NEW TOOLS FOR NEW CHALLENGES: WHAT WORKS BEST TO CHANGE ELECTRIC SYSTEMS’ RULES IN THE AGE OF RES

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ABSTRACT

The paper exposes a methodology to assess the effectiveness of alternative processes aimed at defining innovative, complete and coherent sets of rules for the management of the interconnected electrical system. Several options, which are presently being used at National and/or European level, are compared and evaluated according to the most relevant dimensions of a decision-making process, such as time of delivery, involvement of stakeholders, level of acceptance, and so on, resulting in a definition of strength and weaknesses of the different prescriptive instruments.

A similar classification is then operated with reference to the different areas of system management, such as “connection”, “access”, “operation”, “energy market”, “service market”, etc., by ranking the abovementioned dimensions in terms of their relevance according to the specificities of each one of them.

By comparing the two sets of results, the most effective “transition vehicles” for each one of the given areas are then found.

The paper finally analyzes a specific process (the one related to the delivery of the Connection Code known as “Requirement for Generators”) in order to detect if the characteristics of its development, as it has been observed until now, match with the ones that could have been foreseen by applying the methodology delivered.

INTRODUCTION

It is likely that present years will be regarded, in retrospect, as the ones in which the cornerstones of a new paradigm in the management of electric systems have been laid: the willingness of final customers to be involved in the electrical market, the increased contribution of distributed resources, the urge for enhanced levels of efficiency and the technological development of power and control components allowing Smart Grid deployment all contribute, on one side, to challenge the consolidated operational practices for both transmission and distribution systems and, on the other side, to disclose unprecedented possibilities for the evolution of those systems.

The abovementioned (r)evolution in the electric system requires a change of established roles and tasks of “traditionally involved” subjects, a change which may dramatically affect obligations and rights, boundaries and competencies, costs and revenues of electric operators, technical bodies, category associations, legal entities, etc..

There is little doubt that this change must be operated EU-wide, as system operation, Standards and energy markets naturally refer to an interconnected pan-European electric system. To do so, it is important that the most appropriate prescriptive tool to boost the transition (hereinafter: “transition vehicle”) is chosen and adopted: but which kind of “vehicle” do we need at EU level in order to succeed supporting such an epoch-marking “transition”?

In order to suit such a fast-evolving environment, the prescriptive instrument should be quick in its application, but at the same time the process for its definition, as it involves the interests of many different stakeholders, should be as inclusive as possible; again, coordinating such a large number of stakeholders claims both for a strong leadership of the process responsible and for a high responsibility level of all the other involved subjects, while the variety of technical topics to be checked, easily exceeding the competencies of each one of the involved parties, would preferable imply a “democratic” management of the activities.

While describing the incoming task this way, it may resemble something like a “mission impossible”, as all its possible requirements - in principle - cannot be fulfilled at once. However, the problem is somehow easier, as in practice not all areas (such as “connection”, “operation”, and so on) share the same characteristics, imply the same variety of competencies, require the same “time-to-delivery”, and so on.

Therefore, optimal “theoretical” solutions for each one of the areas can hopefully be found, lying on the characteristics of the area itself and on the strengths of a specific “vehicle” (or, more likely, of a specific combination of “vehicles”). Due to the different maturity
of the national sectors and to the technical/economical complexities of the topics themselves, it is nevertheless very unlikely that a “one-size-fits-all” solution can be agreed on.

THE PROPOSED METHODOLOGY

The proposed methodology includes:

a) the definition of the relevant dimensions of the process
b) the evaluation and ranking of different prescriptive instruments (the “transition vehicles”) according to the dimensions as in a)
c) the evaluation of relevance of the dimensions as in a) with regard to the specific content of system transition (the main areas of electric system management, according to the classification published by the EC and ACER)
d) the design of optimized combined approaches to the process according to the strengths and weaknesses of different instruments as in b) and to their relevance for the specific content of system transition as in c).

The relevant dimensions of the decision-making process

To classify the different “transition vehicles” according to their properties, reference has been made to the following main characteristics:

- involvement of stakeholders. It relates to the contribution that every possible involved party is required to, or can, provide in the process of problem setting and in the definition of the prescription;
- level of detail. It relates to the specificity required in giving prescriptions;
- coordination among processes. It relates to the degree of control that can be operated on a specific drafting activity with reference to the other ongoing ones;
- rate of speed. It relates to the time to complete the “end-to-end” process of drafting, approving and issuing a formal act;
- degree of consensus. It relates to the way in which the process of setting the rules is managed, implying a general agreement among stakeholders (or, more formally, a majority vote among them) is needed before a prescription can be drafted;
- entry into force. It relates to the fact that the prescriptions, once issued, are immediately applicable with no other formal act.

Not all possible processes share the same characteristics, generally the most “democratic” ones implying longer, and less predictable, times of delivery while allowing a wider spectrum of analysis in the scoping phase and granting a greater level of detail and a smoother adoption once issued. On the opposite, pure “top-down” processes generally result in being faster in the drafting stage, but may eventually overlook some relevant issues provided the problem setting phase is not so easily performed, resulting in some difficulties in the approval and, particularly, in the adoption phases (entry into force phase delay or entry into force with “localizations”).

In terms of overall coordination, being able to have a single entity managing the process can more likely grant a general alignment of the activities; however it is not so easy to appoint an individual stakeholder taking care of the process ensuring at the same time an appropriate level of competence (often implying a direct involvement in the processes that have to be ruled) and a due degree of neutrality (more frequently linked to the absence of interests).

As for the entry into force, generally the most “formal” acts, such as Regulations, are immediately applicable and may be seen as preferable in case a quick adoption is required; on the other hand, “looser” documents, such as Technical Standards, can more easily be amended in unessential parts, allowing a faster maintenance in case of need. In addition, a “good” rate of speed in documents definitions could result, easily, in low or insufficient level of details, argument, which could be easily used to stop or slow the “entry into force” stage.

So again, it doesn’t seem a “one-size-fits-all” solution is available, resulting in an “ideal” transition vehicle matching all the requirements that could eventually be set; however, as different areas of system management do not necessarily face the same level of maturity, share the same technological complexity, involve the same number of stakeholders or the same economic implications and require the same degree of harmonization, it may be imagined that ruling different areas may imply adopting different prescriptive instruments.

The “transition vehicles”

Operators’ roles, technical requirements and specifications, and cost allocation criteria have been until now established in individual EU Countries through one (or more) of these types of prescriptions:

a) Laws
b) Regulatory Acts
c) Network Codes issued by TSOs and DSOs respectively
d) Technical standards.

It can be imagined that the possible tools to be adopted EU-wide in order to define new system standards are included in the abovementioned categories, resulting in:

a) Commission Directives/Regulation
b) Regulatory Acts at EU level
c) Network Codes issued by TSO or DSO at EU level
d) CENELEC standards.

It must be noticed that, in this paragraph and later in the
text, the tools are addressed as “theoretical” ones and do not necessarily relate to current practices. As an example, “Network Code” is imagined as a document issued by a TSO (or a TSOs’ Association) after an internal scrutiny not necessarily involving other stakeholders in a regulated way; therefore, it does not correspond to the ongoing process at EU level of the same name, which can be described as an hybrid form implying some guidelines by a technical entity supporting the Legislator, a drafting activity by a TSOs’ Association and a final issue by the Legislator itself.

The individual tools, as described, have been evaluated with direct reference with the relevant dimensions already introduced (involvement of stakeholders, level of detail, etc.); a very simple questionnaire was submitted to a small but significant sample of experts which have been involved, with different roles, in the EU Code drafting, asking them to rank every tool according to a 5-value ascending scale (from 1 to 5) for each one of the dimensions.

Results, coming from averaging the individual judgements, were as in Table 1.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Law</th>
<th>Act of Regulation</th>
<th>Network Code</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Involvement of Stakeholders</td>
<td>2,5</td>
<td>3,2</td>
<td>2,7</td>
<td>4,2</td>
</tr>
<tr>
<td>Level of Detail</td>
<td>1,8</td>
<td>3,0</td>
<td>3,5</td>
<td>4,5</td>
</tr>
<tr>
<td>Coordination among processes</td>
<td>2,8</td>
<td>3,5</td>
<td>3,7</td>
<td>3,2</td>
</tr>
<tr>
<td>Rate of Speed</td>
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<td>3,0</td>
<td>3,5</td>
<td>2,5</td>
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<tr>
<td>Degree of Consensus</td>
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<td>2,7</td>
<td>2,5</td>
<td>3,8</td>
</tr>
<tr>
<td>Entry into Force</td>
<td>4,0</td>
<td>3,7</td>
<td>2,8</td>
<td>2,8</td>
</tr>
</tbody>
</table>

Table 1 – Perceived relationship between relevant dimensions of decision-making process and possible “transition vehicles”

It can be noticed that each tools has its strengths and weaknesses, an act of law being perceived as most effective when it comes to direct entry into force while standards appear preferable with regards to level of detail, involvement of stakeholders and degree of consensus; on the other side, it is perceived that standards may take more time in being delivered and acts of law may lack in details. Regulation and Network Codes are somewhere in the middle, both being perceived as granting a better coordination while lacking a bit in getting an appropriate degree of consensus.

The main areas of electric system management

The areas of electric system management that are being investigated are the ones on which the “Network Code” activity is already happening. More specifically, they have been classified as follows:

- **Connection area.** It includes the prescriptions about requirements of network users;
- **Access area.** It deals with the procedures to enter a specific market;
- **Operation area.** It deals with the way in which the different operators must behave in ordinary condition, in critical conditions and in emergency;
- **Market area.** It deals with the way in which energy and energy-related services are sold and bought.

To analyze how well different “transition vehicles” suit the needs for an evolution in the abovementioned areas, it is necessary to define their required level of performance in terms of “relevant dimensions”. As a direct link between “transition vehicles” and relevant dimensions is far from being intuitive, intermediate elements has been introduced, qualifying the characteristics of the areas with regard of their:

- **Diversity,** meaning the contribution of different phenomena/actors to the matter
- **Economical Relevance,** meaning the estimated content/impact of the area, in particular as a result of a change in existing situation
- **Complexity,** meaning the difficulty of the matter to be understood and ruled
- **Innovation,** meaning the expected dynamics of the changes in the sector
- **Urgency of Integration,** meaning the relevance to reach a homogeneous treatment of the matter at EU level.

These characteristics have then been also linked, on the other side, with the properties of the transition vehicles, thus bringing to a indirect correlation between them, representing the need of a specific property in a “transition vehicle” in order to support an epoch-marking change in a given area.

To do so, two simple distinct questionnaires were submitted and filled; combined results are shown in Table 2.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Connection</th>
<th>Access</th>
<th>Operation</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Involvement of Stakeholders</td>
<td>3,6</td>
<td>3,8</td>
<td>3,7</td>
<td>4,4</td>
</tr>
<tr>
<td>Level of Detail</td>
<td>2,4</td>
<td>2,4</td>
<td>2,6</td>
<td>2,7</td>
</tr>
<tr>
<td>Coordination among processes</td>
<td>4,1</td>
<td>4,3</td>
<td>4,2</td>
<td>5,0</td>
</tr>
<tr>
<td>Rate of Speed</td>
<td>2,0</td>
<td>2,1</td>
<td>2,1</td>
<td>2,4</td>
</tr>
<tr>
<td>Degree of Consensus</td>
<td>3,3</td>
<td>3,5</td>
<td>3,2</td>
<td>4,0</td>
</tr>
<tr>
<td>Entry into Force</td>
<td>1,7</td>
<td>1,8</td>
<td>1,6</td>
<td>1,9</td>
</tr>
</tbody>
</table>

Table 2 – Perceived relevance of dimensions of decision-making process with regard of specific areas of network management

It must be noticed that coordination between processes is perceived as the most crucial characteristics for all areas, followed by involvement of stakeholders and degree of consensus; level of detail, rate of speed and entry into force follow.
ANALYSIS OF THEORETICAL RESULTS

To find the best area-vehicle suits, the two patterns of tables 1 and 2 were matched by considering only the negative gaps (inadequacies), then normalized, again resulting in a ranking of each combination (area-vehicle) within a scale from 1 to 5.

In detail:
- In the cases in which the resulting value was higher than 4, the vehicle was considered as appropriate to support the change in a specific area;
- In the cases in which the resulting value was lower than 2, the vehicle was considered as inappropriate to support the change in a specific area;
- Intermediate values were not considered as acceptable, and a mix of the properties of two different vehicles was required by selecting only the combination reducing the negative values with reference to any single vehicle.

Results are resumed in the matrix shown in Table 3, where each combination “area-vehicle” is ranked as “appropriate” (A), “inappropriate” (I) or “appropriate if combined with...” (a) + XXX.

<table>
<thead>
<tr>
<th></th>
<th>Connection</th>
<th>Access</th>
<th>Operation</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Law</td>
<td>(a) + Standard</td>
<td>(a) + Standard</td>
<td>(a) + Standard</td>
<td>I</td>
</tr>
<tr>
<td>Act of Regulation</td>
<td>(a) + Standard</td>
<td>(a) + Standard</td>
<td>(a) + Standard</td>
<td>(a) + Standard</td>
</tr>
<tr>
<td>Network Code</td>
<td>(a) + Standard</td>
<td>(a) + Standard</td>
<td>(a) + Standard</td>
<td>I</td>
</tr>
<tr>
<td>Standard</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>(a) + Act of Regulation</td>
</tr>
</tbody>
</table>

Table 3 – Perceived adequacy of “transition vehicles” with regards to different areas of network management

A more focussed analysis may be operated by linking more directly the strengths and weaknesses of the vehicles with their adequacy/inadequacy to support the desired change in a specific area.

As an example, notwithstanding Standards have been perceived as appropriate to support changes in most areas, they fall short when it comes to coordination of processes; therefore the use of Standards in combination with other tools ensuring a higher degree of coordination (such as Act of Regulation or a Network Code) may increase the probability of their success.

To show how the theoretical results coming from the application of this methodology can be related to factual events, an application has been made to a real process already ongoing: the drafting of the “Requirement for Generators” (hence: RfG), a Network Code falling into the “Connection” area.

A REAL CASE: WHAT WAS RIGHT, WHAT WENT WRONG WITH RfG

The European Network of Transmission System Operators (ENTSO-E) released in March 2013 a latest version of a Connection Code (1) on “Requirements for Generators” (NC RfG) [1], which is only one of the suite of European electricity Codes that the European Commission has mandated ENTSO-E to develop. The development of these codes is based on Article 6 of Regulation EC/714/2009 and has been in process since July 2011 and drafting of RfG followed the development by the Agency for the Cooperation of Energy Regulators (ACER) of non-binding Framework Guidelines on Electricity Grid Connections.

The Framework Guideline on Grid Connection developed by ACER [2] establishes that the rules should apply to significant grid users and should define the requirements in relation to the relevant system parameters contributing to secure system operation. These specifically include, but are not limited to, frequency and voltage parameters, reactive power requirements, load-frequency control and system balancing, protection requirements including protection settings, fault-ride-through capability and provision of ancillary services.

Following ACER Framework Guidelines, ENTSO-E has quite rapidly issued a first draft in July 2012 and a later version in March 2013. However, although the drafting process has been relatively fast, the RfG has not yet been approved and formally issued, and a number of questions, summarized below, are still open.

Although the network code received a favourable recommendation from ACER in March 2013, following a public consultation and several interactions with a user groups and DSOs technical expert groups which has resulted in a (limited) number of specific amendments of the first draft, since ENTSO-E had a high degree of stakeholder engagement, inevitably not all parties have been or will be satisfied with the resulting draft.

Operation of any power system involving multiple parties requires that all must operate together to ensure that the system can be operated safely, securely and for the benefit of all parties and, especially, for the benefit of their customers, the electricity consumers. This means that inevitably some parties will incur costs for the benefit of the system. The debate between system users and TSOs about the allocation and/or shifting of additional costs for system security is therefore likely to be a permanent feature of the market [3].

(1) As anticipated, the expression “Network Code” is not used here to describe the ongoing drafting process; in order to avoid misunderstanding, the more generic expression “Code” will be adopted.
By their nature most RES-E generators have less control capabilities than traditional generation plants and their growth will have an impact on the future operation of interconnected transmission systems that should be foreseen and accounted for in the network code. The transition from large scale generating units to distributed generation also brings with it a transition from large synchronous generators - which inherently provide some of the support requirements that the system needs - towards small asynchronous and inverter-connected generators that must be forced to make these support requirements available. This is particularly the case when large numbers of uncontrolled RES-E generators are affected simultaneously. Technical and economic implications of the network code in this respect may be relevant.

Where there is a net energy transfer from the distribution network to the transmission network, the TSO will wish this generation to ride through faults in the transmission network, while the DSO will wish it to disconnect for faults in the distribution network. The conflict between the different requirements of the two groups of network operators has been considered in undertaking the review of RfG, but the debate is still open.

RfG is the first part of what will effectively become one overall Code that was drafted by ENTSO-E. Viewing this in isolation has presented a major difficulty for stakeholders identifying exactly what the impact on them will be. The difficulties for stakeholders are not in the technical issues themselves but in the lack of clear harmonisation arrangements with other documents that together with RfG will establish a more complete Code. Harmonisation is therefore an important non-technical issue with significant technical relevance.

Concerns expressed by stakeholders did not refer to the technical requirements only but also to what the technical requirements might become. What is required is establishing appropriate governance arrangements, i.e. a robust amendment and approval procedure through which any changes in the requirements of the code would undertake proper review and consideration before approval is given [3].

As anticipated, the process of drafting RfG can be described as a combination of a Law and a Network Code. According to the methodology exposed and to the qualitative results found, it could have been expected its strength lying in an adequate level of coordination and in a more-than-appropriate rate of speed (coming from the “Network Code” side), as well as in a significant effectiveness when it comes to entry into force and an only slightly less-than-adequate degree of consensus (coming from the “Law” side), the main weaknesses coming from a reduced involvement of stakeholders and from future (for sure necessary) maintenance constraints.

The history of the process shows in fact that, while the drafting activities have proven quite fast, some delay has been experienced in the finalization of the document. This was due, on one side, to a lack of consensus on the text coming from an insufficient involvement of some of the key stakeholders, on the other, to the fact that some relevant topics and some not negligible consequences have not been adequately investigated and evaluated. In methodological terms, it can be said that these disadvantages are somehow intrinsic in the process as it has been designed, while the lack of coordination - which has also been experienced - can more likely be ascribed to the fact that RfG was a “pilot” document, resulting in a lack of confidence of all involved parties and leading to insufficient trustiness from the responsible subject towards all the other stakeholders.

From a “theoretical” point of view, however, according to the methodology exposed, an Act of Regulation (or eventually a Law) supporting and validating a set of Standards would have been an optimal “transition vehicle” instead, resulting in a more general consensus coming from a wider involvement of stakeholders.

CONCLUSIONS
The paper described a qualitative approach to evaluate the effectiveness of prescriptive instruments in supporting the ongoing change in the management of interconnected electric system.

Possible drafting processes and areas of interest were characterized through simple qualitative parameters and ranked, defining - in principle - the optimal tools to support an epoch-marking change in connection, access, operation and market at interconnected electrical system level.

Comparisons with real experiences (RfG drafting activities) show a good level of agreement between theoretical results and practical findings.

REFERENCES