TU Delft

Delft University of Technology

From laissez-faire to intervention

Analysing policy narratives on interoperability standards for the smart grid in the United States

Muto, Sachiko

DOI
10.1016/j.erss.2017.05.036

Publication date
2017

Document Version
Final published version

Published in
Energy Research and Social Science

Citation (APA)
Muto, S. (2017). From laissez-faire to intervention: Analysing policy narratives on interoperability standards for the smart grid in the United States. *Energy Research and Social Science*. https://doi.org/10.1016/j.erss.2017.05.036

Important note
To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Copyright
Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

Takedown policy
Please contact us and provide details if you believe this document breaches copyrights.
We will remove access to the work immediately and investigate your claim.

This work is downloaded from Delft University of Technology.
For technical reasons the number of authors shown on this cover page is limited to a maximum of 10.

Energy Research & Social Science 31 (2017) 111–119

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Original research article

From laissez-faire to intervention: Analysing policy narratives on interoperability standards for the smart grid in the United States

Sachiko Muto

Delft University of Technology, Faculty of Technology, Policy and Management (TBM), Jaffalaan 5, 2628 BX Delft, The Netherlands

ARTICLE INFO

Keywords:
Smart grid
Standardization
Energy policy
Narrative analysis

ABSTRACT

The imperative of realizing utopian visions of the smart grid puts unprecedented policy focus on standardization. Because standards are a prerequisite for deployment, the US federal government - in a departure from established hands-off practice - intervened to coordinate and accelerate standardization activities. This research uses narrative analysis to explore how such a policy of intervention was constructed. What emerges has elements of a hero story, describing a situation to be remedied: an aging electricity grid, plagued by blackouts and modernization hampered by an electric utility industry composed by stand-alone "silos". In contrast, the vision of a future "smart grid" with promises of improved energy security, reduced carbon emissions, renewable resources, "green innovation" and jobs. The threat: without standards, the risk that sizable public investments become obsolete prematurely. The villain: unnamed companies engaging in uncompetitive behavior. The unlikely hero: The National Institute of Standards and Technology, able to act as an "honest broker", proving that the government can as "catalyst" in partnership with industry. While succeeding in making a strong argument for government intervention, the story can be criticized for making exaggerated claims about the effects of standards, for downplaying the complexity of the process and for failure to outline policy alternatives beyond a five-year plan.

1. Introduction

In recent years, the creation of a "smart grid" has become a key element in the quest of policymakers to operationalize the goal of "sustainable development". At a *practical* level the smart grid entails the integration of information and communications technology (ICT) into electric transmission and distribution networks. As a *visionary* project, however, the smart grid also promises to support ambitious targets of reduced carbon emissions and increased use of renewable resources. Additionally, the smart grid is presented with the lure of "green innovation" and jobs. Thus in the European Union (EU), the implementation of smart grids has been described as "a significant opportunity for European industry to research, market and export new technologies, to create new jobs and to maintain global technological leadership." ([1], p. 8). And in the United States (US), progress on building the smart grid is important for the country "to lead the world in the 21st century economy, be at the forefront of the clean energy revolution, and to win the future by encouraging American innovation" ([2], p. v). These visionary accounts of the smart grid promise to solve some of the most pressing societal challenges of today; the appeal to policy-makers is obvious.

Policy documents identify the development of a common set of interoperability standards as a prerequisite for delivering the smart grid. Hundreds of standards are needed and the effort required by the standardization world to achieve this task has been described as *"unprecedented"* in scope and complexity [3,4]. While standardization in more regulated sectors has seen varying degrees of government intervention, US governments have generally been reluctant to intervene in the ICT standardization field because it has been seen as important to ensure that innovation is not hampered by premature standards-setting or lock-in to inferior technology. Instead it has relied for the most part on industry self-organization [5]. However, citing the societal imperative of building the smart grid, the federal government has departed from established general policy on standardization to catalyse activities and act as a convenor.

This paper applies concepts from discourse theory and narrative analysis to explore how a case for federal government intervention in the smart grid standardization process was constructed given a decades-long policy in the US for industry leadership. The next section of this paper introduces the general approach of this research and key concepts used. Section 3 provides institutional and political context to the subsequent analysis. It shows an inherited policy on standardization which in recent years has favoured an industry-driven approach. In terms of the political environment, the development of a policy discourse on the smart grid has taken place against a

E-mail address: m.s.muto@tudelft.nl.

http://dx.doi.org/10.1016/j.erss.2017.05.036
Received 14 October 2016; Received in revised form 22 May 2017; Accepted 30 May 2017
Available online 17 June 2017
2214-6296/ © 2017 Elsevier Ltd. All rights reserved.

background of an aging grid with high-profile blackouts and the need to justify public investment in the wake of the financial crisis of 2008. This paper then considers the argumentative context in which a policy on smart grid standardization has been formulated. Section 5 subsequently analyses the presence, absence, influence and interactions of different discourses in the policy documents concerned specifically with interoperability standards for the smart grid. What dominant and alternative discourses are drawn upon to create the official narrative or story-line on smart grid standardization policy? Key documents are analysed with the aim of discovering what discourses are drawn upon in problematizing the issue of bringing about smart grid interoperability standards and in formulating and legitimating a specific solution or behavioural action in the form of government leadership in the standardization effort. The analysis shows that the US policy discourse on smart grid standardization, while rooted in existing policy on standards as market-driven, draws on a range of discourses to legitimate intervention. Finally, it considers how this policy narrative that emerged displayed many features of the technological hero story [6] and discusses the limits of this type of story in light of the findings. While succeeding in making a strong argument for government intervention in smart grid standardization, the narrative developed in policy documents can be criticized for over-simplification and for failure to outline a practical policy alternative beyond a five-year plan.

Much of the optimism surrounding the smart grid is based on technical research and engineering-based calculations of technical potential, or on economic calculations with regard to what is often called user flexibility. The practical work on smart grid development echoes this: the focus is typically technology-centric. However, in recent years there has been an increase in social-scientific research engaging in critical dialogue with this development. Scholars have pointed to the different ways that public debates on smart grid have been framed [7,8] and to the utopian nature of the smart grid discourse [9]. Others have focused on public acceptance, public engagement, and public resistance to certain salient aspects of a sustainable energy network, such as smart meters and the deployment of wind energy. Finally, legal scholars in both Europe and the US have considered the regulatory innovation required to align energy policy, technology regulation and smart grid developments ([10,11]).

In analysing policy discourse on smart grid standardization in the United States, the article seeks to contribute to this growing literature, and more widely to our understanding of a field that is under-developed yet of growing importance. As our societies are increasingly attempting to solve important challenges through the large-scale application of ICTs (smart transport, smart homes, smart cities), we need a better understanding of policy alternatives in standardization that go beyond the typical binary of legislation versus self-regulation.

2. Research approach and methods

According to Hajer and Wagenaar, “discourse analysis has changed the way policy-making is studied” ([12], p. 1). In the last few decades many scholars have described policy as discursive action [13–15], a trend which is related to the so-called “argumentative turn” in the social and political sciences [16]. A central tenet of discourse theory and the current research is the notion that the study of policy is *necessarily* a study of discourse: because “public policy is made of language” ([17], p. 1). Hajer defines discourse as “a specific ensemble of ideas, concepts and categorisations that are produced, reproduced and transformed in a particular set of practices and through which meaning is given to physical and social realities” ([14], p. 44). In more straightforward terms, policy discourse, as defined by Schmidt [18], consists of “whatever policy actors say to one another and to the public in their efforts to generate and legitimize a policy programme” (p. 211). Discourse is different from discussion as actors with diverging or opposing interests can and often do share the same *frames*.

Crucial for this research is the notion in discourse and narrative approaches that language does not simply mirror the world but it acts to encourage certain ways of thinking and silencing others: policy sets out a dominant conceptualization of the problem which sets limits on what can be said and felt about it. Discourse, in this sense, is controlled by certain regulative principles, which prohibit certain topics, valorise certain concepts or legitimize certain forms of knowledge [19].

The argumentative context, here defined as the macro-social context comprising all the circulating discourses on an issue or that have the potential to be associated with it, includes earlier writings, inherited assumptions, and ideological contexts. Policy actors extract from this context in order to construct their particular argument and problematization Fairclough, 1992 or *storyline*. ÓTuathail describes storylines as “sense-making organisational devices that tie the different elements of a policy challenge together in a reasonably coherent and convincing narrative” (ÓTuathail quoted in [54], p. 16). In Hajer’s terminology, storyline is defined as “a generative sort of narrative that allows actors to draw upon various discursive categories to give meaning to specific physical or social phenomena.” Storylines are strategically employed by policy entrepreneurs so as to impose on others their version of events, as well as possible solutions, thus the ability to successfully frame policy alternatives can become a decisive aspect of the policy process [20].

The power of storylines is based not so much on empirical investigations or structural causality of the situation, but on the idea that it *sounds right* [14]. In addition to drawing on existing ideological repertoires, policy narratives gain credibility and become persuasive by ordering the elements of the story according to familiar plotlines. This can be done by invoking a classic myth or by referring to archetypal figures and motifs, e.g. the hero, martyr, or wanderer. The most common narrative follows a simplified version of the epic hero’s journey ([53], cited in Ref. [6]). In the epic form, the protagonist answers “the call” and finds itself, often in a parallel world, confronting a number of enemies and/or obstacles. Employing strengths, sometimes symbolised as a silver bullet or magic elixir, and overcoming weaknesses, the protagonist becomes a hero and returns to the ordinary world a saviour. In the romanticist form [21] the plot may involve a fall from grace and describe a return to or rediscovery of a purer self. Another recognisable plot has a David and Goliath character, with several small players attempting to topple a very large, dominant player [22]. Stone [23] identifies two broad categories of plots with numerous possible variations: stories of decline and stories of control. The plot of decline is a story emphasizing how things will get worse if the opposing solution is enacted; the plot of control is aimed to convince the audience that things once believed to be out of our control are now within reach.

Common to all these stories is that the recognisable form and characters help them make immediate sense to the audience. As such they can help get the policy message out and to build support for it, but this strength is also a shortcoming. Janda and Topouzi [6] show how the features of the hero story in particular have been used to communicate energy policy and that there is often a discrepancy between the promises of such a story and the policy outcome in the “real world”. They recommend that such accounts be balanced by the use of “learning stories”, which take into account the complexity of policy problems, the limits of what can be achieved, and the nature of the effort required. This paper considers how the case for government intervention in smart grid standardization resembles the hero narrative and whether the development of a learning story would be more helpful in building support for a sustained public involvement in the effort.

In applying concepts drawn from discourse theory and narrative analysis on the case of federal government intervention to bring about interoperability standards for the smart grid, this paper analyses policy documents (legislation, reports, speeches, press releases) produced by or endorsed by the US federal government. Discourse analysis gives epistemological and methodological priority to the study of primary texts like presidential statements and official policy documents [24]. These “monuments” or primary texts are often the result of an on-going discursive negotiation and can, at least in theory, be seen as having formed, absorbed and grasped the strongest representations. Primary

Table 1
Smart grid standardisation policy timeline.

2007	The Energy Independence and Security Act (EISA)
February 2009	American Recovery and Reinvestment Act (ARRA)
March 2009	FERC policy statement citing a sense of urgency
April 2009	NIST staff member George Arnold appointed National Coordinator for smart grid interoperability
January 2010	NIST Framework for smart grid operability standards 1.0
February 2011	White House publishes "A Strategy for American Innovation: Securing our Economic Growth and Prosperity"
June 2011	White House publishes "A Policy Framework for the 21st Century Grid: Enabling our Secure Energy Future"
July 2011	FERC chooses not to mandate firs set of NIST standards
February 2012	NIST Framework for Smart Grid Interoperability Standards 2.0
December 2012	SGIP transitions to private non-profit organization
February 2013	George Arnold steps down from role of National Coordinator

texts set the agenda and shape the issues at hand, and they frame and produce representations of a policy domain. The following three criteria are central to the selection of primary texts: texts should clearly articulate identities and policies; they should be widely read and attended to; and they should have the formal authority to define a political position [24]. The texts chosen for this research score high on all of these criteria, and can therefore with relative confidence be termed "primary texts" or "monuments".

3. Smart grid standardization as a policy problem

The Energy Independence and Security Act of 2007 (EISA; Pub.L. 110–140) sets out the energy policy of the US. The stated purpose of the act is:

> to move the United States toward greater energy independence and security, to increase the production of clean renewable fuels, to protect consumers, to increase the efficiency of products, buildings, and vehicles, to promote research on and deploy greenhouse gas capture and storage options, and to improve the energy performance of the Federal Government, and for other purposes.

EISA provides for the creation of a Smart Grid and requires that standards be developed to enable interoperability (table 1 summarizes the smart grid standardization policy timeline). More precisely, EISA mandates the National Institute of Standards and Technology (NIST) "to coordinate development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems". And once the Federal Energy Regulatory Commission (FERC) is satisfied that NIST's work has led to "sufficient consensus" on interoperability standards, it is directed to "institute a rulemaking proceeding to adopt such standards and protocols as may be necessary to insure smart-grid functionality and interoperability in interstate transmission of electric power, and regional and wholesale electricity markets ([55])."

The smart grid is a complex system of systems with so many possible interactions and uncertainties that a foundation of standards[1] is essential to specify how these interactions take place. Standards are necessary for the exchange of information among multiple domains and thousands of actors connected in complex paths and subnetworks. NIST's Smart Grid conceptual model identifies more than 100 points of interaction between subsystems and substantial variety in proposals for interactions at individual points. Standards will have a considerable impact on the smart grid's architecture and at the outset there is no common understanding of foundational matters such as what types of data are gathered or how they are exchanged [25].

In addition to the sheer technical complexity of the undertaking, two major tensions characterize smart grid standard-setting. The first is that industry participants from the telecommunications and IT sectors, "steeped in the decades-long traditions of technical standards development" and with prior experience with reliability standards "will expect the private sector to lead standards development" ([11], p. 122). The second important set of actors is the state Public Utility Commissions (PUCs). The FERC Smart Grid Policy document recognises that there is "a tension that the Proposed Policy Statement raises between federal jurisdiction and state jurisdiction. . [with respect to] both standards adoption and applicability and whether deployed technology will be subject to state or federal rate authority" ([26], p. 9). The involvement of state PUCs in building a smart grid, and their often tense relationship with the federal government, makes the smart grid different from any previous attempt at building networks. Both the states and the federal government have jurisdiction over parts of the smart grid ([11], p. 118).

The imperative of developing interoperability standards for the smart grid has thrown unprecedented focus on the so far little-politicized world of ICT standardization, and the intervening financial crisis of 2007–2008 had repercussions for the standardization effort. The American Recovery and Reinvestment Act of 2009 (ARRA; Pub. L. No. 111-5, 123 Stat. 115, 2009) provided $3.4 billion in funding aimed at accelerating the development and deployment of advanced electric grid and digital communications technologies, and grid-scale energy storage projects, through the Smart Grid Investment Grant and Demonstration programs. This was matched one to one by industry for funding of almost $8 billion. This funding made available to smart grid investments put more impetus also on the standardization process because of fears that substantial public investments were being made in the absence of agreed interoperability standards. This link between public funding and standardization is emphasized by Eisen, who states that, "ARRA funding also prompted calls for rapid development of interoperability standards, which put pressure on that process to move quickly" ([11], p. 118).

While EISA contains no specific deadline for NIST's work, it had become obvious in early 2009 that the effort was accumulating delays. According to reports in the trade press, this delay had stakeholders examining a plan to use a non-government entity, such as the North American Energy Standards Board (NAESB), to provide support to accelerate the program at NIST [27]. Instead, the Obama administration began a coordinated joint-agency effort involving the Department of Energy (DOE), FERC, and NIST – and including direct White House involvement to accelerate the process. Again, according to reports in the trade press, Energy Secretary Steven Chu, FERC Chairman Jon Wellinghoff and NIST Deputy Director Patrick Gallagher agreed an aggressive strategy with a view to "ensuring effective interagency coordination and accelerating the development of standards for the smart grid," [28]. On 19 March, FERC released a policy statement and action plan to provide guidance to NIST, citing "a sense of urgency within industry and government for the development of standards for and deployment of smart grid technologies generally" [29]. The FERC action was immediately followed by NIST appointing a National Coordinator for Smart Grid Interoperability (NIST staff member George Arnold) and an office to oversee the creation of the standards. The establishment of the post clearly underscored the importance of the issue. FERC's release of its smart grid policy statement and road map to

[1] In October 2010, NIST identified a first set of foundational standards: ● IEC 61970 and IEC 61986: Providing a Common Information Model (CIM) necessary for exchanges of data between devices and networks, primarily in the transmission (IEC 61970) and distribution (IEC 61968) domains. These standards facilitate the exchange of data between utilities, and allow the exchange of data between applications within a single company. ● IEC 61850: Facilitating substation automation and communication as well as interoperability through a common data format. The standard specifies the requirements for how applications interact with and control devices, in addition to the standards for testing for conformity. It also creates common language for devices, results in fewer errors and greater capabilities, and implements modern networking technology in substations. ● IEC 60870-6: Facilitating exchanges of information between control centers. It specifies the method of exchanging time-critical data between utilities, improving reliability and interoperability. ● IEC 62351: Addressing the cyber security of the communication protocols defined by the other IEC standards [41].

accelerate development of the standards was coordinated with the NIST appointment of a coordinator, which was also a sign of the high level of coordination taking place to accelerate development.

In December 2009, NIST created the Smart Grid Interoperability Panel (SGIP) as a public-private partnership tasked with driving the collaboration, coordination, and promotion of smart grid standards interoperability. NIST released its initial version of a framework and roadmap for Smart Grid interoperability standards in January 2010. In addition, the role of standards are given a prominent role in the White House's publication entitled 'A policy framework for the 21st Century grid: Enabling Our Secure Energy Future', which was published in June 2011 [2]. President Obama underscored his commitment to the process in the "Blueprint for a Secure Energy Future" [45]. Following a period of public consultation, Release 2.0 of the NIST framework document was published in February 2012.

After this initial push from the federal government, there have been signs that it is taking a step back. NIST presented FERC with a first set of standards in 2011. Much was made about the fact that FERC chose not to mandate those standards although EISA had foreseen this possibility [11]. FERC cited "insufficient consensus" in its decision not to mandate [30]. Crucially, EISA only provided for the funding of NIST's activity through the years 2008–2012, and the SGIP transitioned in December 2012 to a member-led, industry-based organization, set up as an international non-profit organization. Also, George Arnold stepped down from the role of National Coordinator for Smart Grid in early 2013 with no replacement foreseen, and thus removing the focusing effect that this post had created. However, NIST remains involved in the process. The SGIP gets a $2.75 m annual contribution from NIST [31], and NIST staff continues to hold key technical positions in the SGIP (NIST).

4. The argumentative context – industry-driven standardization and competition discourse

4.1. Standardization as an industry-driven process

There is general agreement among standardization scholars that US policy in the last several decades has been characterized by a strong general preference for delegating leadership in the area of standardization to industry [32,11,33]. As observed in a 1992 report by the Congressional Office of Technology Assessment (OTA), "The U.S. standards setting process reflects a strong political and cultural bias in favor of the marketplace, a preference that has its origins deep in American history" [34]. The National Technology Transfer and Advancement Act of 1995, reinforced by Office of Management and Budget Circular A-119 [35], requires Federal agencies to favour the use of voluntary consensus standards developed by private-sector bodies instead of standards developed by government agencies for regulatory and procurement purposes, whenever feasible. The "United States Standards Strategy", published by ANSI in 2005 and endorsed by the U.S. Department of Commerce contains a characterizing statement on the terms in which standards have typically been described: "[v]oluntary consensus standards are at the foundation of the U.S. economy… The United States is a market-driven, highly diversified society, and its standards system encompasses and reflects this framework…" ([52], 4).

Outstanding features of this discourse are the frequent use of terms like "bottom-up", "private-sector led", and "voluntary". The benefits of favouring industry-driven standardization are the speeding up of processes and the reduction of cost to the Government, while encouraging industry innovation and competition. There is often a link made between this approach to standardization and the overall US society and culture: "[t]he system reflects American political culture, and the general preference for market-based, pluralist solutions… The American preference for private, pluralist solutions is *as old as the Constitution itself* [emphasis added]" [34].

4.2. Standards and antitrust

A discursive influence that is to some extent contradictory to the preference for industry-led standardization outlined above is a long tradition of considering standards developing organizations (SDOs)[2] as a potential arena for anticompetitive behaviour. Assertions of anti-trust infringements and unfairness led the Federal Trade Commission (FTC) in the 1970s to investigate the system and recommend that government assume a greater role in regulating standard-developing bodies [36]. The FTC has since been involved in a number of drawn-out legal cases and in having to justify its position publicly it has published several reports that draw heavily on academic sources.[3] While the focus has been on intellectual property rights and patents, this discourse is of interest here because it links standards to company patent strategies that may end up being harmful to competition and innovation: "When the patented technology is needed to conform to a standard or consumers are otherwise locked in or when the infringing approach is already built into a competitor's product before the patent issues, design-around may be economically impossible" ([37], p. 22).

Specifically, the antitrust tradition introduces the notion that companies in a standardization context cannot always be trusted to behave in a way that is beneficial for society as a whole, and that government intervention might be needed to monitor and remedy a situation:

> However, many in the private sector contend that it is the participants in the system themselves, who should be the final arbiter. This position assumes both that 1) the participants know and are willing to pursue their own best interests; and 2) that participants' interests always coincide with the national interest. Both assumptions are certainly open to question, if not clearly refuted by history. ([34], p. 7)

A feature of this discourse is also the notion that a difficult balance must be struck between different principles:

> Although there is broad consensus that the basic goals of antitrust and intellectual property law are aligned, difficult questions can arise when antitrust law is applied to specific activities that do create market power. That may happen when, for instance, a standard of manufacture for an entire industry or the only treatment for a particular disease incorporates patented technology… [In striking a balance] the Agencies must apply antitrust principles to identify illegal collusive or exclusionary conduct while at the same time supporting the incentives to innovate created by intellectual property rights. [38]

While the industry-driven, bottom-up perspective is dominant in documents describing the general government policy on standardization, one of the effects of an antitrust discourse is the possibility that "industry-led" does not get conflated with a perfectly functioning "market". Another feature of this discourse is that there is frequent referencing to academic research, including economics of standards concepts such as lock-in.

5. Protecting public investment and NIST as an "honest broker": US response to the smart grid standardization challenge

While the US does not have a comprehensive legislative and policy

[2] The three most well-known international SDOs, which bring together the national standards bodies of 157 countries, are the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), and the International Telecommunication Union (ITU). In addition, ICT standardisation takes place in committees of organisations like the World Wide Web Consortium (W3C) and the Institute of Electrical and Electronics Engineers (IEEE).

[3] In one report, the FTC draws heavily on Carl Shapiro, Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting in Innovation Policy and the Economy, Adam Jaffe et al eds. 2001.

framework on standardization, the preference for a voluntary industry approach is mentioned in legislative acts and reinforced by several authoritative policy documents. It is against this background, that the current research explores how a policy based on public leadership to accelerate the agreement of a set of interoperability standards for smart grid has been legitimated. This part of the analysis focuses mainly on four key documents in the US context. They are the two White House reports, "A Strategy for American Innovation – Securing Our Economic Growth and Prosperity" written by the National Economic Council, Council of Economic Advisers, and Office of Science and Technology Policy, published in February 2011, and "A Policy Framework for the 21st Century Grid: Enabling Our Secure Energy Future", Executive Office of the President, National Science and Technology Council, published in June 2011, and the two versions of the "NIST Framework and Roadmap for Smart Grid Interoperability Standards", the first published in January 2010, and the second in February 2012.

As we will see, the way that standardization is described in these documents differs quite markedly from policy statements of the last couple of decades by the US federal government. Policy documents make explicit that efforts to encourage standardization for smart grid is a departure from established practice by emphasizing that standardization initiatives should normally be industry-led and voluntary, and therefore that the proposed government intervention requires justification. The standards system is described as "private-sector led and bottom-up, with the Federal Government acting as the public-sector partner and sometimes as a convener," and emphasizes that, "[c]onsistent with the primary role of the private sector, strategic Federal involvement is sensible and appropriate *where necessary* [emphasis added] to convene key stakeholders and enable standard-setting efforts to succeed" ([2], pp. 26–27). Elsewhere, it is maintained that "reliance on private sector leadership, supplemented by Federal Government contributions to discrete standardization processes […] remains the primary strategy for government engagement in standards development" and it is reiterated that "all standards activities should involve the private sector" [39].

The narrative on smart grid standards draws on the discourses identified in the previous section, but adds a number of other discourses that are used to argue for a change in policy. In these communications, the starting point is that the US standardization system is generally industry-led but the challenge of smart grid is a special case that requires federal intervention: there is an opportunity to build the 21st century grid. The numerous benefits of standards and the risks of not having them in place create a sense of urgency. From the antitrust tradition is added the notion that industry might not always act in the best interests of society. NIST is thus presented as an "honest broker", well-equipped to lead the effort to achieve standardization coordination.

5.1. Economics of standards

The documents analysed for this section all exhibit a strong and explicit influence of the economics of standards literature. In addition to mentioning technical aspects of interoperability, the documents emphasize the economic effects of interoperability standards and directly link them to the functioning of the market, including innovation and pricing. The NIST roadmap contains a comprehensive account of the full range of the effects of compatibility standards, showing a clear influence of the economics of standards literature as summarized in Table 2. The smart grid interoperability process, led by NIST, is described as leading to "flexible, uniform, and technology neutral standards that can *enable innovation, improve consumer choice, and yield economies of scale* [emphasis added]" ([2], p. 4).

A significant emphasis in both White House and NIST publications is on the notion that standards can help ensure the long-term value of public and private investment [emphasis added]:

Table 2
Main functions of interoperability standards.
Source: Ref. [40].

Function of standards	Effects on the Market
Information	Increase market transparency Reduce transaction costs Correct adverse selection Facilitate trade
Compatibility	Create network externalities Increase competition Decrease vendor lock-in
Variety reduction	Allow economies of scale Build critical mass

> Standards help ensure that today's investments will still be valuable in the future. Because smart grid technology is changing swiftly, utilities and vendors may be reluctant to invest in infrastructure that may soon be out of date, and regulators and ratepayers may be justifiably reluctant to compensate them for it. *Standards can ensure that smart grid investments made today will be compatible with advancing technology.* ([2], p. 26)

> NIST will continue to develop and update the standards from the NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0, recognizing that *the continued development and adoption of standards is an important driver for ensuring maximum value from ongoing smart grid investments.* ([2], p. 29)

This focus reflects the fact that "the Administration has made unprecedented investments in clean-energy technologies and grid modernization" ([2][2] preface). A sense of urgency is created by the fact that these investments are already underway, and will be accelerated by Recovery Act funding [emphasis added]:

> There is an urgent need to establish protocols and standards for the Smart Grid. Deployment of various Smart Grid elements, including smart sensors on distribution lines, smart meters in homes, and widely dispersed sources of renewable energy, is already underway and will be accelerated as a result of Department of Energy (DOE) Smart Grid Investment Grants and other incentives, such as loan guarantees for renewable energy generation projects. Without standards, there is the potential for technologies developed or implemented with *sizable public and private investments* to become obsolete prematurely or to be implemented without measures necessary to ensure security. [41]

The same concern about investments stranded because of changing technology and the lack of standards is voiced in a 2009 report to Congress: "Some utilities are incurring costs to replace smart meters installed just a few years ago with newer models, indicating both the rapidity with which the technology is changing and the absence of firm standards" [42].

The notion that standards can protect investments in legacy infrastructure by ensuring compatibility with older technologies as newer ones are deployed echoes the economics of standards literature. For example, Chiao et al. state that, "[a] standard that demands backwards compatibility can ensure ongoing revenues for a legacy product for many years" ([43], p. 139). Other expected benefits of standards are also mentioned, notably the relationship between standards and innovation:

> Standards help catalyze innovation. Shared standards and protocols provide some assurance that new technologies can be used throughout the grid and reduce investment uncertainty by lowering transaction costs and increasing compatibility. Standards demonstrate to entrepreneurs that a significant market will exist for their work. Standards also help consumers trust and adopt new

technologies and products in their homes and businesses. [41]

"Standards do more than make interaction possible. They can resolve confusion and promote investments in technology, giving firms the confidence to market products that meet the standards." ([2], pp. 26–27)

Again, the language is drawn directly from the academic literature on standards, which theorizes that standards lower transaction costs and can help markets take off. The documents also draw on the economics of standards literature when they argue that standards help build critical mass, open up markets, facilitate economies of scale, favour competition, and ultimately lower costs for consumers.

Standards help keep prices lower. Standards can reduce market fragmentation and help create economies of scale, providing consumers greater choice and lower costs […] Standards can help open markets. In addition to being developed in America, smart grid interoperability standards should be coordinated internationally. International engagement helps to open global markets, create export opportunities for U.S. companies, and achieve greater economies of scale and vendor competition that will result in lower costs for utilities and ultimately consumers. [2,p. 27]

This catalogue of the possible effects that standards can have in the marketplace makes a strong case for the government pushing for their development and adoption. It also shows that significant research has been put into the development of policy documents. However, the assumption that the effort led by NIST magically will bring all of the theoretical benefits of optimally developed standards seems overly optimistic. It is notable that the policy narrative stays at a theoretical level with relatively few context-specific details provided – what smart grid standard will remedy what situation currently faced? – and there is no mention of the possibility of suboptimal standardization.

5.2. Standards and anticompetitive behaviour

In addition to the positive effects of interoperability standards, the policy documents also warn of the dangers of a lack of standards. "In the absence of smart grid interoperability standards, companies may attempt to 'lock-in' consumers by using proprietary technologies that make their products (and, therefore, their consumers' assets) incompatible with other suppliers' products or services. Standards "can alleviate those concerns and ensure that consumers have choices." Elsewhere it warns of the situation where "a dominant firm's use of proprietary standards that locks out competition from rival products and services" ([2], p. 46). For this reason, "Federal and state officials should continue to monitor smart grid and smart energy initiatives to protect consumer options and prevent anticompetitive practices." The remedy is an open architecture that can eliminate market obstacles, provide for competition among vendors, and encourage new third-party entrants: "Open standards can encourage a competitive, multi-supplier environment" ([44], p. 21).

5.3. From industry-led to partnership

It is this contrast between the benefits that interoperability standards can bring and the risk that – in the absence of standards, unnamed companies will have the power and act counter to public and consumer interests – that opens up for the description of an enhanced role of the government in smart grid standardization. In contrast with the dominant conceptualisation of the government's role in standardization, smart grid policy documents outline scenarios where public leadership can be desirable. This is echoed by The White House description of NIST's effort:

By setting standards for smart grid technologies and making information technology investments, the Administration is bringing the nation's electricity grid into the 21st century to reduce energy waste In particular, federal investments and policy leadership in this area serve to help consumers and utilities optimize the timing and sourcing of electricity use, which promises to reduce costs, increase reliability, and limit blackouts, while improving the security of the electricity system and enabling it to better use clean energy technologies. As part of this grid modernization effort, the National Institute of Standards and Technology (NIST) is leading a public-private initiative to develop a framework and roadmap to develop smart grid interoperability standards. ([45], p. 38)

A White House document emphasizes the importance of standards for innovation and makes a number of statements about the role of government in certain sectors. It acknowledges the link between public resources and innovative markets and claims that the public sector can take leadership in setting standards and thereby provide certainty in the market place:

Effective management of public resources, such as the electromagnetic spectrum, unleashes innovation by opening markets and reducing uncertainty over usage rights and engineering design… In appropriate contexts, public leadership can help set standards for technology platforms, such as emerging smart grid or health IT technologies, providing confidence to the market place to develop and adopt new generations of products. ([45], p. 13)

It specifies the specific role of the government in standardization – that as a convener – and contrasts the benefits of larger markets for US businesses through coordination with the risks of "balkanized" markets in the absence of such coordination:

Standard setting, *which the government can enable through its role as convener and support through research and development*, often involves facilitating coordination within the private sector to create a larger market, thus enhancing the demand for innovative products. Export initiatives further increase the market scale for US businesses. *Increased scale is an attraction to business innovation, while tiny, balkanized markets are not* [emphasis added]. ([45], p. 13)

In terms of the role of government, a recurring theme across policy documents is the notion of striking a balance between intervention and industry involvement. "Our spirit of public/private partnership motivates cooperation to find the right balance of 'top down' and "bottom up" to achieve the coordination needed for the smart grid" [46].

Government direction can never be a substitute for the free market conditions that propel American innovation. But government must act to support those conditions and ensure that innovation, the engine of our prosperity, drives America further and faster towards higher quality jobs, healthier and longer lives, new opportunities and new industries, and the ever-expanding technological frontier. ([45], p. 13)

The appropriate role for government can be understood by clarifying the precise circumstances where markets, despite their many strengths, will not produce a sufficient stream of innovations on their own. Thus, the true choice in innovation policy is not starkly between government management and no government involvement, but rather choosing the right role for government in supporting private sector innovation. Finally, the government plays essential roles through public investments that businesses rely on but do not themselves create. ([45], p. 10)

Documents refer to successful examples of Federal government intervention in standardization, including in the areas of public health, national security, and the environment:

History has shown that the states and Federal Government have important roles in catalyzing innovation. In the electricity sector, this role can include facilitating the creation and use of standards,

developing new energy efficiency programs, investigating the impact of different consumer incentive programs, and monitoring markets to prevent anticompetitive behavior… In the smart grid arena, the Federal Government is operating in the tradition it has followed previously in promoting the development of standards in a wide array of fields. ([2], p. 26)

5.4. NIST as an honest broker

Having made the case for smart grid and for the role of interoperability in delivering the smart grid. The final component of this narrative is to present the organization chosen to act as convener of the process: NIST. Several NIST publications underline that NIST has a tradition of intervening in this type of challenge, a history of acting as an "honest broker".

Since its establishment in 1901, NIST has earned a reputation as an *"honest broker"* that works collaboratively with industry and other government agencies. Over the past century, NIST's mission has been to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life. Today in the 21st century, then, NIST is ideally suited for its latest assignment. (NIST website, last accessed on 23/11/2015)

NIST is well suited for the role of leading the charge for rapid standards development. The agency has earned a reputation as an "honest broker"—an impartial, technically knowledgeable third party with a long history of working collaboratively with industry and other government agencies. (Arnold testimony, July 2009).

While the EISA mandate gave NIST an unprecedented high profile, the storyline presented in policy communications is that this is a role that NIST has been called on to perform in the past.

NIST […] has a long history of working collaboratively with industry, other government agencies, and national and international standards bodies in creating technical standards underpinning industry and commerce. Government regulators are playing an important role in these efforts to modernize the grid. Traditionally, regulators have been charged with overseeing electric utilities to ensure that electric service is affordable, reliable and universal. Increasingly, regulators also need to ensure that in meeting these goals, appropriate incentives exist to deploy the new technologies and innovations required to realize the smart grid. [47]

Building on NIST's century-long partnership with the electric industry, we are embarking with our partners on this generation's grand challenge—modernizing the electric power grid so that it incorporates information technology to deliver electricity efficiently, reliably, sustainably, and securely. (NIST website, last accessed on 23/11/2015)

5.5. Key concepts and metaphors

An outstanding feature of the US discourse on smart grid standardization is the use of metaphors. In addition to the already mentioned "catalyse" and "honest broker",the term "silo" is frequently invoked by both policymakers and academics, e.g. Ipakchi and Albuyeh [48]: "In most cases, the information in each organizational 'silo' is not easily accessible to applications and users in other functional units." It was used by George Arnold, the national coordinator for smart grid interoperability, in his testimony to Congress: "The electric utility industry has 'many proprietary interfaces and technologies that result in the equivalents of stand-alone silos' [46]. A similar use of metaphor to illustrate the chaotic situation resulting from the absence of standards: "Without standards, trying to exchange information among utilities, vendors, regulators, and others, never mind linking thousands of utility systems together, would be a veritable 'Tower of Babel'" [49]. Another metaphor frequently used in mass media, academic articles and in policy documents and speeches is the term "balkanization".

6. Discussion and conclusion

The empirical part of this paper is based on a comprehensive study of primary policy texts, in which discourse analysis was applied to an existing policy problem, namely the challenge of bringing about the interoperability standards needed to achieve the smart grid. The storyline that was communicated by the federal government is in contrast with recent general policy on standardization which has showed a clear preference for industry to lead. While the narrative takes this industry focus as the default position, policy documents show a significant effort was made to present standards for smart grid as a special case that requires the government to take leadership. In creating this narrative, key texts from both the White House and NIST – the body tasked with coordinating the standardization effort – draw on a range discourses and frames, including the economics of standards discourse and the framing of the "smart grid" as a grand national project with parallels drawn to the building of the electricity grid in the 20th century. The economics of standards discourse provides a direct link between standards to consumer benefits and public investment, and influences from competition law provide the notion of competing interests and the possibility that industry-led efforts may lead to suboptimal outcomes.

The rhetorical device of contrasting the benefits of standardizing with the risks of not reaching an agreement, including the waste of sizable public investments is used throughout the US policy discourse. Evident are also efforts to elevate the topic and increase the audience, by linking standards for smart grid to more salient issue areas such as national security, and through the use of rhetorical devices – most importantly the repeated use of colourful metaphors such as describing NIST as an "honest broker", and pointing to the risk of "balkanization" if efforts to agree on interoperability standards fail. The result is an effective case for a departure from the normal policy of laissez-faire to an active role of NIST as a convener in the process. While succeeding in making a strong argument for government intervention, the story developed in policy documents can be criticized for not properly considering the complexity of the effort required, and for failing to outline a practical policy alternative beyond a five-year plan.

While policy evaluation is not the focus of this paper, it is probably safe to say that progress on standardization has not progressed to the extent that was envisioned in the policy documents analysed for this article. Commenting on the situation in the US, a New York Times article from 2013 concludes that:

For the most part, experts say the grid is not being changed, at least not on a scale big enough to make much difference […] The technology, the engineering skill and even the money are all available, experts say, but the ability to reach agreement on such a grid is not. Dozens of experts said in interviews that there were simply too many players, both commercial and governmental, and too many conflicting interests." [50]

The policy narrative that emerged from the White House and echoed by NIST itself had clear elements of the technological *hero* story [6]. It described a situation to be remedied: an aging electricity grid, plagued by blackouts and modernization hampered by an electric utility industry composed by stand-alone "silos", unable to communicate with each other, a veritable "tower of Babel". In contrast, it held out the vision of a future "smart grid" with promises of improved energy security, reduced carbon emissions, the use of renewable resources, "green innovation" and jobs. The threat: without standards, "balkanization", and the risk that technologies developed or implemented with sizable public investments would become obsolete prematurely or

to be implemented without measures necessary to ensure security.

Who are the villains and the heroes in this story? Janda & Topouzi [6] have found that energy policy stories often lack convincing characters (2015, p. 517). Is NIST the hero, uniquely placed and able to act as an "honest broker", proving that the government can act as "catalyst" in partnership with industry? And are the villains in the story the unnamed companies engaging in uncompetitive behaviour to the detriment of society? A clear effort was made – first in the two White House reports of 2011 and then taken on by the NIST in its Smart Grid Framework 2.0 report – to cast NIST in a special role. However, NIST was given only five years to complete this mission and in 2012, responsibility was largely handed back to industry. The story thus ends abruptly, without the challenges overcome and without a credible explanation as to why NIST is no longer needed to lead.

Today the lack of agreement on standards is still seen as standing on the way of smart grid deployment. To be sure, the work on standardization continues, and in May 2014 NIST published version 3.0 of its roadmap but the additions are technical and not accompanied by vivid language about NIST's role. Interestingly, NIST has not been seen as failing to be either hero or honest broker. No high-level policy documents on smart grid standardization have subsequently been published, and because policy failure is not admitted, there is no blame to distribute. Why has the failure of the hero or the honest broker gone unremarked? Probably because reality is more complex than NIST imagined.

Seen in the larger context of the smart grid, the standardization effort can itself be seen as the hero that will magically bring about the smart grid and all that it has to offer. Certainly the story can be criticized for making exaggerated claims about the effects of standards and downplaying the complexity of the process of reaching them. Standardisation of the smart grid is not a silver bullet or a single achievement. Rather, it is complex and slow work that involves thousands of stakeholders and hundreds of individual standards being developed in different settings. The discrepancy between the outcomes promised by the storyline and what is delivered by the policy is the result of a narrative that fails to grapple with reality.

The findings of this research are in line with those of Janda and Topouzi [6] who argue that hero stories do not work out as intended because reality is more complex than simplistic policy narratives. The case of smart grid standards also illustrates how policy storylines replace complex debates and take away from proper public deliberation ([14], p. 65), a form of black-boxing [51]. To some extent this is an inevitable aspect of all communication, and given that "politics require story-lines" ([14], p. 268), perhaps a better story needs to be told about smart grid standardization. One that is engaging to the audience while taking into account the genuine difficulty in the real world. To use the terminology of Janda and Topouzi [6], a *learning story* may be what is needed, one that tells of us how the challenge is more complicated than initially thought and which recognises that the smart grid is something that will not be delivered in 5 years but is an ongoing process that will need sustained effort.

A broad theme pursued throughout this paper draws attention to the political and institutional factors that influence how policymakers view and respond to the coordination challenge presented by the deployment of ICT systems to achieve societal goals. As an increasing number of government policies and programs are prefixed with "e" and "smart", issues relating to interoperability and standards are likely to become increasingly salient, and the study of smart grid takes on further importance if it is thus viewed as an "emblematic" case [14]. At a fundamental level then, this paper is concerned with understanding the ability of political systems to adapt and respond to challenges that require more than incremental policy change – such challenges include those posed by climate change, energy transitions, and the advent of the digital society.

References

[1] European Commission . Smart Grid Projects in Europe: Lessons Learned and Current Developments 2011; Retrieved from https://ses.jrc.ec.europa.eu/sites/ses/files/documents/smart_grid_projects_in_europe.pdf

[2] EOP, A Policy Framework for the 21st Century Grid: Enabling Our Secure Energy Future, Executive Office of the President, National Science and Technology Council, Washington D.C, 2011.

[3] NIST . Smart Grid Interoperability Panel 2012; Retrieved from http://www.nist.gov/smartgrid/sgipbuffer.cfm, June 18

[4] NIST . NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 2.0 2012; Retrieved from https://www.nist.gov/sites/default/files/documents/smartgrid/NIST_Framework_Release_2-0_corr.pdf

[5] K. Werbach, Higher standards regulation in the network age, Harv. J. Law Technol. 23 (1) (2009) 179–225.

[6] K.B. Janda, M. Topouzi, Telling tales: using stories to remake energy policy, Build. Res. Inf. 43 (4) (2015) 516–533.

[7] R. Langheim, M. Skubel, X. Chen, W. Maxwell, T.R. Peterson, E.J. Wilson, J.C. Stephens, Smart Grid coverage in U.S. newspapers: characterizing public conversations, Electr. J. 27 (5) (2014) 77–87.

[8] J.C. Stephens, E.J. Wilson, T.R. Peterson, Smart Grid (R)Evolution: Electric Power Struggles, Cambridge University Press, Cambridge, 2015.

[9] R. Slayton, Efficient, secure green: digital utopianism and the challenge of making the electrical grid smart, Inf. Cult. 48 (4) (2013) 448–478.

[10] G. Bellantuono, Comparing smart grid policies in the USA and the EU, Law Innovation and Technology. 6 (2) (2014) 221–264.

[11] J.B. Eisen, Smart regulation and federalism for the smart grid, Harv. Environ. Law Rev. 37 (2013) 101–156.

[12] M.A. Hajer, H. Wagenaar, Editors' introduction, in: M.A. Hajer, H. Wagenaar (Eds.), Deliberative Policy Analysis: Understanding Governance in the Network Society, Cambridge University Press, Cambridge, 2003.

[13] C. Bacchi, Policy as discourse: what does it mean? Where does it get us? Discourse Stud. Cult. Polit. Educ. 21 (1) (2000) 45–57.

[14] M.A. Hajer, The Politics of Environmental Discourse: Ecological Modernization and the Policy Process, Clarendon Press, Oxford [England], 1995.

[15] M. Rein, D. Schön, Frame-critical policy analysis and frame-reflective policy practice, Knowl. Policy 9 (1) (1996) 85–104.

[16] F. Fischer, J. Forester, Editor's introduction, in: F. Fischer, J. Forester (Eds.), The Argumentative Turn in Policy Analysis and Planning, Duke University Press, Durham and London, 1993.

[17] G. Majone, Evidence: Argument and Persuasion in the Policy Process, Yale University Press, New Haven and London, 1989.

[18] V.A. Schmidt, The Futures of European Capitalism, Oxford University Press, Oxford, 2002.

[19] P. Rabinow, N. Rose, Introduction to the Essential Foucault: Selections from the Essential Works of Foucault, 1954–1984, New Press, New York, 2004.

[20] J.W. Kingdon, Agendas, Alternatives and Public Policies, Longman, London, 1995.

[21] P. Jeffcut, The interpretation of organization: a contemporary analysis and critique, J. Manag. Stud. 31 (2) (1994) 225–250.

[22] T. Bridgman, D. Barry, Regulation is evil: an application of narrative policy analysis to regulatory debate in New Zealand, Policy Sci. 35 (2002) 141–161.

[23] D. Stone, Policy Paradox: The Art of Political Decision Making (Revised Edition Ed.), W. W. Norton, New York, 2002.

[24] L. Hansen, Security as Practice: Discourse Analysis and the Bosnian War, Routledge, London, 2006.

[25] G.W. Arnold, Opening remarks, Paper Presented at the FERC Technical Conference (2011) (31 January 2011).

[26] FERC, Smart Grid Policy Statement, (2009) Retrieved from https://www.ferc.gov/whats-new/comm-meet/2009/071609/E-3.pdf.

[27] Stakeholders look to jump-start stalled Smart Grid standards, Energy Washington Week, (2009) Retrieved from http://insideepa.com/Energy-Washington-Week/Energy-Washington-Week-01/21/2009/menu-id-93/Page-1.html , 21 January 2009).

[28] J. Siciliano, Administration Pursuing Major Interagency Plan to Deploy Smart Grid, Energy Washington Week, 2009 March 25, 2009.

[29] FERC, Smart Grid Policy, (2009).

[30] FERC, Smart Grid Interoperability Standards, (2011).

[31] NIST, NIST Smart Grid Update, (2013).

[32] J.L. Contreras, Standards, Patents, and the National Smart Grid, Pace Law Rev. 32 (3) (2012) 641–675.

[33] R.B. Marks, R.E. Hebner, Government/industry interactions in the global standards system, in: S. Bolin (Ed.), The Standards Edge: Dynamic Tension, Sheridan Books, Michigan, 2004.

[34] OTA . Global Standards: Building Blocks for the Future 1992; Retrieved from http://www.strategicstandards.com/files/GlobalStandards.pdf

[35] Executive Office of the President, OMB Circular A-119; Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities, (1998) Retrieved from https://energy.gov/sites/prod/files/2013/07/f2/omba119.pdf.

[36] FTC, Bureau of Consumer Protection, Standards and Certification: Proposed Rules and Staff Report, (1978).

[37] FTC, To Promote Innovation: The Proper Balance of Competition and Patent Law and Policy, (2003) Retrieved from http://ftc.gov/os/2003/10/innovationrpt.pdf.

[38] FTC & DoJ, Antitrust Enforcement and Intellectual Property Rights: Promoting Innovation and Competition, (2007) Retrieved from http://www.ftc.gov/reports/innovation/P040101PromotingInnovationandCompetitionrpt0704.pdf.
[39] OMB, OSTP, & USTR, Memorandum from Aneesh Chopra, Miriam Sapiro & Cass R. Sunstein to the Heads of Executive Departments and Agencies, (2012) Retrieved from https://www.nist.gov/sites/default/files/documents/2017/01/30/m-12-08_1.pdf.
[40] T.M. Egyedi, K. Blind, Introduction, in: T.M. Egyedi, K. Blind (Eds.), The Dynamics of Standards, Edward Elgar, Cheltenham, UK, 2008, pp. 1–12.
[41] NIST, NIST Identifies Five "Foundational" Smart Grid Standards [Press release], (2010) Retrieved from https://www.nist.gov/news-events/news/2010/10/nist-identifies-five-foundational-smart-grid-standards-0.
[42] S.M. Kaplan, Electric Power Transmission: Background and Policy Issues, CRS Report for Congress, (2009) Retrieved from http://fpc.state.gov/documents/organization/122949.pdf.
[43] B. Chiao, J. Lerner, J. Tirole, The rules of standard-setting organizations: an empirical analysis, RAND J. Econ. 38 (4) (2007) 905–930.
[44] GWAC . GridWise Interoperability Context-Setting Framework 2008; Retrieved from http://www.gridwiseac.org/pdfs/interopframework_v1_1.pdf
[45] White House, A Strategy for American Innovation: Securing our Economic Growth and Prosperity, (2011) Retrieved from Washington.
[46] G.W. Arnold, Testimony: Smart Grid Architecture and Standards: Assessing Coordination and Progress, House Committee on Science and Technology Subcommittee on Technology and Innovation, 2010.
[47] G.W. Arnold, Challenges and opportunities in smart grid: a position article, Proc. IEEE 99 (6) (2011) 922–927.
[48] A. Ipakchi, F. Albuyeh, Grid of the future: are we ready to transition to a Smart Grid? IEEE Power Energy 7 (2) (2009) 52–62.
[49] Utility Standards Board, Smart Grid: Interoperability and Standards – An Introductory Review, (2008).
[50] M.L. Wald, Ideas to Bolster Power Grid Run Up Against the System's Many Owners. New York Times, (2013) Retrieved from http://www.nytimes.com/2013/07/13/us/ideas-to-bolster-power-grid-run-up-against-the-systems-many-owners.html , July 12, 2013.
[51] M. Callon, B. Latour, Unscrewing the big Leviathan: how actors macro-structure reality and how sociologists help them to do so, in: K. Knorr-Cetina, A.V. Cicourel (Eds.), Advances in Social Theory and Methodology: Towards an Integration of Micro- and Macro-Sociologies, Routledge & Kegan Paul, Boston, 1981, pp. 277–303.
[52] ANSI. (2005). *Overview of the U.S. Standardization System*
[53] J. Campbell, The hero with a thousand faces (2nd ed.), Princeton University Press, Princeton, 1968.
[54] Quach, Thui Thi (2004) The Crisis in Darfur: An Analysis of its Origin and Storylines (Alexandria, VA: Virginia Polytechnic Institute and State University).; H.R. 6 — 110th Congress
[55] Energy Independence and Security Act of 2007." www.GovTrack.us. 2007. June 12, 2017 < https://www.govtrack.us/congress/bills/110/hr6