

Prof. Jan Popczyk

OD DZIAŁAŃ KRYZYSOWYCH 2020 DO ELEKTROPROSUMERYZMU 2050

Transformacja energetyki w trybie przełomowym

Część I. Rozległe uwarunkowania i punkt oddolnego praktycznego startu¹⁾

Część II. Słownik encyklopedyczny teorii i zarys koncepcji rynku wschodzącego 1 na poziomie praktyki²⁾

FROM EMERGENCY MEASURES IN 2020 TO ELECTROPROSUMERISM IN 2050 Transformation of energy industry in the breakthrough mode

Part I. Numerous determinants and the grassroots point of the practical start

Part II. Encyclopaedic dictionary of theory as well as the outlines of the emerging market 1 concept at the practice level

Krzysztof Bodzek

Nietechniczne streszczenie (skierowane do ogółu społeczeństwa)

Non-technical summary (addressed to the general public)

Tłumaczenie na język angielski: mgr Jacek Dubrawski

Efektywna transformacja energetyki potrzebuje gwałtownego wzrostu kompetencji społecznych. Pozwala one na lepsze wykorzystanie lokalnych zasobów i wdrożenie koniecznych innowacji technologicznych energetyki już na poziomie gospodarstwa domowego. Potrzebne jest nowe Prawo Elektryczne, które wyzwoli pretendentów do rynków energii elektrycznej od krępujących i przestarzałych regulacji prawnych. Po to, żeby neutralność klimatyczna w roku 2050 nie była traktowana jako zniewolenie polskiej energetyki ale jako szansa na rozwój Polski. W artykule opisano podstawy teoretyczne koncepcji elektroprosumeryzmu, w tym jego cztery rynki. Zidentyfikowano strukturalny kryzys w elektroenergetyce (i górnictwie) a także pokazano błędy poznawcze utrudniające transformację i wyjście z kryzysu. Zaproponowano konieczne reformy (prowadzi do Prawa Elektrycznego) w których dużą rolę odegrają sandboxy.

Słowa kluczowe: transformacja energetyki, monizm elektryczny, elektroprosumeryzm, prosument, Prawo Elektryczne

Effective transformation of the energy industry needs rapid growth of social competences. It will improve better utilisation of local resources and implementation of the necessary technological innovations in energy generation already at a household level. There is a strong need to adopt a new Electricity Act which will free the pretenders to electric energy markets from inconvenient and obsolete legal regulations. It will also enable to treat the 2050 climate neutrality not as the subjection of the Polish energy industry but as the opportunity to develop the country. Described are here theoretical fundamentals of the concept of electroprosumerism including its four markets. Identified is the structural crisis in energy industry (and in mining). Presented are cognitive errors that obstruct to conduct transformation and emerge from this crisis. Proposed are indispensable reforms (resulting in the Electricity Act) in which a big role will be played by sandboxes.

Keywords: energy industry transformation, electric monism, elektroprosumeryzm, prosument, Electricity Act

Electroprosumerism 2050

Transformation of power industry conducted with no aim, only as a response to current requirements and in the minimum possible range, is doomed to failure and to stranded costs resulting from necessity to pay off misguided investments, the guarantor of which is the State. Therefore it is extremely important to define the aim and then activities allowing to reach it right in the beginning of the transformation. Especially when we know that the time horizon to achieve climate neutrality is the year 2050 (end of transformation). The aim to be reached is the title electroprosumerism, defined in the further part of the summary.

The original concept having strong theoretical foundations (in thermodynamics and electromagnetism laws) is the **electrical monism**. It is the concept (theoretical) allowing to cover all energy needs (including heat and transport) with the help of electric energy but, at the same time, using only the minimum amount of it. This is possible, as the analysis – except the classical electric energy balance – takes into account the environment energy (e.g. heat pumps that make use of energy stored in soil, water and even in the air) but minimizes that one which can be obtained in the way of a low efficiency combustion process (e.g. in a petrol engine). The core determinant of the electrical monism are practical (estimated) coefficients of energy transformation into the useful energy in elektroprosumerism. These coefficients allow to estimate the profit resulting from covering all energy needs with the electric energy only. Application of electric energy for

¹⁾ Dostęp: ppte2050.pl/platforma/, portal CIRE.

²⁾ „Energetyka” 2020, nr 5, Biuletyn PPTE2050 nr 1/2020, s. 217-234.

apartment heating – always after a building passivization i.e. after reduction of energy demand to the target level of at least an energy-saving building (it means that annual energy demand does not exceed 40 kWh/m²) – allows saving 90% of energy, another 70% for DHW and also 70% for transport.

So, at the end of energy transformation there will not exist the model of energy industry as we know it now. After RES electrification there will emerge (will exist) electroprosumerism markets replacing the present electric energy market based on the KSE system with WEK energy industry, fossil fuels and gigantic investments supported by false assumptions concerning dynamically developing consumptionism and exponential energy demand growth. Further on, after electrification of heating industry with heat pumps preceded by building passivization and after transport electrification with the help of electric vehicles (or some other means of transport), our all present energy needs will be covered by electric energy from RES sources.

All present fossil fuel markets (hard coal and lignite, natural gas, oil, nuclear fuels) and numerous coexisting markets, like end-markets of electric energy and heat and transport fuels (in electrical monism of mechanical energy), **will be replaced by four electroprosumerism markets** which will be created by pretenders. These markets are as follows:

- 1) emerging market 1 of electric energy – real time market (RTM) – on low and medium voltage (LV-MV) network infrastructure,
- 2) non-network electroprosumerism devices market (passive house equipment including heat pumps, RES sources, electric cars, ...),
- 3) non-network electroprosumerism services market (thermo-modernisation of the third generation – offering utilisation of latest materials and systems like heat pumps or recuperation with the aim to reduce the annual energy demand to the level below 40 kWh/m², and also balancing, neighbourhood energy trading based on contracts concluded directly (e.g. with the use of *Blockchain* technology), and so on,
- 4) off-shore market for the needs of the north-south infrastructure and urban corridor encompassing the biggest towns, highways, railway trunk lines and industrial sites i.e. areas of high energy density.

The branch of national economy covering these markets is called here "**electroprosumerism**" (authorial name), which constitutes the aim to replace the whole fossil fuels energy industry in the 2050 horizon.

Present condition (2020) of the energy industry

The present critical situation in the Polish energy industry we owe to re-centralization that began in 2000 with establishing of PKE (the Southern Poland Energy Company) and which has been leading for the next 20 years to isolation of the Polish fossil fuels energy industry from global megatrends and to incapacity to join the accelerating global structural changes. As the result of negligence, lack of competence, responsibility and imagination, but first of all the lack of business and political ethics as well as making politics dependent on plans of the more and more unscrupulous interest groups, we must cope now with the present situation of energy companies being on the verge of

bankruptcy. But still they have plans concerning gigantic investments in the liquid fuels sector, starting up investments in the gas sector and far-reaching plans in heating industry. From the other side, they "forget" the fact that the coronavirus pandemic caused the drop in energy demand by 15% which was not accompanied by the drop in the import of electric energy that stayed on the level of 15% (though limited to a large extent by transmission capacities of cross-border connections), and that it was exactly the level of our electric energy export 20 years ago. **Coronavirus exposed the incapacity of the whole Polish energy industry** (not only the electric power one).

The reform of the energy industry began in 1990, but it was not the breakthrough one as there were no new players coming on the scene – here we think about pretenders: end-users, regional self-governments as well as the MMSP sector (micro, small and medium enterprises) with breakthrough technologies (they were simply not existing at that time). After 30 years from the 1989 state's system reform, another profound reform – conducted in the crisis mode – is needed: this time the indispensable reform of energy industry with the aim to close the gap between Poland and the rest of the world. The gap was created by blocking changes in energy industry that was all the time justified by "backwardness" manifesting itself in dominance of energy generation based on coal. There is no further possibility to protect energy industry against changes with the help of "own pace" strategy, announced in December 2019 by the Prime Minister in Brussels on the summit concerning Europe's climate neutrality in the 2050 horizon, but there is a need now to replace incumbent entities in the energy industry with pretenders.

But Poland cannot count on a pretender like Elon Musk and not because it does not possess talented and clever people but because the State's institutions, business infrastructure and social processes (including capital accumulation and credibility levels) do not enable these people to take any action. A bottom-up movement is necessary – not limited by inefficient decision systems and games of interests – conducted by pretenders i.e. these people who in the mode of breakthrough innovation and with the help of new (already available) solutions will build new energy markets.

The masked so far, in energy industry and in coal mining, and presently an open **structural crisis of the whole economy** – the one **disclosed** by the pandemic while the one **caused** by the pandemic is yet to come – results in the fact that in the whole energy industry (not only in the electric power one) there ended the time of childish and false slogans saying that the electrical energy and fossil fuels demand will keep growing, the climate changes are fictitious and that in the energy industry of the exponentially developing world there is a place for all options. In this case the decision-makers have in minds WEK energy industry using coal, nuclear fuels and gas, RES prosumer energy industry, gigantic investments in the liquid fuels sector, all the time developing investments in the gas sector as well as loud shouts for investments in the heating industry.

A myth is the responsibility of politicians for **energy security** just like the myth was the responsibility of politicians for health security and sufficiently good condition of healthcare. The State has not been prepared for the "bad weather" – the weakest individuals during such weather are left to themselves and "lower classes" are more responsible than the government (react more rationally to difficult challenges). If we – as the society – take

the responsibility for what we can by ourselves (and we can acquire competences that will uncover interest groups, make it able to indicate dangers and show solutions) then the – requiring competences – breakthrough mode energy transformation to electroprosumerism will become the collective responsibility. As a result, the **allocation of energy security** will take place.

Energy security, as we understand it today, is the ensuring of energy supply continuity realized entirely by WEK energy industry. Of course, in crisis situations the WEK has at its disposal many tools guaranteeing the enforcement of this security with the aid of obsolete procedures (e.g. in the form of an order to reduce energy consumption as the so-called power supply levels) from energy consumers. In electroprossumerism it is the prosumers, local government entities (JST) and the sector of micro, small and medium enterprises (MMSPs) who partially take over the responsibility (constricted to their needs) for adequacy of energy supply. It changes completely the way of electric energy market operation but in the existing legal frames is not possible to be realized. Therefore we need

- “intelligent” infrastructure operators i.e. network access terminals (network interfaces controlling prosumers’ resources and supporting local energy security, realisable with the help of e.g. power converters, including the solar inverters),
 - the platform of the electric energy market information operator (measurement-billing platform dedicated to local circumstances, significantly increasing the current billing possibilities by covering the products and services of the electroprossumerism markets),
 - SCADA (Supervisory Control And Data Acquisition) information systems used to control the system security from levels of clusters, energy cooperatives etc.
- operators that will change the current centrally managed energy industry into distributed electrical systems and will lead to **competition on the electric energy market** i.e. between the emerging market 1, created on the LV-MV infrastructure by pretenders, and the descending WEK market (including incumbent entities).

Critical cognitive errors (false views)

In the context of the present situation that pretenders must cope with, there are many **critical cognitive errors** functioning in the WEK energy industry conceptual area (and to the dominant extent in the WEK electric energy industry) and from which they draw their strength and contribute to blocking of transformation. They are, for instance, opinions expressed in good faith like this one saying that “heating based on electric current is the most expensive”. It was so, when the heating based on resistance heaters fed with electric energy produced in big, coal-fired power plants of efficiency not bigger than 10% (taking into account losses in coal deposits during mining, transport etc.) supplying the super complicated power system (in Poland – KSE system), with extremely complex 220/400 kV transmission lines and HV (110 kV) and MV/LV distribution networks, but it is completely different now. Today we have new technologies: PV sources on roofs and heat pumps of “efficiency” bigger than 300% (including ambient energy in the energy balance). Alas, there still exist many of such cognitive errors.

Seven critical errors (for the start) are as follows:

1. **Forecast error** – results from the presently used methods to prognose the electrical energy demand basing on advanced mathematical models and, at the same time, assuming the dynamic growth of consumerism. Such example can be the forecast – published at the beginning of 1970s by the Polish Academy of Sciences-Spatial Management Committee – saying that the KSE peak load in the year 2000 will equal 105 GW (reality of 2019 – 26 GW) and extraction of coal (hard and lignite) will reach the level of 510 mln tonnes (reality of 2019 – 120 mln tonnes).
2. **Customers number error** – results from the currently existing laws and allows the distribution system operators (OSD) treat every consumer as if he were physically supplied from the operator’s network. Let’s take for example the case of Ostrów Wielkopolski (72.000 inhabitants) where almost 30.000 consumers have signed contracts for electric energy delivery – mainly with the obligated supplier (Energa) but on the LV-MV network of the OSD operator there is no more supply terminals than 18.000 (mostly LV connections). This means that about 12.000 end-users living in multi-family buildings is supplied from buildings’ “networks” (i.e. internal electric installations of such buildings belonging to housing co-operatives, housing communities and municipal flats). There is no reason to maintain this situation. Especially when we take into account, that it has so far been “sanctified” only by bad legal regulations and the lack of end-users’ awareness that they pay twice for using the multi-family building inner installations (once in the rent for a flat and the second time in their energy bills). There is no doubt that the second fee is unjustified.
3. **RES sources inadequacy error** – RES sources are considered to be unstable and unable to meet the energy demand. At the same time for making analyses there are used models appropriate for the existing type of energy industry without taking into consideration the mechanisms of shaping the energy demand profiles (for instance with the help of RTMs).
4. **KSE network-system syndrome** – once again the reason of the error should be seen in the model dedicated for individual large-scale sources and the lack of local energy balancing. In this model, energy transmission needs gigantic expenditures on networks (mainly the transmission one).
5. **Average rating error** – results from this model of electric energy supply analysis in which costs are averaged and socialized (detached from real costs). A specific example is separation of energy tariffs from a market price. It creates the situation where e.g. the price for energy from a regulatory-balancing source equalling more than 500 PLN/MWh (biogas power plant) is considered unacceptable. And here completely ignored is the fact that this price, in the marginal costs model, concerns only a few percent of energy supply. At the same time the prices fluctuations on the TGE (Polish Power Exchange) can theoretically reach ± 50.000 PLN/MWh (practically they do not exceed 1500 PLN/MWh).
6. **LV-MV network inadequacy bipolar error** – every particular investment into RES sources imposes necessity of LV and MV networks development. In the electroprossumerism the building of local systems assumes the network sharing

and maximization of its use through sources tailored to local needs. And the analysis of competitiveness between network development and a source installation should be always obligatory, starting from today.

7. **Assessment of landscape environment impact and land demand error.** Natural environment is a poorly defined category. In turn, climate has been – as the category – over the last thirty years too one-sidedly reduced to the greenhouse effect resulting from emission of greenhouse gases and consisting in the global warming. One of the most glaring examples is the cognitive error based on the false view that natural gas is the fuel much more friendly for the climate than coal. In fact, the in-depth analysis shows that when we deal with gas transport over long distances (thousands of kilometres) along with unavoidable gas release to the atmosphere, the **CO₂ emission connected with electrical energy generation with the use of natural gas can be only a few per cent smaller than in the case of hard coal as the fuel.**

Even more drastic example is the nuclear power industry. It is promoted very often as emission-free but at the same time it creates the danger of major environmental disasters (even if it is very small, it is still real – *Czarnobyl* and *Fukushima* are facts). Moreover, generally omitted is the fact that the overall efficiency (from extraction, through processing, utilization and finally spent fuel storage) of nuclear energy is close to zero. Connected with it is a massive problem of a several hundred years threat (that has not yet been fully resolved) concerning spent fuel storage.

The next example is the **problem of low emission.** Burning of biomass (wood, energy crops), though omitted in CO₂ emission balances, is not in any case a solution in the segment of surface PM2,5 and PM10 particulate matter emitters.

Another example is the closed circle GOZ economy. As a matter of fact, **waste incineration (energy waste disposal) is not a solution**, either, even if particulate matter emission in case of large combustion plants (dust point source segment) is practically eliminated. This is because of both the lack in this case (high-calorific fuel from industrial and municipal wastes, solid municipal wastes like plastic packagings, paper, floor carpeting etc., sludge) of the effect of CO₂ circulation cyclicity and the economy. **The solution is unification of biogas technologies** (biodegradable wastes subject to CO₂ circulation cyclicity effect) **as well as development of new technologies** (multitechnologies e.g. C-GEN [invented name]) **concerning low-temperature mineralization of wastes not subject to CO₂ circulation cyclicity effect.**

Transformation of the Polish power industry

Transformation of power industry from the state A (present state in 2020) to the state B (electroprosumerism in 2050) is not possible without **pretenders** realizing this transformation in the breakthrough innovations mode (TETIP) during **three waves of electroprosumerism.** Innovations, that with the help of market mechanisms (microeconomic decisions) – not by energy policy imposed by the State from the macroeconomic level – will lead to electroprosumerism.

The first wave refers to prosumers who are not the pretenders. Motivation of a prosumer is not the creation of new markets – it is only the improvement of his own situation by e.g. building passivization, heat pump installation, purchase of an electric vehicle or installing of a PV source on the roof. A prosumer takes responsibility for results of his activities in favour of the green deal because he understands their rationality and the need to follow this way even if the government does not understand it. Potentially, all present-day electric energy consumers are the prosumers in the population segment of detached houses, housing co-operatives and housing communities (more than 12 mln end-users). Moreover, the prosumers are also local self-governments (1500 rural municipalities, 600 rur-urban municipalities, 400 towns including 35 with population of more than 100.000 inhabitants) executing their own tasks, and the entrepreneurs from the MSMEs – all within the framework of increasing their power independence.

The second wave are pretenders-innovators creating innovations for the open market so that a prosumer could implement them. These, of course, must be innovations serving TETIP transformation. The Polish pretenders-innovators may fight for building of electric energy emerging market 1 (RTM market), and here the entities of the biggest potential in this context are local self-governments. For the last 30 years of their existence the self-governments in Poland have practically taken over all tasks indispensable for local communities' functioning – from administration through education, in a great part the healthcare and road and heating infrastructure, the whole water supply and sewage systems (except water management) as well as the whole waste management. Therefore, as the self-governments have potential to create tens of thousands local energy communities (e.g. clusters) they are also able to create local electroprosumerism markets. Here we can find, too, the MSMEs sector entities which have relevant competences to create new appliances and services – competences allowing implementation of breakthrough innovations: both organizational and, first of all, technological. In Poland this is mainly the area of ICT i.e. information and communication technologies.

The third wave of electroprosumerism is the **collective pretender** i.e. the mass social process encompassing the whole power industry and initiated by the first two waves. And if the third wave emerges and the collective pretender shapes itself, it will not be possible to reduce the importance of electroprosumerism to technological and economic dimensions only. The society will discharge itself of cognitive errors occurring in the fossil fuels power industry and of rampant consumptionism in favour of the sustainable economy.

A separate issue is the fourth electroprosumerism market i.e. the **offshore market** (emerging market 2). This market has features of a breakthrough market but with one reservation – it is all the time susceptible to a very strong impact from incumbent entities, like for instance PSE as the OSP transmission operator or WEK energy groups existing not only in the area of electric energy industry (e.g. PKN Orlen). It should be stressed now that pretenders to the offshore market, originating from gas and oil sector, are in the North Sea and Baltic zone the rule rather than the exception. But differences between them lie in process stages in which they try to assume the role of pretenders. The ones which become pretenders in the pre-emptive strategy mode (e.g. Norwegian Equinor) are more reliable while the ones trying to play the part of a pretender in the stage of a serious crisis will be less believable.

Pretenders need a completely new legal act – *Electricity Act* (not the *Energy Law Act*) – that will focus on regulating by legal provisions the activities that are prohibited i.e completely different than in the existing *Energy Law Act* which in the basic scope concentrates on what should be done and concerns very specific issues. Such law blocks diffusion of innovations into the electric energy market and cannot be accepted any longer. Results for Poland have serious implications and our country begins to stand out from Europe and the rest of the world. There are still many more examples of bad management. Irrational are for instance the Polish regulations concerning the power market or the DSM/DSR systems (Demand Side Management/Demand Side Response) i.e. systems managing the reduction of electric energy consumption in response to the call from the transmission system operator (OSP). Europe is preparing itself intensively for implementing – with the beginning of the year 2021 – the competitive real time electricity market together with the new balancing market “brought” to the MV network level (with balancing sources of the lowest limit power value 1 MW) i.e. just like the one which is required by clusters.

Building of intelligent infrastructure must be connected with activities concerning creation of **sandboxes** (demonstrators of solutions, especially the legal ones). This concept will allow local energy areas (e.g. clusters) to adapt themselves to rapidly changing technological conditions. The group of entities that are interested in this issue, those whose innovation diffusion potential is blocked by the commonly binding legal regulations, can be relieved of these regulations in favour of the local ones for which they will be granted concession from the Sandbox Regulatory Authority (URS). This way several tens of the already existing certified clusters will become the driving force of power industry transformation.

Description of electroprossumerism with the aid of terms relevant for WEK energy industry leads to misunderstandings and critical cognitive errors which facilitate blocking of innovations. It is necessary to elaborate a new language and a conceptual compliance covering five areas: technology, economics, law, social science (sociology), natural environment and climate.

The key to understand the electroprossumerism is unification of the gigantic fossil fuels energy industry (WEK) including technical markets (frequency regulation market, balancing market, ...) with technical markets of electroprossumerism leading to a competition between local systems' own resources and WEK markets' offers. Here arises a need (for a start) of energy units unification (MWh, MJ, kcal, l, kg, m³, BTU, toe, tpu, ...) to one MWh unit relevant for electroprossumerism, as well as the unification of law, tested in sandboxes to become the electricity law obligatory for all entities on electroprossumerism markets (ensuring them the same rights) and unification of economics introducing marginal costs into energy markets (reducing socialisation of costs).

Heuristics of transformation in the breakthrough mode

(note from the author: verification of transformation based here on Prof. J. Popczyk own experience)

Achievement of electroprossumerism in 2050 is a challenge authenticated by heuristics (though still needing verification) concerning:

- 1) energy balances for the final state B(2050),
- 2) costs of electric driving energy in state B (compared with costs of three final energy markets in state A) and three final markets in state B for energy policy PEP2040 (project),
- 3) cumulated economic assessments (covering operation and investments) for the whole trajectory A→B(TETIP).

The starting point for the conducted **energy balances for final state B(2050)** are the real, though very approximated, balances in the year 2019 for the primary energy market (chemical one of hard coal, lignite, natural gas and oil) as well as the gross final markets (of electric energy, heat and transport fuels). Poland's energy balance equalled 1100 TWh in 2019 (chemical energy – primary) with an annual market of final energy equal 600 TWh but it can be replaced by 205 TWh of useful electric energy (in electrical monism) **reducing more than 80% of the Polish energy needs in relation to primary energy and more than 65% as regards WEK markets.**

Cost heuristics (in constant prices) of electroprossumerism after transformation A→B(TETIP) **equals** 40 billion PLN. The base for its creation was the electroprossumerism balance in state B(2050) i.e. the national RES sources generation mix and the annual gross electric driving energy equal 200 TWh as well as the prices (constant) of investment goods in accordance with their level in 2019 (so there still exists the potential to reduce them, also to reduce the whole cost of covering what is now called energy needs). For comparison, the values of the three final markets (electric energy, heat and transport fuels) i.e. their real value in 2019 and the estimated one in state B will amount – in both cases – 200 billion PLN. It means, that in electroprossumerism the cost of meeting the energy needs is five times lower than at present (2019) and also five times lower than the one proposed in the WEK 2050 model. This results in a surplus which can finance the energy industry transformation.

Cumulated surplus (calculated on the basis of the cost heuristic within the period of 30 years) equal to 2 trillion PLN allows financing required investment outlays on RES re-electrification in the amount of 750 bln PLN. Moreover, it allows financing the support (tax mechanisms are better than the direct support) of buildings' passivization (500 bln PLN), heating electrification (350 bln PLN), transport electrification (200 bln PLN) and the "fair" transformation in the whole WEK energy industry (200 bln PLN).

Conclusions

Prosumers, pretenders-innovators and the collective pretender must possess indispensable competences to efficiently build the electroprossumerism (in three waves/stages): of market innovations' consumers in case of prosumers, innovative competences in case of pretenders-innovators and social competences in case of the collective pretender.

And the key issue in the energy industry transformation is liberation from cognitive errors of fossil fuels energy industry. Only this, after achieving the electroprossumerism, can make a man free – able to be responsible for himself and the natural environment.