BUSINESS MODELS FOR THE ENERGY FIELD. ENERGY STORAGE AS A BUSINESS OPPORTUNITY

MODELE DE BUSINESS PENTRU DOMENIUL ENERGETIC. STOCAREA DE ENERGIE CA OPORTUNITATE DE ACTIVITATE PROFITABILĂ

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Abstract. *The business model typology presented here is directly related to the energy storage activities commonly seen as business. The most important aspect to be debated is whether Transelectrica could manage such business. The related characteristics of such business, the limits and the necessary degree of adaptability are notably described. The paper reviews the general models for the energy field and then slightly modifies the business models for a transmission system operator like Transelectrica. Its option leads to the network of storage capacities, seen as power reserve networks that can replace or overlap the classic power reserves.*

Keywords: energy storage, business model.

Rezumat. *Tipologia modelelor generice prezentată în articol este legată direct de stocarea energiei, activitate care formeză o afacere în sine. Aspectul cel mai importat dezbătut aici este dacă Transelectrica poate administra o astfel de activitate profitabilă. Sunt prezentate caracteristicile asociate unei afaceri de acest tip, limitele acesteia și gradul necesar de adaptabilitate. Lucrarea prezintă modelele generale din domeniul energetic și adaptează aceste modele pentru un operator de sistem – un OTS. Opțiunile conduc către capacități de stocare, văzute ca și rezerve de putere care pot înlocui sau suplimenta rezervele existente.*

Cuvinte cheie: stocarea energiei, model de afacere.

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1. Introduction

The evolution of energy demand has become less and less predictable and controllable. On the other hand, the energy related industry is in the process of reinventing itself. The obsolete technology used for power generation proved its limits. A certain minimum of evolution seems to be about to take place.

The Distributed Generation implies that the energy transmission and distribution networks have no longer the same strategic value as in the past and also they are no longer a valuable support and objective of the future development. More or less visible, the intermediate services between production and consumption are slowly disintegrating. The ability to assimilate new technologies in a timely manner also slowed down.

Some short and medium term trends for the energy industry are, as listed below [1]:

• Reaching and exceeding the parity between conventional and renewable energy production;

• Decreasing effective costs of the energy generation. Acknowledged costs of energy generation are incurred; • Energy storage on an increasingly large scale. The storage capacities owners could also be asserted as virtual energy producers;

• More (and more) decentralized or locally efficient energy networks, as well as parallel virtual "networks".

• The omnipresence of "behind the metering" equipment - of energy own production and self-consumption, especially outside the networks. The prosumers become more and more present.

Following from the above, the initial positioning, further repositioning and controlled evolving of every participant on the energy market could be essential for the benefit of the entire market. Among these participants and their cooperative games, the TSO will be considered as representative for the network but implicitly inner oriented towards its network. Consequently, the TSO could have and follow a strategy of expansion to a wider area of action, in addition of its current one. The table below summarizes these types of evolution.

2. OTS related Business Models. Generic tipology

Future roles	**Energy provider**	**Integrator**	**Facilitator**	**Optimiser**
	Assets oriented	*System oriented*	*Value oriented*	*Opportunities oriented*
Primary interest domain	**Power generation**	**Transmission or Distribution**	**Distribution or Client**	**Client**
	Energy production management - at the level of *minimal doing*	New Fields and Territories to participate or co-participate	Migration towards alternative roles and (closely) related fields of activities	New models of business or maturity of the new business models
Slogan	*It must do*	*It will be done*	*It should be done*	*It could be done*
Essential tendencies	Assets optimisa-tion (utilisation and acquisition) and, simultaneously, orientation towards markets' prices evolution	Network (own or in joint administration with other developers) interconnection facilitation	Strengthening and increasing the value and utility of the network for all its own shareholders	Permission granted to customers to improve their own technology beyond meters.
	Achieving a solid balance between own assets base and the significant transactions in terms of (hedging) risks.	Extended implementation of (new) technologies or equipment in the distribution networks	Solving the problem of how technology could improve the system perfomance and the customers' involvement.	Broad involvement of the customers/consumers aiming to increase the value of supply through advanced data mining/analysis.

Figure 1. Future tendencies în the business field for a TSO

A TSO should be considered the main actor of its power system. However, other players could play on its market, from the same or adjacent markets or fields of activity, even power transmission. A TSO can also overcome its current limitations and regulations to prove itself as an interconnections facilitator: with other power transmission networks and other energy systems in the area, as a high technology promoter. The profitability of a TSO lies in the regulated assets and therefore the TSO should have regulated rates of profit or even constant marginal profit. However making profit from the power transmission assets (lines and stations, holding portfolios - if applicable) tends to be no longer enough. A further opportunity might be found in the field of energy storage.

Another paradigm can be outlined here: the transmission network is not a network from or up to a certain voltage threshold but a viable network that connects the essential power plants and consumers - namely "the entries to orderly and balanced communities of consumers”.

3. Business models related to a TSO.

The tables below outline the business models in the energy field. Other players could be able to provide energy for no-name consumers and, on the other hand, self-producers/prosumers – consumers dedicated to that energy source – could have their own role on the market. This is already visible.Same considerations could be drawn if distribution companies and other energy network developers could claim their role in power transmission. Even the end-consumers and consumers cooperatives or communities with an appropriate interest could claim the same role.

Values chain	*Energy generation*	*Power transmission*	*Power distribution*
HIGHER degree of integration			*Lesser degree of integration*
Business field or activity	Prosumers’ power generation and/or dedicated consumers power generation	Network management Network developer	Own network management Own network developer
Tendency towards rewarding assets			

Values chain	*Wholesale energy market*	*Retail energy market*	
HIGH integration degree			*Lesser degree of integration*
Business field or activity	Product innovation Business partners	Product innovation Partner of (business) partners Virtual entities on the energy market	
Tendency towards rewarding assets			*Tendency towards rewarding services*

Figure 2. Generic types of businesses related to the energy field

4. The main business models for a TSO are listed below.

4.1. Model A. The TSO as a developer of its own power transmission network

A TSO, sooner or later, reaches a maximum of its relevance and importance as a major decision-maker of the control of its own transmission network and a maximum degree of control of this network. Moreover, the TSO could still play a role, sometimes important and, very rarely, decisive, namely maintaining an equilibrium among the distribution networks. On the other hand, its relevance as an "Observer" of local power/distribution systems could be (very) useful or mutually useful. These are the limits of its strategic "movements" on the market.

A TSO connects large energy generation plants or centers with consumer communities. As such, a TSO could constantly create and recreate a network - its own or a participatory one -, which is or (re) becomes the network it operates and which has the principal and, most often, the only role, to connect the power plants for large-scale energy production and consumers, a large scale that should have been sufficiently rewarding for the scale for which they operate.

These "large" plants are usually geographically distant or remotely situated from the places of consumption. We could consider here, firstly, the large hydroelectric plants and the large wind farms. But that involves, from the very beginning, a restriction, a tendency and, later, a dedication of the transmission network for these large(r) energy-efficient sources of energy and not for large communities of consumption. The profitable transmission of produced energy means, in fact, this constraint: more desirable, larger centers of energy production connected with "consumer worlds" - worlds organized by a number of distributors.

So far, this is only theoretically necessary from the point of view of economic energetics, only such infrastructure becomes or remains profitable, namely a network allocated to profitable plants and dedicated to at least useful consumption. But even if it relies on cost-effective centers, a carrier can exit the area of profitability without cost-effective administration of this network. This means, in fact, the following cases:

1. TSO's ability to support a business model.

Such an operator must have, create and maintain its own collection of historical data on its activity, with the analysis and conclusions attached.

The TSO should also have (access to) excellent capabilities in designing, operating and effectively managing the network and supporting infrastructure.

The key of his business thus becomes maintaining a general state of "wellbeing" of the energy system of which it is a part. *It is thus equivalent to the Chinese adage that says a patient pays his doctor only when he is or remains healthy*.

2. The wholesale market and the relationships of the TSO with such a market involve the ability to manage or participate in its administration in the most effective form. This means managing the demand and supply of energy at this level in real time and formally flawlessly. Creating an advanced degree of confidence is essential.

Such a market forces fair and equitable relationships with those it needs in fulfilling its tasks: owners of goods or with goods that reach the interests of TSO's or can be made available to its projects, communities, authorities, customers and equipment suppliers.

The business model of a TSO includes here a first great opportunity: what TSO wants is to create and maintain an impeccable network of own investors (potentialmostly) and / or partners and / or of potential co-partners for various projects - related to this administration. These investment partners are or are quickly becoming useful in terms of access to finance with low costs and useful conditionality on the credit market.

As energy management moves, step-by-step, from small (and local or self-producers and networks that allow them to connect) to large sources (or portfolios interconnected by small resources) and to effective management of the network that connects these large sources, sometimes to virtual connecting platforms, the number of connections with the facilitators of individual or collective creation or administration of these sources grows or diversifies and becomes more and more complex.

3. Directly following the above, the activity of a TSO can also be oriented towards identifying new locations for large scale energy production - within its own market or in/for new markets: from renewable sources and for flexible production from conventional sources and the network extensions required for them. Establishing and preserving rights regarding

these new locations and the opportunities associated with them, e.g., the right of pre-emption, are not unnecessary. Even just as "promises", they can be included in the portfolio which can raise the value of a company's portfolio of assets and "sensitize" the market.

The issue here is to be able to orient present applications, especially on the wholesale market, to such projects or opportunities.

It also has a somewhat more "volatile" purpose, to be able to influence the "network" of its own risks or attached to the energy transmission network it manages.

In fact, currently managing at least a high level of efficiency of the network's own connections can allow for increased productivity and lower operating costs. Beyond this, but also more subtle, are the modeling and reshaping of alliances with energy distributors, which allow the transition to another scale of participation in the distribution of income and opportunities. Moreover, new investment opportunities can be created at that scale, in co-participation or not.

What could a TSO do for itself and for its development under its own natural monopoly conditions? It is mandatory and it derives implicitly from its own purpose - the relationship with the distribution operators is essential. Further, it is possible to reach alliances for creating and developing large-scale opportunities, mainly large-scale energy production plans.

Contacting partners or independent investors to invest in the development of renewable energy projects, projects with lower costs. Recovering the own operational procedures to include a larger vision of the own environment for the activity. Creating a portfolio of forms contracts with energy producers, local or regional administrators and with providers supporting the activity of networks, contracts oriented towards solid performance and cost management.

Under these conditions, what are the risks? Developing strong networks of local or sparsely located sources of energy in urban areas and residential or business communities, micro-networks. These lead to the reduction of the need for the energy transmission network. Developers of networks, including virtual and financial-virtual, that can obtain advantages of the first-come on the market, including new markets. Additional opportunities could create benefits for market participants from the regulator. These risks cannot be managed by a single TSO. Profitable opportunities:

- Accessing capital with a (lower) cost;
- Own network of partners in the field of energy production, with access to larger projects;
- Solid operations to keep own network costs under control and an effective program to replace the old assets or inferior technology;
- Identification of regions or areas for future expansion;
- A breakthrough in implementing contracts with suppliers for joint or preferential risk management.

4.2. Model B. The TSO as its transmission network administrator

Typically, a TSO is a natural monopoly. It manages the power stability in the grid and coordinates/controls/dispatches the electricity supply and demand to avoid imbalances and interruptions. A new role the TSO can assume is the integration of (unconventional) distribution networks and distributed energy resources for which it can be held responsible. As energy production and the spread of these networks increases the opportunity to manage all interfaces between local energy systems and traditional distribution networks.

Models like this can be stated in areas where energy production and consumption are decentralized, where there is positive and beneficial competition and where the TSO is a natural monopoly. Such models can occur if there are effective capabilities for managing a network, related to both the network assets and the integration of different energy sources at different levels. In this case, it must develop serious capabilities for managing asset-related data and optimizing network activities. The latter capabilities can be supported by smart technologies and multiple sensor use. Monitoring and collecting system performance data become essential, as well as high-level analysis of energy flows, risk of equipment failure and asset damage.

What to do next? It is useful to invest in network's evolution by implementing smart technology throughout the system. It is also useful to move to a higher stage of managing large data collections and analytically assessing energy quality, equipment failures, associated risks and investment priorities. It is more than useful to anticipate the deployment of future energy resources, including energy storage, micro-networks, distributed generation, electric vehicles and their necessary infrastructure. These will be new services and, in parallel, new rules should be discussed and agreed to cover them. Last but not least, it is necessary to implement unified procedures on a large scale, for example for cost management.

We could list the necessary actions of the TSO to support such a model:

- Agreements with the regulators regarding approvals for investments oriented to advanced capabilities of the system and / or the managed network and / or for the strengthening of the network;
- Developing partnerships with power plants and owners or investors in order to create, operate and manage new connections and interconnections.

Threats and risks:

- High penetration of distributed energy resources outside the meter system and micro-networks;
- New regulations that can allow current distribution operators to have capabilities and activities in the field of power transmission networks.

New opportunities to increase profitability:

- Access to low(er) cost capital;
- Alternative investment recovery mechanisms;
- Data analysis systems;
- Fault prediction software;
- Integration of distributed energy resources.

4.3. Model C. Energy storage as a business. The business model

For simplification we can consider two major situations:

- TSO is the Owner of the storage capacity;
- TSO is the User of one or more storage capacities.

The extension of such an approach is the network of storage capacities, owned, used (exclusively or not) or mixed. An "inverse" extension is the exclusive use of one, more or all of the storage capacities. In addition, the situation of a full load regime - a total discharge - is a particular case.

The typical business situation refers to the ownership / shared use of storage capacity / capacities. The situation allows the use of blockchain technology.

Necessary actions to be taken by the TSO to do this business:

- Agreements with the regulators regarding the approvals for investments oriented towards storage capacities;
- Same for creating a network of storage capacities;
- Adopting high standards and implementing them;
- Developing partnerships with power generation owners to install, operate and manage storage capacities.

Threats and risks:

- Game of interests of private holders of storage capacities;
- New regulations that can allow current distribution operators to have multiple and superior capabilities and activities in the field of holding and/or managing storage capacities;
- A loading/unloading regime in contretemps or inefficient.

New profitable areas that can be reached in energy storage:

- Improved dispatch;
- Alternative mechanisms for mitigating the reserves costs
- Integration of distributed energy storage resources;
- Blockchain technologies and association of transactions in virtual currencies.

The blockchain technology operates on a decentralized platform, where each participant has access to exactly the same transaction log and/or only the same data regarding transactions with stored energy and/or storage capacities and allowing for each participant to register their own or desired transactions. Each participant contributes directly to data protection, especially its own transactions.

However, the transactions are verified and approved by consensus among the participants in such a network, thus avoiding fraudulent attempts. The entire succession of transactions that are carried out is tracked, ensuring everyone has access to it.

The blockchain technology and associated use can be summarized as below, in the context of energy storage:

- The transactions are pairs of supply-demand. They appear when a request is matched with an offer (or vice versa).

- The strengths of such a concept: they allow "smart" contracts. These contracts allow or help the energy producer / owner to manage their own energy rights. It can allocate quotas or rights to the energy it holds (stored) or can produce.

These contracts are different from conventional contracts. Firstly, because they are an exchange of rights over energy, an exchange that is close to the notion of barter. A certain energy or a right over energy at or from a certain time or a certain entity may be exchanged with another amount or at another time. The exchange unit is not necessarily a real value but can be a conventional unit, respectively "a virtual currency".

Such a transaction can be exemplified as follows: “I own 100 MWh. It is stored for up to three days. It is available at peak hours - preferably. I want a similar energy that can be delivered over a week or upon request. I evaluate my energy at 30,000 handshakes.”

- Such transactions may exceed or bypass a third party or a useless or inefficient authority. In the majority of cases, these are exchange equivalence units.

Moreover, it may be energy transactions (stored or produced at a time - derivatives) or trading with energy rights (rights over a storage and production capacity). Transactions are transparent, but they are always pairs, a Demand and an Offer. An advantage of this technology is its public nature.

All transactions can be viewed and validated. Alternative requests or offers are available including the transaction prices. This allows an overview at any time of the transactions and their developments, by consulting the transaction log. Moreover, one can consult records related to the actual energy producers, as well as the owners of the energy produced and / or stored. The ownership of the energy or the rights to the energy as well as their transfer can also be viewed.

4.4. Prices

The tradable energy, available, unavailable, or that is already traded, may have a (real, concrete) non-compliant or insufficient price. Following the evolution of prices throughout the transactions allows detecting the dynamics of these prices. The utility is obvious. Prices can evolve, conveniently, according to demand and supply. If the price control is available, the pricing can only be imposed directly by the manufacturer without a whole network of intermediaries. And this is possible dynamically, a competitive advantage.

A set of micro-metering capabilities of energy and / or traded power can be retained and developed. As such, services can be developed for micro-measuring the energy extracted from the storage capacities, for example, and for micro-valorizing these extractions according to various characteristics: the trivial one of the hourly interval but also according to the energy use. The power used for the production of a certain "slice" of energy and the "depreciation" of this price depending on the anomalies of delivery / consumption (interruptions, quality, etc.), can be micro-measured on intervals and on fields of use. Each "slice" of energy, as measured, can be assigned its own virtual currency. This is because trading can refer only to certain characteristics of the energy - e.g., the delivery time interval - and the "non-consumed" energy may have a different price, automatically and not through the intermediation of authorities. We are talking here about virtual currency, exchange equivalence.

The major advantage. The most important advantage of such a technology is the establishment of a system of trust and reputation. Both consumers and producers, as well as the participants in the transactions, can check each other. This can allow for closer collaboration and more open behavior as well as promoting cooperation. Participants who do not fulfill their contractual obligations or play with transactions can see their actions recorded and can be blamed for inappropriate behavior.

4.5. Model D. Investments in storage capacities. Generic examples

A set of tables with economic values related to (investments in) electricity storage is thought-provoking. The values are very close to the reality of today. The tables contain the current optimal values for various storage sources and are based on the Lazard Report of November 2017. The respective tables are presented below.

5. Conclusions

The business models presented above (a typology is summarised in Figure 2) are applicable in and for the energy and power market and even more to activities and operators with regulated activity (also a tupology for OTS is presented in Figure 1). However, the tariffs are limiting and do not allow, in most cases, the actual investment sufficiently and more beneficially than simple capital expenditures - even in contradiction with the status of a listed company.

Any business model can be applied if it is based on the relationships of the respective operator with the regulator on which it depends, in the possible scope of extension of its activity. Limitation of this kind quickly leads to a shortage of equity, to a decapitalization of the operator or, as the current case is, to the inaccessibility of raising capital.

Therefore, any promising attempt can be channeled in three directions: a solid negotiation with the regulator for a sufficient economic triple, then a reduction of costs without unnecessary internalizations and without harmful outsourcing and, above all, a wise administration of the network, parallel networks, sub-networks, surcharges and interconnection points of common interest.

An energy storage activity/business is dedicated for the TSO, in order to replace the power reserve with stored energy that leads to the integration of a network of storage capacities.

Such networks of storage capacity may be growing under different interested owners, interests and uses. Here the flow of loading/unloading of storage capacities follows a model of energy trading and contracting rather than one of demand/supply type or of energy stored for limit situations. In such cases and for such types of loading and unloading, blockchain technology, pair-by-pair registers and trading, is of further application

More importantly, such a business model that can be attached to a carrier can withstand trading in crypto-currencies. Although the use of such crypto-currencies is debatable and contested, it introduces into the energy system, in the field of mirror transactions, the collective responsibility of maintaining a level of trust and the equivalent exchange in "non-taxable" currency. Moreover, the purpose is to "get rid" of the bureaucratic brake and excessively bureaucratic authority. Thus, what matters is placing the exchange of energy quantities in time, for desired durations or at desired moments, the exchange being suspended to the levels of mutual trust. The barter system applies here only as exchange. Crypto-currencies value this exchange for trading pairs, types of transactions and times.

Finally, energy storage is not as cheap as it seems. Even if we assume that it will be (significantly) cheaper over time, the energy storage has a rather low retention compared to expectations. Moreover, the storage itself increases or forces the final price increase of the consumed energy - economically speaking, artificially and low justifiable. Therefore, energy storage has reached its current availability only if it is extremely needed or the lack thereof is too expensive. In the current regulated case, storage capacity is feasible only in cases where its lack is intolerable or it is not an option - even at the regulated level. However, the economic aspect is strongly distorted. This is also the “technical” approach of the decision makers and justifications in the field: "the storage capacity is not economic so the economic part does not count for storage capacity". These decisions will have their "price".

Below it is presented some useful figures in order to temperate some unrealistic enthusiasm. Please note carefully the actual retention time of the energy. However the evolution of this retention so far is optimistic.

Table 1 - Optimal investments fields.

Optimal limits of the investments. Energy storage projects. [2]

Source/Plant	Optimal installed power capacity (equivalent)	Optimal storage energy capacity	Optimal retention of the energy Optimal cycle of load – discharge
Pumped storage plants	60 MW – 1 GW and above	100 MWh – 11 GWh	2 – 22 hours
Hydrogen	0,5 MW – 800 MW	10 – 350 MWh	0,5 minutes – 1 month
Synthetic methane	1 – 1000 MW	10 – 1000 MWh	1 minute – 2 months
Cars batteries (local network)	4 – 80 kW	1,5 – 110 kWh	0,5 sec – 2 hours
Lithium – Ion batteries (any configuration)	3 kW – 12 MW	0,7 – 110 MWh	0,5 sec – 1 day

Table 2 - Optimal cost for storage related investments.

Main investment data, in terms of stored energy amounts. [2]

Source/Plant	Minimal cost of investment capital	Minimal cost of energy storage	Optimal lifetime of the plant
	Euro/kWh	*Euro/MWh*	
Pumped storage plants	189	135	At least 20 years
Hydrogen	500	Probable 280	0,5 minutes – 1 month
Synthetic methane	510	Probable 300	1 minute – 2 months
Cars batteries (local network)	420	305	10 years
Lithium – Ion batteries (any configuration)	345	237	5 years

Table 3 - Minimal price of the energy storage to be added to the initial energy price.

Main economic data concerning the energy storage. Refferential prices/costs. 2018.[3]

Field	Additional cost to the energy price.
	Euro/MWh
Power transmission	30.90
Peak energy	30.95
Frequency regulation	41.82
Distribution networks	32.20
Micro-grid	93.19
Local network - Island	250.70
Commercial and industrial consumers	61.65
Commercial and industrial equipments consumption	93.20
Homes and residential sites.	110.45

Please note also that the final price of the stored energy should include the additional costs. This is important and very restrictive.

REFERENCES

[1] *Florin Teodor Tănăsescu,* „Sistemele de stocare a energiei, o soluţie pentru optimizarea funcţionării reţelelor electrice la care sunt racordate surse regenerabile intermitente", Buletinul AGIR. Supliment Buletinul AGIR 1/2015 - DEZVOLTAREA DURABILĂ FAVORABILĂ INCLUZIUNII (I), https://www.buletinulagir.agir.ro/ articol.php?id= 2222

[2] Lazard`s levelized cost of energy analysis. Version 11.0 – November 2017.

[3] Lazard`s levelized cost of energy analysis. Version 12.0 – November 2018.