
Ria Langheim, Melissa Skubel, Xiao Chen, William Maxwell, Tarla Rai Peterson, Elizabeth Wilson and Jennie C. Stephens

I. Introduction

Electricity fulfills an ever-increasing role of critical societal functions, and calls to modernize the U.S. electric power system are growing stronger (SmartGrid, 2013; Beyea, 2010). Among national leaders, including both President Bush and President Obama, the creation of a “smarter” grid has been repeatedly framed as a critical policy priority. While building a smart grid (SG) is a costly political and financial commitment—infrastructure investments on the order $300–500 billion over the next 20 years have been estimated for U.S. grid modernization (EPRI, 2011), the costs of not investing in this critical infrastructure are also high. But building a smarter grid is not simple, and it requires the alignment of national, regional, state, and local priorities spanning multiple jurisdictions. SG development and policy creation is challenged by many...
Understanding how public conversations about SG are evolving over time helps to engage diverse stakeholders in the design and implementation of future electricity systems. This research seeks to inform SG development by analyzing the complex and evolving public conversations about SG through media analysis. The media play a dual role in public engagement of policy issues: the way the news media cover an issue can contribute to shaping public opinion and the extent and type of news coverage can reflect and communicate public priorities within the policy process (Graber, 1997; Hansen, 1991; McCombs, 2002; Gamson and Modigliani, 1989). National-level newspapers influence, inform and shape public discourse on energy, technology, climate change, and environmental issues, and the extent and level of coverage on these issues also influences public perception. Newspapers report on ongoing technological and social developments, policy issues, and energy-relevant financial ventures, as well as provide opinion pieces. Analysis of SG media coverage provides an opportunity to assess the public discourse surrounding SG development.

II. Approach

Justification

Media analysis provides a useful approach to analyze public discourse because the news media represent and reflect public conversations and public policies (Graber, 1997; Hansen, 1991; Gamson and Modigliani, 1989; Feldpausch-Parker et al., 2013). The media also have potential to influence public perception and reinforce – or potentially change – the direction and scope of public discourse on a particular issue.
Salience of reporting across newspapers demonstrates the relevance and “newsworthiness” of a topic for specific audiences and timeframes. Analysis of newspaper coverage also allows for a characterization of the types of challenges and opportunities mentioned in public conversations. With respect to technical issues including energy policy and energy technologies, the news media also play a critical role linking technical assessments of experts to the more socially recognizable assessments of laypersons (Dunwoody and Neuwirth, 1991; Gregory, 1989; Murray et al., 2001; Singer and Endreny, 1987).

To characterize the different ways that energy technologies are communicated in the media we use the SPEED (Socio-Political Evaluation of Energy Deployment) framework that identifies six distinct frames including: Technical, Economic, Political, Health & Safety, Environmental, and Cultural (Feldpausch-Parker et al., 2013; Boyd et al., 2013; Chaudhry et al., 2013). This framework provides structure to analyze and explore interactions among multiple socio-political factors (beyond technical feasibility), which influence energy technology deployment. This includes regulatory, legal, political, economic, and cultural factors using multiple approaches including policy review (Wilson and Stephens, 2009), media analysis (Feldpausch-Parker et al., 2013; Stephens et al., 2009), and stakeholder interviews (Fischlein et al., 2010, in press). The SPEED framework adapts and operationalizes Luhmann’s (1989) theory of society as a system made up of self-organizing subsystems that function interactively (Luhmann, 1989, 1995).

New demands on electricity systems to provide reliable and low-cost power are now coupled with demands for increased efficiency, enhanced security, and a reduction in environmental and climate impacts. Meeting these additional demands requires new sensors and information and communication technologies (ICT) to manage an increasingly complex electricity system; SG has become the catch-all phrase which represents these changes. Many discussions of SG highlight its ability to improve system efficiency by reducing the costs to generate, deliver, and consume electricity. SG also is associated with potential to enhance system reliability and resilience by optimizing grid performance, ensuring power quality, and enabling quicker restoration of power after outages. SG is crucial for the integration of variable renewable resources like wind and solar power, and SG is also linked to enabling more distributed power generation. Integrating plug-in electric vehicles, and creating local microgrids are also promises of SG. Adoption of dynamic pricing and smart meters could allow consumers to monitor and manage energy in a more responsive way.

Despite its potential benefits, diffusion of SG technologies in the U.S. has been patchy, the level of investment remains daunting, and the path forward for SG remains uncertain and often contested (Amin and Gellings, 2006; Levinson, 2010). Societal recognition of the importance of SG in the U.S. is evident in the inclusion of $4.5 billion in SG government support in The American Recovery and Reinvestment Act (ARRA) of 2009 (DoE, 2010), and in local, state, and regional policies, projects, and initiatives promoting the development of SG systems throughout the U.S. (Minnesota Dept, 2010; PR News Wire, 2010).

Public opposition to SG has also emerged, with consumer concerns over cost, privacy, cybersecurity, and health becoming increasingly prevalent (Levinson, 2010; Investors Business Daily, 2010; Hess, 2013). Health concerns are primarily
associated with risks of exposure to radio waves emitted from wireless smart meters installed in homes, though this remains similar to emissions from cell phones or wireless Internet routers (Hess, 2013). Complex jurisdictional issues coupled with institutional and economic challenges of SG deployment are apparent, yet social science analysis of non-technical sociopolitical factors influencing SG development remains limited. This article attempts to bridge this gap.

III. Methods

To characterize public discourse on SG in the U.S., we analyzed the content and framing in SG-related articles from 1998 to 2013 in The Wall Street Journal (WSJ), USA Today, and The New York Times (NYT). The WSJ, the largest circulating newspaper in the U.S., focuses on business and financial news with a total digital and hard copy circulation of 2.29 million copies. USA Today is a more general newspaper distributed in all 50 states with a circulation of 1.7 million digital and hard copy editions. The NYT has a circulation of roughly 1.6 million digital and hard copies (Alliance for Audited Media, 2013). We selected these three newspapers because they represent national-level discourse across the country and reach a wide range of different audiences. While USA Today is truly national in that it does not have a specific geographical focus, The WSJ and the NYT are distributed nationally but are both based in New York City, resulting in an East Coast orientation and higher readership in the New York region.

A. Searching for SG articles

To find articles on SG we used the Factiva database (which provided access to all three newspapers) and searched all article types (news, business, editorials, etc.) published between 1998 (the year in which the first article mentioning SG was published) and Dec. 31, 2013, that included the following phrases: smart grid, smart meters, smart metering, smart electric grid, and smart electricity grid. We reviewed the retrieved articles for relevance to electricity systems and extent of focus on SG. Articles that were not related to electricity systems (e.g., articles that discussed smart parking meters) and articles that only mentioned the search terms without further relevance or context (e.g., John Mayer who is the CEO of the SG Company X joined the meeting) were removed from the sample. We classified the remaining articles into two categories (SG-focused and SG-subsection) based on the extent of SG discussion; SG-focused articles were those where the entire focus of the article was SG or a specific SG technology, while SG-subsection articles included articles where the main focus of the article was not exclusively SG, but SG or a SG technology was discussed within a subsection.

B. Analysis of articles

We used the text analysis software NVIVO 10.0TM to analyze (1) salience in terms of placement (i.e., whether published in business, op-ed, energy section, etc.), (2) the diversity of technological components mentioned (Table 1 describes technology categories mentioned), (3) the frequency and type of SPEED frames used to describe

<table>
<thead>
<tr>
<th>Technologies</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission and distribution</td>
<td>Power lines, transformers, voltage, AC, DC, relays, capacitors</td>
</tr>
<tr>
<td>Smart meters</td>
<td>Smart meter, advanced meter</td>
</tr>
<tr>
<td>Energy storage</td>
<td>Batteries, fly wheels</td>
</tr>
<tr>
<td>Sensors, information, and</td>
<td>Sensors, software, hardware, SCADA</td>
</tr>
<tr>
<td>communication technologies</td>
<td></td>
</tr>
<tr>
<td>Renewable generation</td>
<td>Wind, solar, photovoltaic, geothermal, wave, tidal</td>
</tr>
<tr>
<td>Electric vehicles</td>
<td>Volt, Plug-In Prius, Tesla</td>
</tr>
<tr>
<td>Consumer load appliances</td>
<td>Programmable dishwashers, air-conditioning</td>
</tr>
<tr>
<td>Consumer interface tools</td>
<td>Websites, apps, cellphone</td>
</tr>
</tbody>
</table>

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Two researchers independently coded each article, and they reached an intercoder-reliability of 90 percent and a Kappa value of 0.8, indicating a high level of consistency. We analyzed which technologies the articles discussed by calculating the frequency of mentions of different technologies for all articles. Among the SG-focused articles, the co-occurrence of different technological categories was assessed using the Pearson’s correlation test, a statistical correlation method that can be used to analyze the degree of association between two dichotomous variables (Hair, 2006). The resulting phi-coefficients determine the strength of the association in mentioning the presence or absence of different technology components in the articles. Statistically significant ($p \leq 0.05$) correlation coefficients of $|0.4|$ are generally considered to show a moderate degree of association between two variables and correlation coefficients of $|0.7|$ and higher have a strong degree of association (Cohen, 1988).

We also analyzed who was presented as the influential or knowledgeable actors in these articles (Table 2). We analyzed the framing of SG risks and benefits in all SG-focused articles characterizing the frequency of technical, economic, political, health and safety, environmental, and cultural frames (Table 3).

### IV. Results and Discussion

A total of 231 articles were retrieved from the search including 87 SG-focused articles and 144 SG-subsection articles (Table 4).

### Table 2: Categories of Different Actors Associated with SG.

<table>
<thead>
<tr>
<th>Actors and Institutions</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Consumers</td>
<td>Home owners, businesses</td>
</tr>
<tr>
<td>Electric Utility and Power Companies</td>
<td>California Edison, PG&amp;E, N-Star</td>
</tr>
<tr>
<td>Private Sector</td>
<td>Siemens, General Electric, Cisco</td>
</tr>
<tr>
<td>Federal Government</td>
<td>Obama, White House, DOE, EPA</td>
</tr>
<tr>
<td>State Government</td>
<td>State public utility regulator, state legislator</td>
</tr>
<tr>
<td>Independent System Operator or Regional Transmission Organization</td>
<td>ERCOT, RTO, NE-ISO</td>
</tr>
<tr>
<td>Academia</td>
<td>Universities and academic researchers</td>
</tr>
<tr>
<td>Non-profit sector</td>
<td>Sierra Club, Conservation Law Foundation</td>
</tr>
</tbody>
</table>

### Table 3: Descriptions of SPEED Risk and Benefit Frames.

<table>
<thead>
<tr>
<th>SPEED Frame</th>
<th>Benefit</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical</td>
<td>Improve electric infrastructure, allow creation of a more reliable grid, better integration of renewable resources</td>
<td>Increased grid vulnerability, cyber-attacks, reliability concerns of smart meters</td>
</tr>
<tr>
<td>Economic</td>
<td>More efficient use of the electric grid, strengthen economy (jobs, manufacturing), save money because there is less need to build new facilities</td>
<td>Increased cost of electricity, cost of SG outweighs benefits</td>
</tr>
<tr>
<td>Political</td>
<td>Positive political ramifications, i.e., energy independence, enhanced national security, energy security</td>
<td>Negative political ramifications, i.e., public frustrations, difficult legal and regulatory process</td>
</tr>
<tr>
<td>Health &amp; Safety</td>
<td>Reduced respiratory problems from improved air quality</td>
<td>Health and safety concerns associated with power lines, smart meters (i.e., wireless radiation, headaches)</td>
</tr>
<tr>
<td>Environmental</td>
<td>Reduce GHGs or carbon emission, mitigate climate change, energy conservation, less air and water pollution</td>
<td>Potential threat to ecological health, i.e., bird kills, protected species, habitat destruction or disruption</td>
</tr>
<tr>
<td>Cultural</td>
<td>Increased individual awareness of electricity consumption behavior and electricity costs, behavioral change</td>
<td>Privacy concerns, fear of loss of control over appliances or data, inequality concerns (e.g. elderly, low income)</td>
</tr>
</tbody>
</table>
A. Salience of smart grid in the media

The frequency of articles mentioning SG was low until 2007, which was the year of the Energy Security and Independence Act (Figure 1), when public discourse on energy issues increased. In 2008 and 2009 the total number of SG articles increased significantly and decreased again after 2009. The increased attention to SG in 2009 is likely related to an important policy driver, the enactment of the American Recovery and Reinvestment Act (ARRA or “Stimulus Bill”) in Feb. 2009, which included $4.5 billion in federal funding designated for SG (Aldy, 2011). This stimulus funding resulted in rapid deployment of smart meters in communities throughout the country which led to increased media coverage of SG and some opposition and controversy. President Obama’s related speeches explaining the energy-related investments within the stimulus bill stressed the importance of an intelligent electric infrastructure in the U.S., explicitly mentioning SG. This “stimulus bill” is discussed in 57 percent of all articles published in 2009, in 16 percent in 2010, 13 percent in 2011, 9 percent in 2012, and 12 percent of the articles published in 2013. The WSJ has the greatest SG coverage from 2006 to 2011 with a total of 96 articles during that period. In 2012 the NYT devoted more articles to SG than the WSJ and USA Today combined with coverage increasingly focused on big storms connecting the vulnerability of the electric grid to potential benefits of SG. More SG articles were found in the “Business and Finance” sections than in other sections (Figure 2), highlighting the investment opportunities in building SG infrastructure. Variation in section distribution among the different newspapers is apparent. The WSJ had the highest percentage of SG articles in the special “Energy” section, while over 70 percent of all the USA Today articles were found in the “Business and Finance” sections. The NYT published the most editorial/opinion pieces focusing on different government investment, power outages, deregulation, and sustainability.

B. Smart grid technologies

A broad representation of different technologies associated with SG is mentioned in these articles (Figure 3), and most articles mention multiple different SG technologies (Figure 4). More than half of all articles mention smart meters as the “key component” of the bidirectional utility-consumer relationship in the SG network, about 40 percent mention information and communication technologies, and renewable energy is mentioned in almost 30 percent of articles. Analysis of co-occurrence of different technologies using

<p>| Table 4: Number of SG Articles in Three National-level Newspapers 1998–2013. |
|------------------------|------------------|------------------|------------------|------------------|</p>
<table>
<thead>
<tr>
<th>Wall Street Journal</th>
<th>USA Today</th>
<th>New York Times</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>SG-focused</td>
<td>40</td>
<td>13</td>
<td>34</td>
</tr>
<tr>
<td>SG-subsection</td>
<td>74</td>
<td>16</td>
<td>54</td>
</tr>
<tr>
<td>Total</td>
<td>114</td>
<td>29</td>
<td>88</td>
</tr>
</tbody>
</table>

Figure 1: SG Coverage in the Wall Street Journal, USA Today and New York Times Newspapers from 1998 to 2013
Pearson’s test correlation coefficients demonstrates two distinct technology-association pairs in the data. Consumer interface technologies and consumer load appliances tend to be mentioned together (positive degree of association ($r = 0.41$)) and energy storage and electric vehicles (EVs) are discussed together ($r = 0.49$). This quote from the WSJ demonstrates how storage and EVs are connected:

Mayor Wynn envisions the parked electric cars plugging into a network operated by the city’s utility, which would then use the powerful car batteries as a big storage system from which to draw power during peak demand (Fialka, 2007, p. A1)

Although these technologies are mentioned together in these articles, these linkages remain in early stages of deployment. The potential of these technology pairings seems to provide intrigue for SG coverage, while other possible technology linkages (such as the potential link between renewable generation and electric vehicles) are less prominent.

Smart meters are the technology mentioned the most, with roughly a third of all SG-focused articles triggered by smart meter installation. The NYT had the most, with 44 percent of articles focused on smart meter installations. The WSJ and USA Today focused on smart meter installations in only about 25 percent of the articles.

C. SPEED framing of smart grid risks and benefits

In all newspapers benefits (positive SPEED framing) were mentioned more often than risks (negative SPEED framing) when discussing SG (Figure 5). Benefits were mentioned more than risks for the technological, economic, cultural, and environmental SPEED frames, while risks are mentioned more often only in the health & safety and political SPEED frames.

Technological and economic frames dominate the SG discourse while the political frame was largely absent. The minimal political framing is different from media analysis of
other emerging energy technologies including wind and carbon capture and storage (Feldpausch-Parker et al., 2013; Chaudhry et al., 2013; Fischlein et al., 2010). The minimal political framing may reflect the low level of political salience of basic infrastructure or the lack of policy development for SG. Technical benefits of SG are mentioned in more than 70 percent of articles and economic benefits in 60 percent. More than 20 percent of articles also frame environmental benefits. The benefit to risk ratio is approx. 6:1 for technological frames and 3:1 for economic frames. Cultural benefits, like behavioral change, are represented in twice as many articles as cultural risks, indicating that the positive role and impacts of SG for electricity users has received more attention than potential negative impacts.

Concerns about privacy are among the most frequent

**Figure 4:** Number of Technologies Mentioned within Individual Articles from 1998 to 2012
Most articles mention multiple different technologies; only 8 percent of articles mention only one technology. No article mentioned all eight of the different technology categories.

**Figure 5:** Percent of Articles that Mention Each of the Six SPEED Risk and Benefit Frames from 1998 to 2012
A similar distribution of SPEED frames was found in all newspapers.

**Figure 6:** Percent of Articles from 1998 to 2012 that Mention Specific Stakeholders/Actor Groups

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cultural risks mentioned as demonstrated in this example from the NYT:

Before long, the meters in our homes will be able to measure electricity usage down to the level of individual air conditioners, plug-in cars and microwave ovens. That data is potentially valuable, and it may reveal more about customers than they want to disclose. (Greising, 2011, p. 27A)

Mistrust about how electricity data might be used and what private details this data could reveal represents a powerful negative cultural association.

Cultural benefit associated with SG include mentions of how information provided through SG technologies can change energy use and increase an individual’s ability to manage their electric bill as demonstrated in this examples from the WSJ:

Seeing that her consumption rose when she turned on her electric oven to heat up an individual pizza for lunch, she bought a toaster oven and now uses it or her microwave as much as possible. (Gold, 2011, p.R7)

V. Conclusions

Policies promoting SG have spurred media coverage and

while regional transmission organizations, which plan and manage the bulk power grid, are largely absent from these public conversations.

D. Key actors in smart grid discourse

The articles present many societal actors as influential and involved in SG development (Figure 6). The private sector is mentioned the most, particularly in the WSJ. University/academic representatives and system operators are mentioned in less than 10 percent of all articles, public discourse; media attention began within the past five years with a distinct peak in media coverage after the 2008 ARRA investments. SG coverage is found in many different newspaper sections demonstrating the breadth of SG relevance to multiple actors. SG discourse after 2010 decreased, possibly attributed to reduced novelty of the SG concept and reduced news-worthiness as smart meter installations become more commonplace.

Among these three national-level newspapers, SG coverage the WSJ focused more on economic framing, reflecting its business angle and the financial significance of SG development. Despite the important role of government and civil society in SG policy and development, the WSJ did not often mention these actors and tended to concentrate its coverage on the private sector.

Any of the articles on SG were triggered by smart meter installations; the NYT had the largest percentage (over 40 percent) of all SG articles mentioning smart meter installations. USA Today had the fewest SG articles, but most of the USA Today articles attempted to present a broader and more comprehensive SG story than was presented in many of the WSJ articles which often were reporting on a specific project or initiative. More SG articles were placed in the Business and Finance section than any other section, highlighting the important business opportunities associated with SG development. The financial focus also suggests a perceived potential of SG to influence costs and revenues of existing industries and to connect with enabling technologies like the smart meter, and future technologies like electric cars and energy storage technologies (Brown and Zhou, 2012).

Analysis of the SG media discourse highlights the sociopolitical complexity of SG systems, as the term does not represent a single technology, but system-wide change involving multiple actors and interacting technologies and policies. The breadth of technologies

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mentioned within the SG term is both an asset and a limitation. While SG includes multiple components of electricity system innovation and allows multiple actors to participate, the lack of clarity on what SG means creates ambiguity for individuals, communities, and policymakers. For some key actors, this ambiguity is a challenge that reduces their use of the “smart grid” language.

Smart meters are the dominant technology associated with SG, but not all SG articles explicitly mention smart meters. This analysis demonstrates how the media coverage of SG simultaneously encompasses a list of different technologies and sub-sets of specific technologies and highlights how different actors view SG from different perspectives.

The higher frequency of positive rather than negative framing of SG represents the multiple potential benefits associated with SG and the optimistic technological perspective that is dominant in mainstream media in the U.S. (Basiago, 1994). Technological and economic SPEED frames have a much higher prevalence across the three newspapers than environmental, health & safety, or political framing, suggesting that public discourse in newspaper coverage about SG is similar to discourse of other technologies where the technological and economic SPEED frames dominate (Feldpausch-Parker et al., 2013; Stephens et al., 2009).

This research demonstrates that the complex nature of SG media coverage arises from both multiple technological changes and social changes. A diverse set of actors will engage with, build, regulate and operate future electricity systems, and electricity system innovation is being shaped by complex socio-political contexts. SG policies and investments across multiple levels (local, state, regional, and national) are likely to expand, so understanding the social dynamics of the discourse analyzed through public conversations in the mainstream media, provides important insights on the pace and direction of electricity system change informing current and future SG development.

References


Endnote:

1. Analysis of technologies, actors, and the SPEED frames was conducted on all articles except for the 17 articles published in 2013 articles.