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THE EVOLVEMENT OF ENERGY INFORMATICS IN THE INFORMATION SYSTEMS COMMUNITY - A LITERATURE ANALYSIS AND RESEARCH AGENDA

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Abstract

This paper analyses the current state of research in the domain of energy informatics. The intention is to provide a structured overview of the existing body of knowledge in the investigated field. To accomplish this, the authors employed a literature analysis including major and relevant outlets from the IS and business study disciplines. In total, 109 papers were . To illustrate the state of the art of the discipline, the authors develop a concept matrix showing the used methods and investigated units of analysis. On that basis, the agenda for future focused research opportunities is laid out.

Keywords: energy informatics, smart grid, literature analysis, research agenda

1 Introduction

The energy sector[1] is currently undergoing major changes in all parts of the value chain: The power generation, which was carried out with centralized, conventional power plants, including the ability to produce a constant base load, changes noticeably and increasingly towards the use of more decentralized and volatile renewable energies. According to the International Energy Outlook 2011 "renewables are the fastest-growing source of world energy, with consumption increasing by 2.8 percent per year" (World Energy Outlook 2011). This development imposes new challenges on the power grids, which were often not suitably designed for dynamic energy supply. Amongst other things, it is mainly for this reason why the term smart grid is emerging.

For the IS community the question arises, how to focus its research to counteract climbing greenhouse gas emissions, support sustainability and close the research gap to help the vision of a fully connected energy system to become realized. After Watson (2010) published his article defining the term "energy informatics" in 2010, authors started to react to his call to focus on this topic. Corbett (2011) analysed the domain demand side management from an information processing perspective and introduced a theoretical model. Graml et al. (2010) showed, that socio-psychological theories "are effective in supporting energy conservation behaviour in regard to influencing the choices users make, making users come back more often, and having an impact on energy consumption itself" (Graml et al. 2010).

According to Webster, literature reviews are important for every academic field. They should be carried out to establish a firm foundation for the advancement of knowledge and help to identify areas, where research is needed (Webster & Watson 2002). However, within the domain of energy informatics, no specific meta-literature review has been published yet.

Hence, the domain of energy informatics needs to be structured by a fundamental literature review, embracing what has been done by the (IS) community in the recent years and setting a framework for the future IS research focus. The following research questions will be answered in this paper:

- What research has been done that can be counted towards the domain of energy informatics? How can the domain be structured to classify the conducted research into more specific sub domains?
- How should a future research agenda be outlined, considering the findings, to structure the future energy informatics research?

The authors' objective is to develop a concept matrix which helps to identify research gaps. Additionally, it codifies already existing literature by means of unit of analysis, perspective of the publication, and the research methods applied.

The remainder of the paper is structured as follows: First, definitions within the research area are explained. In chapter 2 the boundaries of this review are illustrated on the basis of a taxonomy (see Figure 1). The used methodology is laid out in detail in chapter 3. Afterwards, in chapter 4 the findings are presented and discussed. The resulting research agenda is provided in chapter 5. Chapter 6 concludes the article with the summary of the findings.

2 Definitions

The concept of sustainability has become more and more important. Accordingly, a number of terms have appeared in the last years to adapt the role of IS. A general definition for sustainability was

[1] While in the United States the term "energy sector" usually refers to the oil industry, the authors use it from the European perspective describing the electricity sector.

formulated by the United Nations, suggesting that it is "[…] development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987).

Three key elements of sustainability were identified by Dyllick and Hockerts (2002), namely economic, ecological, and social goals. Transferred to the IS area, based on deductive reasoning, sustainable IS needs to include these three aspects as well. While „Sustainable IS" includes social norms as well, the term „Green IS" should exclude this perspective to avoid redundancy.

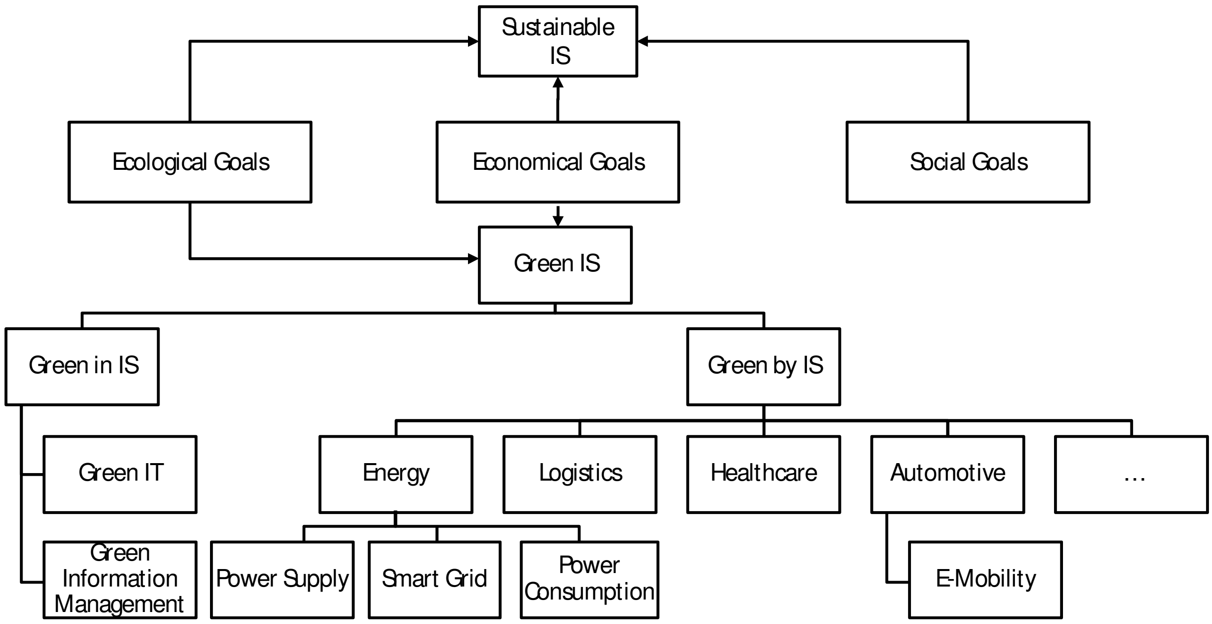

Figure 1 Taxonomy for the subfields of sustainable IS research

Watson et al. (2010) "[…] argue that this exclusive focus on information technologies is too narrow and should be extended to information systems, which we define as an integrated and cooperating set of people, processes, software, and information technologies to support individual, organizational, or societal goals. To the commonly used Green IT expression, we thus prefer the more encompassing Green IS one, as it incorporates a greater variety of possible initiatives to support sustainable business processes. Clearly, Green IS is inclusive of Green IT."

While the authors of this article agree with Watson et al. (2010), that the concept of IS is broader than IT and therefore, preferably as a general term, the definition of Green IS is so broad, including societal goals, that it would be easily interchangeable with Sustainable IS. It would become difficult to distinguish between the two terms.

As shown in figure 1, we further distinguish between *Green in IS*, including the efforts of the IT industry to produce more products and services with using less resources in a more ecologically friendly way, and *Green by IS*, which encompasses the other industries and their efforts to pursue the new IS enabled opportunities to achieve their economical and ecological goals.

A sub domain of the *Green by IS* field is the energy sector, where energy informatics comes into play. Watson et al. define the term as follows: "Energy informatics is concerned with analyzing, designing, and implementing systems to increase the efficiency of energy demand and supply systems." (Watson et al. 2010). The definition seems to be oriented merely towards the economical goals, using the term "efficiency" only. On the other hand, more efficiency in the use of resources leads (irreversibly) to an increase of eco-friendliness.

The sub domain "Energy" can further be divided into the terms power supply, smart grid and power consumption (see figure 1). For Corbett (2011), the term smart grid is a "[…] rather nebulous label that broadly speaks to the modernization of the electricity sector, including the introduction of distributed and renewable energy generation, self-monitoring and self-healing infrastructure, and advanced metering infrastructure (e.g., smart meters)" (Corbett 2011). This point of view is comprehensive and shows, that the term is not yet clearly defined in the community. Researchers might consider that a grid cannot be "smart" and therefore the term is simply a frequently used buzz word without scientific meaning. Also, IT cannot be "green", yet this term is already commonly accepted. Therefore, for this article, the authors use the term and follow the definition of the SmartGrids European Technology Platform (SG ETP), which can be regarded as commonly accepted. For the SG ETP, a smart grid is "[…] an electricity network that can intelligently integrate the actions of all users connected to it – generators, consumers, and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies" (SG ETP 2011).

3 Methodology

An extensive analysis of the available literature was conducted for this study. The "VHB-Jourqual 2.1" ranking (JQ2.1) was chosen as the foundation of the literature analysis. This ranking lists the notable journals and conference proceedings relevant to business research, based on the evaluations by the member of the German Academic Association for Business Research (VHB). Overall, the ranking encompasses 838 outlets (VHB 2011). In this case, where the research field is still emerging, the authors prefer to include all scientific publications in the analysis to ensure not to miss important findings, which might not have appeared in a highly ranked outlet yet.

The literature search was conducted using a two-tier process. On the first tier, based on the JQ2.1-ranking, the authors selected all journals and conference proceedings containing one of the following terms in their title: "information", "energy" or "IS" (case sensitive). Furthermore, the search was expanded by the term "ACM", due to the fact that some specific publications were found in the Association for Computing Machinery *(ACM)* journals and proceedings prior to the actual literature review. Journals or conference proceedings which additionally include the terms "banking" or "tax" were excluded, because these terms clearly indicate another focus, which is not relevant for our concern. The same selection was applied in German. Using this modus operandi, a list of 50 outlets was created (see appendix).

On the second tier of the literature search, the selected journals and conference proceedings were searched for articles containing the terms "energy informatics" or "smart grid". At first, the search term "energy" was also included. However, it quickly turned out that including this search term meant considering too many papers, which did not qualify for the domain specific research.

The authors wanted to include as many related articles as possible, so the search terms could have appeared in the title, abstract, text body or references in the analyzed articles. Overall, 73 journal articles and 36 proceedings of conference papers[2] were identified applying the specified search terms (see appendix).

Starting with the review, first of all the authors tried to use the keywords of the articles (if provided) for further classification, but this approach was not effective. The selected keywords were too different in terms of abstraction to find a common pattern. A formalized approach with the application of data mining techniques to identify the most frequently used terms and their relationships did not lead to comprehensive results either. So, the authors independently from each other analyzed and classified the articles in terms of origin, used methodology, unit of analysis and perspective. The intercoder

[2] The "Lecture Notes in Business Information Processing" are classified as conference proceedings for this review.

reliability after the first phase was 91.4 %. When the articles where classified differently, the authors discussed the issue until a common understanding was reached.

The used methodology of classification follows the scheme of Palvia et al. (2004). It is an extensive framework including 14 different methods and was already used successfully for a comprehensive literature analysis in the IS discipline as a whole (see table 1) (Palvia et al. 2004).

1	Speculation/commentary	Research that derives from thinly supported arguments or opinions with little or no empirical evidence.
2	Frameworks and Conceptual Model	Research that intends to develop a framework or a conceptual model.
3	Library Research	Research that is based mainly on the review of existing literature.
4	Literature Analysis	Research that critiques, analyzes, and extends existing literature and attempts to build new groundwork, e.g., it includes meta analysis.
5	Case Study	Study of a single phenomenon (e.g., an application, a technology, a decision) in an organization over a logical time frame.
6	Survey	Research that uses predefined and structured questionnaires to capture data from individuals. Normally, the questionnaires are mailed (now, fax and electronic means are also used).
7	Field Study	Study of single or multiple and related processes/ phenomena in single or multiple organizations.
8	Field Experiment	Research in organizational setting that manipulates and controls the various experimental variables and subjects.
9	Laboratory Experiment	Research in a simulated laboratory environment that manipulates and controls the various experimental variables and subjects.
10	Mathematical Model	An analytical (e.g., formulaic, econometric or optimization model) or a descriptive (e.g., simulation) model is developed for the phenomenon under study.
11	Qualitative Research	Qualitative research methods are designed to help understand people and the social and cultural contexts within which they live. These methods include ethnography, action research, case research, interpretive studies, and examination of documents and texts.
12	Interview	Research in which information is obtained by asking respondents questions directly. The questions may be loosely defined, and the responses may be open-ended.
13	Secondary Data	A study that utilizes existing organizational and business data, e.g., financial and accounting reports, archival data, published statistics, etc.
14	Content Analysis	A method of analysis in which text (notes) are systematically examined by identifying and grouping themes and coding, classifying and developing categories.

Table 1 Used Methodologies in MIS Research (Palvia et al. 2004)

The unit of analysis was chosen, using the understanding proposed by Bhattacherjee: “The unit of analysis refers to the person, collective, or object that is the target of the investigation “(Bhattacherjee 2012).

The coding was carried out in three stages. First, the authors reviewed the articles to see, if the unit of analysis fits into an energy informatics subfield. If that is not the case, the paper was excluded from the next stage.

Secondly, the authors did the coding again in a detailed way to find precisely the unit of analysis. With this information, the authors were able to develop a concept matrix. Therefore, some coded units of analysis needed to be abstracted on a higher lever to obtain an accessible, yet meaningful scheme. While the unit of analysis is about the object of the investigation, it would remain unclear, from which perspective the authors of the analyzed papers examined their target. Hence, the authors categorized the paper in one of the four perspectives: “Consumer-/Market-oriented”, “Technical-/IT-oriented”, "Policy-/Regulation-oriented" or "Methodological-oriented" (see table 2). Thirdly, the concept matrix was completed (see table 3).

4 Findings

After the coding was carried out, the authors were able to exclude 51 articles. These used one of the search terms at least once, mostly in the reference section, but were regarded as out of scope for the literature analysis in the energy informatics domain, according to our taxonomy (see figure 1). The majority of them are focused on the *Green in IS* field (e.g. Dedrick 2010) which is part of the overall Green IS community, but not included in the energy field. Further articles deal with cloud computing (Brynjolfsson et al. 2010), different schemes to meet climate goals (Russ & van Ierland 2009), which is, in this context, regarded as too general, or the enrollment of IS Students (Koch et al. 2010). The authors considered 58 articles to be relevant for the energy informatics field.

Out of the 58 papers in total, seven papers are in German, the others are written in English. The authors of the articles, taken into account the first authors organizations, come from different parts of the world. The most often origin are the USA (20 research articles), followed by Germany (7 articles in English), Spain (4), the UK (3), Canada (2), the Netherlands (2), and Switzerland (2). In Australia, Belgium, China, France, Hong Kong, India, Italy, Japan, New Zealand, Portugal, and South Africa one article was published each. Even if the statistic is slightly biased towards the German speaking IS community, it is still descriptive to see how globally distributed the researchers are, who are concerned with the future energy system.

Used Theory	**Power Supply**	**Smart Grid**	**Power Consumption**
Agent Strategy Design		(Lamparter et al. 2010)	
Agent-based end-use Model		(J. Jackson 2010)	
Baligh-Richartz-Effect			(Strüker et al. 2011)
Carbon lock-in Theory	(Carley 2011)		
Economies of Scale			(Strüker et al. 2011)
Energy Informatics Framework		(Watson et. al. 2010)	
Feedback Interventions Theory (FIT)			(Yim 2011)
Information Processing Theory		(Corbett 2011)	
Integrated Resource Strategic Planning Model		(Hu et al. 2010)	
Learning Selection model	(Shum & Watanabe 2008)		
Maslow Pyramid			(Frei 2008)
Model of Adoption of Technology in Households (MATH)			(Kranz & Picot 2011)
Motivation – Ability – Opportunity Model			(Graml et al. 2011)
Platform-based customization Model	(Shum & Watanabe 2008)		
Prosocial Behavior Theory			(Yim 2011)
Technology Acceptance Model (TAM)			(Kranz et al. 2010)
Unit Commitment Model			(Wang et al. 2011)

Table 2 Theories used in the domain

Several theories were already used in the energy informatics domain (see Table 2). Most of them were applied in the power consumption subfield, followed by the smart grid and the power supply subfield. Nevertheless, less than one third of the published articles employ a theory and no theory is used more than once. This indicates a lack of theory and focus due to the young age of the evolving field.

Different units of analysis are identified by the authors. Mainly, the subject of the publication can be related to one of the categories power supply, smart grid or power consumption. Each of the categories includes some of the coded units of analysis. Power supply consists of the unit “Distributed, renewable Generation”, which deals with articles whose authors are primarily concerned with the change in the energy generation towards a greener, on renewable energies based electricity production. Additionally, two articles fit in the unit of analysis “Energy Storage”. This unit includes papers which investigate the role of the different types of storage and their use for the future energy system. Articles which deal with the topic of virtual power plants could not be identified in this search.

The smart grid category comprises three units of analyses. The one labeled “Flow /Sensor Network Governance” encompasses all issues related to design and control of the transport, and distribution network. “Security and Risks” is about the question, how the critical infrastructure can be protected. All questions regarding electrical mobility and the connection and integration of electric vehicles to the grid are the focus of the papers classified in the unit “Vehicle to Grid”.

The category called power consumption contains the unit “Smart Metering / Demand Response”. In this unit, publications deal with the newly won opportunities through digital (smart) meters. The future home and their sensitized devices are topics of the unit “Smart Home / Sensitized Objects”.

Some papers have not only a single unit of analysis, but deal with the entire field. Therefore, these papers are only classified following their perspective (consumer-/market-oriented, technical-/IT-oriented, policy-/regulation-oriented or research-oriented). Other publications can be clearly assigned to a unit of analysis, but do not have a specific perspective. If that is the case, the article is not referenced in the perspective section (see table 3).

The authors of the covered articles are applying different methodologies to reach scientific progress. The way, which was used most so far, is speculation/commentary. In these publications no rigid methodological approach, following the methodologies of IS research by Palvia et al. (2004), could be identified. Nevertheless, these articles are helpful to form the future research field. Mainly, the articles deal with policy issues for the renewable energies and as a result are already quite distinguished from the core of the domain. A reason might be, that common IS research methods are not applicable in this subfield. Mathematical Model and Simulations have been used several times to research a particular issue, but so far it is hard to combine them for a common ground of knowledge, because the research field is yet not developed enough.

Some methodologies (field experiment, laboratory experiment, library research, content analysis, qualitative research, interviews) have not been applied so far in the energy informatics field.

Many articles could be found in the outlet “Energy Policy”, therefore it is not surprising, that the authors see their unit of analysis through the lens a “Policy-/ Regulation-oriented” perspective.

It is an unexpected result that the number of publications in the core subject of the energy informatics field – the smart grid – is not considerably higher than in the other categories, especially when the keywords for the literature search are taken into account. Only two papers are engaged in the security and risk subfield. One reason for that might be that the overall governance for the future energy grid is not yet established and thereof, the requirements are unclear.

Methodology	Subject of the Publication							Perspective of the Publication			
	Power Supply		Smart Grid			Power Consumption		Consumer-/ Market - oriented	Technical- /IT- oriented	Policy-/ Regulation- oriented	Research- oriented
	Distributed, renewable Generation	Energy Storage	Flow /Sensor Network Governance	Security and Risks	Vehicle to Grid	Smart Metering / Demand Response	Smart Home/ Sensitized Objects				
Frameworks and Conceptual Model			(R. T. Watson, Boudreau & Chen 2010), (Lamparter et al. 2010), (González et al. 2011)	(Zio & Aven 2011)	(Guille & Gross 2009), (San Román et al. 2011)	(Corbett 2011)		(R. T. Watson, Boudreau & Seth Li 2010)	(Guille & Gross 2009), (Corbett 2011), (Lamparter et al. 2010) (R. T. Watson, Boudreau & Seth Li 2010), (González et al. 2011)	(San Román et al. 2011), (Zio & Aven 2011)	(R. T. Watson, Boudreau & Chen 2010)
Literature Analysis			(Shaw et al. 2010)							(Shaw et al. 2010)	
Case Study										(Hu et al. 2010)	
Survey						(Kranz et al. 2010), (Kranz & Picot 2011)	(Daim & Iskin 2010)	(Daim & Iskin 2010), (Kranz et al. 2010), (Kranz & Picot 2011)			
Field Study						(Graml et al. 2011)		(Graml et al. 2011)			
Mathematical Model/ Simulation	(Shum & Watanabe 2008), (Esteban et al. 2010), (Ken 2010) , (Eva 2010)	(Wade et al. 2010)	(Nutaro et al. 2008), (J. Jackson 2010), (Blokhuis et al. 2011), (Müller et al. 2011)		(Wang et al. 2011), (Camus et al. 2011), (Pehnt et al. 2011)	(Alberini et al. 2011), (Eva 2010), (Friedmann 2011), (Chanana & Kumar 2010)		(Alberini et al. 2011), (Ken 2010), (Wang et al. 2011), (Camus et al. 2011), (Friedmann 2011), (Chanana & Kumar 2010)	(Wade et al. 2010), (J. Jackson 2010), (Esteban et al. 2010), (Nutaro et al. 2008), (Pehnt et al. 2011)	(Hu et al. 2010), (Shum & Watanabe 2008), (Eva 2010), (Blokhuis et al. 2011), (Müller et al. 2011)	
Secondary Data	(Nicolosi 2010)	(Grünewald et al. 2011)				(Yim 2011)		(Carley 2011), (Yim 2011)		(Nicolosi 2010), (Grünewald et al. 2011)	
Essay / commentary /News	(Elmar 2011), (Arent et al. 2011), (Green et al. 2007), (Aviel 2008), (Cossent et al. 2009), (Cossent et al. 2011), (Passey et al. 2011)		(Savage 2010), (Nair & L. Zhang 2009), (Sebitosi & Okou 2010), (Terzidis et al. 2010)	(I. L. G. Pearson 2011)	(Brown et al. 2010), (Skerlos & Winebrake 2010), (Vom Berg et al. 2010)	(Faruqui et al. 2010), (Jagstaidt et al. 2011), (Neumann 2010), (Strüker et al. 2011)	(Geller 2010)	(Frei 2008), (Neumann 2010), (Strüker et al. 2011), (Vom Berg et al. 2010)	(Geller 2010), (Savage 2010), (Passey et al. 2011)	(John P. 2011), (Elmar 2011), (Arent et al. 2011), (Green et al. 2007), (Aviel 2008), (Nair & L. Zhang 2009), (Guerrero-Lemus et al. 2009), (Cossent et al. 2009), (Brown et al. 2010), (Sebitosi & Okou 2010), (Skerlos & Winebrake 2010), (Faruqui et al. 2010), (Cossent et al. 2011), (I. L. G. Pearson 2011), (Clastres 2011)	(Richard Watson et al. 2009) , (Terzidis et al. 2010)

Table 3 Concept matrix of research in the energy informatics field

5 Research Framework

Looking at table 3, three main categories can be identified: Power Supply, Smart Grid and Power Consumption. These categories are giving direction for further research and can be seen as the three parts of the energy informatics domain. To establish the field further, it is necessary to conduct research in all of these categories from a dedicated IS centric view, as Watson et al. (2010) have already proposed. Building on the energy informatics framework of Watson (2010), we illustrate in a more concrete way (see figure 2), which subfields are necessary to be addressed to obtain an information system, which allows increasing the efficiency of energy demand and supply systems.

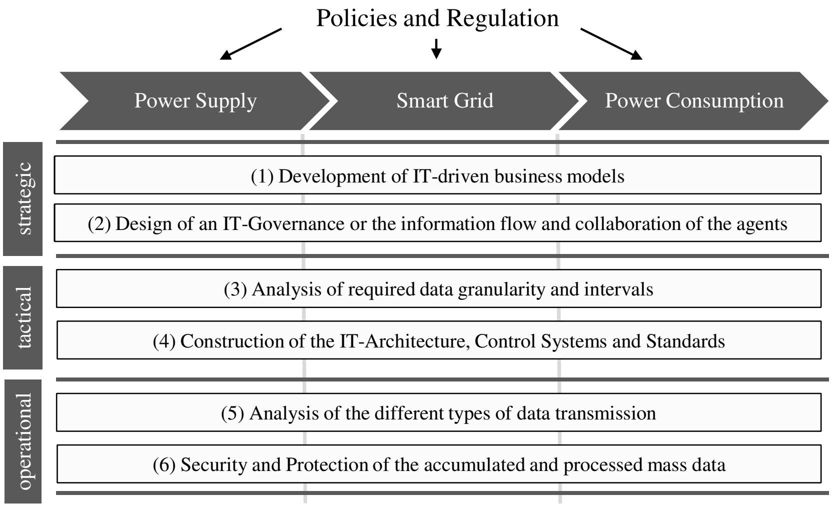

Figure 2 Research framework for the energy informatics field

The authors derive the research framework on the basis of the investigated articles and findings of the concept matrix. The research conducted within the policy-/regulation-oriented perspective gives guidance for the further development of the whole energy lifecycle, from the supply over transmission to consumption.

From an IS centric view, we see six main subfields for the energy informatics research domain:

1. With the changes in the value chain of the energy sector, the actors identify opportunities to pursue new IT enabled business models. Frei (2008) deals within this subfield with the challenges of utilities in the decade until 2020. Stüker et al. (2011) develop a business model for the exchange of Smart Meter Data.
2. New information regarding the state of the grid will be available in the future. Which information is needed the most and how the information flow should be handled effectively is the main area of this subfield. Guille and Gross (2009) proposed a framework for the integration of electric vehicles in the grid. Corbett (2011) started to apply the Information Processing perspective in this subfield, but further research is needed in this subfield.
3. The data flow needs to be analyzed to find the optimal data granularity and intervals for the different actors (Watson et. al. 2010). Nutaro et al. (2008) published an article about the integrated modeling of the electric grid, communications and control. Further information is needed in this subfield as well.
4. A corresponding IT-Architecture with its respective layers needs to be designed and implemented to support the data flow efficiently. Brown et al. (2010) is concerned with the role and importance of standards for electric vehicles. In the smart grid context, this field is not yet developed.
5. Different types of data transmission exist. This subfield should contain all research which is related to the question, how data can be processed to meet the demand of the actors. For this subfield, the literature review does not comprise related articles.

6. The energy system as a critical infrastructure needs to be secured and protected. The research of this subfield includes all aspects related to that issue. Pearson (2011) is engaged to propose the foundations for this subfield, which is not researched in more detail yet.

For establishing the domain, the authors propose to start with the strategic level (subfield 1-2) to set a common ground and give guidance for the tactical tasks (subfield 3-4), which are influenced by the research results and concepts on the strategic level. If the research on the tactical level has made progress, the operational research opportunities (subfield 5-6) can be carried out in a more extensive way.

6 Summary

This paper gives an overview of the current status and upcoming opportunities of the domain of energy informatics in the information systems community. To structure the review explicitly, a taxonomy (see figure 1) is developed, which distinguishes between Green in IT and Green by IT. The energy informatics domain belongs to the Green by IT domain. Drawing on the taxonomy, the literature analysis was conducted to obtain the relevant articles with the researched unit of analysis and the applied methodology.

The central findings are that the amount of articles in the field is increasing strongly (see appendix), showing that the field gains worldwide attention. The published articles are very diverse in their unit of analysis and used method and yet are often not related to each other. The used methodology is mainly mathematical modeling or remains unclear. IS-theories or theories from other disciplines are applied to a certain extent, but further theories can be used to enrich the body of knowledge in the domain. Promising theories seem to be the principal-agency theory, the transaction-cost theory or the technology - organization - environment framework.

On the basis of the reviewed articles, the authors opt for a more coherent, IS-centric research stream, which could be based on the constructed research framework (see figure 2). The framework was developed, taken into account the already exiting articles. For establishing the energy informatics domain, in particular theory-guided research is needed in the smart grid sub domain.

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Appendix

JQ2.1 Rank	Name of outlet	<2007	2007	2008	2009	2010	2011
8	Information Systems Research	0	0	0	0	0	0
24	MIS Quarterly	0	0	0	0	1	0
35	Proceedings of the International Conference on Information Systems (ICIS)	0	0	0	0	3	0
46	Journal of Management Information Systems (JMIS)	0	0	0	0	0	0
76	Information Systems Journal (ISJ)	0	0	0	0	0	0
78	Journal of the Association for Information Systems (JAIS)	0	0	0	0	0	0
89	Journal of Strategic Information Systems (JSIS)	0	0	0	0	0	0
128	Journal of the ACM (JACM)	0	0	0	0	0	0
147	ACM Transactions on Database Systems	0	0	0	0	0	0
170	International Journal of Energy Sector Management	0	0	1	3	1	0
171	Energy Policy		1	3	4	14	19
178	Proceedings of the European Conference on Information Systems (ECIS)	0	0	0	0	0	11
198	Wirtschaftsinformatik (WI) / Business Information &Systems Engineering (BISE)	0	0	1	0	1	3
199	Journal of Information Technology	0	0	0	0	0	0
228	Management Information Systems Quarterly Executive	0	0	0	0	1	0
230	ACM Transactions on Information Systems	0	0	0	0	0	0
256	ACM Computing Surveys	0	0	0	0	0	0
271	International Journal of Information Technology and Decision Making	0	0	0	0	0	0
274	Information Technology and Management	0	0	0	0	0	1
289	Proceedings of the Conference on Advanced Information Systems Engineering (CAISE)	0	0	0	0	0	0
297	Information Systems	0	0	0	0	0	0
310	Information and Organization	0	0	0	0	0	0
326	Tagungsbände der Wirtschaftsinformatik (WI)	0	0	0	0	0	2
330	Information and Management	0	0	0	0	0	0
347	Information Systems Frontiers	0	0	0	0	1	0
369	Communications of the Association for Information Systems (CAIS)	0	0	0	0	2	1
378	Journal of Information Systems	0	0	0	0	0	0
379	Information Systems and eBusiness Management	0	0	0	0	0	0
384	European Journal of Information Systems	0	0	0	0	0	0
385	International Journal of Accounting Information Systems	0	0	0	0	0	0
401	Energy Economics	0	0	0	1	0	4
405	Information Systems Management	0	0	0	0	0	0
412	ACM Transactions on Computer Human Interaction	0	0	0	0	0	0
434	Communications of the ACM (CACM)	0	0	0	0	4	2
451	International Journal of Information Management	0	0	0	0	0	0
471	Lecture Notes in Business Information Processing	0	0	0	0	0	1
480	Journal of Enterprise Information Management	0	0	0	0	0	0
482	ACM Computing Reviews	0	0	0	0	0	0
488	Enterprise Modelling and Information Systems Architectures	0	0	0	0	0	0
498	International Journal of Information Management	0	0	0	0	0	0
506	Australian Journal of Information Systems (AJIS)	0	0	0	0	0	0
540	Information Resources Management Journal	0	0	1	0	0	0
547	Proceedings of the Americas Conference on Information Systems (AMCIS)	0	0	0	1	3	11
569	Tagungsbände der Konferenz Modellierung betrieblicher Informationssysteme (MOBIS)	not available					
571	Information and Organisation (formerly: Accounting, Management and IT)	0	0	0	0	0	0
583	Zeitschrift für Energiewirtschaft	0	0	0	0	1	2
643	Proceedings of the Multikonferenz Wirtschaftsinformatik	1	0	1	0	2	0
668	Journal of Logistics and Information Management	0	0	0	0	0	0
686	HMD - Praxis der Wirtschaftsinformatik	0	0	0	0	0	0
793	Information Management & Consulting	0	0	0	0	0	0
	Overall	**1**	**1**	**7**	**9**	**34**	**57**

Table 4 Outlets with papers relevant for the energy informatics domain literature review