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Faculty of Electrical Engineering

Department of Economics, Management and Humanities

Name of candidate Marek Adamec

TITLE OF DOCTORAL THESIS: SYSTEMATIC APPROACH FOR IMPLEMENTATION OF SMART TECHNOLOGIES INTO THE ENERGY INDUSTRY

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*) *leave out as appropriate*

1. CURRENT SITUATION OF THE STUDIED PROBLEM

The public discussion about new and innovative technologies implemented into energy industry is mostly done only to the end of popularization. The expert discussion deals with technical problems. Arguments that are used are mostly partial and do not provide the complex view. The whole Energy Industry (EI) is now in the crucial point. The socio economic aspects begin to impacts on this industry massively. The customers are now connected to energy industry as a direct market participant and electricity market undergoes more or less successful changes in the way of higher liberalization, represented mostly by legislation changes in the whole Europe Union (EU). The lots of such aspects and changes cause brand-new energy smart technologies (ST) development. This dissertation thesis represents a short introduction into way how to valuate and describe these smart technologies implementation. It suggests using systematic approach to this end.

2. AIMS OF THE DOCTORAL THESIS

Public articles concerning with SG are mostly descriptive and marketing aimed, explaining the promises of manufacturers of advanced metering infrastructure (AMI). There are very little scientific articles describing SG from the systematic viewpoint. Author´s thesis therefore represents first-of-its-kind analysis of real SG implementation impacts. Author´s goals for his thesis are as follows:

- **Description of Main Aspects of Energy Branch**. As a basis for research the author has conducted description of today´s energy branch with its main aspects. Smart grid in this point of view constitutes one representative of smart technology applicable into the energy branch.
- **Description of Today´s Theoretic Framework for ST Concept Implementation.** For the deep analysis of SG implementation the author conducted description of state of the art of smart technologies implemented into the energy branch as well as the financing methods applicable for research and development (R&D) and ST implementation.
- **Formulation of Systematic Description of Energy Branch.** The Author´s analysis is based on the application of systematic approach. Energy branch represents system with its infrastructure of market participants and internal connections between them. In addition to that any structural change would provoke a feedback. Smart grid represents subsystem of the energy branch.
- **Formulation of Methodology for Smart Grid Impacts Valuation.** Formulation of cost benefit analysis of SG implementation is one of author´s results. This result originates in application of analysis based on the systematic approach.
- **Identification of Real Impacts of SG Implementation.** Author has identified lots of consequences originating in SG implementation. These consequences are highly applicable for future development of business for commercial market participants.
- **Author´s Hypothesis.** Author´s hypothesis is that implementation of smart grids concept would influence energy branch as a system; all market participants and relationships between them as well.

3. WORKING METHODS

The energy branch (EB) can be generally seen as a system transforming of inputs originating in its environment. The outputs represent results of transformation process in the system. The transformation process is moreover influencing the inputs by the feedback [1], [2]. This fact represents first resolution approach. In more detailed resolution each system consists of its sub-systems, creating its structure. These sub-systems have its inputs and outputs as well. Method of author´s research is systematic analysis of EB. Smart technologies (ST) and in more detailed view smart grids (SG) are classified as a subsystem of the whole EB. Author utilizes the analysis to investigate the structure of the sub-system as well as the relationships between elements creating it. The mentioned sub-systems, presented in EB are investigated using method of analogy between existing sub-systems and future sub-system, mostly smart grids. The systematic analysis provides relevant description of today´s energy branch. In the way of more detailed description needed for case studies author of this thesis applied deduction process.

Systematic Approach to Energy Industry

The attributes of system application is based on presumption that each impact (regardless of the fact that influences directly the customer or other participant) represents finally benefit or cost for customer and to its social welfare (SWF). This idea is based on the fact that the customer is the final market participant who pays for not only market, but also regulated part of electricity price. Moreover electricity price enters to all other goods and services cost-calculations and influence their market prices. There are internal mutual connections between the particular subjects in the power industry. This structure is valid under simplified presumption that it is isolated entity. Via some external connections (let it in general call motivation), the financial and electricity flows inside of the electricity market are influenced.

Energy Industry as a System

During research author of this thesis reveals most important aspect of ST implementation. This implementation exhibit attributes of system application. Situation in the power industry differs from lots of other industries. It is mostly caused by duality of this industry represented on the one hand by regulated and on the other hand by liberalized part. Therefore final electricity price for customers consists from two parts. One part is set by competition on liberalized market; the second part as a majority of the price is set by regulation authority.

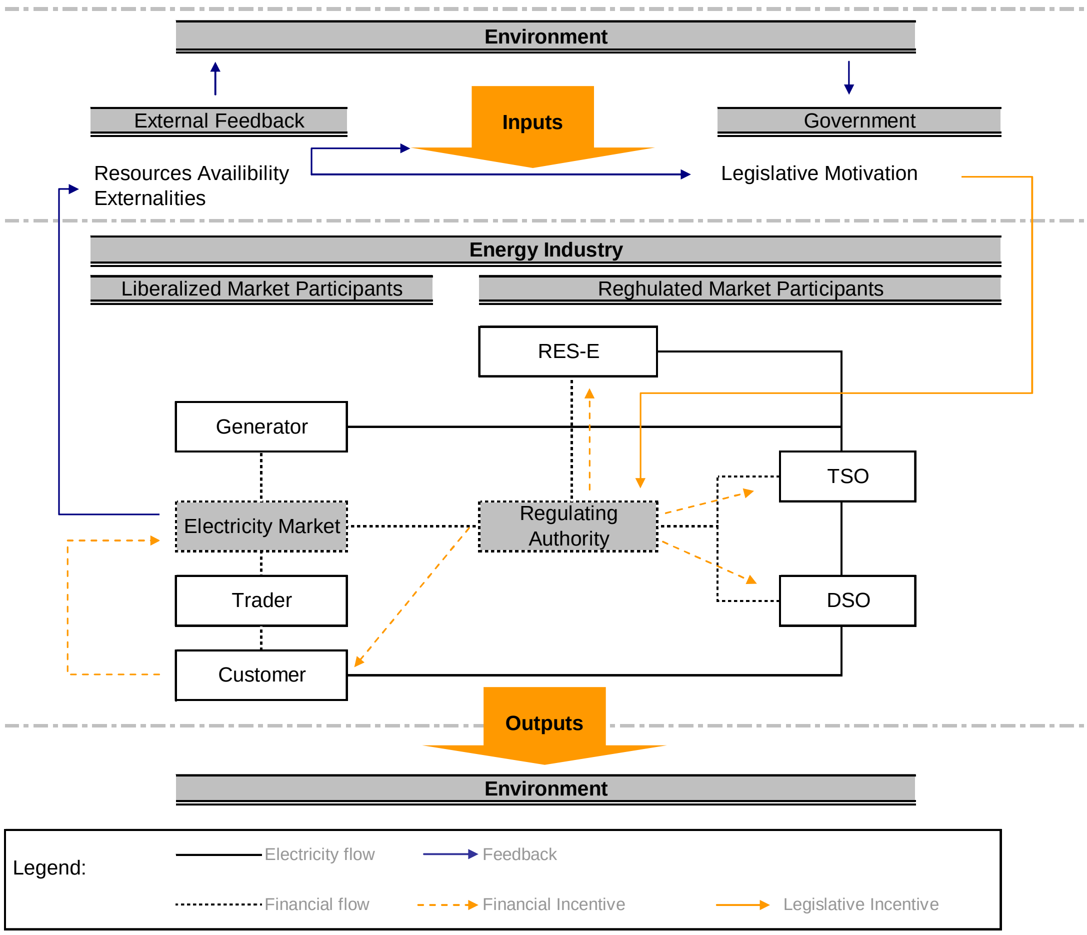


Fig 1. System in the second resolution – energy Industry

For the correct methodology the author will suppose the Customer to be final investor of all ST system and related costs as well as final stakeholder of such implementation.

Economic Effectiveness

Before direct discussion about SWF the economic effectiveness criterion shall be defined. The economical effectiveness expresses basic advisability of some investment [3]. In the most trivial case it represents calculation (balance of future costs *Cost*(t) and benefits *B*(t)) with regard to the time value of money by net present value (NPV) method.

$$NPV = \sum_{t=0}^{T} \frac{CF_t}{(1+r)^t}, \quad (1)$$

where NPV is net present value of some investment, CF_t is cash flow in some year t, r is discount (time value of money) and T is lifetime of particular investment.

Refer to equation (1) the future *CF* is the most important aspect of the economic effectiveness. Therefore calculation of future *CF* represents the most important aspect of SG implementation. Such calculation would be utilized only by correct estimation of future cash costs *Cost*(t) and benefits *B*(t) regarding the evolution and liberalization of electricity market.

General Principles for Economic Motivation

It is pretty obvious that each rational market participant behaves in the way of its utility augmentation. It is much more serious question what does utility for some market participant mean. Ultimate utility can according to author mean anything according particular market participant willingness. Therefore the analysis must reach real basis of utility which is the only correct manageable criterion and the first cause of system development. Ultimate utilities of legal persons differ from ultimate utilities of physical persons.

Physical Persons Motivation – Social Welfare

The change of social welfare (SWF) from costumer’s point of view can be expressed by equation (2). According to [4] the aggregate NPV for customers can influence the change of SWF. The relation depends on customers NPV change that was chosen by the author of this thesis as criterion for SWF evaluation. Therefore relation in equation (2) represents only the pure cash benefit for customers.

$$\Delta SWF \approx \sum_{k=1}^{N} (NPV_{CUS})_k = \sum_{k=1}^{N} \left(\sum_{t=0}^{T} \frac{(B_t(t) - Cost_t(t))}{(1+r)^t} \right)_k, \quad (2)$$

where ΔSWF is change of social welfare, NPV_{CUS} is net present value of benefits brought by SG implementation during its lifetime T to the customers, B_t is benefit of SG implementation in the year t to the customers, $Cost_t$ are costs of SG.

Advanced Metering Management (AMM)

It is obvious that management of local consumption is most important aspect of decentralized power industry. SG concept in the same time is supposed to bring large savings by the means of AMM. According to author´s opinion appropriate price management will represent the only way how to motivate consumer to behave (and manage his consumption) according to needs of the grid. It is not admissible to constrained consumers in their free consumption behavior by ordering when and how much electricity are they allowed to consume. Therefore in this thesis the price management is proposed to serve as an appropriate method of demand management in the decentralized power industry.

Free-Market Legal Persons Motivation

The behavior of legal person’s free-market participants is according to author driven by market value added (MVA) maximization, because of management motivation. This maximization is according to author set by following equations.

Regulated-Market Legal Persons Motivation

Regulated market participants can reach only regulated earnings. Mostly the real value of regulated earnings is set by particular per cent of invested capital. The regulation is performed by regulation authority. In case of Czech Republic the regulation authority uses methodology of revenue-cap. The regulation of e.g. distribution system operator (DSO) is set by exact methodology of earnings regulation [5].

4. RESULTS

RES-E are components of decentral EIS as well as SG concept. Considering the mentioned growing share of RES-E we logically come to the conclusion that growing percentage of generation becomes an independent variable, together with an increasing share of these non-manageable resources involved in the grid. Moreover large RES-E installations are mostly concerned to some areas with suitable weather conditions. Transporting capacity is in the same time strictly limited by physical conditions. This could result in congestion occurrence. Only $G'_{\text{managable}}(t)$ can be utilized as decentral ancillary service (DAS). From long term strategic grid planning point of view the real occurrence of bottleneck depends on N-1 criterion fulfillment as it is described in [6]. The interruption of N-1 criterion can cause the virtual bottleneck. Overload of this bottleneck results not in blackout, but in interruption of N-1 criterion which massively jeopardizes grid stability in case of some additional not favorable event occurrence.

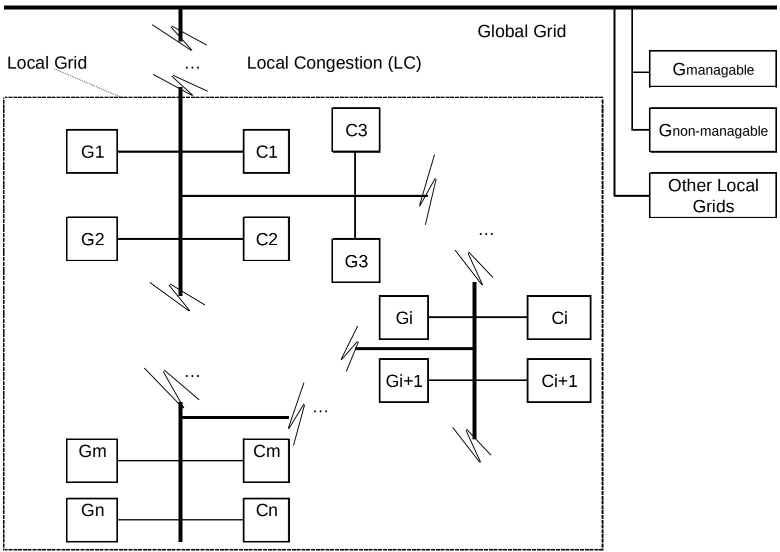


Fig 2. Local electrical grid is element of global grid separated by congestion.

Local grid for each customer differs. It is divided from global grid by nearest local congestion (LC).

$$C^*(t) = G_{non-manageable}(t) + G^*_{manageable}(t) + G_G(t) - L(t), \quad (3)$$

$$G_G(t) \leq \text{LCC} \quad (4)$$

*where C(t) is maximal electricity consumption in some local grid, $G_G(t)$ is available generation capacity in global grid, $G_{non\text{-}managable}(t)$ is generation in non-manageable local resources, $G^*_{managable}(t)$ represents generation in manageable local resources, L(t) are losses in local grid and LCC is local congestion capacity (regarding N-1 criterion). Operand * (star) marks time variable in real grid which can be managed by local AMM / AMI devices.*

Bottleneck is caused by insufficient conductor capacity according to [5]. This fact as well as exact value of *LCC* is set by physical conditions (according to conductors dimensioning methodology [5]). The following analysis was conducted regarding presumption of demand side management. Each case represents only one parameter change. Real situation will be accompanied by coincidence of more cases of grid situation.

Local grid consumption surplus

In case local consumption intends to transgress against equation (4) the grid stability by *C(t)* growth can be ensured as follows:

Critical point is LCC transgress.

- Local generation $G^*_{manageable}(t)$ increase. This possibility can be used only in local areas where manageable resources e.g. micro combined heat and power (CHP) are presented. Such generation devices shall be therefore equipped by AMI management – smart trading system (STS).

- Consumption $C^*(t)$ decrease. The prices in local grid in that case decouples from global ones. Price increase must at any time ensure sufficient consumption decrease.

Existence of local congestion capacity (*LCC*) would cause price decoupling (ΔP) between local and global grid. Shown increment of consumer electricity price shall secure stability of the grid, because local consumption will be changed from first stabilized state C_{g0} to Q_{g1} which is maximal volume of electricity that can be consumed without jeopardizing of grid stability.

Q_A represents avoided amount of electricity that would cause overload without AMM management. The dashed part of local supply curve is cut by AMI. Electricity price is changed by the market from P_0 ($P_{G0} = P_{L0}$) price level to P_1 ($P_{G1} = P_{L1}$) price level in both local and global grid. Price level P_{L2} is managed by the means of AMI and occurs only in local grid to secure grid stability. P_G is price in global grid.

Local grid generation surplus

LCC can be also transgressed by local generation, $G_{non\text{-}managable}(t)$. In that case for grid stability there are following possibilities:

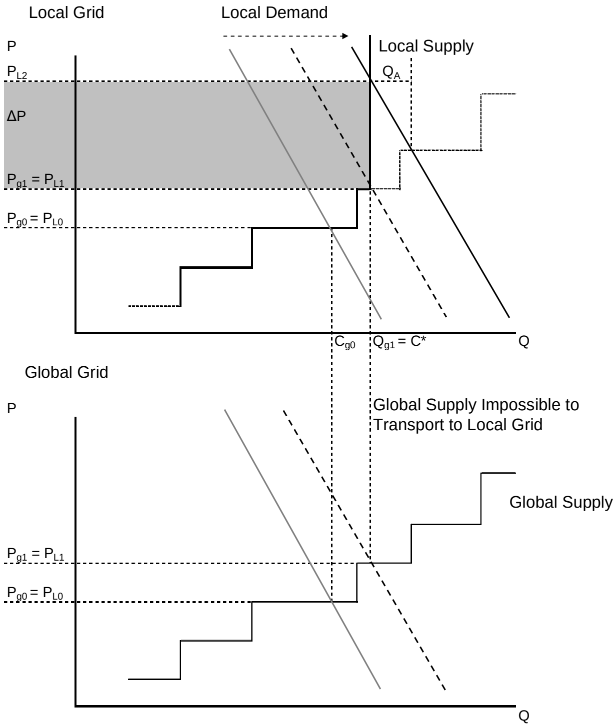
Critical point is production in local non-manageable resources impossible to export via LCC.

- Local generation $G^*_{manageable}$(t) decrease. This possibility can be used only in local areas where manageable micro generation is presented. Such generation devices shall be therefore equipped by AMM management as well as consumers.

- Consumption $C^*(t)$ increase. The prices in local grid in that case decouples from global ones. Price decrease must at any time ensure sufficient consumption increase.

As it is shown on Fig 2, existence of *LCC* would cause price decoupling (ΔP) between local and global grid. Shown descent of consumer electricity price will secure stability of the grid, because local consumption will be changed from first stabilized state C_{g0} to Q_{g1} which is minimal volume of electricity that can be consumed without jeopardizing of grid stability. The dashed parts of local supply curve are cut by AMM. Price level P_{L2} is managed by the means of AMM and occurs only in local grid to secure grid stability.

Global grid generation surplus



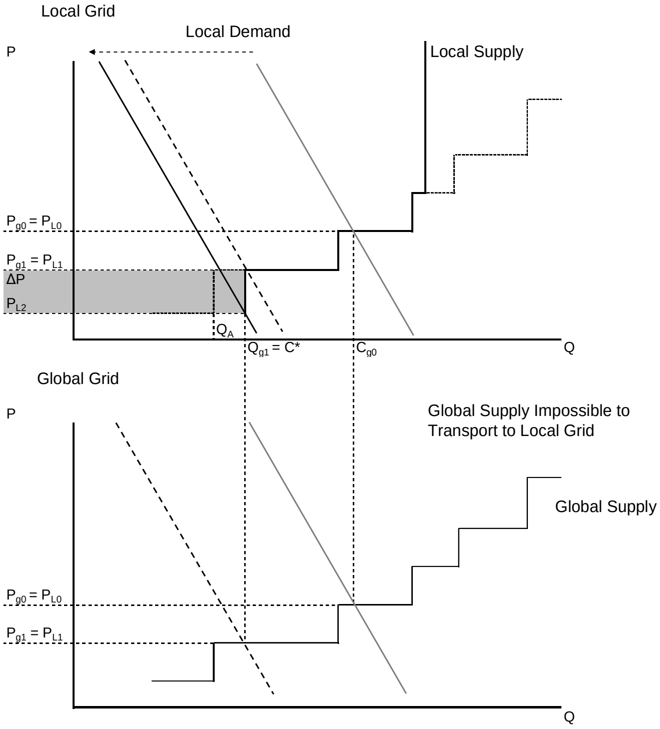


Fig 1. (on the left side) Local Grid Consumption Surplus

Fig 2. (on the right side) Local Grid Generation Surplus

Another case is represented by situation when grid stability intends to be violated by insufficient consumption in global grid. For grid stability there are following possibilities:
Critical point is LCC transgress in combination with global grid ancillary services capacity.

- Global grid generation shall be decreased. This response could be done by ancillary services descent or by management of resources (not only ancillary ones) equipped by AMM. Author deal with presumption that ancillary services will not have to be equipped by AMM because they are managed by the needs of grid (by dispatching) according to the contracts with TSO.

- Consumption $C^*(t)$ in local grid can increase only to the limit set by equation (4) to avoid overload of *LCC* capacity. Other local grids have also its *LCC*. The maximal regulation potential is therefore set by sum of all congestion capacities of local grids. Additional increment of consumption when all *LCC* is used shall happen in other parts of global grid. This implies decrease of global price.

As it is shown on Fig 3 below, existence of *LCC* would cause price decoupling between local and global grid. Shown decoupling of consumer electricity price will stop the growing volume of electricity consumption on level Q_{g1} which is maximal volume of electricity that can be consumed without jeopardizing of grid stability to consume at least local production and not to overload *LCC*.

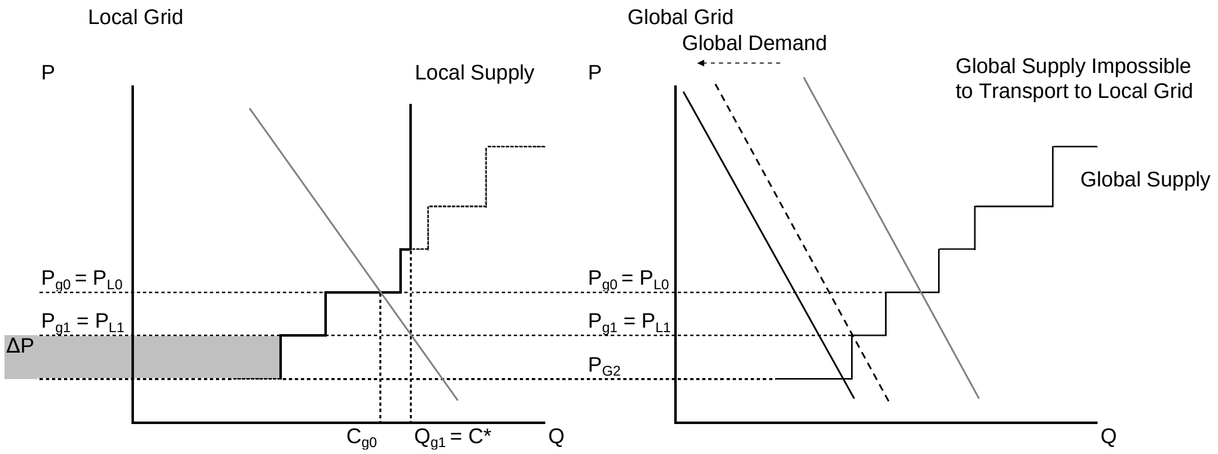


Fig 3. Global Grid Generation Surplus

Electricity price is changed by the market from P_0 price level to P_1 price level in both local and global grid. Price level P_{G2} occurs only in global grid.

Global grid consumption surplus

In that case all manageable resources will have to increase its generation.
Critical point is production in local non-manageable resources impossible to export via LCC.

- Decentralized micro generation shall increase. Limit for maximal possible regulation from (decentralized micro generation resources) is set by local *LCC*. In other words sum of *LCC* of all local grids set again the maximal regulation energy provided by decentralized manageable micro generation resources equipped by AMM (not their aggregate capacity).
- In the same time resources connected to global grid equipped by AMM devices shall be forced to increase their generation as well as ancillary services.

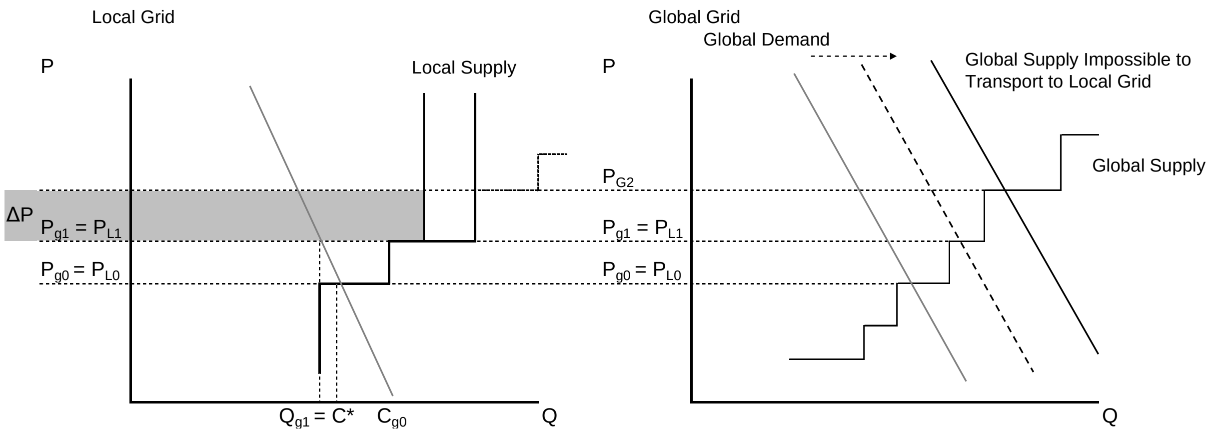


Fig 4. Global Grid Consumption Surplus

Electricity price is changed by the market from P_0 price level to P_1 price level in both local and global grid. Price level P_{G2} occurs only in global grid and by the means of AMM will not occur in the local grid to secure grid stability.

Cost – Benefit Analysis

Capital Expenditures (CAPEX) Inputs into SG System

These investment and other costs occurring in the beginning of decentralized power industry (DPI) and SG operation have mostly capital character. Therefore they can be called CAPEX costs. These costs as system inputs are timely shifted from SG benefits as outputs. Therefore appropriate way of financing method shall be employed for that.

- Threshold investment into SG infrastructure I_0

– Interim investment into state of the art maintenance of SG system I_I

– Financing capital costs that originate from selected methods of financing C_{Debt}

– Costs into establishment of marketing communication and market share possession C_M

Operating Expenditures (OPEX) Inputs into SG System

These costs occurring mostly during operation of AMI have mostly operating character. These costs as system inputs are not timely shifted from SG benefits as outputs.

– AMI communication costs C_{AMI}

– Operating costs of AMM devices C_{OP}

Benefit Outputs from SG System

– Benefits of increased price of energy produced in RES-E B_{RES-E}

– Decrease of necessary amount of grid regulation service B_{REG}

– Benefit of various consumption monitoring $B_{integration}$

– Benefit of cross-border monitoring $B_{Monitor}$

– Implementation of brand new intraday price changes (smart tariffs) that would motivate the customer to move consumption (e.g. demand response, load shifting). B_{Market}

– Avoidance part of future investment cost into transmission and distribution grid infrastructure, necessary without SG concept. $B_{Inv.D/TSO}$

– Benefit of accumulation utilization B_{acc}

– Benefit of illegal consumption avoidance B_{ill}

Optional outputs from SG System

Some outputs represent optional future benefit. Its valuation depends on future market conditions. Today it can be evaluated by price of the option..

– Benefit of electromobility utilization B_{MOB}

– Benefit of mutual concurrence between various energy commodities $B_{concurrence}$

Smart Tariff Formulation

The smart tariff will motivate the customer on the one hand for energy (and capital) savings in the way of SWF maximization and on the other hand to shift the consumption in the way of grid stability. According to author's opinion smart tariff will be based on combination of two basis, availability and price intraday development. Availability is based on possibility of appliance demand response. Manageable consumption represents value of possible ancillary services as well as potential of customer savings. Structure of price changes represents motivation for customer demand response as well as customer financial savings.

5. CONCLUSION

Description of Main Aspects of Energy Branch

The main feature of electricity is higher usability than other forms. The main physical aspect is unstorability of electricity. Therefore there is the necessity of massive investments into the grid stabilization. This fact influenced i.a. regulation of EB and thus infrastructure of market participants. The main structural aspect is the fact that EB is in fact divided into two parts, liberalized and regulated. This fact influenced price structure as well as relationship between particular market participants. The implementation of any ST in fully liberalized part of energy branch should subordinate this new technology under market optimization. The risk is connected with the fact that liberalized capital [9] tries to avoid the capital-intensive technologies with long construction and life times and prefer capital less intensive investments.

Description of Today´s Theoretic Framework for ST Concept Implementation

The massive structural change has recently taken place in the EB. It was motivated by liberalization of energy branch and the second aspect is prevailing opinion that global climate change is influenced mostly by human activities. The support of energy produced in RES-E (as a regulation) was applied and it influenced the system of EB massively. As a feedback it influenced market participants not only in regulated part but also in liberalized part of EB, because it results in massive decrease of electricity price on the market (not for customers).

Formulation of Systematic Description of Energy Branch

The author utilizes systematic analysis for description of EB system relations. The feedback is identified as a crucial aspect of future system behavior and possibility of its management. Free market optimizes in the real time. Sectors with large inertia (long construction times and tricky sub-contractor chains necessary for construction) cannot be flexible for rapid market changes. The most important fact that author identifies is, that this system has its specific feedback, influencing again the inputs. As a criterion for system development the social welfare of market participants was chosen by the author. This criterion motivates market participants for some specific behavior.

Author expresses opinion that appropriate principles of motivation represent instrument applicable for system management. Incentive strategies for system regulation manifesting aspects of the future system development can be provided only by the qualified legislation. Bad legislative regulation can cause on the other hand SWF descent.

Formulation of Methodology for Smart Grid Impacts Valuation

Future development of SG concept will be reinforced by development of AMI devices, conducted together with growing share of distributed RES-E and PHEV. According to author´s research this fact can result in risk of local grid overweighting. The real time measurement of electricity flow will moreover enable nodal structure of electricity price level. When local consumption of electricity or generation of electricity in intermittent distributed resources grows, the pressure for local transmission conditions of the grid grows as well. The fact of intermittence makes this situation moreover worse. The above mentioned findings (previously published by the author in [8] and [10]) were by the author analyzed by the means of described systematic analysis. Potential nodal structure of electricity price influences the future economic effectiveness of SG concept massively. Presence of AMM / AMI elements in the grid should logically results in establishment of data management system, called by the author data pooling system. Such a system will be according to the author necessary for grid stability. This fact will eliminate the mentioned risk of grid overloading. It can partly eliminate problems with land purchase or easements.

Identification of Real Impacts of SG Implementation

Author identified lots of impacts that will represent opportunity for the future market participant´s behavior. These findings originate in author´s systematic analysis of SG implementation.

- **Smart Tariff**. The smart tariff is presented as a condition for economical and sustainable development of the presented SG subsystem. As an important aspect (output) of SG implementation is according to author´s methodology (previously published in [7]) occurrence of local prices (called smart local price – SLP). To determine such SLP, it will be needed to create a brand new kind of market, called by the author local balancing market (LBM) parallel to current global market. Existence of such market can enable B_{Market} benefit which represents output form the SG subsystem as well as important motivation (feedback) for market participants. This market will associate more consumers, decentralized RES-E generators, accumulators or CHP and last but not least more traders in such a way which would allow determination of optimal SLP. Existence of more available traders in local balancing market complies with generally accepted doctrine of liberalization and market management Third Party Access Platform.

- **Compliance of Grid Management**. One important output of SG concept implementation would be according to the author of this thesis that the AMM allows demand management according to the needs of the trader. Therefore there should be the merger of the needs of trading and distribution. The optimally market-oriented model of smart grid management therefore presumes demand response upon trader (SLP management) limited by physical condition provided by DSO as a limiting condition. This fact requires data providing (datapooling, this concept described and published in [11]) between market participants and can be in contradiction with unbundling. The mentioned facts would require the appropriate legislation change.
- **Data Energy Coupling (DEC) and System of Datapooling**. The concept that will as a feedback from SG implementation emerge is called by the author datapooling. This concept would provide necessary data for market participants and it is obvious that it represents direct impact of SG concept implementation. Potential way of communication - the data energy coupling (DEC) would after implementation of SG represent opportunity for energy utilities to spread their commercial activities to the area of data transport because communication channels for relevant AMM data would require related infrastructure.
- **Local TPA**. As it was many times mentioned above, the decentralization of energy branch connected with SG concept would accent local conditions in the grids. Access to the grid as well as to the market would need to be decentralized as well. The author called this concept local TPA and it represents following impact of SG concept implementation. Each market participant should after SG implementation has opportunity to access and behave in the market platform to utilize potential benefits described above. Particular condition for behavior will be set by local conditions in the grid and by behavior of other local consumers. The necessary related legislation should be discussed in the future in more detail.

Author´s Hypothesis

As it is obvious from the goals reached in this thesis, the influence of SG implementation on EB will be massive. It would change status of market participants as elements of EB system. It will establish opportunities and market participants will have to adapt. The hypothesis “that implementation of smart grids concept would influence energy branch as a system; all market participants and relationships between them as well” is therefore confirmed. Real examples of such changes will in full extend appear after roll out of SG concept, if it will be forced by the EU. The first pieces of evidence are nevertheless visible today. European energy utilities are now orienting to customers with complex services and not only with electricity supply. These companies are massively investing into ICT systems, telecommunications, electric vehicles promotion, financial services, etc…

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List of candidate's works relating to the doctoral thesis

Publications in peer-review journals

[1]. Adamec, M. - Pavlátka, P. - Starý, O.: Costs and Benefits of Smart Grids on Liberalized Markets. Journal of Electronic Science and Technology. 2012, vol. 10, no. 1, p. 22-28. ISSN 1674-862X. **Share of the author Marek Adamec is 40%, leading author**

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SUMMARY

Autor se ve své práci zabývá problematikou systematického přístupu k implementaci moderní techniky a způsobů řízení do energetiky. Během svého výzkumu autor aplikoval postup systematické analýzy dané problematiky. Východiskem jsou základní vlastnosti sektoru energetiky v současné době. Podstatou autorova přístupu je rozdělení nadřazeného systému – sektor energetiky na menší sub – systémy. Takovými sub-systémy jsou i moderní postupy a technologie, tedy i inteligentní sítě, na něž se autor podrobněji zaměřuje. Autor podtrhuje nutnost popisu transformace vstupů na výstupy v takových sub – systémech. Důležitým aspektem je především existence zpětné vazby, která má zpětný vliv na transformaci vstupů. V autorově pohledu je navíc možno případné ovlivnění zpětné vazby vnímat jako možnost ovlivňovat vlastnosti sub – systému a motivovat jednotlivé elementy (v autorově pojetí účastníky trhu). Základní premisou ovšem přesto zůstává nutnost popisu důsledků jakéhokoliv vnějšího zásahu.

Autor si vytyčil několik cílů, kterých v průběhu výzkumu docílil. Zároveň autor formuloval hypotézu, že implementace inteligentních sítí ovlivní celý sektor energetiky, stejně jako všechny účastníky trhu. Zásadní vliv inteligentních sítí na celou energetiku je dokumentován právě dosaženými cíli. Autor ve své práci formuloval metodiku přístupu k hodnocení důsledků zavádění inteligentních sítí, vycházející z porovnání budoucích nákladů a výnosů pro jednotlivé účastníky trhu. Konkrétní číselné zhodnocení v současnosti ovšem není možné pro zjevnou nedostupnost potřebných dat.

Autor dále předpovídá některé důsledky a možnosti pro účastníky trhu, plynoucí z případné implementace inteligentních sítí. Důležitou možností, která se otevře pro účastníky trhu, je možnost zavedení nových tarifů, které by motivovaly spotřebitele k časově diferencované spotřebě tak, aby příslušný obchodník dosáhl vyrovnané bilance. Důležitý je předpoklad neomezování užitku spotřebitele společně s nutností udržení fyzické stability sítě. Dalším důležitým identifikovaným faktem je možnost zavedení společné služby dodávky energie a zprostředkování přenosu dat. Rozšíření konceptu inteligentních sítí by totiž s sebou přineslo vhodné komunikační kanály. Větší míra sdílení dat je pak vnímána jako nutná pro optimální obchodní motivaci zákazníků za současného udržení nutné stability sítě.

Výše popsaná fakta znamenají zásadní změnu postavení jednotlivých účastníků trhu na jedné straně a možnost komplexnějších služeb spojených s dodávkou elektrické energie na straně druhé. Není přitom bez zajímavosti, že podobné směřování lze v poslední době vyčíst z chování mnohých energetických firem v ČR i Německu. Zavedení inteligentních sítí by pak logicky doprovázelo postupnou úpravu směřování těchto společností.