of these actions. We want to give confidence to operators. How to bring social welfare (SW) in system operations? By quantifying the cost of reliability and benefits for stakeholders. We intend also setting market capacities in short term based on probabilistic contingency list rather than N-1 criterion. Endly we want to anticipate threats to reevaluate maintenance planning.

Data will plan a key role but a lot of data are already collected by TSO. However there are some missing links in data. We need to have a better understanding of the failure probability. That will take into account in particular weather conditions. We don't want any black box but metrics of risk that make sense for operators. Today we are closer to Garpur than we think. We already use a mix between N-1 and other methods and this results from the experience of operators.

One of the shortcomings of N-1 is that it does not allow capturing the risk faced by operational planners and system operators. A good way to go is the GARPUR framework for risk-based operations. It does not take more risky decisions but makes the risk visible. To support the decision making we want to go to situation-aware operations: make sense of the right data with the right indicators and quantify the trade-off of actions: cost vs. impact on risk.

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Benefits would then be more informed decisions, less reliance on human intuition and as a result more confidence in the actions taken.

> Q) Alina Neagu, ENTSO-E. Regarding the real-time (RT) you don't want to have black box operations, how will it be implemented in relation with the SCADA systems?
> A) Today every 5 min you run contingency analysis.
> Q) Thomas Trötscher, Statnett. The operators know very well the performance. What they don't have today is the quantification of the probability of failure. A very big gain is to expose the operators to probabilities. You don't need to do the complex part with all the consequences but just presenting weather data to help them with valuable information. For TSO that should be a first step.
> A) Camille: We did receive opposite feedback. Operators do need better knowledge about the systems and better metrics to evaluate consequences of their decisions (for example, cost of staring up a nuclear unit if they fear wind to be lower than expected).
> Efthymios: operators could do the analysis in their head if very experienced. Another dimension is the socio economic impact.
> Camille: There are two values: the probability framework of course but also the quantification of the socioeconomic impact
> Remy: we could also calculate the consequences of energy not served (ENS).
> Thomas: The first thing is not to change in risky situations but when looking the next day. This is a first gain. Then you could calculate probabilities and progressively change behaviours.
> Dirk: this is what we do. The ideal decision making support and at the same time what is possible also.
> Efthymios: this will be shown after lunch.
> Camille: most of the time operators know what will happen but some indicators will help.
> Louis: about migration on what is available today in tools and in terms of expertise, it is a big part of Garpur and it will be TSO specific.
> Alina: the risk in the network connected (neighbors) should be involved
> Tin Bobetko, TSCNET Services: this is what we do at regional security centres. We are close to real time (2 hours ahead), everything is coordinated at the regional level.

Lunch break, afternoon session.

14:00 "The overall mathematical and algorithmic challenges for the new RMAC" by Efthymios Karangelos, Université de Liège

The 4 ingredients of the GARPUR RMAC are reminded: the reliability target, the socio-economic objective function, the discarding and the relaxation principles.
We will take as a case for illustration RT operation: uncertain scenarios, candidate decision, reliability target, socio-economic objective, discarding and relaxation principle.
How to solve this problem on an algorithmic standpoint for RT operation?

First we disconnect the RMAC discarding problem and the RMAC control. Issues are:

- *Discarding problem: How to select a manageable contingency subset as per the RMAC discarding principle?*
- *Control problem: How to select between preventive/corrective control options as per the RMAC reliability target & socio-economic objective?*

About the control problem now, we will try to choose between preventing / corrective solutions.
The GARPUR RMAC appears as a non-convex, non-linear, continuous and discrete variables and large-scale MINLP. In principle it should be solvable by iterative decomposition.

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To our purpose, we have been inspired from the contingency ranking method well described in literature. We distinguish the (a) "prevently secured" / (b) "correctively secured" and (c) "not secured contingencies" and we progressively classify contingencies into these three categories. The principle is to move as many (c) leftwards (ie to the preventively/correctively secured situations).

Two demonstrative case studies are then presented: case A (summer) exploring "control vs N-1 subset" and case B (winter) consisting in addressing "Increased loading, outage rates & value of lost load, discarding & control".

Benchmark results are discussed including preventive only (pSCOPF), preventive/corrective (cSCOPF).

- For the case study A: Control vs N-1 subset, it appears that for a less restrictive reliability target: RMAC returns the same solution as the cSCOPF (cheapest), and a potential failure of corrective control is acknowledged & tolerated. For a more restrictive reliability target the RMAC solution between cSCOPF/pSCOPF, the choice of corrective control limited due to its possible failure, and RMAC is less conservative than the pSCOPF.
- For the case study B results are presented for RMAC Discarding and for RMAC Control.

Efthymios concludes with key messages. Data availability remains a key challenge both for the development & the future use of the methods. RMAC vision appears however reachable from the proof-of-concept viewpoint. Reliability management was/is/will be a multi-stage & multi-level decision making under uncertainty problem.
We could certainly make the best of recent advances: in simulation tools, to more accurately study the dynamic behavior of power systems & identify the most prominent risks, in optimization & constraint satisfaction to tackle the large-scale, non-convex, mixed integer non-linear problems, in machine learning & statistics, to combine simulations & optimization to generate "proxy" models useful for the assessment & control of large-scale power systems.

> Discussion:
> Q) Jussi Matilainen, Fingrid: you speak several times about optimization of costs. What about the benefits?
> A) Efthymios: see slide 3, the socio economic function includes the sum of all costs and benefits imposed on the markets and end-users. In mathematical terms, benefits can also be modeled as negative costs.
> Jussi: In final report you could describe because it is hard to understand as is it.
> Thomas: I was wondering about the cost of corrective actions, the objective is to minimize SW, from the TSO such as Statnett the corrective action, what is paid is not equal to the social economic costs. It is a cost we have to pay but not the socio-economic cost.
> Efthymios: This point is related to a topic addressed in WP3. Part of the question is TSO specific.
> Tin Bobetko, TSCNET Services: this is related to this question you could expect more complex in the end. You cannot know the cost in real-time.
> Dirk: in all these analysis the model we use is not an exact model, we make proxies.

14:40 Pilot testing of the new RMAC in TSOs' environment by Camille Hamon, NTNU, Task 8.1 leader
Camille introduces the pilot tests within the Garpur scope. Objective 1 is to validate the possibility to compare different reliability criteria in terms of their induced socio-economic impacts by using the GARPUR quantification platform (GQP). Objective 2 is to validate the practicalities of incorporating new reliability criteria into TSOs' actual decision making processes by performing pilot tests in near-real life context: 8 pilot tests have been specified: 3 pilot tests are planned to use the GARPUR quantification platform and 5 pilot tests are planned to be carried out in near-real life context. A ranking has been made since all of them will not be run.

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- The RTE pilot test (ST and RT) is presented. First objective is to implement the theoretical elements presented by Efthymios (e.g. maximize expected social surplus by finding the optimal trade-off between day-ahead preventive actions and real-time post-contingency corrective actions, considering possible failures of corrective actions and to compare the GARPUR RMAC with the N-1 criterion). Tractability issues is managed by the support of specific zones organized in concentric circles.
- A second test is the Landsnet pilot test (RT). The three objectives include the implementation of a RT risk assessment model using data available today at Landsnet, the investigation of methods of displaying the output of the risk assessment, the evaluation of the sensitivity of the risk assessment to inputs.
- A third test is the Elia pilot test (LT) with the objectives to implement a proposed method, developed within GARPUR, to select the credible operating scenarios for which the future grid needs to be designed and to compare the proposed method with the method in place at Elia. This is very related to what was presented by Bernard this morning. The aim is not to select the best but credible scenarios. We have the same type of data as for Landsnet.
- ČEPS pilot test is concerned with RT and ST. Aim is to compare the N-1 criterion and the GARPUR RMAC on specific hours of a particular day by using the GARPUR quantification platform and to focus on preventive and corrective actions suggested by the two reliability criteria (N-1 and GARPUR RMAC). Here only few hours and on Central Eastern Europe region will be focused.
- Finally, the ESO pilot test (ST+RT) aims to compare the selection of short-term preventive actions for enforcing the N-1 criterion and the GARPUR RMAC.

Full specifications are available in deliverable D8.1. Deliverables D8.2, D8.3 are scheduled for 2017 with results. In conclusion we have specified 8 pilot tests covering grid development, short-term operational planning and real-time operations are specified with 5 TSOs involved. Pilot tests will test the concepts developed in GARPUR, compare the GARPUR RMAC with N-1 and implement some of the GARPUR concepts in near real-life context using data available today.

> Discussion:
> Q) Jussi: There is no pilot test for Asset Management?
> Q) Thomas: What about the estimation of the consequence of rare events? Garpur relies on estimating consequences of contingencies, doesn't it?
> A) Camille: There is no pilot test for Asset Management. Regarding the estimation of the consequence of events, we haven't discussed that so far.
> Louis: this will be assessed in sensitivity analysis. We can use Monte Carlo type approach to sample it. Some of the parameters will be accurate, some other inaccurate. We will use simulation approach to assess this impact. ΔE could thus be calibrated. It is not yet the focus of the project.
> Thomas: yes, it is a different thing to measure in real in the system.
> Camille: from the discrepancy from the runs we could do some calibrations between the outputs of the RMAC and the other approach.
> Bernard: it is already planned to carry out some ex post analysis, a kind of back testing. First we will improve the tool and then the ex post analysis will allow to update our policy.
> Q) Stefan, APG: this ex post analysis is key to convince people
> A) Louis: In relation with this issue, the probability of parameters have to be estimated from data. Not only from best guess and this could play also a role.

Coffee break 15h10/30

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15h30 "The principles and software development ambitions to quantify the socio-economic impacts of the new RMAC» by Dirk Van Hertem, WP7 leader

Dirk introduces the rationale of the GQP (Garpur Quantification Platform) based on a comparison of reliability criteria: project ambitions and functions of a GQP are presented. It is made clear that the GQP is not intended to be run in real-time or to replace existing computational tools at the TSO side.

A realistic platform will ensure a good balance between level of detail, flexibility and possibility to implement. It will remain within the capacity of the project and will be designed on a modular concept to allow for future improvements, with open API and making use of existing software where possible. Focus will not be exact representation of events.

A GQP feature list for pilot testing is presented. First tests of GQP are shown for illustration purposes.

In conclusion Dirk presents the ambitions for software development and next steps.

> Discussion:
> Bernard: TSO struggle to manage all the data. Here you add a lot of additional data. Obtaining the data is one thing, maintaining them is another thing!
> Louis: Are there parallel computations?
> Dirk: We have not yet optimized that, there are possibilities to do things in parallel. This is easy to manage later on.
> Alina, ENTSO-E: On slide 15, is the reliability of the system the same in all cases? (Only cost varies?) You said that relative costs in N-1 are higher than in the probabilistic case due to redispatching. You need also to consider cross-border lines.
> Dirk: we have foreseen the modelling of some topological actions to be implemented
> Bernard: It would be ideal to model three control zones with loop flows.
> Dirk: with three control zones it will be possible to see effects such as N-1 in one zone and probabilistic criteria in other zones.
> Alina: will the platform be accessible online?
> Dirk: this is not fixed yet. An Optimate-like solution could be chosen for a future exploitation.

16:10 "Conclusions and next steps" by Matthias Hofman, WP9 leader

Matthias reminds the status of the project as of today and summarizes the main conclusions.

We have a framework that can work and will allow to make the risk visible while not necessary increasing the risk level.

It appears that Reliability Management is a multi-stage and multi-level decision making under uncertainty.

A prototype quantification platform is available and pilot tests are under way.

Seven challenges to solve by GARPUR are then presented:

- Ongoing work on modelling the multi-stage decision making processes for reliability assessment (proxies), and on how to work with probabilistic indicators if we put ourselves in the shoes of the operator;
- The design of the proxies in general is crucial to ensure as well a realistic assessment as the tractability of the assessment;
- Modelling the degradation process of the assets and the associated failure rate;
- Data availability both for the development & the future use of the methods;
- Translation of high-level aggregated data from market tools to nodal data for grid reliability calculations in a way that takes into account the local variability of load and renewable generation;
- Proxy for short-term cross-border capacity allocation based on an N-1 criterion. This should change if we use a probabilistic criteria;

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- In system development, assumption that cross border capacity constant. In reality variable due to planned outages or other changes in topology.

Matthias concludes with the announcement of a "Report on recommendations towards stakeholders and tentative transition roadmap to evolve from the current N-1 practices" which will address the question on barriers as seen by the TSOs.
Matthias ask to the audience: "*In your views as TSOs, what are the barriers that could prevent or slow down the replacement of N-1 with a probabilistic reliability approach?*

> Discussion:
> Tin: you should think on how to present the whole results and the backgrounds to future users. The main advantage of N-1 is that it is deterministic criterion easy to understand. Operations is not a scientific department and such migration will be difficult.
> Dirk: Maybe the operator do not need to know running the RMAC, a first step would be to bring some predefined elements in their background with predefined contingency list. This could be acceptable.
> Tin: if you have no visibility in this part of calculation, you need to understand what it means with the contingency list management.
> Jussi, Fingrid: it would be good to involve more TSOs from the operational side in the next GARPUR events. Also it would be beneficial to circulate the material in advance to allow people reading it before the workshop and providing inputs during the workshop, because there is very much information.
> Stefan, APG: the way you present it as a first idea, you could also elaborate some use cases.
> Alina: What do you think that can arise by such shifting?
> Efthymios: We did that in WP1 and we ask that in all workshops. We have Guðjón involved in operations for real and could share his experience as operator.
> Louis: we are preparing several deliverables that will be public in month 36. For sure for the next workshop we will send materials beforehand.
>
> Q) What are the next workshop dates?
> A) On 24th August we shall have the joint w/s back to back with Cigre session in Paris. The other dissemination workshops for next year will be scheduled soon.
> Louis: before the publication of deliverables, there is an internal quality process, everything is carefully checked by partners.
>
> Q) Thomas: at Statnett we have a tool (PROMAPS) which ensures some features. They tried to solve the whole problem but the result is not so satisfying. If you do something in operation centres you need to start small and do it right (and not to do everything with low performances).
> Dirk: if you look at the System Operation, in Germany, and how it is operated, you will see that it is not N-1 and due to the increasing RES capacity this will be increased. Things go quickly and this is one reason for the support of TSC.

Sophie concludes the workshop with some announcements. Presentations will be available on the project website on Monday 6th June 2016. A feedback form will be sent to all participants as well as some information about the planning of next deliverables. For next dissemination events, operators are of course welcome.

End of meeting 16:45.

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ANNEX 5: INTRODUCTION OF MR O. GRABETTE TO THE JOINT WORKSHOP GARPUR/ITESLA DURING THE CIGRE PARIS 2016 (FRANCE)

24th August 2016, Paris (France)

18h30 WELCOME ADDRESS New approaches for reliability management in transmission networks

Welcome address by O. Grabette, RTE

It is my pleasure to introduce this workshop dedicated to a very challenging topic for all of us: **"New approaches for reliability management in transmission networks"**

Two R&I FP7-funded projects (iTesla and Garpur) have joined today to summarize some of their respective results-tools, approaches and methods – which will help better addressing network reliability issues:

- iTesla is completed since end of 2015 and is currently deploying the industrialization stage of the most promising tools developed so far as prototypes
- Garpur is still one year ahead of completion, revisiting the well-known N-1 criterion.

Why uncertainty management will matter more and more for TSOs?

TSOs are responsible for the electricity system reliability, even though disturbances may happen at any time.
Uncertainties are already highly multiform in today's electricity systems, like for instance forecasting errors on the power injections or imperfect information sharing between the electric system players.
In the near future, disturbances will also come from an ever growing share of intermittent RES and their massive continental-wide system integration, thus pushing TSOs to operate their network closer to their physical limits while ensuring the security of supply.
Thus, the general pattern "uncertainties // secure operational margins // conservative country-based attitudes to plan, operate or manage the system assets" will no longer be sustainable, since too costly.

iTesla and Garpur: R&I activities to serve uncertainty management

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The iTesla project has developed prototype tools that enable system operators to model and simulate uncertainties and flexibilities to support system operations. It leverages on computational power to achieve more accurate system simulations in order to better appraise its physical limits. More specifically, continental-scale dynamic simulations that

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take into account curative remedial actions are now possible. This will help operators both assessing network security in real time and easing their decision making to keep the electricity system flexible enough.
The GARPUR project digs into a new power system reliability management approach with its related criteria (RMAC) in view of optimally balancing reliability and costs. **The use of probabilistic reliability criteria to supplement the pure preventive N-1 criterion may offer promising alternate routes** for reliability management of the electric system at European level.

Yet, both projects also stress future challenges to implement efficient uncertainty management in the years ahead:

- Developing "proxies", i.e. sets of imbricated approximate models that allows a controlled trade- off between computational speed and accuracy of the resulting simulations.
- Getting a more realistic description of uncertain variables (in particular taking into account their spatio-temporal correlations);
- Improving the risk-based methods to take decisions under uncertainty (semi-automatic steering in operation taking into account corrective control measures which, in turn, enable operators to take appropriate decisions).
- Proposing and developing methods which go beyond the present day N-1 criterion.

----------Conclusions----------

It is our conviction that the application of the "N-1 approach" will reach its limits sooner or later, both in terms of network security and costs (OPEX and CAPEX). We are therefore excited at exploring novel approaches for security assessment and reliability management in transmission networks, this in view of making our electricity systems even more flexible. Let us listen now to some of the results reached so far at research level.

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