*"Innovative **grid-impacting technologies** enabling a clean,*
efficient and secure electricity system in Europe"

Conclusions of the regional expert-workshops and assessment of the overall impact of the regional events

Deliverable 5.8

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This report has been produced as part of the GridTech project "Innovative grid-impacting technologies enabling a clean, efficient and secure electricity system in Europe". The logos of the partners cooperating in this project are shown below and more information about them and the project is available under www.gridtech.eu.

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Executive Summary

The main objective of the GridTech project is to conduct a fully integrated assessment of new grid-impacting technologies and their implementation into the European electricity system. This will allow comparing different technological options towards the exploitation of the full potential of future electricity production from renewable energy sources (RES-E), with the lowest possible total electricity system cost. The time frame of GridTech analyses is up to the year 2050, with a particular focus on the target years 2020, 2030 and 2050.

Under the project framework, regional analyses focusing on RES-E grid and market integration issues to be dealt with in seven target countries – Ireland, the Netherlands, Germany, Spain, Italy, Austria and Bulgaria – within different time horizons were carried out: (i) in the short-term (from 5 to 10 years' time horizon), analyses are focused on technologies that optimize the use of the existing transmission network and on the effects of these technologies on power system operation and integration of RES generation; (ii) in the long-term (target years 2030 and 2050), analyses are focused on innovative technologies implemented to integrate larger shares of RES generation.

In order to guarantee robust methodology implementation, critical discussion and review of preliminary results of regional case studies with regional target groups and stakeholders, a regional workshop was organized in each one of the seven target countries (Ireland, the Netherlands, Germany, Spain, Italy, Austria and Bulgaria). More specifically, the regional workshops aimed at:

- Presenting the interim methodologies applied and preliminary results of the project to the national energy community;
- Gathering feedback from national target groups and stakeholders in order to incorporate the received opinions into the study in order to fine-tune or modify the analyses whenever needed;
- Attracting attention to the final dissemination and communication activities of the overall GridTech project;
- And, most important, trigger overall impact (e.g. in terms of methodology provision, insight into challenges in other European regions, etc.) of the regional events for the entire grid-related RES-E discussion in the region beyond the core objectives and the end of the GridTech project also in the longer-term.

In several of regional events, important feedback was obtained from stakeholders – i.e. TSOs, policy makers, regulatory authorities, RES-E promoters and manufacturers – during the workshops. Suggestions regarding input data and sensitivity scenarios provided by invited experts were taken into account as much as possible into the regional studies. The attendees also confirmed, that the GridTech related events were important to get hints for further discussions in the regions in general and in terms of robust analyses methodology development in particular. In addition, insights into challenges in other European regions were very helpful for the discussion in the own region.

In that sense, this document summarizes the main issues discussed and contributions as well as feedback obtained during each regional case study workshop.

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Acronyms

CHP: Combined heat and power

DG: Distributed generation

DLR: Dynamic line rating

DSM: Demand-side management

DSO: Distribution system operator

ENTSO-E: European Network of Transmission System Operators for Electricity

EV: Electric vehicle

FACTS: Flexible AC Transmission Systems

HTLS: High Temperature Low Sag

NSE: Not supplied energy

OHL: Overhead lines

PHES: Pumped hydro energy storage

PST: Phase-shifting transformer

PV: Photovoltaic

RES-E: Renewable Energy Sources - Electricity

TSO: Transmission system operator

WP: Work Package

1 Introduction

The main objective of the GridTech project is to conduct a fully integrated assessment of new grid-impacting technologies and their implementation into the European electricity system. This will allow comparing different technological options towards the exploitation of the full potential of future electricity production from renewable energy sources (RES-E), with the lowest possible total electricity system cost. The time frame of GridTech analyses is up to the year 2050, with a particular focus on the target years 2020, 2030 and 2050.

For this purpose, pan-European scenarios for future RES generation, as well as for innovative grid-impacting technologies' implementation, have been defined for each target time-horizon (i.e. 2020, 2030 and 2050). The set-up of these scenarios has required the acquisition of a comprehensive set of reliable data. Taking into account these scenarios, two types of cost-benefit analyses for innovative transmission/storage/demand-side technology investments are carried out within the project:

- Top-down, pan-European, analyses (WP4), which enable the analysis of electricity flows in the meshed pan-European transmission grid, and the identification of inter-regional transmission bottlenecks and possible relief actions carried out in a transnational context, through the implementation of different innovative technologies.
- Bottom-up, country-specific/regional, analyses (WP5), which focus on the individual peculiarities of single electricity systems (i.e. a single European target country or area and its neighboring systems).

The regional analyses carried out in WP5 of GridTech introduce the following novel aspects in relation to existing country-specific RES integration studies:

- The regional analyses focus on grid RES integration issues to be dealt within different time-horizons: (i) in the short-term (from 5 to 10 years' time horizon), analyses are focused on technologies that optimize the use of the existing transmission network and on the effects of these technologies on power system operation and the integration of RES generation; (ii) in the long-term (target years 2030 and 2050), analyses are focused on innovative technologies deployed to integrate large shares of RES generation.
- Analyses are carried out of the interdependences ("breathing") that exist between a national electricity system and neighboring ones that result from the use made of regional infrastructure assets (interconnection capacity and storage capacity).
- In-depth annual analyses of the functioning of the targeted regional systems under extreme conditions (summer/winter, high/low load, high/low wind and/or PV generation, dry/wet hydro generation situation, etc.) occurring over short periods of time (from several hours to a few days) are conducted.

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- Based on the above mentioned regional studies, cost-benefit analyses of grid-impacting technologies for different technology portfolios (available in each time-horizon) for each target country are conducted whenever this is possible.

Regional analyses were performed for seven selected countries being mainly characterized by the following features of the electricity system:

- Ireland: high wind and other offshore generation potentials. Despite these potentials, the country faces the challenge of accommodating large amounts of RES production due to the lack of interconnection capacity with neighboring countries and Continental Europe.
- The Netherlands: large potentials for both onshore and offshore wind generation. The country plays a relevant role in the design of the future offshore grid in the North Sea since it may became a major transit area crossed by large power flows coming from the North Sea to supply the load in Continental Europe.
- Germany: country with the highest wind and solar PV installed capacities in Europe. Such high amounts of RES production can have significant impacts in the national and trans-national grid.
- Spain: the country has one of the largest wind penetration shares in Europe and high potentials for solar generation and it may became an important transit country with power flows coming from North Africa to supply load in Europe. High penetration of RES generation added to weak interconnection capacity with the rest of Europe is likely to increase the demand for innovative grid-impacting technologies.
- Italy: high wind and solar potentials. While these potentials are located in the South of the country, demand is concentrated in the North, which leads to the need to transport significant amounts of power over long distances. Furthermore, as well as Spain, Italy may play an important role in interconnecting Europe and North Africa and the Western Balkan.
- Austria: high shares and potentials still to be deployed of pumped hydro storage, which can be operated in combination with large amounts of wind and solar generation to be installed in Northern and Southern Europe, respectively. Nevertheless, in order to enable this combined operation an adequate and sufficient development of the transmission grid is needed.
- Bulgaria: has high wind potential and considerable pumped storage capacity. This storage capacity is of strategic importance to balance generation intermittency in South-East Europe. For this purpose transmission interconnection capacity between Bulgaria and the other countries of the region is needed.

In order to guarantee robust methodology implementation, critical discussion and review of preliminary results of regional case studies with regional target groups and stakeholders, a regional workshop was organized in each one of the seven target countries. More specifically, the regional workshops aimed at:

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- Presenting the interim results of the project to the national energy community;
- Gathering feedback from national target groups and stakeholders in order to incorporate the received opinions into the study in order to fine-tune or modify the analyses whenever needed;
- Attracting attention to the final dissemination and communication activities of the overall GridTech project.

This report presents the main issues discussed and conclusions obtained for each case study during the regional workshops. The lists of participants of the regional workshops are included in the Appendix. Finally, the summary of results and main conclusions of the analyses performed for each target country can be found in (Fernandes et al., 2015a).

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2 Seven regional workshops

2.1 Irish Workshop

The Irish workshop was held on the 4th April 2014 at the premises of Eirgrid (Irish TSO), in Dublin. Due to the early stage of the analyses by the time the workshop was held, the main topics of discussion were the assumptions for 2020 and 2030 analyses and the methodology to be used in the assessment of different technological options. The list of participants can be found in the Appendix (see Figure 1).

2.1.1 The Irish case study

Ireland has high wind-onshore and wind-offshore potentials, but faces the challenge of accommodating and successfully integrating large amounts of wind generation due to the lack of interconnection transmission capacity to neighbouring countries and Continental Europe. The analyses carried out for the Irish case study focused on the above-mentioned issues and take into account the following possible developments:

- The British strategy of RES-E deployment (Scotland, onshore&offshore and Irish Sea);
- The possible Irish interconnection strategy to England and France;
- The neighbouring continental countries, i.e. Belgium and the Netherlands who may still further affect the influence of their strategy on the British and France Grid developments and as a consequence on the Irish connection to these latter countries.

The 2020 case will be considered as a starting point common to all long-term trajectories. In particular it is assumed:

- a Sea Storage plant, Marex/Glimex Project to be connected to Britain;
- an initial deployment of Offshore in the Irish Sea of about 800 MW;
- a reduced gate3 deployment, about 60 % in ROI compared to planned;
- no significant DSM and EV policies are implemented.

The 2030 analyses are considering Demand Side Management, Electric Vehicles and RES+ (increase renewable in Offshore East and West).

Input data, methodologies, results and conclusions of the Irish regional case study are presented in detail in (Mansoldo, 2015).

2.1.2 Discussion and main conclusions of the Irish workshop

At the beginning of the workshop, Hans Auer (Energy Economics Group - EEG) provided an overview of the GridTech project. After that, Angelo L'Abbate (Ricerca Sistema Energetico - RSE) introduced the top down model used in the project WP4 and a few preliminary results of the 2020 scenario. Andrea Mansoldo (EirGrid) illustrated the description of the Irish case study and some preliminary results. Finally, Gerd Schauer (Austrian electricity company Verbund) presented his approach for modelling electrical vehicles.

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The discussions mainly addressed the hypotheses of the analyses and the modelling approach. Important feedback in terms of details/particularities of the Irish electricity system has been obtained during the workshop by different stakeholders. Several of the details and suggestions received have been taken into account in the analyses.

2.2 Dutch Workshop

The regional GridTech workshop for the Dutch case study was held on the 18th September 2014 at the premises of Watt Connects in Arnhem, The Netherlands. Selected representatives of different stakeholders in the Netherlands were invited to this workshop. As the workshop focused on onshore transmission of offshore wind power, organisations related to this subject were especially invited (see participants list in the Appendix, Figure 2).

2.2.1 The Dutch case study

The Dutch case study focused on the possibilities of transporting large amounts of offshore wind power via the onshore transmission network. Wind parks are located at west coast of the Netherlands and the generated power is transmitted from the western part of the Netherlands to the eastern part of the country. An internal virtual boundary consisting of two 380 kV-lines has been created between the western and eastern parts of the country. The n-1 grid transfer capacity of this boundary is used as main input in the (cost-benefit) analysis.

Different innovative technologies to increase grid transfer capacity were compared with increasing transmission using standard overhead lines. More specifically, the 2020 analysis assessed the cost and benefits of increasing transmission capacity of the 380 kV ring by (i) upgrading the existing congested grid and (ii) implementing Dynamic Line Rating (DLR) in this grid. These solutions were compared to a base case scenario without considering these options for increasing transfer capacity. Benefits are assessed in terms of avoided congestions, i.e. avoided wind curtailment/out-of-merit generation dispatch. In the 2030 horizon, apart from assessing the options of upgrading existing lines and installing DLR devices, the alternative of adding a new corridor is also evaluated. Both HVAC and HVDC connections are studied. For the target year 2050, a qualitative assessment focusing on the developments of the European energy policy and the possible effects on the transmission network and storage systems was performed.

Input data, methodologies, results and conclusions of the Dutch regional case study are presented in detail in (van Houtert et al., 2015).

2.2.2 Discussion and main conclusions of the Dutch workshop

During the workshop the main hypotheses and results of the 2020 and 2030 analyses were presented and discussed (by the type the workshop was held, 2050 analyses were not completed). The main topics of discussion concerning 2020 and 2030 analyses are summarized below:

- *Hypotheses regarding off-shore wind parks:*

  In 2020, it is assumed that 1,000 MW of offshore wind and 1,300 MW of onshore wind parks will be connected to the western part of the Netherlands through the onshore transmission network. It is considered that by 2030 offshore wind capacity reaches 3,500 MW and the installed capacity for onshore wind remains equal to 1,300 MW. These amounts of onshore and offshore wind power refer to the capacity connected to the area of study analyzed in the GridTech project. Further capacity will be installed in other areas of the country.

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These figures are important as starting point for the analyses.

- *Assumptions regarding the impact of DLR:*

  There is a strong relation between large amounts of wind power and the cooling of the overhead lines by wind. This effect is much stronger in 2030 than in 2020, because the ration between wind and conventional generation is much larger in the 2030 horizon.

- *HVDC:*

  The study on the effectiveness of HVDC is investigated in a network were the lines are already upgraded to 4000 A.

  Asked questions included: What would be the extra transmission capacity with a HVDC connection when this upgrade was not yet in place? How far should the HVDC transmission capacity be increased to get to the optimum?

  The controllability of HVDC connections is seen as a positive control feature. Furthermore, it has been mentioned that it would be good to look at the possibility to connect offshore wind with an HVDC connection directly to a substation further away from the coast (in the eastern part of the country).

- *Cost/benefit analyses:*

  The cost of wind curtailment is expressed in terms of marginal cost of conventional power plants. The remark from several participants is that it is better to show that the curtailment of conventional power plants is necessary instead of curtailment of wind, because in practice wind is curtailed as a last resort measure. Another suggestion is to change the reasoning and mention the additional amount of RES-E that can be facilitated.

  In the analyses, it was assumed that the system marginal cost during hours with congestion is constant. However, this is only valid for small amounts of curtailed energy. When large amounts of energy need to be curtailed, costs are likely to increase since out-of-merit generation needs to be redispatched. Therefore, the result figures can be considered as lower bounds for redispatch costs, especially for the 2030 analysis.

  During the discussions stakeholders also pointed out the importance of better clarifying indicators such as social welfare *versus* socio-environmental impact and CO_2 emissions reduction versus RES-E spillage, and that conclusions might change when hypotheses (e.g. flexible prices, DSM) change. Finally, it was suggested that a 16 2/3 Hz system might be a good solution for medium to long distances (200-300 km), since it can be cheaper and simpler than HVDC connections.

- *DSM:*

  Stakeholders pointed out that demand side management is a tool for real-time balancing of generation and demand rather than a solution for transmission bottlenecks. Regarding this, it was emphasized that DSM potentials to relieve network congestions is higher at the distribution level than at the transmission level.

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Some of the questions/points raised regarding the 2050 horizon included the following:

- What will be the future of the extra high-voltage transmission grid? It may function mainly as a coupling grid in 2050 since bulk power transport might decrease as a result from large decentralised production.
- Storage will become highly important in 2050. Alternatives include power2gas (although losses are currently still very high), increased interconnection capacity (use of pumped storage in Scandinavia/the Alps) and even the concept of an 'energy island' might become interesting again.

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2.3 German Workshop

The German workshop has held on the 1st July 2014 at the premises of EnBW in Stuttgart. Representatives of utilities, transmission system operators, environmental organizations, regulatory authority and the academia have been invited to the German workshop (see participants list in the Appendix, Figure 3). The discussion covered main hypotheses regarding generation, grid development and the assessed technologies. Furthermore, results for the 2020 horizon study have been presented.

2.3.1 The German case study

The German case study focused on the interconnection of the wind-dominated northern part of country and the solar-dominated south by HVDC lines. Connecting these power areas with HVDC lines will allow supplying the whole country with RES power depending on weather conditions. The German transmission grid is divided in four zones operated by four TSOs: 50Hertz, Amprion, TenneT, and TransnetBW. Due to confidentiality and organizational reasons the consortium has decided to focus the German case study on the region the partners know best, i.e. the control zone of TransnetBW (DE2), taking into account the transfer capacities with the remaining part of Germany and the interconnections with neighbouring countries (DE1).

The control zone of DE2 is highly affected by the North-South power flows, triggered by wind energy located in the North of country. The underlying scenario on the way from 2020 to 2050 is the step by step connection of wind-dominated North and the solar-dominated South with up to four HVDC corridors. The TransnetBW area will be connected to two of these corridors. In GridTech analyses the HVDC solution is compared with other grid extension alternatives. DLR and flexible AC transmission systems (FACTS) devices were assessed in all time horizons (2020, 2030 and 2050). Detailed input data, methodologies, results and conclusions of the German regional case study can be found in (Burgholzer and Heyder, 2015).

2.3.2 Discussion and main conclusions of the German workshop

At the beginning of the workshop, the relevance of the German “Energiewende” (or energy transition) for EnBW as a major European utility company has been emphasized. In 2013, a strategic reorientation has been launched, based on a target to decrease the contribution from conventional power generation by 80 % percent by 2020. This is to be fully offset by strong growth in the areas of renewable energies (250 %), grid infrastructure (25 %) and the decentralised sales business (100 %). Research and innovation projects such as GridTech contribute to position the company as a successful player in the “Energiewende”.

The representative of TransnetBW has also described the national grid development plan process from the point of view of one of the four national TSOs. The TransnetBW control zone, which has been represented in the German regional analyses, is located in the core of the European transmission system and is highly affected by transit flows caused by RES-E generation far away from demand centres. The challenge of the yearly repeated re-calculation of the plan, with about 20,000 working hours on the side of TSO and modellers has been pointed out. In addition, the current TransnetBW grid extension projects inside its control zone, and Ultranet and Suedlink (two of the planned HVDC corridors) have been also

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described. Ultranet is special in terms of innovation by partly using free suspension points on the towers of an existing line.

The bottom-up modelling approach and the first results of scenarios for the German case study have been presented. The market model performs a minimisation of the short-term generation costs on an hourly basis. The results are used to compare several grid extension measures with the current situation. The following scenarios have been analyzed for 2020 horizon:

1) Status quo (reference scenario);
2) Implementation of FACTS and/or DLR;
3) Doubled capacity of transmission power lines with an average annual utilisation of more than 60 %;
4) Minimize not supplied energy (NSE) by installing additional thermal generation capacity at two nodes, where the maximum of NSE occurs;
5) Avoiding the occurrence of NSE by a combination of scenario 3 and 4.

The discussion points are summarized in the following:

- *Model:*

  The model type has been discussed, if a static or dynamic model would be the preferred approach. The model is based on nodal pricing, but it is also possible to implement zonal pricing. The assumptions concerning generation mix is significantly, therefore, conventional plants are considered according to their supposed lifetime and renewables corresponding to political targets. The market model has been evaluated using Austrian data of 2012. A problem of simulations like done in GridTech will persist that there can only be the focus on one of the models (grid or market model), the other then will have weaknesses and impreciseness.

- *Generation:*

  The consideration of CHP plants has been discussed due to the currently changed operating mode, but CHPs are considered as driven by heat demand and not by electricity. The regional generation capacities of DE2 have been derived according to the snapshot of the study model of ENTSO-E. It has also been discussed how to deal with geographical changes of generation development in the grid model. Up to 2020 the development can be aligned with historical values.

- *Grid development:*

  It has been discussed, if the grid development plan considers alternatives to grid extensions. For the GridTech project the measures RES-E curtailment and not supplied energy (NSE) are important indicators for grid extensions. The commitment for TSOs is to achieve a transmission grid free of congestion, but TSOs and the German regulator are already in discussion about these conflicting approaches. In addition, the question if a cost comparison of alternative solutions for parts of a whole measure is considered in the grid development plan. The experts from TransnetBW negated this, because cost efficiency of the supposed measure is a matter of confidence in the know-how of the TSO.

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- *DLR and FACTS:*

  The experts mentioned that DLR should follow not the temperature profile, but the wind profile and that the FACTS premise assuming 5 % transmission excess is wrong under disregard of reactive power flow like done in the model. FACTS controls the shares of load flow between existing lines, but do not allow increasing the overall active power flow.

- *Diverse:*

  An additional scenario has been suggested to consider the current situation in Germany of market-driven closures of thermal power plants before the end of lifetime.

The workshop has attracted the leading scientific institutes which are engaged in grid and market simulation in Germany, thus, the GridTech team has received several valuable remarks. The GridTech approach for the cost-benefit-analysis in general has been endorsed. Owing to the early stage of the simulations in the German case study the whole picture has not become as clear as necessary to evaluate the simulations. Therefore, the responsible modeller of the German case study has continued the discussions with modelling experts from RWTH Aachen and from BET, who have been engaged in the calculations of the German Grid Development Plan.

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2.4 Spanish Workshop

The Spanish workshop was divided into two sessions held on the 10th and 17th October 2014. The attendees included the following experts (see participants list in the Appendix, Figure 4):

- Rodrigo Escobar, analyst expert at the Comisión Nacional de Mercados y Competencia (Spanish Regulatory Authority) involved in ACER and PCI projects;
- José Luis Fernández, System Planning Expert at Red Eléctrica de España (Spanish TSO);
- Roberto Veguillas, Head of Technology Innovation at Iberdrola Renovables (first Spanish RES promoter);
- Alberto Ceña, Technical Director at the Spanish Wind Industry Association (AEE);
- Fernando Nuño, Energy & Electricity Project Manager at the European Copper Institute;
- Fatima Fernández, expert at ABB Technologies Spain.

The presentations included the case description, main hypotheses and results from the analyses performed for the Spanish case study for all time horizons (i.e. 2020, 2030 and 2050).

2.4.1 The Spanish case study

The analyses performed for the Spanish system focuses on different solutions to deal with RES integration issues in the different time horizons, i.e. 2020, 2030 and 2050, and are briefly described below:

- 2020: Use of technologies that allow a higher use of the existing transmission grid without jeopardizing system reliability, such as Flexible AC Transmission Systems (FACTS) devices. In this analysis, the FACTS technology studied refers to a device that re-directs power flows from congested lines to parallel corridors with available capacity (power flow control device). By avoiding or reducing local grid congestions, the device contributes RES generation integration. More specifically, the 2020 study focuses on the installation of the FACTS device in the Southern Spanish transmission network to facilitate integration of RES power coming from Morocco, assuming a significant deployment of RES generation in North Africa by 2020. Since the analysis is focused on installation of a single FACTS device to avoid local grid constraints in the network area close to the interconnection with Morocco, it is assumed that power flows in the remaining interconnections are not affected.
- 2030: Use of innovative technologies, such DSM and storage, to integrate higher amounts of RES generation and avoid significant RES generation curtailment. More specifically, CAES and load-shifting are separately analyzed. Since these technologies are considered to be implemented at the whole Spanish system level and the amounts of RES production integrated are expected to be higher than in the 2020 horizon study, the effects on interconnection power flows can be significant. Therefore, for the 2030 horizon, both the Spanish and the French systems are modelled.
- 2050: In the long-term, massive amounts of RES generation are expected to be deployed. As uncertainties related to grid developments and integration solutions are significantly higher than in the above-mentioned time horizons, two alternative types of solutions are analyzed in the 2050 study: the first one considers the development of an

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HVDC supergrid to bring RES electricity from North Africa to Europe, which is based on the DESERTEC vision1; the second one focus one "local" or country level solutions such as DSM and electric vehicles to integrate RES generation.

Detailed input data, methodologies, results and conclusions obtained from the Spanish regional analyses can be found in (Fernandes et al., 2015b).

2.4.2 Discussion and main conclusions of the Spanish workshop

The workshop was opened with a brief introduction on the major energy challenges to be faced within the next decades in Spain, emphasizing the possible shift of the role of the Spanish electricity in Europe from an "energy island", which has to integrate RES generation internally, to an "electricity hub", which transfers power from North Africa to the rest of Europe. The main discussion points of the workshop are presented below:

Technology issues

Questions raised by attendees regarding the technologies assessed in the Spanish case study comprise the following ones:

1) Which kind of FACTS device has been used? Why?

   A series compensation device. According to the manufacturer ABB and Iberdrola experts, this is the cheapest option since it is as simple as a series reactor. The most complex part is the connection to the existing substation, where there is a need for additional space. According to ABB this is a very fast device.

2) Is there a comparison FACTS vs. new transmission line?

   Only in qualitative terms. At least in the short-term these types of devices can be the only solution for highly congested areas due to environmental constraints and long permitting procedures for new transmission lines. The TSO expert indicated that new technologies are being installed due to the previously mentioned non-technical constrains: e.g. currently, there are two installed phase-angle regulating transformers in the north of Spain. Furthermore, in the new network development plan of the TSO additional FACTS devices are included. The regulator expert pointed out that there is an approved PCI for the installation of a phase-angle transformer at Arkale Substation located at the Basque Country.

3) Which technology of CAES is used? Which efficiency is considered?

   The efficiency considered in GridTech analyses is equal to 65 %. Experts pointed out that, currently, efficiency levels for CAES are in the range of 40-50 %. The attendees believe that CAES is not a good option in Spain, mainly because there are few places to use it, which is different from Germany or Poland, which have many salt mines.

[1] http://www.dii-eumena.com/

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4) What type of DSM potential is considered?

Mainly residential load-shifting was analyzed. Some experts believe that mainly industrial DSM will be activated since it is easier to implement (compared to residential DSM) and benefits for individual customers are higher. It was also pointed out that DSM is a promising option for solving local network constraints at the distribution grid level.

It was emphasized the importance of transferring the benefits of DSM to the final consumers if residential DSM is to be implemented. It was also pointed out that in the Spanish case study it is assumed that the necessary infrastructure for the implementation of direct load control is available.

5) What is the current situation of the HVDC technology?

ABB expert pointed out that is improving day by day, but slowly. Iberdrola expert indicated that the current cost is considerably high. Moreover, the time to build a HVDC connection varies between 8-9 years. Also, the size of the converter changes every year.

The regulator indicated that there are two confronting approaches to integrate RES in EU: macro solutions such as HVDC supergrids and micro solutions such as DSM and storage. The macro approach is being led by the industry (e.g. DESERTEC), while the micro approach is being incentivized by the European Commission.

Input data and modelling assumptions

1) In the first 2030 scenarios running, the interconnection capacity between Spain and France was assumed to increase to 3.1 GW by that year.

Several of the participants agreed that this scenario was rather conservative. Therefore, a new scenario with an ES-FR interconnection capacity of 6 GW was studied.

2) How are the economic benefits of the different technologies evaluated?

The ROM model computes system marginal costs. The benefits of these technologies are evaluated comparing system costs resulting from the cases with/without the assessed technologies. There is a limitation in this analysis since in practice market prices differ from marginal costs. This has an impact on the use of storage (especially PHES) resulting from the model, which is based on differences between hourly marginal costs, and the real use of storage, which is based on differences between hourly market prices. Regarding this, the TSO expert pointed out that the planning studies made by the TSO also use unit commitment models based on marginal costs.

3) RES flow among countries under a joint unit commitment dispatch:

The TSO expert suggested that when analyzing RES flows among countries using a minimum cost approach model it is important to include some kind of fee that would represent energy losses or the priority of "national" RES in each country. This could eliminate results such as having large amounts of curtailment in one country and at the same time large imports of RES from neighbouring countries.

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As a result of the discussions with stakeholders some modifications/sensitivity analyses were implemented to the Spanish regional study:

- Interconnection capacities between ES and FR: the simulations for 2030 and 2050 were repeated considering the (higher) values managed by the TSO and other stakeholders for the time-horizons;
- Priority dispatch for RES-E generation in Spain with respect to imported RES-E generation from other countries was implemented in the model in order to avoid unrealistic results such as importing RES-E from Morocco and spilling it in Spain;
- Finally, as an alternative to macro solutions such as the implementation of a super HVDC grid in 2050, regional solutions (i.e. internal flexibility with DSM and EVs) are also studied for the 2050 horizon.

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2.5 Italian Workshop

The Italian Workshop, organised by Terna Rete Italia (TRI) with the support of RSE, was held on the 9th October 2014 in Rome at Terna premises. That participants list can be found in the Appendix, Figure 5.

2.5.1 *The Italian case study*

Over the past years, Italy has installed a great amount of RES generation, especially PV and wind power, capacity. The fact that a significant share of this capacity is installed in the South of the country while load is located mainly and the central and the northern parts of Italy has considerably increased grid congestions and RES curtailment. In addition, the geographical location of Italy naturally predisposes it to be an electricity hub in the Mediterranean Sea, and it may act as a transit country for power flows coming from North Africa and from South-East Europe. Focusing on these issues, the innovative RES integration solutions assessed in the Italian case study for the different time horizons are the following ones:

- 2020: HVDC (Italy-France interconnection);
- 2030: HVDC interconnections, phase-shifting transformers and High Temperature Low Sag conductors;
- 2050: HVDC interconnections and storage options.

The assessment of these technologies was carried out through the use of the model of MTSIM (Medium Term SIMulator), developed by RSE. This tool represents zonal electricity markets, considering DC optimal power flow. The objective function of the model is the minimization of costs (including load shedding and energy curtailment costs), determining the hourly market clearing over a yearly time horizon.

Input data, methodologies, results and conclusions obtained from the Italian regional case study are presented in detail in (D'Addese et al., 2015).

2.5.2 *Discussion and main conclusions of the Italian workshop*

The Workshop programme developed on a series of topics of interest in the field of power system expansion, transmission grid planning and innovative technologies implementation, which can be split in two main parts.

1) *First part: General remarks on grid developments in Italy and Europe*

At the beginning of the workshop, an overview of the GridTech project has been provided. A representative on behalf of ENTSO-E System Development Committee (SDC) explained the ENTSO-E organisation purpose and mission as dictated by the European Union Regulations in terms of European Network Grid Codes and European Network Development Plan. Furthermore, the overall picture of long term prospects and challenges ahead of the European power system from ENTSO-E's perspective has been provided. A key document in this respect is the biennial TYNDP (Ten-Year Network Development Plan) issued by ENTSO-E since 2010. It was also highlighted that the recent TYNDP2014 includes third party transmission and storage projects (belonging to the list of EC PCIs, Projects of Common Interest) as well as 2030 scenarios evaluation. There is also a focus on long term planning activities ongoing at ENTSO-E level, looking ahead at 2050.

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The need for a possible agreement on the 2050 framework common to the GridTech and e-Highway2050 projects was raised, especially due to the fact that some GridTech partners are also involved in the e-Highway2050 project.

The responsible of transmission grid development studies within Terna and convenor of ENTSO-E System Adequacy and Market Modelling (SAMM) Working Group has reported about the status of the Italian power system. The evolutions of the system and the effects of increasing transmission grid investments over the years 2007-2013 in terms of a significant zonal price differential reduction and gradual inter-zonal congestion decrease has been highlighted. Furthermore, the significant changes of the system introduced by the impact of the booming of RES-E penetration and the financial crisis over the last 6 years have been pointed out.

The last point of the first part illustrated the Italian TSO's experience on the storage devices. After explaining the main issues related to the need for system flexibility as consequence of massive RES-E penetration and load decrease, the potential role of storage devices was highlighted. Furthermore, it has been mentioned that for Terna storage devices like electrochemical batteries can be key solutions for the short term horizon: in fact, Na-S batteries will be used for energy intensive applications, while Li-Ion, Zebra and flow batteries will be implemented for power intensive applications.

The representative from Terna Storage clarified that the storage capacity included in the grid development plan (35 MW) refers to projects that are part of the EC PCI list: within the PCIs, the battery storage projects in Italy will totally amount to a 250 MW capacity.

2) Second part: GridTech studies

In the second part it was introduced more in detail the pan-European study, focusing on the inputs and main assumptions used and on the preliminary results for the interrelated seven regional cases. The ultimate goal of the pan-European study is to apply a techno-economic assessment methodology to the European system's 2020, 2030 and 2050 scenarios fostering large-scale RES-E integration. This study is based on a top-down zonal approach by endogenously including in the model the entire European system (EU30+). The pan-European study exogenously includes the bordering systems of North Africa, Middle East and eastern neighbours (Russia, Belarus, Ukraine, and Moldova) by imposed injections.

It was explained the model MTSIM developed by RSE has been selected also because it takes into account innovative technologies, such as HVDC, PST/FACTS, storage devices, DSM/DR; moreover, a key feature of MTSIM relates to the so-called planning modality, allowing to install additional interconnection capacity whenever it is the most efficient solution (i.e. when fixed yearly interconnection investment costs are lower than the yearly redispatch costs for bottlenecks removal).

The GridTech scenarios were then introduced with their general framework: starting from S0 (base case), three scenarios - S1, S2, S3 - have been developed for each target year (2020, 2030, 2050) having as main drivers two factors: RES-E penetration and technology progress. In addition, the main data, assumptions and results of the pan-European top-down analyses have been presented for the different time horizons and scenarios.

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Finally, the inputs, the assumptions adopted in the Italian regional case and the main results have been presented. For the Italian case study a market zonal approach has been generally adopted: the internal Italian system has been divided into its six market zones (North, Center-North, Center-South, South, Sicily and Sardinia) as the respective inter-zonal sections of the 400/220 kV HVAC grid are frequently constrained. Furthermore, Sardinia is linked through HVDC interconnections with Center-North and Center-South.

The MTSIM tool has also been applied in the Italian case study. The installed RES-E (other than hydro) capacity share over total generation capacity in Italy is foreseen to rapidly grow, from 14 % at 2013 to 33 %, 47 % and 59 % at 2020, 2030 and 2050, respectively. In this situation, the use of innovative technologies can represent a key option. After introducing the main Italian transmission grid projects, especially those ones considered for 2020 and 2030 scenario studies, the innovative technologies which will be taken into account in the Italian case study in presence of significant RES-E penetration were presented: HVDC in 2020; HVDC, PST, DLR, HTLS conductors in 2030; HVDC and bulk storage in 2050.

All the data related to bulk storage and cross-border interconnections are consistent and aligned with the pan-European study. The additional elements and details on Italian HVDC projects, such as the underground self-commutated VSC (Voltage Source Converter)-based link – Italy-France (±320 kV, 2x600 MW maximum, 190 km long) and the submarine line-commutated CSC (Current Source Converter)-based interconnection with Montenegro (±500 kV, 2x600 MW maximum, 390 km long) have been also introduced.

The following conclusions extracted from the discussion are the following ones:

- The drastic change of paradigm in the Italian power system due to the boosting of RES-E penetration over the last years and load demand decrease due to economic crisis is already impacting the system in terms of predominant flows, large reduction of thermal plants operational hours, and need for flexibility;
- To address the new situation, transmission grid expansion is still the key task, also including the use of innovative technologies and new grid operational approaches, at both cross-border and internal system level;
- In the short to mid-term, Italy may still be a net electricity importer, especially from neighbouring Alpine countries, while a trend of net electricity export to Greece can be considered;
- In the mid to long-term (2030 to 2050), a trend of higher net electricity exports to Western Balkans may be considered, but much will depend on the scenario developments for countries like Italy and Turkey, especially in terms of RES-E and load demand evolutions
- The implementation of innovative technologies – such as HVDC, DLR, HTLS conductors, PST, bulk storage, DSM/DR – able to add flexibility to the system, may be a key action for the successful integration of RES-E in 2030 and beyond.

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2.6 Austrian Workshop

The GridTech Austrian case study workshop was held on the 26th June 2014 at the Vienna University of Technology, Austria. Representatives of utilities, transmission system operators, environmental organizations and the regulatory authority attended this national workshop (see participants list in the Appendix, Figure 6). The main topics of discussion included considered assumptions, applied methodology, and preliminary results of the 2020 and 2030 analyses for the Austrian case study.

2.6.1 The Austrian case study

The analyses performed for the Austrian case study for each time horizon are the following ones:

- 2020: in the short-term, it is important to extend the interconnection to Germany, due to high import expectations from Germany. Therefore, the expansion of the transmission power line in Salzburg is necessary to connect the imports with the high PHS capacities in the Alps. Furthermore, the extension in Salzburg is of high interest for closing the so-called “380 kV HVAC transmission ring” in Austria, which is necessary for guaranteeing sufficient security and reliability of supply. In addition, the interconnection to Italy will also be extended;
- 2030: within this time horizon, the main focus of analysis is the final closing of the 380 kV circuit in Austria, whereby the last missing part is located in the south, in Carinthia. Furthermore, the expansion of the TPL in Tirol, which forms a bottleneck between western and eastern Tirol, will also be analysed. In comparison, a general flexibility via DLR and FACTS is analysed separately and also in combination;
- 2050: in the long-term, a RES-E share of 64 % is assumed for Austria; especially the increase of Wind and PV capacity is significant. Therefore, in order to provide more flexibility in the transmission system one focus will be to analyse the impact of DLR and FACTS. The second emphasis is set on the extension of PHS capacities (turbine as well as pumping capacity). This could provide to neighbouring countries, e.g. Germany, more flexible generation and additional storage potentials. Furthermore, the impact of high/low annual production of RoR is analysed. Finally, the focus of analyses is set on the first interconnection to Slovakia, a 2 GW HVDC line.

Input data, methodologies, results and conclusions of the Austrian case study are described in detail in (Burgholzer et al., 2015).

2.6.2 Discussion and main conclusions of the Austrian workshop

At the beginning of the workshop, the project objectives, the grid impacting technologies and the cost-benefit-analyses (CBA) methodology have been explained. In addition, the considered target years for the pan-European analysis (top-down modelling) and for the seven target countries (bottom-up modelling) have been stated. The comparison of ENTSO-E’s CBA of the projects listed in the Ten-Year Network Development Plan (TYNDP) and the Projects of Common Interest (PCIs) with GridTech’s approach has been shown.

A representative from the Austrian TSO APG stated the major objectives of the APG Masterplan for 2030: (i) power supply from an overall system view, (ii) APG responsibility to

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meet predefined security of supply standards and (iii) the development of the Austrian transmission grid to meet several other national needs. The implications of the European and Austrian energy policy towards RES penetration cause critical grid situations and increase the need for expanding transmission capacity in Austria. The NOVA-Prinzip (NetzOptimierung Vor Ausbau, i.e. grid optimization before grid expansion) has also been explained, which has been being applied by APG for years.

The next discussion point was the approach for modelling electrical vehicles (EVs), which belongs to the category of Demand Side Technologies (DST). The EV simulation model of Verbund, the values of the potential charging power and the influences of the chosen business model have been presented.

In the last part of the workshop, the methodology of the bottom up model for the Austrian case study analyses and the first results for the time horizon 2020 were discussed. In addition, the calculation of the PTDF matrix for the DC load flows and the modelling approach for EVs, FACTS and DLR have been shown by the modeller. The influence of the considered assumptions for the European and Austrian case study and those of the inputs of the top-down modelling on the results of the national analyses have been pointed out. The first results for the time horizon 2020 for two different scenarios, without and with transmission expansion of the Salzburg transmission line, have been presented and, furthermore, preliminary results for the year 2030. For 2030 five different scenarios have been simulated and analysed:

- without expansion of transmission power line in Carinthia;
- without expansion, but with FACTS and DLR;
- with expansion;
- with expansion and extended transmission capacity to Italy;
- with expansion and EV modelling.

During the discussion, a representative from the utility has proposed that a weighted Merit Order curve with full load hours would be a good representation to show the behaviour of the electricity system on average. A representative from the TSO has stated that the currently existing PTDF matrix should be checked for exchanges with neighbouring countries. He offered to check the susceptances and maximum transmission capacities.

Several participants suggested that further scenarios could be interesting for GridTech analyses:

- 2020/2030: shutdown of Mellach Combined Cycle Gas Turbine Plant (832 MW Capacity) and study of the behaviour of the electricity system in that region;
- 2030: removal of one of the 220 kV transmission power lines inside of the 380 kV circuit;
- 2050: upgrading of all 220 kV TPLs to 380 kV in Austria; high PHES scenario.

A representative of the Austrian Regulator mentioned that the defined scenarios and assumptions are very important. For example, in the European “E-Highways” project, the expansion path of the Austrian wind capacities is assumed to be too conservative. He

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emphasized that the duration curve of the wind generation is also critical. The full load hours should be greater than 2000 hours in the long-run. The representative from the Austrian DSO has remarked that in practice several of the transformers (i.e. the older ones) cannot manage large scale DSM implementation. In general, participants agreed on the scenarios and assumptions defined previously to the workshop.

The potential of pumping capacity for the time horizons 2030 and 2050 was also discussed. There is a study of Pöyry, which analyses the potential of pumped hydro storage capacity in Austria. This is a good indication for the high PHS scenario definition.

Finally, it was mentioned that the final results will be presented in a special session in the "9. Internationale Energiewirtschaftstagung 2015" (IEWT 2015). The conference will be held from 11-13 February 2015 at the Vienna University of Technology.

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2.7 Bulgarian Workshop

The Bulgarian GridTech Workshop was held on the 27th June 2014 at the Press Centre of the Bulgarian Ministry of Economy and Energy, in Sofia. The event gathered representatives of the Ministry of Economy and Energy, Sustainable Energy Development Agency, investors in wind and solar energy, environmental organisations, electricity distribution companies, engineering companies, consultants and the media (see participants list in the Appendix, Figure 7).

2.7.1 *The Bulgarian case study*

The Bulgarian case study mainly focuses on the development of the transmission grid, especially in the North-East of Bulgaria where wind power plants are located, and on the increase of storage capacity. More specifically, the technologies analyzed in the different time-horizons are the following ones:

- 2020: increase of transmission capacity in the North-East of Bulgaria by building new transmission lines using either conventional Aluminum Stranded Conductor (ASC) with DLR devices or High temperature, Low Sag (HTLS) conductors; increase of PHES storage capacity by enlarging down reservoir “Yadenitsa” of existing PHES “Chaira”.
- 2030: further increase of transmission capacity in the North-East of Bulgaria by building new transmission lines using either conventional Aluminum Stranded Conductor (ASC) with DLR devices or HTLS conductors; construction of new PHES (148 MW); introduction of EVs (2 % of penetration - 35,000 vehicles); and implementation of DSM (from 20 MW to 100 MW, depending on price signals).
- 2050: 10 % penetration level of EVs (180,000 EVs); and increase of DSM participation (from 120 MW to 225 MW, depending on price signals).

Detailed input data, methodologies, results and conclusions obtained from the Spanish regional analyses can be found in (Andreev et al., 2015).

2.7.2 *Discussion and main conclusions of the Bulgarian workshop*

First, a short overview of the expected RES-E deployment in Bulgaria, the relations between producers and the grid, and the existing challenges faced by the Bulgarian system was provided. Afterwards, the objectives, scope of work, methodology, and expected results of the GridTech project were presented. Special attention has been laid on the innovative generation, balance control and grid technologies required for the smooth integration of RES production.

Afterwards, the several technological options for RES integration and the interim results of the 2020 Bulgarian analyses were described. The results of the power flow analyses when wind installed capacity is increased showed the need for the construction of a double 110 kV power line, which would remove constraints to generation located in the North-East part of the country.

Two alternative technologies for increasing transmission capacity were analysed:

- Regular aluminium conductors with Dynamic Line Rating (DLR);
- High Temperature Low Sag conductors (HTLS).

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The analyses have been conducted by the "Resource Optimization" model of Siemens.

The following topics for further analyses have been proposed during the workshop:

- Investment costs for the different technologies;
- Approaches for the assessment of benefits other than social welfare, such as power system reliability;
- Expected operation life of the different technologies.

The second presentation was devoted to the discussion of the interim 2030 results. In the 2030 analyses, the following technologies were assessed: PHES, DLR, HTLS, accumulators, EVs, and DSM. It was estimated that transmission network should be enhanced by conventional 400 kV lines and 400/110 kV substations in order to integrated wind power to be installed in the North-East of Bulgaria by 2030.

Some of the main contributions/comments from received during the workshop are listed below:

- The ex-Director of ESO EAD (Bulgarian TSO) has estimated highly the approach of the project, which aim is to contribute to RES-E integration at lowest possible cost by implementing innovative technological solutions;
- A very substantial intervention was made by the Chief expert at EU Sunday AD (solar power investor owning 61 MW of solar capacity). A persistent appeal for the implementation of technological solutions to solve grid constraints and to further integrate RES generation was made;
- The director of "Security of energy supply" Directorate at the Bulgarian Ministry of Economy and Energy indicated the need for coordination between the development of RES power and the development of the transmission and distribution systems with the use of innovative grid technologies. A critical issue in Bulgaria is the cost of developing the required infrastructure to integrate RES power due to the overall economic situation of the country.
- The importance of the progress of hydrogen-based technologies for storage and power balancing was also pointed out;
- The director of the engineering company TECHENERGO AD commented on the advantages of distributed generation (DG) versus bulk power and recommended to Bulgarian policy makers to incentivize the development of DG in the country;
- Demand-side technologies were especially recommended by the experts, as among the cheapest and most effective technologies for integrating RES.

The following main conclusions could be obtained from the discussions:

- Due to grid constraints and the difficulties to implement low cost solutions, the Bulgarian TSO is forced to limit RES production;

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- The national transmission system needs investments to increase transmission lines' capacities and to implement innovative technologies for power flow control and demand and generation balance already by 2020;
- The deployment of wind potentials in the north-eastern part of the country requires the construction of new 400 kV lines and substations by 2030;
- Innovative technologies, such as DLR, HTLS conductors, accumulators, EVs, DSM, will be needed for an efficient integration of RES generation by 2030.

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3 Conclusions and assessment of the overall impacts

The seven regional workshops organized under the framework of the GridTech project have attracted the attention of leading industry and industry institutions' experts, policy and decision makers, associations, NGO's as well as representatives from applied and scientific research institutes. During the workshops, discussions regarding the currently ongoing and the future of RES-E deployment based on traditional as well as innovative grid solutions provided important inputs for the detailed GridTech analyses, on the one hand. On the other hand, the regional experts appreciated to get insights into the technical, economical and societal-economic challenges having to be faced in other European regions in the context of RES-E grid integration and confirmed that this will significantly support them when trying to find solutions for a smart integration of large shares of RES-E into their grids not only in the short-term, but also in the longer-term. This is very important for each of the regions (target countries) also in the context to meet the 2020 and future RES-E targets.

In that sense, several of the regional GridTech events finally resulted in a win-win situation for all experts involved:

- On the one hand, the experts within the GridTech consortium got valuable feedback from the regional experts to fine-tune the case study and to streamline the analyses with the needs and particularities of the individual regions. Furthermore, networking among the experts also has triggered further activities in parallel (besides the GridTech project), finally also supporting accelerated RES-E grid integration in a region and so meeting the upcoming RES-E policy targets.
- On the other hand, several of the experts in the region have met to commonly discuss the status quo as well as the future strategies/policies of further RES-E grid integration with international/European experts. This has resulted in a better common understanding of the challenges. Moreover, the regional experts also benefited from the methodologies applied in the GridTech, notably those to analyse the longer-term time horizons up to 2030 and 2050 (at present, the 2020 horizon only was – more or less – tangible for them). The regional experts explicitly confirmed, that the GridTech related events were important to get hints for further discussions in the regions. In addition, insights into challenges in other European regions are very helpful for them to shape the future in the own region.

In that sense, several of the regional workshops have been successful since they triggered overall impact to the entire grid-related RES-E discussion in the different regions also beyond the core objectives addressed in the GridTech project and also beyond the end of the GridTech project duration.

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5 Appendix

Participant lists of the regional workshops

Martin

Security, Oval

From:	McCarthy, Martin
Sent:	02 April 2014 13:13
To:	Reception; Security, Oval
Subject:	Visitors for Friday morning
Categories:	Red Category

70364 Friday 9. am

Hi folks,
The following people have registered for a full day (9-3.30) workshop on Friday.

Can you arrange visitor passes for them please? If possible with their names on them.
Let me know if this is not possible.

On the day I can be contacted on 085 7200522 if we have any issues or if some smokers manage to escape and can't get back in.

Also, if we could get the lock on the 5th floor lobby released on Friday it would be great.
Thanks.

Martin \ Customer Relations \ 70364 \ W02-019

18 No SHOWS

Brian Mongan	AES UK & Ireland
~~Ciaran O'Brien~~	Bord Gáis Energy
~~Damian Wilson~~	Budget Energy Ltd
~~Denis Cagney~~	Commission for Energy Regulation
~~Jim Cronin~~	Cronin Energy Consulting
~~David McMullin~~	Enercon
Eamonn Lannoye	EPRI International
Mohammad Mousavi	ERC
Dr Nestor Aparicio	ERC
John Whelan	ESB
Fergus Sharkey	ESB
Shane O'Sullivan	ESB - Generation
Liam Kieran	ESB G&WM
Paul Doyle	ESB GWM
Pearse Corbett	ESB International
Paul Cash	GridConnect
Héctor Usar	GridConnect
~~Carlos Galvan~~	GridConnect
Neil Walker	IBEC
Frank Burke	Independent Consultant
~~Mary Doorly~~	IWEA
~~John P O'Sullivan~~	JOSPA
Joe Corbett	Mainstream Renewable Power
~~Sinead Brennan~~	MullanGrid Consulting
~~Rory Mullan~~	MullanGrid Consulting
~~Gorman Hagan~~	NIE
Frank Fergusoon	NIRECON
~~Sam Alexander~~	Northern Ireland Electricity
Brian Wilson	Northern Ireland Electricity
Michael Hewitt	Northern Ireland Electricity
~~Paul Dempsey~~	Premium Power
~~Alan O'Kelly~~	Premium Power
~~John Mc Cann~~	SEAI
~~Daniel Duggan~~	Siemens
~~Marian Troy~~	SSE
Donal O'Sullivan	Trinity College
Clara O'Dwyer	UCD
Billy Walker	URegNI
John Brennan	Wind Prospect
~~Peter King~~	Wind Prospect
Cian Fitzgerald.	
Patrick Liddy	

Figure 1: Participant list of the Irish case study workshop.

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*"Innovative **grid-impacting technologies** enabling a clean,*

efficient and secure electricity system in Europe"

Presentielijst Workshop 18 september 2014

Naam	Organisatie	Paraaf
RUTGER VAN HOUTERT	TENNET	
Kees Jansen	TenneT	
Gert Bos	TenneT	
Richard de Groot	DNV GL	
Wim van der Veen	DNV GL	
Peter Wouters	TU/e	
Lennart Verheijen	Enexis.	
Josco Kester	ECN	
Mihai Broekmans	Stedin	
Jaap de Boer	Energy Watch	
Hans Scholten	Energy Watch	
Herman van Doorn	ECOFYS	
Joris van Doorn	Ecofys	
Gerrit van Zuylen	TKI Wind op zee	
Inge Janssen	TenneT	
Mart van der Meijden	TenneT	

Figure 2: Participant list of the Dutch case study workshop.

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List of Participants

	Name	First Name	Institution	Signature
1	Auer	Hans	Techn. Universität Wien	
2	Awater	Philipp	RWTH Aachen	Ph. Awater
3	Bertsch	Joachim	EWI, Universität Köln	
4	Bothor	Sebastian	IER, Universität Stuttgart	
5	Brunner	Christoph	EnBW	
6	Burgholzer	Bettina	Techn. Universität Wien	
7	Dr. Suriyah	Michael	KIT Karlsruhe	
8	Gunkel	David	TU Dresden	D. Gunkel
9	Hagspiel	Simeon	EWI, Universität Köln	
10	Heyder	Bernhard	EnBW	
11	Hinz	Fabian	TU Dresden	
12	Kubiczek	Tim	TransnetBW	
13	Loitz	Sönke	EnBW	
14	Dr. Nolte	Isabell	TransnetBW	Isabell Nolte
15	Schuffelen	Lukas	BET	
16	Slednev	Viktor	KIT Karlsruhe	
17	Unterberger	Sven	EnBW	
18	Wolpert	Jürgen	TransnetBW	J. Wolpert

Figure 3: Participant list of the German case study workshop.

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UNIVERSIDAD PONTIFICIA ICAI ICADE COMILLAS MADRID
INSTITUTO DE INVESTIGACIÓN TECNOLÓGICA

Regional Stakeholder Workshop Spain
Madrid, 10th of October 2014

www.GridTech.eu - Impact Assessment of New Technologies to Foster RES-Electricity Integration into the European Transmission System

Venue
Institute for Research in Technology, Comillas University, Santa Cruz de Marcenado 26
28015 Madrid

Workshop language: Spanish

Nombre	Organización	Firma
Pablo Frías	IIT-Comillas	
Luis Olmos	IIT-Comillas	
Camila Fernandes	IIT-Comillas	
Antonio Malpica	IIT-Comillas	
Roberto Veguillas	Iberdrola	
José Luis Fernández *	Red Eléctrica de España	
Fátima de la Fuente	ABB	
Alberto Ceña	Asociación Empresarial Eólica	
Rodrigo Escobar*	CNMC	
Fernando Nuño	Copper Alliance	

* 17th. October.

Figure 4: Participant list of the Spanish case study workshop.

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Regional Stakeholder Workshop Italy

Rome, 9th of Oct 2014

Via Marcigliana 911

Roma

Impact Assessment of New Technologies to
Foster RES-Electricity Integration into the European Transmission System

LISTA PARTECIPANTI

	Partecipanti	Società
1	Luigi Apicella	Terna Storage
2	Davide Astiaso Garcia	ANEV
3	Andrea Bianco	TRI
4	Roberto Calisti	RSE
5	Francesco Careri	RSE
6	Oreste D'Addese	TRI
7	Giuseppe Dell'Olio	GSE
8	Davide Falabretti	POLIMI
9	Maria Teresa Fiore	GSE
10	Modesto F. Gabrieli	TRI
11	Angelo L'Abbate	RSE
12	Mihai Paun	ENTSO-E
18	Carlo Panachia	TRI
13	Alessio Sallati	TRI
14	Pietro Tisti	TRI
15	Fabrizio Vedovelli	TRI
16	Chiara Vergine	TRI
17	Andrea Zaghi	assoRinnovabili

Figure 5: Participant list of the Italian case study workshop.

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Impact Assessment of New Technologies to Foster RES-Electricity Integration into the European Transmission System

Agenda – Nationaler Workshop
Netzintegration Erneuerbarer Stromerzeugung

TU Wien, Donnerstag, 26. Juni 2014, 10:00 – 13:00

TEILNEHMERLISTE

Name	E-Mail	Unterschrift
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Figure 6: Participant list of the Austrian case study workshop.

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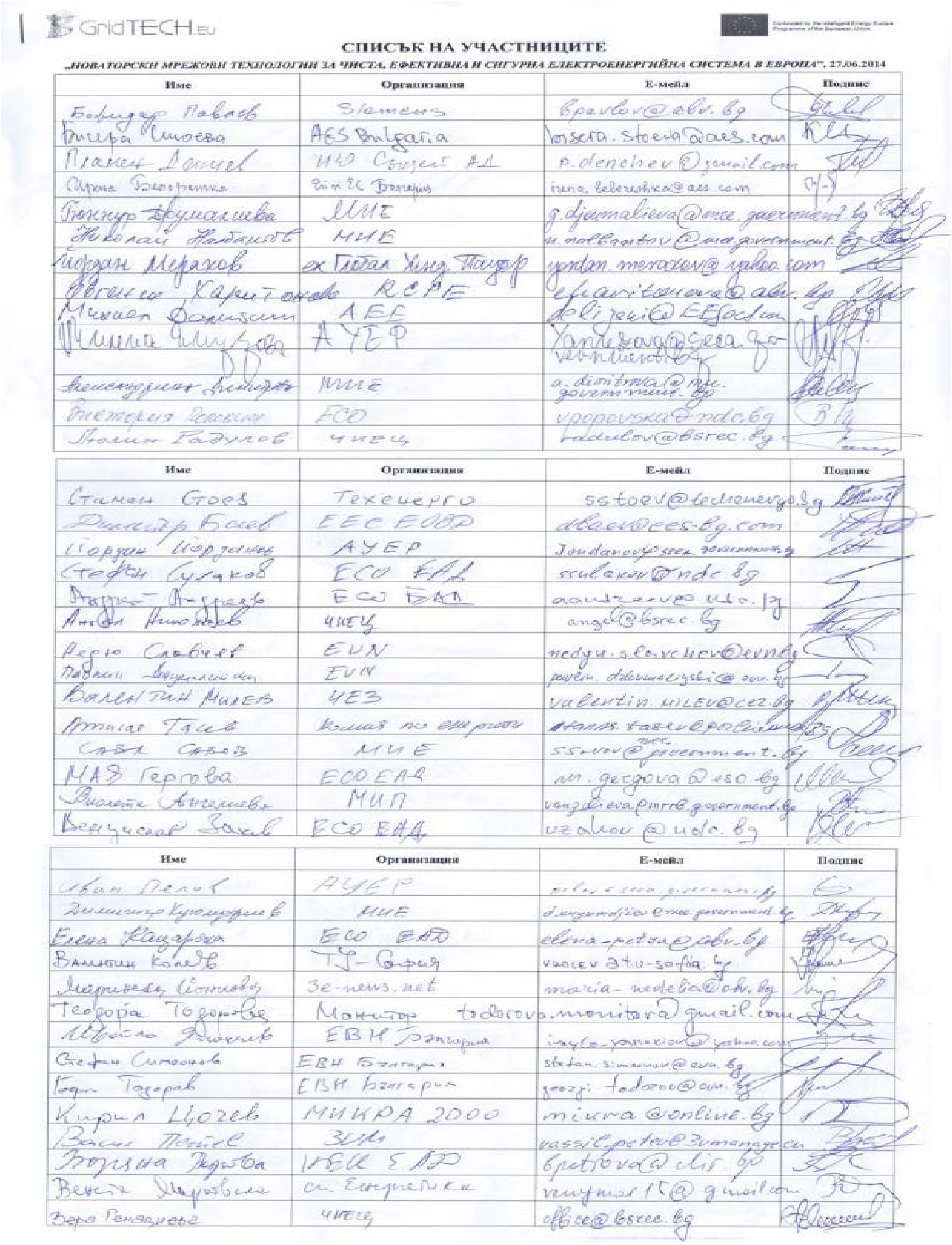

Figure 7: Participant list of the Bulgarian case study workshop.

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