CONSULTATION DOCUMENT
645/2017/R/EEL

INCREASING THE RESILIENCE OF ELECTRICITY TRANSMISSION AND DISTRIBUTION NETWORKS

Activities carried out and further guidelines

Consultation document

as part of the proceeding initiated with AEEGSI resolution 483/2014/R/eel

21 September 2017

TRANSLATION of chapter 1 (out of 7)

1. Context and Overview

Resilience: network robustness and recovery capability

1.1 Over the course of recent years, there has been a significant increase in prolonged interruptions of the electricity supply due to extreme, particularly violent and wide-ranging meteorological events. Particularly significant events include those that occurred in Emilia Romagna and Lombardy in February 2015, when over 360,000 customers were without power for more than 8 hours, and more recently in the Abruzzo and Marche regions in January 2017, with disruptions that lasted over 72 hours for 39,000 customers[1].

1.2 In these events, there was, on the one hand, structural failure of transmission and distribution networks due to the structural infrastructure design limits being exceeded (in particular, the "ice sleeve" phenomenon that tends to form on naked conductor of the overhead power lines in the presence of wet snow and wind, or trees outside the buffer zone falling onto power lines due to the weight of wet snow), and, on the other hand, the difficulty of implementing the distribution companies' emergency plans for a number of exceptional reasons, such as impassable roads.

1.3 Appendix 1 of this document shows, at national and regional level, the number of customers without power for more than 8 hours and for more than 72 hours, which reveal that the impact on electricity networks of particularly severe weather events, whose occurrence is very hard to predict, except, for certain phenomena, just before they occur, can vary widely both in space and over time.

1.4 On a national level, minutes lost per user due to interruptions caused by *force majeure*, due largely to the events mentioned above, reached worrying peak levels in the period 2012-2015 (58 minutes lost per user in 2012, 69 in 2015), in comparison to peaks that, up until 2011, had reached at the most 32 minutes lost per user in 2004[2].

1.5 There are two aspects to increasing the resilience of a system that need to be investigated: on the one hand, it is possible to increase *network robustness* by raising the design limits that identify the infrastructural capacity to withstand extreme stresses; on the other hand, improvements can be made to the effectiveness and promptness of *recovery*, i.e. the system's capability to return to acceptable working condition, even by means of temporary interventions[3].

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[1] Approximately 2,800 of these were without power for more than 7 days.

[2] See graphic C in appendix 1 for reference.

[3] Network robustness and the ability to recover an electricity network can also be enhanced by preventing and mitigating the possible consequences of severe environmental phenomena. Prevention includes the adoption of "networking" actions such as those described in the second part of point a) of point 2.16 (under iii for ice and snow phenomena, under ii and iv for each phenomenon) or management" actions for restoring the supply (see appendix 4, prerequisites and risk reduction). The mitigation also includes

1.6 For example, for an electric system exposed to snowfall with "ice sleeves" forming along the naked conductor of the overhead power lines, increasing network robustness can be performed by raising, to an economically sustainable level, design limits of stress in relation to loads caused by ice and wind. Temporary re-powering could be, for example, supplying electricity using generators in areas where the network has been damaged due to stresses exceeding design limits.

1.7 It is important to emphasise that increasing resistance cannot be limited to increasing network robustness, since a system with high resistance entails higher costs (that increase beyond proportion to the expected increase in network robustness). These higher costs may not be justified in relation to the benefits that can be obtained, provided that it is possible to estimate these benefits with a sufficient level of confidence. Therefore, the overall performance of the system's resilience can be improved only by means of the adequate balancing of actions aimed at increasing network robustness and actions aimed at improving recovery capability.

The Authority's aims and actions

1.8 The Authority has already begun work to improve network resilience. The Authority's objective is to promote, including through the use of new regulatory tools, an increasing in resilience of electricity distribution and transmission systems, seeking the best "mix" of greater network robustness and more prompt and efficient recovery.

1.9 With the reward-penalty regulation of energy not supplied by the transmission network, in force since 2008, the Authority had already introduced elements of holding Terna responsible, including for interruptions due to the exceeding of design limits (caused by *force majeure*): indeed, within this context, Terna is responsible, albeit with the "smoothing mechanism" of effects, even for large-scale interruptions caused by *force majeure*[4].

1.10 Regarding electricity distribution, the incentivising regulation for service continuity, however, excludes outages due to *force majeure* from the category of interruptions that contribute to the determination of improvement objectives and their verification for the purpose of calculating rewards and penalties.

1.11 In December 2015, following the consultation process prior to the fifth regulatory period, the Authority established, with the Decisions on the output-

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the adoption of the "network operating" actions (second part of letter a) of point 2.16 (under (i) for ice and snow phenomena) or "management" actions aimed at restoring the supply (see appendix 4, preparedness and emergency management).

[4] This regulation includes the energy (entire or partial) not provided due to interruptions caused by exceptional weather events as part of the energy which is not subject to benefit-penalty regulation (subsection 3.4, sub-paragraph 3.5, letter b of annex A to resolution 653/2015/R/eel).

based regulation of electricity transmission and distribution services[5], that the main network operators must prepare work plans for resilience improvement.

1.12 With regard to the electricity network robustness, in March 2017, the Authority's Energy Infrastructure and Unbundling Directorate, following a request from network operators participating in a specific "Resilience Task-force"[6], identified a methodology to be applied by network operators[7], aimed at identifying the most vulnerable parts of electricity networks in relation to the various adverse meteorological phenomena (also called critical factors: "ice sleeves", floods from heavy rainfall or "cloudbursts" etc.). In addition, cost-benefit analysis was started for each risk mitigation intervention.

1.13 Finally, regarding supply restoration in the event of prolonged outages, Resolution 127/2017/R/eel stipulates that, from 1 October 2017, network operators are liable for compensation awarded to customers for interruptions triggered by *force majeure,* for the share exceeding the outage limit of 72 hours. Moreover, also as of 1 October 2017, this compensation will increase with the interruption up to a maximum of 10 days, and so will no longer be subject to the previous financial compensation limits (see Section 2.8 below).

Network replacement and development investments

1.14 The main drivers that have led development investments on electricity distribution networks over the course of recent years include the following:

a) in certain areas with a relative shortage of distributed generation, adaptation to increased demand for electricity, which, however, has seen in general a period of reduction in intensity due to the economic crisis;

b) since 2000, and more intensively since 2008, the regulation of the continuity of service governed by the Authority resolutions;

c) since the two-year period 2008-2009 and particularly in the years 2010 to 2012, the connection to the network by the generation from renewable sources, in particular photovoltaic.

1.15 These drivers, in particular that referred to in point c) above, have had a major impact on both development and operation, especially of distribution networks, which, in their progressive transformation from passive to active networks, have benefited from the improvement of SCADA systems, as well as the development of tools for monitoring and regulating electrical indices within a smart grid logic with increased network intelligence and flexibility.

[5]Annex A to the resolution 646/2015/ R/eel (TIQE) and 653/2015/R/eel (TIQ.TRA). In particular, the provisions concerning the preparation of the work plans are contained in article 77 of the TIQE and in article 37 of the TIQ.TRA.

[6] Established with the Determination of the Authority's Infrastructure Directorate, 6/2016/DIUC, in the implementation of point 3 letter c) of resolution 646/2015/R/eel.

[7] Determination of the Authority Infrastructure Directorate 7th March 2017, 2/201 /DIEU "Guidelines for the Presentation of Work Plans for Increasing the Resilience of the Electrical System - Part One".

1.16 Regarding the transmission network, further drivers of development include the integration of markets at both domestic and European level and the upkeep of safety, particularly as a result of the increase in unplanned energy production and the reduction of conventional thermoelectric energy production.

1.17 Analysis becomes more complex when focus is shifted towards the investments intended for the renewal of distribution and transmission networks. Network renewal decisions are influenced by many factors: in addition to technical requirements (such as technology modernisation) that should play a major role, renewal decisions may be affected by both costs recognition (remuneration for such assets is carried out in accordance with the rules established by the Authority over a period of time corresponding to their regulatory life) and economic or financial considerations linked to specific company or group objectives. In particular, in relation to financial-economic business evaluations, for distribution companies, the limits of financial capacity may be related to the multiple fields of activity in which the integrated groups to which the distribution companies belong operate, while Terna activity is mainly directed at the core business of transmission and dispatching.

1.18 With reference to the relationship between development and renewal investments, Appendix 2 of this document presents the result of the preliminary quantitative processing of data on investment in transmission and distribution networks, using an index created to provide primary broad-based indications of the "level of investment" in infrastructure. This index compares the investment ratio with the economic depreciation of existing assets. This index assumes positive values if the investments exceed depreciation; vice versa, it is negative if investment is less than depreciation. The presumed value of the index also depends on several factors, such as the intertemporal variation in the value of the money, the technological solutions adopted (for example, developments in smart grid logic require fewer investments in "copper and iron" and more in control systems) and the efficiency in performing the investments, the evaluation of which requires specific technical analysis of the consistency and quality of the service, as well as analysis of efficiency in procurement and development policies.

1.19 Even with such caveats, and also bearing in mind that certain useful regulatory lives vary between transmission and distribution assets, observation of the values assumed by the "investment level" index shows a marked differentiation between the e-distribuzione (major Italian DSO) network and the transmission system (with significantly lower index levels for the former, as compared to the latter).

1.20 All of the above reinforces the Authority's position with regard to the opportunity of performing further in-depth analysis of the methodologies used by distribution companies to make decisions on (mostly distribution) network renewal, including in relation to the ageing of components, and more generally to the "state of health" of the network.[8]

[8]In this context, see "DNO Common Network Asset Indices Methodology. Health and Criticality. Version 1.0 - 01/08/2016" set up by the British Electrical Distributors Association, available on the UK

Consultation aims and summary of guidelines

1.21 With this consultation, the Authority intends to present an overview of possible incentive mechanisms, not only financial but also reputational, which must be consistent with:

a) the twofold component of resilience, thus insisting both on increasing network robustness and on the increased efficiency and promptness of restoration;

b) the need to limit as far as possible the overlapping of effects among different incentive mechanisms, in particular those that are already in place for the continuity of service (which, as mentioned above, vary from distribution to transmission from the point of view of inclusion/exclusion of interruptions due to *force majeure*);

c) the perspective of ever increasing integration of tariff and quality regulation, projected towards two main directives: on the one hand, a forward-looking approach that will involve increasingly the planning of investments and management activities (medium-term business plan); and a "total expenditure (totex)" approach for the recognition of costs that exceed the current regulatory disparity for the recognition of capital expenditure (capex) and operational expenditure (opex).

1.22 The Authority intends to outline guidelines for the Development Plans so that the forward looking approach outlined above will be put into effect during the current regulatory half-period 2016-2019 (see Chapter 4). From a reputational incentive perspective, the Authority establishes that, for larger companies, as of 2018, a path should be set up for the gradual integration of existing development plans, plans for resilience and plans for technology renewal of the network into Distribution Integrated Plans (IDP), and for their progressive publication, including through the monitoring of their implementation and possible deviations. Within this context, the Authority also believes that investment selection processes for distribution networks should be increasingly supported by appropriate cost-benefit analysis to be publicly highlighted.

1.23 The Authority also intends to consider introducing forms of incentives for interventions by operators to increase network robustness (see Chapter 5) and to speed up and improve the efficiency of the recovery phase, also including prevention and preparatory measures (see Chapter 6).

1.24 With respect to increasing network robustness, three options are presented, applying the RIA (Regulatory Impact Assessment) methodology:

a) to establish only the reputational incentives described in Chapter 4, in the event that the Ministry of Economic Development (see also points 1.28 and 1.29), according to that forecast in the recent consultation on the National Energy Strategy, decides to introduce any obligations for the recovery and

regulator’s website: www.ofgem.gov.uk/publications-and-updates/decision-dno-common-network-asset-indices-methodology

technological modernisation of outdated and inadequate network parts (option *TE-0*);

b) to introduce an incentive mechanism in the form of penalties in the event that the distribution company does not perform at least the "high priority" interventions to increase network robustness within an appropriately established timeframe (option TE-1);

c) in addition to the penalties of the previous option *TE-1*, in the case of failure or delay in implementing "high priority" interventions, to introduce a further incentive mechanism in the form of rewards, subject to certain conditions (option *TE-2*).

1.25 Again with respect to accelerating the recovery of supply, three options are presented in compliance with the RIA (Regulatory Impact Assessment) methodology:

a) to maintain existing regulatory obligations in terms of management of emergencies, which provide for the regular updating (and improvement) of the distribution companies' emergency plans (option *RI-0*);

b) to introduce an incentive mechanism to promote the increased effectiveness of recovery under emergency conditions, with an *ex-ante* annual reward in proportion to a points mechanism based on the assessment of specific "certified actions" established by the distribution companies, with due verification of the effective implementation of these actions in the event of exceptional situations (option *RI-1*);

c) to introduce an incentive mechanism to promote the increased effectiveness of recovery under emergency conditions with the recognition of *ex-post* costs in the event of exceptional occurrences, within the limits of predetermined costs established for special recovery operations (option *RI-2*).

1.26 In order to do this at least the following points should be defined, on which the Authority intends to gather useful elements through this consultation:

a) a practical path for the first consolidation of the Resilience Guidelines, both in terms of stress resistance and recovery (mainly using the Resilience Task-force), taking into account the various risk factors to be considered;

b) a timeline for the preparation and publication of the planned interventions for resilience, consistent with the first consolidation of the Guidelines referred to in the previous point a) and integrated with the Development Plans (by network operators);

c) the defining of incentive mechanisms, both in terms of network robustness and recovery capability, according to the first guidelines presented in this consultation document (by the Authority).

1.27 Finally, the document draws attention to a critical issue emerging from comparisons with operators regarding the mapping of national weather conditions, which are ideal for the forming of ice sleeves on overhead power lines with naked conductors. The Authority believes that this mapping, which takes into account the events up until 2004, needs to be updated so that design

limits in the technical regulations can take the severe weather phenomena that have occurred since 2005 into account (see points 3.1 to 3.3 below).

Interactions between institutions

1.28 It is also necessary to align the Authority's decisions with the possible methods for implementing the provisions set out in the consultation on the National Energy Strategy, with particular reference to possible provision for network resilience by the Ministry of Economic Development of (i) specific addresses for network operators in order to quickly identify intervention plans with precise implementation times and priority areas, (ii) any legislative action which may be necessary to implement the plans quickly.

1.29 The Authority considers it appropriate that, within the framework of fair cooperation between institutions, the elements that emerge from this consultation are made available to the Ministry of Economic Development, so that they can be used to define the SEN specifically for resilience and its implementation methods.

1.30 Lastly, improving resilience also requires greater co-ordination between different network operators with the various local, regional and national institutions - both for emergency prevention and management and to participate, as far as competence is concerned, in the technical-environmental evaluation of network development proposals.

Structure of the document

1.31 In this consultation document:

a) chapter 2 is dedicated to the review of existing and ongoing initiatives ("current scenario") and to summarise what emerged from the analysis of resilience work plans submitted to the Authority by network operators;

b) chapter 3 is dedicated to updating the technical regulations and the first consolidation of the Resilience Guidelines;

c) chapter 4 is dedicated to the theme of planning and the relative transparency and monitoring mechanisms ("reputational" incentives);

d) chapter 5 is dedicated to presenting the Authority's initial guidelines, with alternative options in the Regulatory Impact Assessment (hereafter: RIA) for possible incentive mechanisms and relative control mechanisms in a "network robustness environment";

e) chapter 6 is devoted to presenting the Authority's initial guidelines, with alternative options in the RIA for possible incentive and control mechanisms in a "recovery environment", both in terms of speed and extent of mitigation of effects of events that have caused structural failures;

f) finally, chapter 7 tracks the possible timings for the next steps, taking into account also the developments expected in the “business plan” and the "totex" perspectives.

1.32 The document has 4 appendices:

a) appendix 1 shows the trend over time of some aggregated resilience indicators on a regional basis (2012-2016) and as a result of *force majeure* (2004-2016);

b) appendix 2 contains an analysis of the dynamics of transmission and distribution investments made since 2000;

c) appendix 3 develops a template for communicating to the Authority the costs and benefits linked to interventions for increasing the network robustness of electricity networks carried out by the network operators;

d) appendix 4 contains a list of possible certified actions carried out by network operators, aimed at accelerating the recovery phase of the electricity supply.