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Infrastructures of Smart Platforms – Mobile Tools to Control Intelligent Networks in Dynamic Urban Space

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1 ABSTRACT

Energy and communication networks are in today's urban environment ubiquitous and are highly dynamic infrastructures. It is important for these networks to quickly respond to changes and adapt the parameters in order to be able to strive for the best possible utilization and also to satisfy the needs of the user. The aim of this paper is to show the influence of intelligent networks on users, and the integration of information via smart platforms in everyday life is examined. Smart power grids and control systems for Electric Mobility will be used as examples. Since conflicts between the optimum utilization of networks, human needs, and economic aspects, occur regularly, their interdependencies will be shown in a conflict triangle. The core function of smart networks, in addition to collecting and interpreting the information and the control of the endpoints , is to generate an optimal solution of the conflict. Hence, the features of smart grids will be worked out with special emphasis on renewable energy and electric mobile transport systems. Particular attention is paid to the information flows, which are caused by a high demand of the data source and the control of the systems at the endpoints. As a result, an assessment with regard to privacy aspects will be presented. Then the most widespread and most innovative smart grids used platforms are shown and analyzed. Criteria for the assessment of usability, transparency and efficiency of the platform will be defined and subsequently included in a utility analysis. In focus are mobile applications because of their ubiquitority. Finally, a concept of a meta-platform for centralized and simplified control of various smart networks is designed and presented.

2 INTRODUCTION

The dream of an inexhaustible source of light, heat, energy, and agility seems to be in reach in face of new technologies and developments. Renewable energy sources have the potential to provide an inexhaustible supply of energy. These sources include geothermal energy, renewable resources, hydropower, wind power, and solar radiation. The statement about the inexhaustibility of these resources is limited to the human perspective. It must be assumed that even the sun and our planet have a limited lifespan. In politics, sustainable energy and an energy revolution, is often an issue. The global initiative, "Sustainable Energy for All," attempts to connect three aims and to implement them by 2030. These aims are a universal access to modern energy services, doubling the share of renewable energy in the global energy mix, and doubling the global rate of improvement of energy efficiency [cf. SUSTAINABLE ENERGY FOR ALL OF US, 2012]. In Germany, objectives or strategies and long-term scenarios for sustainable energy policies have been developed as well. The main aspects of these scenarios are the substantial development of renewable energy (RE), the significantly increased use efficiency in all sectors, and the increased conversion efficiency. The increase of the conversion efficiency is to be realized in mutual structural and temporal interaction in all sectors of the energy industry, by further extension of combined heat and power, and the replacement of obsolete power plants (nuclear power plants) through more efficient ones [cf. BMU, 2009].

On a national level, the federal government attempts, through the Climate Change Initiative of the German Federal Ministry for the Environment, to reduce greenhouse gas emissions by 40 % by 2020 (compared to 1990) [cf. BMU, 2007:1FF]. Additionally, on an international level, the federal government attempts, through the International Climate Initiative, to support Countries with funded projects. The projects should especially help developing countries, emerging countries, and the transition countries in protecting the climate. Furthermore, hope is set in the computer and artificial intelligence (AI) and network to solve current global problems. These techniques may offer some help with the protection of the climate, climate monitoring, and in the energy industries. Just networking and knowledge by linking such networks are an important part to solve many problems of humanity. Due to the high penetration rate of networks in the population, mobile information systems can help us to connect knowledge. Mobile information systems provide access to information resources and information services through "end-user terminals," which are mobile and whose operation is possible in almost any environment or location [cf. PERNICI, 2006:4]. Examples of these are mobile phones, netbooks, notebooks, PDAs, etc. The devices differ from each other especially in size, weight, performance, power consumption, built-in sensor technology, and usability. Increasingly, computers surround us. Often they are imperceptible or we use them unconsciously, for instance a brake assist supports driving a car or, in the household, we get help of intelligent waste disposal units. In the future, we will not adapt to the computer, but the Computer will adapt to us. These small computer systems that are incorporated into other articles, are referred to as "embedded computers," and they are highly interconnected. Literature also often speaks of "ubiquitous computing" or "pervasive computing [cf. MOSEMANN, 2009: XII]." Now, it is time to integrate these tools in the protection of the climate and in the energy industry.

3 ELECTRICITY PRODUCTION AND POWER GRIDS

The power grid consists of different parts, which are differentiated by their voltages: The transmission and distribution grid. The passage of current generates costs, which are fees for grid use and are part of the electricity price. The transmission and distribution grid operator`s range of tasks changed through the integration of renewable energy (RE): From the pure transmission and distribution "on demand" towards more balance and flexibility. In addition, the grid gains a more and more important storage function. In particular, through the feed-in of wind power there are grid shut-downs, because the existing network capacity is not sufficient to accommodate the amount of electricity produced. The wind turbines must be switched off in order to prevent damage to the grid.

Integration as such is heterogeneous: It must be distinguished between grid-related problems (smart grid) and market issues (smart market) even if the concatenation is narrow. This distinction is analogous to the categorization of the Federal Grid Agency (FNA) [cf. BUNDESNETZAGENTUR, 2011:4FF]. Due to subadditivity, the power grid has all the characteristics of a natural monopoly. After the liberalization of the electricity market, which was associated with an unbundling of vertically integrated energy producers and suppliers, various instruments of incentive regulation for grid fees were introduced by law (AregV) since 2009. Currently (2013), the revenue cap regulatory tool is applied in Germany. As part of the unbundling, the energy producers were forced to outsource their grids to legally independent companies. Since the opening of the internal market in 1998, the energy producers are forced to lead through the current from other providers, in order that the end user has the possibility to choose between different suppliers. The aim of the incentive regulation instruments is to encourage the efficiency of the grid operator, which should lead to lower grid fees. It is important to secure the availability of supply and reliability.

For this reason, there is always a quality component integrated into the various regulatory instruments, which ensures that efficiency gains, in form of cost savings, do not lead to a higher failure rate. Prior to the introduction of the renewable energy law (REL), electricity was generated on demand, which was estimated from the aggregated consumption curves of the end users. The priority purchase and transmission obligation of RE, which is derived from §4 of the REL, leads to an extension of the grid function. Additional to the pure transport function from the generation source to the customer and a guarantee to deliver the desired amount of energy at any time, great flexibility and storage function is required of the power grid because of the additional feed-in of RE. The ideal grid is able to absorb, store, and deploy any amount of electricity generated at any time. Such a grid would have to be capacitatively oversized by a multiple. This cause significant higher fees for grid expansion and, therefore, higher fees for the grid use, which would ultimately lead to higher electricity prices. At this bottleneck, the idea of the Smart Grid applies: The available grid capacity and electricity is supplied to the end user, who is able to directly control it, by purchasing energy and capacity.

Definition of a Smart Grid: "The conventional electricity grid is a smart grid when it is upgraded through communication, measurement, control and automation systems, and IT components. As a result, "smart" means that grid conditions can be recorded in "real time" and opportunities for control and regulation of the grid are integrated, so that the existing grid capacity can be fully used."

Definition of a Smart Market: "Smart Market is the area of the grid in which quantities of energy or derived services, based on the available grid capacity, are traded between various market partners [cf. BUNDESNETZAGENTUR, 2011:11]."

The challenges for the Smart Grid and Smart Market are: More coordination, more flexibility, and more innovation. Just by feeding-in fluctuant RE, the demand for grid capacity increases significantly. Greater fluctuation and the need for storage are the causes for this. In addition to grid-related means, in the form of smart grid components, it is necessary to influence production and consumption according to market signals, in order to guarantee stable grid operation. The resulting price-sensitive behavior of grid users, leads to an integration of electricity from RE into the market. Nevertheless, a wide grid extension is still necessary, but to a much lesser extent than without smart grid and smart market. Through the integration of information and communication technology into the grid, consumers have the possibility to participate in the energy markets itself. Thus, new marketplaces will emerge that differ significantly from the traditional ones.

Changes of the energy consumption could be monetarily valued and traded in order to increase grid stability. In the development of a safe, economical energy supply, which is mostly based on RE, a smart grid is not an end in itself, but rather plays a subservient role. Out of this reason, it has to be the aim to bring as many parts as possible of the grid services to the market. The allocation of competitive functions to the grid operators is not possible due to the unbundling regulations. Economically, a scenario with vertical integrated energy providers would not be desirable because of the risk of cross-subsidization of competitive areas, to the detriment of the regulated areas. This leads to distortions of competition. Occurring grid problems should mainly be solved by the market, regulatory intervention should be kept to a minimum. A good solution in the conflict between economic efficiency, consumer needs, and grid utilization has to be found. Due to the importance of energy supply and the market characteristics, a regulatory instance cannot be completely eliminated.

To generate the data, which is needed to control the power grid and the consumption, smart meters are used. These form the basis for the introduction of flexible rates and energy efficient behavior, being essentially used for the market, not for the grid. While the transmission grids in Germany are already lead intelligently, there is still space for improvement in the distribution grids. However, since there are 850 electricity network operators with completely different characteristics, it is impossible to introduce a standard. The legal provisions of ARegV require the selection of the most efficient path, taking into account the necessary grid expansion. The expansion towards smart grids is done as capital-effective as possible by means of intelligent restructuring. The technical requirements, such as the laying of fiber optic cables for the customers, are not prerequisites for the installation of smart meters. Indeed, depending on market conditions and stakeholder needs, the form of the communication infrastructure will be decided individually. The additional amount of information is not considered separately from the rest of the infrastructure, but can be integrated into the planning, because neither a special optimization for smart grids nor a particular bandwidth is necessary. It can be assumed that a low-sized broadband internet access to transport the information flows is currently sufficient. To achieve the aim of the grid capacity management in the form of the most efficient power grid usage, the market involvement for the users should be facilitated, to avoid, or respectively to reduce inhibitions. This requires constantly available instruments, which allow the users` participation in the market in a simple, understandable way. This may be ensured by programs, or mobile applications (Apps).

4 ELECTRIC MOBILITY

The expansion of electric mobility in combination with RE is considered to be strategically important by the federal government of Germany. The reduction in carbon dioxide (CO2) emissions and the dependence on fossil fuels are the crucial reasons. Additionally, the German supremacy in the automobile sector should be maintained and strengthened. Electric mobility was identified as an essential element on the way to a sustainable energy supply and the introduction of electric vehicles will take place in several phases, which are designed by the political framework and the interaction of global and local operating participants [cf. DIE BUNDESREGIERUNG, 2009:4FF].

By incorporating batteries into the power grid, the grid stability can be increased in the long term. This is becoming more and more important. Smart charging systems contribute to the load management besides the additional energy demand. A constant load curve can be generated by an increased absorption in production peaks. In medium term, there will be the option of providing control energy.[1] With the ability to store the

[1] Control energy serves to compensate unforeseen fluctuations in current demand. The batteries of smart vehicles are able to provide control energy.

absorbed energy and release it again into the grid, electric mobility affects the whole concept of RE in a positive way. In the future, the forms of mobility, especially in conurbations, will change. They will adapt to the needs of the residents of metropolitan areas. However, these changes must offer economic advantages and an increase in the perceived quality of life. Thus, the ownership of a vehicle is emotionally important for many people [cf. DIE BUNDESREGIERUNG, 2009:9].

In the first phase of the grid integration, the charging of electric vehicles will still be vehicle sided. Capacity bottlenecks are avoided due to the vehicle's intelligent control of the charging process, which takes place during off-peak times. In the second phase of the grid integration, the vehicle's battery can also function as a grid storage component with the possibility of back-feeding energy. In this stage, additional power capacity is needed due to the increased number of vehicles. The use of smart grids is necessary for the equalization of load curves, since they help to avoid inefficient utilization of power stations and grid utilization, and the reduction of the power station`s control and reserve capacity. Since 2008, the research program "E-Energy: ICT-based energy system of the future" of the federal government of Germany, whose aim is to test new concepts for digital energy grid systems and market relations, is being tested in six regions [cf. DIE BUNDESREGIERUNG, 2009:21FF].

Information and communication techniques are used for the accounting of the loading and unloading of electric cars, which communicate the data generated by smart meters through networks. These mechanisms serve both, the individual needs of users and the grid-sided coordination. Not all interests can be satisfied to the same extent at all times. Appropriate priority-based conflict resolution mechanisms need to be established where the grid stability and security of supply must be guaranteed. Mobile applications are ubiquitous helpers for the users to acquaint themselves with costs and amounts and control over the flexible pricing of their own consumption within their individual preference.

5 CONFLICT TRIANGLE

The conflicts between the needs of users, the optimal grid utilization, and economic aspects of electricity generation can be represented in a conflict triangle (Fig. 2). The user needs to get any amount of energy at a reasonable price at any time, especially during times of high demand. Through the aggregation of numerous private and commercial consumer demands, one can observe an equalization of load peaks, but they are nevertheless significant. Demand peaks are mainly in the morning from 7am to 8am, around noon, and from 6pm to 8pm. Minima are usually between 2am and 4am in the morning. To guarantee security of supply, large over capacities need to be kept ready on generation and supply side. Additionally to the needs of an affordable energy supply and security of supply, environmental awareness has been added in the last years. This includes interest in the origin and generation of electricity, an awareness of energy conservation, as well as an increasing price consciousness. These, partially new emerged, customer needs are supplemented by the claim for more comfort. Smart grids bear, on the one hand, the new user needs; on the other hand, they reduce overcapacities in supply and generation and facilitate the integration of RE.

An appropriate solution for the control of smart grids is offered by software solutions with user-friendly graphical interfaces, which are ubiquitously usable in the form of mobile applications. They offer the user a permanent overview of consumption and prices as well as a way to control their feed-in of current. Looking at the power supply of a fictitious operator, which consists of various types of power plants, the marginal costs of production per kilowatt hour (kWh) emerge in the following ascending order: nuclear power plant, lignite power plant, hard coal power plant, gas and steam power plant, gas turbine power plant, oil-fired power station. According to the merit order effect, the power plants are activated in ascending order of their marginal costs and according to their physical and operational characteristics, when demand increases. Thus, gas turbine and oil power plants have extremely short reaction times and can respond to needs very fast and flexible, but weeks and months are needed to regulate nuclear power plants. The last activated, and regarding the marginal cost most expensive power plant, determines the price of electricity for the entire quantity sold. In consequence, for power plant operators it is of major economic interest to sell their electricity during peak load times. Since the introduction of the REL, there is an obligation for priority supply of renewable energy. Therefore, RE will be fed-in regardless of their marginal costs. On average, the use of the most expensive types of power plants becomes increasingly rare, so the producer surplus is consequently reduced as a consequence of the law [cf. SENSFUSS, 2011:3]. This situation is not marked-based, because RE are fed-in with priority, not in order of their marginal production costs. Only through the integration of the external effects of the conventional current production, RE are competitive. This observation refers to the average marginal cost per kWh of renewable electricity. In individual cases (hydroelectric and wind power) RE are competitive with cheap conventional alternatives. Externalities such as air pollution or the long term consequences of nuclear power plants can hardly be measured monetarily. Thus, the internalization of externalities is just vague and speculative. The capacity and infrastructure of transmission and distribution grid must be designed so that the needs of the customers are covered at all times. Ideally, the power supply can also take up the energy generated at any time. If the share of RE increases, this is more and more difficult, for instance due to the high volatility of fluctuating energies like wind. To protect the grid from overloading under certain weather conditions, the plants must be taken off the grid. The tasks of the power grid are increasingly in transition: From a transmission medium, purely driven by demand, into an intelligent infrastructure, which determines market prices for the existing grid capacity and to adapt the demand to the offer. Without this coordination function significant power overcapacities would be feed into the grid, which would cause higher electricity prices for the costumers. A smart grid leads to a reduction of overcapacities and a better integration of RE. The core functions of stability and availability with minimal downtime, must remain unaffected by this paradigm shift.

6 PRIVACY ASPECTS

In the context of smart metering, detailed and finely granular data of the energy use of customers is gained. The data will be used to equalize peak loads and to optimize the utilization of grids and producer capacities, and therefore the costs. Due to the broad and highly detailed data base an accurate profile of individual households and persons, which contains personal and sensitive private data, can be created. In this context, data privacy considerations have to be done. By law, all Member States of the European Union are obliged to introduce smart grids and smart meters [cf. EUROPÄISCHE UNION, 2009].

Germany started with these measures in 2011 as part of the amendment of the Energy Act. The resulting data are worthy of protection, because of their high sensitivity. For this reason, the European Commission published appropriate recommendations to protect privacy in March 2012 [cf. EUROPEAN COMMISSION, 2012].

The constitutional inclusion of the right to informational self-determination results from Article 2 paragraph 1 of the German Constitution (GG), in conjunction with Article 1 paragraph 1 GG. The principles are purpose limitation, data prevention, transparency, data sovereignty of the individual, data security, and "privacy by design." Smart meters only collect the data which is necessary for purposes of §21.1 German Energy Act (EnWG). Data processing systems shall be designed in a way that as little as possible personal data will be gathered and the reading intervals should be large. The data has to be aggregated and made anonymous, as far as it does not circumvents the original purpose. The data generation is expected to be at the end-user side and not at an external processing point so the number of data access points is minimal. The end-user should be informed of the nature and use of the smart meter data and he or she has enforceable claims for cancellation, change, and contradiction at all times. In order to comply with the requirements of the right to informational self-determination, the collected person-specific data may be solely processed under the control of the person concerned. Specific technical mechanisms have to be implemented, allowing the end-user to control all available data. Technical and organizational measures should be taken to prevent the misuse of the data. Standards must be established that provide the necessary protection and control options to the consumer [cf. KONFERENZ DER DATENSCHUTZBEAUFTRAGTEN DES BUNDES UND DER LÄNDER UND DÜSSELDORFER KREIS, 2012:5FF].

Depending on the granularity and time intervals, it was measured by current studies that 15-minute-intervals are sufficient to determine when people stay at home, and whether they eat or sleep [cf. MOLINA, 2010]. Investigations, in which a smart meter of the company Discovery GmbH has been tested (results were obtained in August and September 2011, the measured distances were two seconds) confirmed that. It was possible to extract the activities of refrigerator, water heater, geyser, kitchen appliances, washing machine, TV, lamp, and stove from the consumption profiles. Especially, by the power consumption of the TV, the TV, the exact determination of light and dark sequences can be identified, and, by this, even the watched film.

To read-out of the pattern of the total consumption profile was possible without great technical effort. This leads to the conclusion that from a large data set the recognition of a predefined audio-visual content is possible. The users' power consumption data could also be used for finding copyright protected material. The comparison of the pattern of consumption profiles with a corresponding database data could identify law violations [cf. DAPRIM, 2011:1F]. This example shows the scope of collection and analysis of consumption data. To avoid a development towards the "transparent consumer," appropriate technical measures must be implemented. For this, the profiles need to be made technically fuzzy, or aggregated and made anonymous to a certain level.

7 MOBILE APPLICATIONS FOR SMART GRID DEVICES

Various mobile applications for smart home and smart mobiles are examined on the criteria of functionality, usability, transparency and efficiency. They were weighted and supported by sub-criteria, which were evaluated (Fig. 1, Tab. 1).

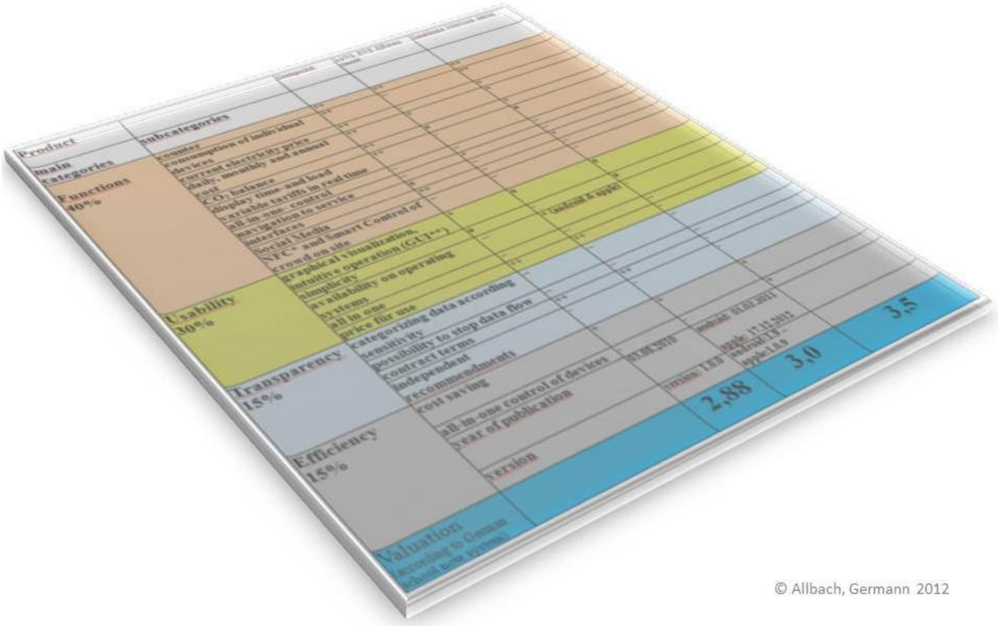

Fig. 1: Use Mobile apps to control smart devices and vehicles (Extract!).

valuation	School note	meaning
++	1	The component or function meets all the requirements in their entirety or beyond
+	2	The component or function meets the most important requirements entirely
o	3	The component or feature satisfies the key requirements to a satisfactory extent
-	4	The component or feature has significant deficiencies
--	5	The component or function does not meet the requirements

Table 1: Valuation scheme.

It was noticeable that none of the programs which were analyzed had the opportunity to control all intelligent devices, including electric vehicles. Instead, there were some standard functions, such as counter and overview of costs, which worked out well in general. As a result, the use of multiple applications is required in order and to control the whole, with smart technology equipped home and the electric vehicles. The lack of coordination among the components makes the use difficult and can discourage potential users. Another common feature was the fact that many of the apps were downloaded for free, but the access to the service has to be paid. There is also a lack of transparency. The pricing is confusing and complex in itself. An extensive test was complicated since a contract had to be completed with the electricity supplier to obtain access and to test the application. Under data protection aspects, the installation of apps is disputable. Therefore, some programs require full access to Internet, phone book, and the cell phone's memory card.

Mobile devices already have useful features and a rudimentary ability to conduct a kind of "Urban Sensing." Unfortunately, this is only available for the purchaser's own internal use of the mobile telecommunication companies. By CDRs (Call Detail Records), which are gathered of each SMS (Short Message Service) or of every call, additional data is gained. It is possible to determine the position of every CDR with an inaccuracy of one kilometer. From the recorded data conclusions about the distance traveled were gained. It was further found that, for example, residents of Manhattan had covered only 2.5 miles per day, as opposed to the residents of Los Angeles, which moved five miles per day. The data is not 100 % accurate, but it shows clearly how much this information could bring to city and energy planners. [cf. SIMONITE, 2010]. This data can be also used to optimize the schedules of carsharing-concepts and to control the devices in the smart houses. Mobile device applications act as coordinator between the supply and demand for network capacity, transport infrastructure and energy consumption (Fig. 2). A future use of Near Field Communication (NFC), Smartphones, and a meta-app could, besides paying and buying tickets, serve to steer users currents. Examples are users (e.g. at a bus stop) who want to travel by public transportation, carsharing, or ridesharing. The app would allow them to group together and use the available transport possibilities. Social, economic, and environmental benefits can be gained by connecting the interfaces to various social media platforms.

Fig. 2: Conflict triangle with smart phone and meta-app as coordinator.

A meta-app for smart grid devices has to meet various technical and content requirements:

- Stability
- Security
- Provide interfaces
- Standardization
- Always online
- Semantic analysis
- Usability
- Modularity
- Scalability
- Storage capacity
- Simplicity
- Expendability
- All-in-one solution

The meta-application has to be easy to use for all user groups-even old people with only little technical knowledge should be able to use it. Usability is a key criterion for a successful market introduction of such a project. Only if it is easy to understand, to configure and to use, people can explore the benefits of the program. These benefits consist of cost savings, more comfort, and social aspects like a good environmental consciousness. It is also important to offer the user the possibility to share his opinion und data via the Social Media platforms. It can also be considered to integrate an own Social Media platform into the app. A standard for an interface has to be definedin order to guarantee a smooth exchange of the different data types. It has to be ensured by the the meta-app that the sensitive private data cannot be abused. This can be done by a secure transmission with encoding and an integrated firewall. The app should consist of different modules, which can be chosen by the user to adapt to his or her individual needs. A semantic analysis can be used to interpret the user`s behavior and to recommend and inform the user about new offers, developments and laws. Despite an analysis tool, persistent storage must be provided for this function. To keep the storage scalable and always available, the data can be stored in online clouds which are independent of devices or locations.

The most important function of the meta-app is the unique selling proposition: The all-in-one-solution. It has to be extendable and flexible to react to new developments in energy market, technology, and society. This seems to be the only possibility that users will accept such an application as omnipotent control tool for their smart homes, devices, and vehicles.

8 CONCLUSION

Through the energy revolution and integration of RE, society faces significant challenges. Awareness of energy saving, environmental protection, and generational responsibility must be strengthened. These changes must be as economically efficient and as convenient as possible to overcome resistance. Without tangible benefit, monetarily, social and legal incentives, it will fail to perform a complete change in the responsible use of resources and capacities. Goods, such as current and grid capacity according to their timing and quantity of availability, will receive a market price and will thus be tradable. Smart power grids, the intelligent control device, and electric cars are essential to master a successful energy revolution. Modern ICT collects data, transmits it via the Internet, evaluates them, and serves for coordination and allocation. The Internet owes its success to the principle "keep it simple and smart." It offers information and communication possibilities to almost everyone. Nobody is excluded per se. This must also be the basic idea for smart grids, smart devices, and cars. A system that is to be successfully established in the market must, in all its complexity, be easily accessible and invite to participate. The implementation of the system implies an immense need for coordination, for which the current infrastructure is sufficient. However, the use for consumers must be as easy and comfortable as possible. This can be realized through mobile apps, respectively a meta-app, which handles all the tasks and the control and coordination of intelligent structures.

The ideal meta-app is modular, scalable, compatible and adaptive to individual needs, drives all smart devices of a user, is safe and intuitive to use, and produces a noticeable benefit (e.g. economically or climate change). It is a critical fact that smart devices and apps still have significant gaps in data protection. This has to be corrected by far-reaching legislative requirements to prevent a possible refusal of the users. The technological gap between developing countries and the modern ICT society becomes increasingly larger. The countries with lower economic standards have no access to smart technologies. It is essential to integrate these regions to reach global climate change aims. This must be institutionalized through agreements between governments. On the production side, cost reductions and compatibility can be realized through mass production and standardization. Under the given market conditions and with focus on the needs of the users, apps could serve to adjust the energy consumption by a significant degree of the production and to relieve the grids, as well as to avoid over capacity and bottlenecks in grid and current production. Ultimately, mobile apps to control smart components accelerate this development. They make sure to shape the energy revolution faster, more economical, more efficient, and comfortable, thus, they make a contribution for saving energy and an economic, secure, and sustainable power supply.

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