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# ELEKTROPROSUMERISM

## Transformation of energy industry in the breakthrough mode

### From emergency measures in 2020 to electroprosumerism in 2050

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# Transformation of energy industry in the breakthrough mode

## From emergency measures in 2020 to electroprosumerism in 2050

The subject matter of this article refers to energy industry transformation – from crisis measures in 2020 to the electroprosumerism in 2050. This transformation is particularly justified at the present stage when its reasons have been extremely strengthened by the pandemic crisis. A lot of attention has been paid to unification of inconsistent uniformity of the large-scale corporate energy industry description and the consistent variety of electroprosumerism. It is stated that for implementation of a large part of solutions/concepts it is quite enough to build one's own, individual competences, create own microinnovations and build the social capital. But the mainstream of the breakthrough transformation must be created by a collective pretender by means of exerting pressure on the State which is constitutionally obliged to balance citizens' liberties and the principle of subsidiarity.

**Keywords: energy industry, transformation, breakthrough mode, electroprosumerism**

### ENCYCLOPAEDIC DICTIONARY OF THEORY AS WELL AS THE OUTLINES OF A RISING MARKET 1 CONCEPT AT THE PRACTICE LEVEL

The elaboration is addressed to pretenders having enough potential to build the first three electroprosumerism markets but it is mainly focused on the electric energy rising market 1. The subject matter is particularly justified at the present stage (3rd quarter of 2020) when its three causes were extremely strengthened by the pandemic crisis.

- the first cause – the crisis situation in which the big part of the MSP sector has found itself
- the second one – it is the experience of local self-governments which must, during this pandemia, challenge the problem incomparably greater than it results from the compulsory principle of subsidiarity (i.e. the necessity to take over, in the crisis mode, a big part of real responsibility assigned to the Government)
- the third one – it is the multilayer change in situation of many people – at least that one, which causes transferring onto them the electric energy demand in the part related to remotely performed work.

These three causes treated as one create a unique, collective (three-segmented) pretender to the first three electroprosumerism markets which must shoulder that role under compulsion, but to whom the history brings at the same time the historic chance to benefit from it (from that role).

**Collective pretender means, by its very nature, conversion of physical pretenders into a social process. And, if we want the pretender to act effectively in this form, urgently needed is a critical conceptual electroprosumerism area for the needs of a collective – in the form of a social process – pretender to the first three electroprosumer markets.**

It must be a minium but also a sufficient area, meeting the criterion of the Ockham's razor.

It must be a coherent area guaranteeing social efficiency of the process.

It must be the area "handling" (which is very important in the practical aspect) the whole transformation trajectory: from the initial state A (in 2020) i.e. the present power industry based on fossil fuels, to its final state B (in 2050) that is to the electroprosumerism in its mature form.

The collective pretender in the form of a social process means, in particular, necessity to make the breakthrough – from the point of view of energy transformation – innovation more precise (extension of its description). That is to say, in this context the definition narrowing the breakthrough innovation only to pretenders of Elon Musk class and others alike is no longer sufficient. Elon Musk and others were indispensable to initiate the energy transformation, but to maintain the process dynamics there are needed millions anonymous prosumers forming together one collective pretender to electroprosumerism markets.

Thus the key importance of the conceptual area simplicity needed for description of electroprosumerism; terms creating this area must be understood by pretenders of the microeconomic level and, at the same time, ensure macroeconomic efficiency of a collective pretender (social process) i.e. also the adquate (and only like that) range/extent of the subsidiarity principle at the level of the state and higher.

**Commentary 1**

It is impossible here to avoid the reference to the sequence of what Thomas Carlyle (philosopher of history) and shortly afterwards Herbert Spencer (sociologist) said in the middle of the XIX century. According to Carlyle, the history is created by (eminent) individuals. In his reply Spencer stated that the history is processes. The answer to the question concerning pretenders to markets on transformation trajectory from initial state A (markets of WEK energy industry) to the final state B (electroprosumerism markets) is surprisingly similar. These two answers deserve – apart from the excessive faith of both Carlyle and Spencer into dynamics of historical changes „always forward to the better" – a serious analysis of energy transformation in the mode of breakthrough innovation in the ongoing process of civilisation changes.

Amazingly substantial is for instance the comparative analysis of Spencer's hypotheses combining progress with the growing complexity of processes (social and lower levels, especially biological ones) – from one side, and hypotheses concerning complexity (even such ones like distribution including the growth of the number of active entities and technological distribution, growth of processes' dynamics, exponential rise of very different types of interactions) in the area of energy transformation – from the other.

And though one should be very critical about Spencer's hypotheses, there is one of them that says „... the matter transforms from the state of undetermined, inconsistent uniformity into the state of determined, consistent variety ..." and it is extremely interesting in the light of conducting the research trying to answer the question what the complexity – (physically/naturally true, legally decreed, also coded in the public space in the form of cognitive errors) of the KSE system as well as the whole WEK power industry and its markets – is, in the context of macroeconomic electroprosumerism simplicity (conceptual) and its microeconomic diversity (complexity).

From the point of view of the latter i.e. the consistent variety of electroprosumerism we should do a serious research on the role of artificial intelligence on the rising RCR1 market of electrical energy and which (the role) is still to be shaped, but this issue is not addressed in this elaboration. Still, it cannot be stalled *ad infinitum*. Practically, it must be addressed right away both in the context of cognitive errors and empiric sociological studies; after all, poorly designed empirical sociological research can perpetuate cognitive errors. Poorly designed solutions concerning the electric energy rising market 1 might render the artificial intelligence to perpetuate them (bad solutions) i.e. it will be the source of new cognitive errors (different, but still errors).

## Encyclopaedic dictionary of theory

The dictionary consolidates (the most basic) terms from the energy industry transformation conceptual area in the mode of the breakthrough innovation needed for the initiation of description of the rising market 1 concept on the practice level. Moreover, the dictionary is burdened on the present level with all consequences of the fact of its "suspension" between the Ist part of this elaboration and all PPTE2050 platform resources, and further on – consequences of very strict time frames in which it had to be edited. The most important effect is the omission (for the time being) of those parts of the presented definitions which were already placed either in the first part of this elaboration or in the PPTE2050 platform resources. At the same time that fact is signalized only with the help of very abbreviated explanations, though in three cases (items **3**,**6** and **7**) a significant use of the platform resoureces is made (it is also emphasized that consolidating redaction of the dictionary to its mature form is still a task to do).

The applied solution (temporary) enabled the author to focus on what is the most important for urgent practical activities of a collective pretender. These are as follows: unification of inconsistent (deeply critical, transforming already into the descending one in the way of a process) "uniformity" (silo type of the whole WEK energy industry) into a real consistent (evolving, rising) heterogeneity (of electroprosumerism). Subsequently a basic definiton is here introduced into the encyclopaedic dictionary of theory according to which the title (elaboration title) power transformation in the breakthrough mode is the:

**inconsistent consistency transformation**
(of WEK fossil fuels energy industry, sectoral)
**into consistent variety**
(of RES electroprosumerism, realised by pretenders)

This definition lays the foundation for seven headwords presented in the further part of this elaboration – in its theory part. It is the minimum set of headwords enabling passing in the next step to the catalogue of issues with basic solutions/concepts expressed for pretenders in an already new language. However, it is clear that finally it is the pretenders (natural persons, legal entities) making use of the collective pretender entitlement – acting outside WEK energy industry area (next to it) and having at disposal the catalogue of practical solutions/concepts but first of all making use of their own experience – who will implement these solutions/concepts according to circumstances.

But for implementation of not a small part of solutions/concepts it is quite sufficient to develope one's own (individual) competences, create own microinnovations, build social capital. However, the main stream of the breakthrough transformation must be created by the collective pretender by putting the pressure on the State that is constitutionally obliged to balance citizens' liberties and the principle of subsidiarity.

**Commentary 2**

If the pretenders to the four electroprosumerism markets stayed in the WEK conceptual area, so, when declaring building of these markets with the help of the State's innovation financing system (subsidies for start-ups) in coexistence with incumbent entities, they would be indistinguishable from democracy supporters proposing building of this democracy, at the stage of socialism disintegration (before 1989 political system transformation), in coexistence with the socialist State by improvement of this socialism (to the form of the democratic one) – the same State that would fairly allocate the money (of unknown origin) between "pretenders" whom it "picked out".

## 1. Cognitive errors of energy industry

With no reduction of cognitive errors in the whole social area it is not possible to stimulate the microeconomic pretenders. Deeper reflection on this matter and replacement of views functioning in the public space with simple research as well as building of foundations of electroprosumerism critical conceptual area leads to a surprising conclusion. And on this conclusion focuses the first headword of the presented dictionary. However, broader aspects of this headword will not be introduced into it, especially the ones from the former, but still present (though not yet in the structured framework) platform PPTE2050 resources.

**1.1.** Seven critical errors:

1° – forecast error
2° – customers number error
3° – RES sources inadequacy error
4° – KSE network and system syndrome
5° – average rating error
6° – LV-MV network inadequacy bipolar error
7° – assessment of landscape environment impact and land demand error

Seven critical errors blocking energy industry transformation "owe" its strength to the fact that they function in the WEK energy industry – and in the prevailing degree in the WEK electric energy industry – conceptual area. The essence of the first error, the key one in the context of energy industry transformation in the breakthrough mode is shown in p.**1.2**. In turn, the seventh error is raised within the wider problem of environmental protection in p. **5.5**.

**1.2.** Examples of prognoses concerning the KSE electricity peak power demand and further on coal (hard and lignite) and crude oil, announced at the beginning of 1970s and complemented by a prognose concernig natural gas (announced at the beginning of 1990s), are presented in **Tab.1**. The first ones were announced by Polska Akademia Nauk – Komitet Przestrzennego Zagospodarowania Kraju and these were prognoses for the year 2000. The gas prognosis was announced for the year 2010 and it was the government one. It is emphasized that prognoses dating (development time of each one of them and the validity horizon) as well as the authorship are very important for uncovering what the prognosis cognitive error is in the energy industry.

So, one of the fundamental issues in the context of prognosing process applied in the past was (and still is) prognosing the demand for energy/fuels having its origin in gigantic investment interests of energy industry (prognoses were just like the interests and that is why they in general escaped measures of economic rationality criteria but they had powerful support in the form of political and corporate propaganda of energy safety). From this point of view it is important that somebody who wants successfully be involved in energy transformation in the breakthrough mode will not begin the education, like it is now, from acquiring prognoses of "dynamic" demand growth for fossil fuels and especially for electrical energy. And it must be pointed out that it is not easy. This is because the "seductive" thing in these prognoses is that they usually have methodological background in advanced mathematical models like extrapolation of energy/fuels demand with the use of regression models as well as the input-outpt models used in the centrally planned economy. Mental deadly danger connected with such kind of prognosing, being a trap for everyboy who wants to use them in the energy industry breakthrough transformation, results from the methodical contradiction founded on an assumption that the basis of the energy industry breakthrough transformation are new technologies (factory, small-scale, intelligent – enabling replacement of economies of scale effect with the network effect), prosumers, pretenders-innovators, market competition, social capital, and not centralism and planning.

And just in breaking through the dramatic disparity between prognoses and reality, like the ones shown in **Tab.1**, we seek the main chance for rationalisation of energy industry transformation in the 2050 horizon (i.e. in the horizon which, during the last few years, has settled in the global dimension as the standard in transformational analyses). Electroprosumerism breaks through this disparity because it ignores the old forecasting.

**1.3.** It is really surprising that the strength of cognitive errors of the present WEK energy industry extremely decreases in the electroprosumerism conceptual area due to its microeconomic orientation. Of course, one must remember (in this case it is important) that cognitive errors are the errors of false consciousness (P.Ruszkowski). Efficiency of their reduction in the electroprosumerism conceptual area does not come out of the blue, but...

**Table 1**

Examples of two energy forecasts for Poland, developed at the beginning of the 1970s and 1990s – comparison with reality

| Specification | Forecasts for 2000 | Reality of 2019 |
|---|---|---|
| Electric capacity demand, GW | 105 | 26 |
| Hard coal mining , Mt | 270 | 70 |
| Hard coal consumption, Mt | 240 | 70 |
| Lignite mining/consumption, Mt | 120 | 65 |
| Oil import, Mt | 90 | 25 |
| Natural gas consumption, bln $m^3$ | PAN study does not contain forecasts for natural gas. According to the government forecasts from 1990s the demand for this fuel was to be in the year 2000 equal to aprox. 27 bln $m^3$, and in 2010 about 40 bln $m^3$ (high option of economy development). Reality of 2019 in the range of gas consumption for energy generation purposes – a little more than 10 bln $m^3$. | |

**1.4.** ...it flows directly from the adequacy of this area to a collective pretender needs. From the other side, it results from the compatibility of the electroprosumerism conceptual area with paradigms of electrical monism. It is a very important contribution confirming the need of unification of the whole WEK energy industry inconsistent uniformity with the consistent variety of electroprosumerism.

## 2. Three paradigms: prosumer, exergetic and virtualization

At this point, paradigms are treated as the basis for unification – about which we tell in **1.4.** – in the range concerning the energy industry cognitive errors. It must be stressed, however, that the problem of electroprosumerism unification with paradigms of electrical monism goes far beyond these errors. It covers practically the whole energy industry transformation in the breakthrough mode (TETIP) and discloses itself, for instance, in all conceptual area segments to which the points **2 - 7** relate.

**2.1.** Particular significance of **prosumer** paradigm reveals in economy as well as legal segments and resultatively in the most general social segment. Hence, it is the most important paradigm in the context of research (modeling) of the whole A→B transformation trajectory.

**2.2.** In turn, particular significance of **exergetic** paradigm reveals in technical (balance) and also economy segments. First of all it is the basis to build – in the intial state A – the heuristic of the elctroprosumerism practical potential (!), in the state B and overe the whole transformation trajectory A→B (heuristics are generally the estimations which – though they are not perfect as they were made in conditions of high uncertainty – give reliable results thanks to compensation of uncertainty with experience, intuition and imagination of researchers making these estimations). Regarding the exceptional theoretical importance of the paradigm in electrical monism, a special place is devoted to it in sec. **3**.

**2.3.** Finally, particular significance of **virtualization** paradigm reveals mostly in the technical segment (within the area of the whole intelligent infrastructure, but first of all in the concept of distribution networks LV-MV-110 kV sharing) and, to a lesser extent, resultatively, in such segments like economy and legal and social ones.

## 3. Scaling of electrical monism

In scaling of electrical monism described in various aspects in PPTE2050 platform resources, exposed is here the aspect of interconnecting the microeconomic and macroeconomic scaling over the whole A→B transformation trajectory and this is because the interconnection gives a better picture of each individual paradigm functioning.

**3.1.** Exergetic paradigm has the greatest strength in microeconomic scaling. In macroeconomic scaling it is the prosument paradigm which is of utmost importance but only at the level of a collective pretender i.e. of a social process, sec. **4**. It follows that exergetic paradigm allows creation of a very good heuristic of electrical monism potential by application of the transformation initial state A (inductive method) for this purpose. Saying in other words it allows to rescale the real energy balance of state A into a hypothetical for this state balance of electrical monism and, at the same time, its (electrical monism) "real" potential (!). On the other hand, the trajectory A→B is shaped by the whole paradigmatic triplet and, over all, the prosumer one. So, the quality of balance heuristic for RES driving electric energy (the only one in final state B) and the quality of economy trajectory heuristics depends on the whole triplet (deductive approach).

**3.2.** From the paradigm triplet of energy industry transformation emerge directly the frames of establishing practical solutions on the electric energy market which is the main driving factor shaping the energy industry transformation trajectory A→B. It is stressed in this context, that the energy industry transformation (evolutionary, being performed under the influence of market forces) is not a mechanical reproduction of a program comprised in initial conditions (state A). Instead of it, it is the creative process where there is a place for creation but with the help of market mechanisms (microeconomic decisions) and not the energy policy imposed from the macroeconomic level by the State which, after all, has already lost its competences needed for this purpose (it is the phenomenon which still affects many countries in the world, but the Polish State in particular).

**3.3.** States A and B in the energy industry transformation, ruled by the three paradigms, cannot be directly treated in categories of the thermodynamic state equation which is the description of this state, making use of three thermal parameters: pressure, temperature and specific volume (of course, only two of them are independent); while the cardinal feature of this state equation is that it is not sensitive to the trajectory of a system transition from one state into the other. From the other side it is useful to seek inspiration in functioning of the state equation for the needs of shaping the energy industry transformation trajectory between states A and B.

**3.4.** That is to say, the state B (full RES electrification, electrical monism) is in the present technological, economy and social reality too remote to conclude that independently on the trajectory it will finally be reached. Tabulation of practical factors of energy industry transformation to electrical monism in the very first attempt (needing still a very stringent verification) is very simple (**Tab. 2**).

**3.5.** Central category of electrical monism is the usable energy $E_{uż}$. It is the energy necessary to meet all prosumers' energy needs and is equal the net electric driving energy (equal the gross energy generated in RES sources decreased by losses in the infrastructure between these sources and receivers) and increased by external exergies (air, water, soil) of heat

**Table 2**

Practical (estimated) coefficients of power industry transformation to electrical monism

| Energy market | | Driving factor | „Binding" unit | Estimation | |
|---|---|---|---|---|---|
| | | | | equation | numerical |
| Electrical energy | | population, economy | kWh (per capita, GDP) | (-) | 1 |
| Heat | heating, district heat | population, housing | kWh/m² | $\frac{E_{PH}}{E_g} \cdot \frac{1}{COP}$ | $\frac{1}{3} \cdot \frac{1}{3} = 0{,}1$ |
| | domestic hot water | population | kWh/percapita | $\frac{1}{COP}$ | $\frac{1}{3} = 0{,}3$ |
| Transport | | population, transport | kWh/veh. | $\frac{\eta_s}{\eta_{EV}}$ | $\frac{0{,}2}{0{,}6} = 0{,}3$ |

sources (heat pumps). With the aim to link the usable energy $E_{uż}$ (expressed in denominate units, practically in kWh and multiple units) with coefficients in **Tab. 2**, it is useful – for modeling transformation trajectory of energy balances – to introduce the standardising of relative (superscript *) usable energy with the help of the energy balance structure coefficient of the final energy $E_k$, appropriate to specific cases (e.g. one family house, the whole country, the world) in state A:

$$w = \sum_{i=1}^{4} w_i = 1, \tag{1}$$

where:

$w_1 = w_{el}$ – relative share of electric energy in the balance

$w_2 = w_{CG}$ – relative share of district heat in the balance

$w_3 = w_{CWU}$ – relative share of district heat used to produce utility hot water

$w_4 = w_t$ – relative share of transport fuels chemical energy

Using coefficients (1) and the ones given in **Tab. 2** we can express the usable energy in state B, equivalent to the final (standardised) energy in state A, with the formula

$$E_{uż}^{B*} = E_k^{A*}\left(w_{el} + w_{CG} \cdot \frac{E_{PH}}{E_g} \cdot \frac{1}{COP} + w_{CWU} \cdot \frac{1}{COP} + w_t \cdot \frac{\eta_S}{\eta_{EV}}\right). \tag{2}$$

This equation is not dependent on time i.e. on the transformation trajectory. It depends only on states – initial A (pretransformational) and final B (posttransformational). In other words this equation is a kind of equation of state. In practical issues it is convenient to assume that in the state A the energy $E_k^{A*}$=1 (it is a very natural methodological approach). Then the structure "*w*", formula (2), becomes the conjugate driving variable (the usable energy $E_{uż}^{B*}$ in state B depends only on this structure).

## 4. Mode of breakthrough innovation in energy industry transformation

Collective pretender in the form of social process implies necessity to redefine the breakthrough innovation for the needs of energy transformation realized in the mode of breakthrough innovation (TETIP) in three aspects:

**4.1.** Breakthrough innovation (as generally understood) is the innovation that breaks the development course of some particular industry (sector, now the corporation), as distinct from the incremental innovation that guarantees development continuation (especially technological). In case of breakthrough innovation it is also the issue of changes by which the pretenders will transform big markets – being in possession of very strong incumbent entities applying incremental innovations (imitative) – into completely new markets (with breakthrough technological innovations, new economics and new business models).

**4.2.** In case of TETIP transformation i.e. transformation to electroprosumerism, the term of breakthrough innovation still more radicalizes because it includes an impersonal collective pretender i.e. a social process. Such pretender generates demand for a new language, but it itself also creates its own conceptual area. The terms in this area must be understandable and efficiently used by pretenders of the microeconomic level. At the same time, these concepts must provide the collective pretender its macroeconomic efficiency (i.e. efficiency of the social process).

**4.3.** In the whole conceptual area of TETIP transformation the status of the breakthrough innovation is given to both prosumer energy sector and the electroprosumerism, as both of them alter the hitherto permanent order, shaped on big power markets during their so far existing historical process of development. The prosumer energy sector is entitled to the breakthrough innovation status particularly with regards to the past time and will still be entitled to it in the initial stage of TETIP transformation when microeconomic approach to this transformation will be decisive. But electroprosumerism is entitled to the breakthrough innovation status in a fundamental way (in micro- and macroeconomic approach, over the whole A→B transformation trajectory).

**4.4.** Reversal of the market order is essential from the point of view of distinction between incremental and breakthrough innovations. The incremental one ensures improvement of products/services but does not change the big market organisation and in particular it does not alter the client's (in energy power industry – consumer) behavior. Breakthrough innovation changes organisation of the big market and radically transforms the way

in which the entities behave there. In case of energy markets it is, in the initial stage, subjective transformation of a client into a prosumer and in the mature stage it is the transformation of numerous markets – in the area of fossil fuels – into four electroprosumerism markets. It is stressed that breakthrough innovations could be – even after a long time – not accepted by clients (those to whom they are addressed). That is why in the prosumer energy industry the most important thing now is to start, as quick as possible, matching of the market (business models) to new technologies. For instance, nowadays it is important to abandon matching RES (a very potentially significant part of prosumer energy industry) to "the main" (big, sector) energy markets and to start adjusting the prosumer energy market to the needs of RES (generally speaking, we should make efforts to change prosumers' preferences). But, at the time being, we have practically no chance to shape different – from the presently used – capabilities of the corporate energy companies, highly specialised and dependent on their historical practices in the range of applying traditional technologies on traditional energy (fuel) markets.

## 5. Unification of (WEK)fossil fuels energy industry to electroprosumerism

It is the unification which is the key to practical energy industry transformation meeting its requirements concerning rationality in a broad sense. And, if we want this unification to lead us to the conceptual area of this what is called here the "consistent variety", it must comprise five areas: **technology, economy**, **legislation**, **social sciences (sociology)**, and **natural environment** with **climate**.

**5.1.** In the **technology** area it is – first of all – the unification of gigantic WEK energy industry systems (of every individual fossil fuel) – mining, transportation, generation (processing) and transmission/distribution (networks) together with market infrastructure of every individual fossil fuels sectors and three energy end-markets (of electrical energy, heat and transport fuels) – always of national scale, often continental and sub-continental, and also of the global scale – to the factory-made (mass-produced in factories) microeconomic prosumer infrastructure and generally infrastructure of electroprosumerism (i.e. for the needs of two non-network electroprosumerism markets, that is the equipment and services of the electric energy rising market 1); smaller scale of the factory effect refers to the rising electrical energy market 2 (offshore) but it is also incomparably bigger than in the case of WEK energy industry.

Secondly, the absolutly critical area in technical unification in the electrical energy sector is the unfication of systemic technical markets: frequency regulation market, balancing market and, generally, technical market functioning for the needs of the electrical energy system itself as well as the entirely passive systems of electrical energy use by end-customers from one side and completely different methods of supply and demand balancing on the electrical energy rising market 1, not saying about different active methods applied by the prosumers to use and manage the electric energy balances.

In this context we must emphasize an unnoticed so far in Poland very important aspect. It consists in the fact that the technical unification on a system level (KSE in Poland, UCPTE in Europe) is realized with extremely strong individual resistance from the side of national systems' operators. At the same time the unification of electroprosumerism markets in the area of the single European market is realized very evenly under the influence of prosumers themselves not only on the electrical energy rising markets 1 (real-time markets RCR) but also on rising markets 2 (offshore, with PPA contracts). But, at the present stage, above all under the influence of a high dynamics of pretenders' striving for the market of non-network equipment and services (entrepreneurs).

Thirdly, we must here turn our attention to the need of such fundamental unification like unification of energy units with which we can describe WEK fossil fuels power industry and the electroprosumerism (it is the last example that is signalised in this work, though their list is still very long). But even the EU itself, having on its flag climate neutrality in 2050, is still very far – in the area of energy units – from urgent breaking the unification barrier (to the electroprosumerism conceptual area). This is clearly seen on a basis of the EU documents concerning the (fundamental) 2030 programme framework of energy transformation. And so, the "uniformed" unit in all final energy balances (of electrical energy, heat, transport fuels) as well as in balances of fuels (hard coal, lignite, oil, natural and shale gas and others) is one ton of oil equivalent (toe, TOE) and not MWh (and its multiples). So we can imagine how long is still the distance to go (and how essential it is to cover it) to achieve the unification of sector measurement units systems (MWh, MJ, kcal, l, kg, $m^3$, BTU, toe, tpu, ...) to MWh (and its multiples and submultiples).

**5.2.** The importance and, at the same time, the difficulty of **econonomic** unification results from the fact that the WEK electrical energy industry (the most important now in the whole WEK energy industry) was ignored as the object of serious research interest from the side of economists and, like it or not, it were power engineers who dealt with economy of this sector. The barrier in economic research was, for economists, the natural monopoly (network, technical) of electrical power industry; for decades it could not be changed by any technological incremental innovations (regulatory monopoly, backed up by interest groups i.e. incumbent entities, was able to block the competition which potential was created by technological incremental innovations). Rising electrical energy markets, RCR 1 market in particular, have potential that cannot be blocked any more. But there is still a chance for rationalization of TETIP transformation (sec. **6**) and reduction of its (process, collective pretender) social costs. Benefitting from this chance needs unification (on electric energy markets: two rising and the descending one) of the whole set of economic categories.

The most important areas of this unification are:

1° – unification of micro- and macroeconomy; significancy of this unification goes far beyond the range of TETIP transformation,

2° – unification of short-term marginal costs (RCR) and long-term (investment) ones; the most difficult theoretical problem of this unification is connected with a proof

(hypothesis) that the optimum transformation should guarantee equality of short-term marginal costs and the long-term ones over the whole transformation trajectory,

3° – unification on the electrical energy market; it is the unification in the whole area of this market, comprising also the PPA market, technical markets' pricings, price systems DSM/DSR and price elasticity of the demand for electrical energy.

**5.3. Legal** unification of governance and subsidiarity is also of crucial significance. In concrete terms in case of the TETIP transformation we must talk about unification starting from the *Energy Law Act*, through → sandboxes → principle TPA+, to → *Electricity Act* (after technical and economic unification and taking into account the sociological unification).

**5.4.** The most general **sociological** unification is the unification of six categories which are:

1° – sectors in WEK fossil fuels power industry,
2° – consumers (customers, clients) in WEK energy industry
3° – prosumers in the prosumer energy industry coexisting with WEK energy industry (over the whole practical TETIP transformation trajectory),
4° – pretenders in the initial stage of TETIP transformation,
5° – electroprosumers in the mature stage of electroprosumerism, and
6° – electroprosumerism market participants.

In every one of these six areas there are characteristic internal unification processes. But the most significant, going beyond the energy industry transformation, is the unification of physical pretenders' description with the description of a collective pretender.

**5.5. Natural environment** is a poorly defined category. In turn, **climate** as a category during the last thirty years has been reduced to the greenhouse effect (having its cause in greenhouse gases emission) consisting in global warming. This situation both facilitates and impedes unification of (WEK)fossil fuel energy industry to electroprosumerism in the context of natural environment and climate. There are quite a few examples of difficulties connected with it but now they are completely unnoticed.

*One of the most vivid examples* is the cognitive error based on a false belief that the natural gas is much more friendly for the climate than coal. But the full exergy analysis (W.Stanek) shows that when we deal with gas transport over long distances (thousands of kilometres) along with unavoidable gas release to the atmosphere, the $CO_2$ 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.

*The second example*, even more drastic, of the need for fossil fuels unification in the context of environment protection and global warming, 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 low, it is still real – *Czarnobyl* and *Fukushima* are facts). Moreover, generally omitted is the fact that nuclear energy exergy 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 the spent fuel storage.

*The third* example is a problem of low emission. Burning of biomass (wood, energy crops), though omitted in $CO_2$ emission balances, is not in any case a solution in the segment of surface PM2,5 and PM10 particulate matter emitters.

*The fourth* example is the closed circle economy GOZ. 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 (PRE-RDF, RDF, MSW wastes, sludge) of the effect of $CO_2$ circulation cyclicality and the economy. The solution is unification of biogas technologies (biodegradable wastes subject to $CO_2$ circulation cyclicality effect) as well as development of new technologies (multitechnologies e.g. C-GEN invented name) concerning low-temperature mineralization of wastes not subject to $CO_2$ circulation cyclicality effect.

In this case, some feature of exergetic paradygm reveals itself in a special way. It is the same feature that occurs in thermal processes ruled by principles of macroscopic thermodynamics. And this feature tells us that the barrier for reduction of thermal processes imperfection is the lack of adequate, market technologies and that only development of such technologies opens the way to reduction of thermal processes imperfection with the help of thermodynamics principles (J.Szargut). And here the following association appears persistently: just like the innovative technologies enable reduction of thermal and combustion processes imperfection, in the same way the innovative competences allow reduction of imperfection of WEK fossil fuels energy industry and electroprosumerism unification processes.

*The fifth* example (quoted here as the last one though their list is much longer) is landscape conservation and protection of the surface of a set aside (partially or totally) land. In this range, the fundamental need for unification of natural resources protection is still unnoticed in Poland – of these resources which are being engulfed by WEK fossil fuels energy industry and those needed by electroprosumerism.

The comparison below takes into account the resources for only one sector – electrical energy industry – and only in the aspect of EHV (220 and 400 kV, total length 14.000 km) transmission networks and 110 kV distribution networks (total length 35.000 km) as well as for electroprosumerism (as the whole) in the aspect of wind energy (the share of onshore and offshore windfarms in the whole electroprosumerism balance is 30% and 20%, respectively). Then, the number of cross arms in EHV and 110 kV networks equals 40.000 and 150.000, respectively. The number of onshore and offshore turbines is equal to 2.000 and 400, respectively. It must be emphasized here that the system of simplifications adopted to conduct the comparison is extremely disadvantageous for electroprosumerism.

But the main problem consists in something else than only in the disadvantageous system of simplifications, weakening the power of that extremely meaningful comparison. And so, in this comparison you cannot find any natural resources for which the demand is created by sectoral power infrastructures except the electrical energy industry (and they are still only marginally subject to the external costs account).

The most important ones are as follows:

- mining infrastructure of crude oil and gas (in Poland of nitrogen-rich gas and natural and shale gas in the world);
- transport and transmission infrastucture of crude oil (maritime transport: fleets of tankers, handling ports), rail transport, raw material pipelines;
- infrastructure of the oil sector in that part that begins in refineries (petrochemical plants), dedicated to transport fuels; these are (except refineries): transmission infrastructure (product pipelines), fuel storages, distribution infrastructure (road transport) and sales infrastructure (filling stations network);
- infrastructure of natural gas sector (considerably less complicated than the oil one but also not simple, particulary after the LNG gas and its export-import terminals entered the game);
- infrastructure of the heating sector (in Poland with its biggest in Europe and the whole world heating networks in Warsaw, Łódź, Cracov, Wrocław, Tri-city agglomeration, et al.).

The signalized problem of natural resources protection unification shows how bad is the competence and ethical condition of Polish politicians who enacted the Windmill Law introducing the condition of admissibility, concerning constructing of onshore wind farms in Poland in the formula of 10H criterion.

## 6. TETiP heuristics (energy industry transformation in the breakthrough innovation mode)

Building of a canon set of TETIP transformation heuristics is a very urgent matter though completely open at the same time. In the PPTE2050 platform resources, four heuristics for our country have been available as of yet (they constitute a starting point for further in-depth research – in any event, such status was given to them in this elaboration). These are heuristics concerning:

1° – energy balances for final state B (2050),
2° – electric driving energy costs in state B (including their comparison with costs of three final energy markets in state A) and three final markets in state B for energy industry policy PEP2040 (project),
3° – cumulated economic estimates (comprising operation and investments) for the whole trajectory A→B(TETIP),
4° – balancing of fiscal mechanisms and support schemes on A→B(TETIP) trajectory.

**6.1.** Available in initial state (A) balance heuristic of final state (B) is presented for Poland in **Tab. 3**. The starting point for the conducted estimates are the real – though very approximate – retrospective balances up to the year 2019 for the market of primary energy (chemical of hard coal, lignite, natural gas and crude oil) as well as for the gross final markets (of electrical energy, heat and transport fuels). Eligible is the hypothesis that, especially when taking into account the corona pandemic consequences, 2019 global maxima (in the mathematical meaning) on oil-derived fuels market (particularly on the markets of light and heavy diesel oils and the heating ones) and gas markets (of high-methane and nitrogen-rich natural gas and the liquid one) mean that all fossil fuels markets entered in Poland the permanent, very dynamic declining phase (they will never be bigger). That, in turn, means that primary energy (of fossil fuels) being equal in 2019 about 1100 TWh (**Tab. 3**) could be roughly divided into: hard coal – 450 TWh, lignite – 200 TWh, crude oil – 300 TWh, natural gas (including the liquid one) – 150 TWh and will be subject – on trajectory A→B(TETIP) – to a theoretical feature which is important from the practical point of view. And so, it will be a slightly concave (downwards) trajectory similar to a straightline one (declining). This is because slightly convex (upwards) oil and gas trajectories will "add" themselves to the dominant coal trajectory concaved downwards. This concavity of coal trajectory is the consequence of the fact that its maximum occurred in the year 1980, i.e. 40 years ago. At that time the hard coal production ensured chemical energy (primary) for the domestic market on the level of approx. 1.100 TWh (i.e. equal the whole primary energy in 2019), whereby the total hard coal production in 1980 reached the level of 193 mln tons, export amounted 30 mln tons while ensuring primary energy from hard coal in 2019 needed the import of 18 mln tons.

**Table 3**

ENERGY BALANCE OF POLAND – 2019
(coal, oil and gas energy industry)

chemical energy – 1.100 TWh
final energy – 600 TWh

↓

meeting demand for energy services in RES 2050
electroprosumerism environment

(electrical) driving energy RES (gross/net) – 200/175 TWh
useful energy – 205 TWh

↑

| mix after RES re-electrification | | |
|---|---|---|
| | energy, % | capacity, GW |
| GOZ | 5 | 1,2 |
| μEB | 5 | 1,2 |
| EB | 10 | 2,5 |
| EWL | 30 | 16 |
| PV | 30 | 60 |
| EWM | 20 | 8 |

↑

potential of electrical energy market reduction
130 TWh → 95 TWh

thermal potential of housing construction passivization
160 $TWh_c$ → 30 $TWh_c$

potential of heating sector electrification
(30+30) $TWh_c$ → 20 TWh

transport electrification
200 $TWh_{ch}$ → 60 TWh

**6.2.** In case of final markets the subject matter is more complicated. The total gross final energy market has been, for the last forty years, a very stable market of a very gentle upward trend (total rise did not exceed several per cent). However,

it was the market whose structure has changed very much. First of all, there occurred a multiplication of the transport fuels market (not less than 5x). Going further on we observed a very strong reduction of the heat market – despite the dynamic development of housing sector – resulting first of all from improvement of district heating energy efficiency and also the reduction of demand for district heat in the housing sector as the result of thermal upgrading projects. Finally, there took place a slight increase in electrical energy market after the previous strong reduction resulting from economy system reform begun in 1989.

The future of each individual final market on A→B(TETIP) trajectory, determined by the electrical monism, is as follows.

On the critical, in the context of electroprosumerism, electrical energy gross final market – on which the maximum (during the last 40 years) amounting 170 TWh occurred in 2018 (it was the electric energy produced in almost 90% from fossil fuels – hard coal and lignite were the basis for generation of about 80% of electric energy, while 10% from gas; still not more than 12% came from RES sources) – there will be accomplished a process, decisive for the whole A→B(TETIP) transformation.

At the first stage it will be the competition process between the RES electric energy rising market 1 (with the highest dynamics) and the WEK descending market. Final markets of heat and transport fuels basing on fossil fuels (the first one to the large degree on the hard coal, gas and – to a small extent – on heating oil; the second one entirely on transport fuels) will enter the permanent declining phase. The strongest decreasing dynamics will affect the heating market and two processes will decide about it: passivization of building constructions and electrification of heating sector. Big decreasing dynamics will also affect the transport fuels market. In this instance there will be two reasons: transport electrification, but also expansion of public transport, and the process of rationalization of their needs by people themselves (society self-restraint). Smaller decreasing dynamics will affect the final electrical energy market basing on fossil fuels – and here again two reasons/processes will be decisive: from one side this market will be under tremendous pressure of decreasing dynamics because of its coal structure, from the other – it will become the beneficiary of the big electroprosumerism rising dynamics (electrification of heating sector and transport).

The starting point for building the final state B heuristic of the A→B(TETIP) transformation is the balance of the energy gross final markets. In 2018 and very much like in 2019, the annual gross final markets amounted about 600 TWh (divided as follows: except of 170 TWh of electric energy there were still 210 TWh of heat – including 170 TWh for heating and 40 TWh for domestic hot water (DHW) production – as well as 220 TWh of chemical energy in transport fuels).

**6.3.** From annual gross final markets we should move on to net final markets: in state A (at consumers) and their "equivalents" in state B (at the self-restraining prosumers making use of incremental innovations in the present environment of fossil fuels energy industry but not at the electroprosumers benefitting from breakthrough innovations). And so, markets in state A (real values) are equal: 130 TWh – electrical energy, 190 TWh – heat and about 200 TWh – transport. Their equivalents in state B, taking into account the potential of traditional energy efficiency (in economies of electric energy, heating and transport), development processes in the whole economy and prosumer self-restraint amount to: 95 TWh – electric energy, 190 TWh – heat and 200 TWh – transport.

In case of electric energy the equivalent diminution against the real value by more than 25% has its reason in great electric energy consumption by those economy branches which will be restructured (steel industry, chemical industry) and, in a big part, completely extinguished (fossil fuels energy industry). Maintaining of equivalents at a real value level, in case of heat and chemical energy of transport fuels, reflects, from one side, very prudent (conservative) assumptions for energy industry transformation in the incremental innovation mode i.e. just like the one that has been conducted in Poland for the last 20 years and, from the other side, closing up (due to demographic situation, among the others) of the development space for quantitative growth of individual transport and housing construction.

**6.4.** Making use of the estimated equivalents (p. **6.3.**) and further on factors (presented in **Tab. 2**) of energy transformation to electrical monism, there was built (presented in **Tab. 3**) the initial (A) balance heuristic of the final state (B) for Poland. According to this heuristic the driving (electrical) gross and net RES energy are in state (B) equal 200 and 175 TWh, respectively. At the same time the useful energy (acquired thanks to the driving electrical energy) is equal 205 TWh (these are of course the values of a fully mature electrprosumerism). Stressed is, that the useful energy value takes into account exergy increment of external heat sources which is estimated to be about 40 TWh. Such value of exergy results from the housing construction passivization potential equal about 130 TWh (diminution of district heat from 160 TWh to 30 TWh), **Tab. 3**. Therefore, after the passivization the demand for heat will be equal 30 TWh for heating purposes and 30 TWh for DHW production. Taking into account the operational coefficient COP=3 (this is the value estimated in a very cautious way for the present-day air-to-water heat pumps) we obtain the value of demand for the driving electrical energy, indispensable for housing construction passivization, equal 20 TWh.

**6.5.** A separate comment is needed on the heuristic of the presented in **Tab. 3** technological mix of RES generation sources in final state (B) ensuring full RES re-electrification up to the level of electrical energy gross production equal 200 TWh. The paragraph **6.6.** is dedicated to this heuristic.

**6.6.** Cost heuristic (in constant prices) of the electroprosumerism final state B(2050) in the form of the cost of electrical driving energy produced in RES sources in conditions of 2050 electroprosumerism after realization of A→B(TETIP) transformation, presented is in **Tab. 4**, and is equal 40 billion PLN. The basis to build it was the balance of electroprosumerism in state B(2050) i.e. the one presented in **Tab. 3**: domestic manufacturing mix of RES sources and an annual gross electrical driving energy equal 200 TWh, additionally capital goods prices (constant) in keeping with their 2019 level (so there is still the potential to reduce these prices, therefore also to reduce the cost of meeting what today is called energy requirements as the whole). For comparison, in **Tab. 4** there are also given

the values of three final markets (of electrical energy, heat and transport fuels): the real one in 2019 and the estimated value in state B, after realization of the energy inudstry development program according to the energy policy PEP2040, particularly after finishing of the already ongoing investments in electrical energy industry based on coal (hard coal and lignite) as well as after realization of the nuclear energy investment program – in both cases it is equal 200 billion PLN.

**Table 4**

Cost heuristic (in constant prices) of the final state B(2050) after TETIP transformation

| | |
|---|---|
| Value of electric energy, heat and transport fuels final markets in 2019 (with taxes and parafiscal taxes) | 200 mld PLN |
| Cost of electric driving energy produced in RES sources in electroprosumerism 2050 after A→B(TETIP) transformation | 40 mld PLN |
| Value of final markets 2050, option PEP2040 (project) | 200 mld PLN |

**6.7.** Economic heuristic, (complete set of heuristics) of A→B(TETIP) transformation and concerning the whole A→B trajectory, was presented in **Tab.5**. Accumulated surplus over the whole trajectory, equal 2 trillion PLN, has been estimated as follows. The growth of the gross market of electrical energy from RES sources, passes from the level of 15 TWh in state A(2020) to the level of 200 TWh in state B(2050), following the curve slightly convex upwards, linearized segmentally. In turn, reduction of gross market of electrical energy generated with the use of coal (and gas) sources occurs through superseding of this energy from the level of 155 TWh in state A(2020) to the level "0" following the curve slightly concave downwards, linearized segmentally. The sum of these markets creates the curve of gross "mixed" electrical energy growing from the level 170 TWh in state A(2020) to 200 TWh in state B(2050) following the curve only subtly convex upwards, linearized segmentally.

**Table 5**

Heuristics of TETIP transformation A(2020)→B(2050) trajectory (in constant prices)

| | |
|---|---|
| Cumulated (2020-2050) surplus | 2 bln PLN |
| Investment outlays on RES re-electrification | 750 mld PLN |
| Housing construction passivization and electrification of heating sector | (500+350) mld PLN |
| Transport electrification | 200 mld PLN |
| Remains for (fair) trasnformation | 200 mld PLN |

**6.8.** If to make electrical energy (for research purposes) the carrier of all three final markets' values on the whole A→B trajectory, then we obtain – in marginal prices environment on the competitive electrical energy market, and further on competitive mechanisms in housing construction passivization as well as in electrification of heating sector and transport – very intuitive heuristic of the surplus created in transformation to electroprosumerism in the form of difference in prices over subsequent years. It is easy to calculate that the price in initial state A is equal 1.200 PLN/MWh and in final state B it is 200 PLN/MWh. The last price, as the marginal one, is in 2020 not shocking any more even in Poland where it was surpassed by PV sources (marginal prices of electrical energy from RES sources are lower than the network parity of electrical energy from fossil fuels prices already in the 2/3 of the world).

**6.9.** Accumulated surplus equal 2 trillion PLN enables first of all to finance required investment expenditure on re-electrification of RES over the whole trajectory A→B, amounting to 750 billion PLN (**Tab.5**). Moreover, it allows financing the support (tax mechanisms are beter than direct support) of housing construction passivization (500 billion PLN), heating sector electrification (350 billion PLN), transport electrification (200 billion PLN) and "fair" transformation, in the whole WEK energy industry (200 billion PLN); these are sums which have now only tentative meaning (directional assumptions for their estimation are presented in p. **6.10**).

**6.10.** Areas for an urgent verification of market forces sufficiency to realize TETIP transformation are as follows: **RES re-electrification**, **housing construction passivization**, **heating sector electrification** and **electrification of transport.** For qualitative-quantitative verification there is usually used a set of tools in the form of exponential functions connected with estimations presented in **Tab. 3, 4, 5**, and additionally a set of author's hypotheses concerning shaping of A→B(TETIP) trajectory of housing construction and transport resources (markets). Finally, the author's own experience covering the period of 1970-2020 (50 years) in the range of development dynamics of various segments of all WEK fossil fuels energy industry sectors as well as the period of 1995-2020 (25 years) in the range of development dynamics of RES generation sources and various segments of pro-efficiency activities on all three final energy markets.

**Re-electrification of RES.** Verification (2019) basis in case of RES re-electrification is electrical energy generation in RES sources equal 15 TWh (in simplified form it is the rising market 1). Annual increment on the rising market equal 8,5% gives the required annual electrical energy generation on the rising market 1 in state B(2050) equal 160 TWh. In turn, the construction of one 1,2 GW wind farm on the rising market 2 every 4 years ensures the required generation equal 40 TWh. Therefore, these are the entirely realistic in their realization targets (on the scale of investment difficulties they are undoubtedly below the moderate level).

**Housing construction passivization.** In this case, the basis for market forces sufficiency verification is the 2019 state described with the help of three figures: 6 million of existing detached houses, 6 million of existing apartments in multi-family buildings and about 150.000 delivered houses and residential units on an annual market. Stabilization of construction market (at the level up to the year 2019) ensures 4,5 mln of new houses and residential units in the 2050 horizon. This figure compensates the anticipated required increase in number of houses and units equal about 1 mln and the demolition range equal 30% i.e. 3,6 mln (in case of demolitions there is a change – under the influence of the announced in the second half of 2019 position of the EU – in relation to 2018 Base Report in PPTE2050 resources in which the considered demolition range was equal 50% and was bigger than the one announced in the EU and equal only 20%, but the case is still open).

If the housing construction passivization in the 2050 horizon is to be realized, new houses and multi-family buildings must be built as the passive ones (there are full grounds to create a system of legal regulations and market mechanisms enabling right now the construction of new, passive houses and multi-family buildings for costs comparable with the running market costs). More difficult task is revitalization of existing resources (apart from these resources that will be subject to demolition) to passive standard – around 8,5 mln of houses and flats. The required stable revitalization market (280.000 revitalized houses and flats per year) is about 2 times bigger than the existing market of new houses and flats. Furthermore, the allocated onto the market achievable cumulated market surplus (not the direct support) equal 500 billion PLN means the individual surplus (for substitute house/flat) equal almost 60.000 PLN. Such surplus is quite enough (with a big reserve) for realization of revitalizing program under the condition that every individual revitalization is the target revitalization (to passivization standard) and not the staged one.

**Heating electrification.** The basis here is the heat pump sales market (developing for the last 10 years with practically no supporting systems and with the annual dynamics of 15%). In 2019 there were 25.000 heat pumps sold (the air-to-water pumps market in 2018 has increased, in relation to 2017, by 31%). According to forecasts of the PORT PC society, the number of heat pumps will amount to 1 mln in 2030. The target pump volume in the transformation process is about 6 mln (this number is correlated with the number of real electric energy supply terminals of detached houses and, in case of multi-family buildings, the number of supply terminals and the number of heat exchanger rooms in heating networks supplying these buildings). The increase in heat pumps number (ignored here is the heat pumps capacity) from 1 mln in 2030 to 6 mln in 2050 can be realized with the annual market dynamics equal 10%. Therefore, the cumulated transformation surplus (its part) allocated via market to heating electrification segment, equal 350 billion PLN, is quite sufficient (with a big reserve). It is the full confirmation of the heating electrification rationality.

**Transport electrification.** The basis is (2019) 20 mln cars being in use; the annual sales market of new cars is equal 0,6 mln vehicles; average purchase price of a new, traditional car is 80.000 PLN; forecast for 2025 concerning the number of electric cars according to the governmental program – 1 mln (program dated for 2017) and 300.000 (information released in 2019); achievable purchase market price of an electric car (after taking into account the State's declaration concerning support in the sphere of tax mechanisms) – 90.000 PLN. Characteristics of the basic state shows clearly that its fundamental rationalization is needed here.

Rationalization basis is the cumulated transformation surplus (a part of it) allocated via market to the transport electrification segment, amounting to 200 billion PLN. The (market) support that can be provided thanks to this surplus, ensures the unit "extensive" price reduction (of every "first" electric car on the 20 mln market) equal 10.000 PLN (it reduces an electric car market price to the level of the present combustion engine car price). But if the whole car market shrinks to 10 mln in the 2050 horizon (this is completely rational and strongly needed, and the task here is to reduce the number of cars connected with the life style, causing limited increase of substitute investments), the reduction of every first car price (on the sole electric car market) will equal 20.000 PLN. This is the confirmation of the transport electrification rationality – electrification ensuring the electrical energy consumption equal only 20 kWh/100 km (the value for an average car with neither heating nor air-condition, and this value must be constantly verified in many aspects), in comparison with the present one equal 60 kWh/100 km.

**6.11.** Separated (treated in a more detailed way) **tax and incentive heuristic**, counterbalancing protection of the State Budget revenues, realization of subsidiarity principle (mainly at the EU and member states level) and diffusion of innovations into the area of energy industry transformation, supported by tax mechanisms replacing the dedicated supporting systems, concentrating first of all on estimations of the dedicated support systems transformation into tax mechanisms – is as yet completely non-existing in the debate concerning TETIP transformation, though it is of a crucial importance to it, and is stil waiting to be created. Tax and incentive heuristic must be close-coupled with heuristics presented in pp.**6.1.** to **6.9.**, but must also take into account the extensive macroeconomic environment: *pre-pandemic* and *post-pandemic* ones.

The *pre-pandemic* environment is presented below in a very general way.

**GDP of the EU** (with Great Britain) in 2018 was equal 14 trillion €.

**Annual budget of the EU** in the perspective of 2021-2027 – about 115 bln € (the EU GDP without Great Britain equals about 11,5 trillion €, percentage share of the EU budget in the EU GDP is about 1%). To compare, GDP of Poland in 2019 was 2 trillion PLN, budget/taxes – 420/390 bln PLN.

**Taxes in the Polish power industry** (as a whole) – about 85 bln PLN (excise duty not less than 38 bln PLN, VAT not less than 35 bln PLN) this is more than 20% of tax revenues to the budget (value of electrical energy, heat and transport fuels final markets in GDP is about 10%).

**Subsidies to mining sector** (during the whole restructuring period (1990-2019) i.e. starting from the State system reform - about 250 bln PLN).

**Systems for direct support of RES sources** (after 2005). These are: certificates – estimated very roughly – 30 bln PLN (system degenerated by political and corporate but also business groups of interests responsible for such solutions like co-combustion of biomass in coal-fired units and subsidising the electrical energy generation in already amortised big hydroelectric power plants).

**Guaranteed prices.** It is the mechanism of direct support, useless for TETIP transformation at the present stage; in the EU the pressure from interest groups to use this tool practically disappeared.

**Auctions** in the EU also are on their way out (in favour of the market competition). **Net metering** is a good system but it needs a dynamic conceptional development (transition to the dynamic net metering).

**Power market.** In the EU practically of no use, in Poland it devoured already large resources (of time, administrative and organizational, financial); further use of this solution will not bring any positive effects, at least those that could be already achieved with the help of a competitive investment market (but it also will not be entirely consumed).

## 7. Scaling of electroprosumerism

Electric monism and its three paradigms lead directly to theoretical (deductive) grounds for elctroprosumerism scaling of a basic practical importance for TETIP transformation. This practical importance is confirmed by the growing dynamics of interdependence between three factors:

- technological development (the rising tide of of breakthrough innovations in the intelligent infrastructure and the scale of RES generation sources technological integration),
- storage technologies and electrical energy usage, thereafter social processes (in the large area of electroprosumerism and the social subsidiarity principle),
- decreasing role of the State (increasing harmfulness of its interventions at levels where – with the existing technological level and the level of social processes development – sufficient is the realisation of subsidiarity principle at lower levels).

**7.1.** In the technological area recalled is the next stage (2019) of onshore wind farms development though it is only an incremental innovation and not the breakthrough one; this is so, because this area is of key importance in the aspect of electroprosumerism scaling, particularly in the aspect of growing extent of technological and prosumer integration. And so, new generation of onshore wind farms which enetered the market in 2019 results generally in the need to adjust energy balances scaling in the KSE control front-ends. Wind farms – of specific capacity 6 MW, an annual installed capacity utilisation time exceeding 4.000 hours and which entered the market in 2019 – once again change the hitherto perception of RES sources. It is easy to calculate that for a town with 75.000 inhabitants in 2050 – virtual control front-end OK(JST) – seven wind farms is a sufficient number to meet the town's energy demand. And, in practical terms, there are as many of them as can fit (on the demand side) into the electroprosumer fron-end OK(JST) after the technological mix of RES sources was rationalized by JST unit. Surely enough, the electrical energy generated by these power plants – after they are built and connected to 110 kV network in accordance with the new rule TPA+ meaning an access to KSE resources i.e. accordingly with the principle of KSE resources sharing – will be cheaper (in constant prices) than the one from the KSE system.

**7.2.** Three basic factors of scalability (connected with population number as well as prosumer and virtualization paradigms) are (indicatively) presented in the following way:

1° – in the form of the call catalogue of the population coefficient connected with administrative division of the State (population and self-governmental coefficient),

2° – in the form of the call set of widely understood prosumer virtual front--ends OK(W) giving right (entitling) to utilise the principle of KSE resources sharing (TPA+ rule) on each individual voltage level (LV, MV, 110 kV, EHV),

3° – in the form of the call catalogue of standardized technological mixes of RES generation sources coupled with OK(W) front-ends; for electrical monism scaling (described in the further part of this elaboration) and, first of all, widely described in various aspects in the PPTE2050 platform resources – and here is introduced an important extension to its description (scaling).

**7.3.** The example of extension of the hitherto generation sources technological mix scaling for the OK(JST) front-end of a town with population equal 75.000 is presented in **Tab. 6**. This is the extension of the up to now used on the PPTE2050 platform scaling, limited to electrical energy markets 1 and 2, whereby **Tab. 6** was used for: adjustment modification in the range resulting from entering the market of 6 MW new generation onshore wind farms, technological mixes of RES generation sources for the country, the anchor i.e. the infrastructural and urban planning corridor north-south and rural areas (it all happened without infringement of the fundamental grounds for shaping of electrical energy rising market in the way of division into markets 1 and 2).

**Table 6**

Scaling of electroprosumerism in four canonical front-ends, a characteristic example in the case of the fourth one – OK(JST)

| Technology | Country | | Anchor (DC-AC backhaul systems, KSE resources sharing on EHV level) | | Rural areas resources sharing on LV-MV-110 kV levels, KSE | | Town – 75.000 inhabitants, OK(JST) front-end, rural areas | |
|---|---|---|---|---|---|---|---|---|
| | % | TWh | % | TWh | % | TWh | % | GWh |
| GOZ | 5 | 10 | 3 | 6 | 2 | 4 | 4 | 16 |
| μEB | 5 | 10 | 1 | 2 | 4 | 8 | 6 | 24 |
| EB | 10 | 20 | 1 | 2 | 9 | 18 | 15 | 60 |
| EWL | 30 | 60 | 5 | 10 | 25 | 50 | 40 | 160 |
| PV | 30 | 60 | 10 | 20 | 20 | 40 | 35 | 140 |
| EWM | 20 | 40 | 20 | 40 | 0 | 0 | 0 | 0 |
| | 100 | 200 | 40 | 80 | 60 | 120 | 100 | 400 |

Paradigmatic triplet of electrical monism allows to introduce a very unambiguous message from encyclopaedic dictionary of theory (Par. **1-7**) to electroprosumerism practice.

First of all, the uniqueness of electrical energy from RES sources (RES electrical monism) in meeting all demands called now energy de-

mands – resulting from its exergy surpassing exergies of any other types of energy and radically extended by external exergies in passivization processes of housing construction and heating electrification – makes the electrical energy become a common good, similar to the most indispensable ones for a human being, and not only like food, housing and transport security, but also health (access to medical care), education (access to education), social and legal security (all institutions protecting life and property of citizens as well as the national wealth, constitutional system and the State sovereignty).

Secondly, possibility to define a collective prosumer (as the social process resulting from the development of prosumer energy industry) to three electroprosumerism markets – of value exceeding, or at least comparable, with each of the markets/budgets associated with the above mentioned, critical for functioning of a human being, areas – makes nowadays the electroprosumerism to be the most powerful key driver of civilizational changes.

Thirdly, breaking the technical monopoly with the help of the KSE resources sharing principle (generally of the SSE power systems resources) makes the transformation of TETIP energy industry a testing ground for counterbalancing of competition and the subsidiarity principle (on all of its levels) extending over all the mentioned critical areas.

Therefore, the message is as follows: practical solutions for the electrical energy rising market 1 must be tailored to the historical context because there is no time for the conjunctural ones. And, what is the most important, solutions must be founded on values, then on the knowledge and, only at the end, on money. In such environment the solutions for the electrical energy rising market 1 can be conceptionally transparent, technically simple and economically efficient.

## Practice – catalogue of issues with basic solutions/concepts

Eight-point catalogue covers propositions (solutions/concepts) known as keywords from the Part I of the elaboration. Grounds for these proposals have been created for 10 years and are now collected in the form of resources available on the PPTE2050 platform (they, for sure, need to be put in order). The author, for all these years, has treated these propositions as a starting point for the discussion. But, as no such discussion arose, no governmental proposals appropriate to TETIP transformation needs were submitted and the lack of actions in the power industry becomes dangerous for the State, this catalogue is now addressed to pretenders-innovators (natural persons and legal entities) and into the area of a collective pretender. At the same time it is assumed that pretenders-innovators have already exclusive technical (mainly in the range of the intelligent infrastructure from the ICT area), economic, legal, social and environmental competences. As a consequence, a collective pretender (pretenders-innovators operating in the area of a collective pretender) has in Poland competences sufficient to ensure process diffusion of solutions/concepts into the TETIP transformation area. The current language from the conceptual area of the WEK fossil fuels energy industry is only to a small extent useful for pretenders: pretenders-innovators and a collective pretender. That is why proposals and solutions are presented mainly in the language of electroprosumerism (alas, it is still very feeble and only in the initial phase of development).

## 8. Architecture of the electrical energy market. Markets: rising 1 and 2 vs descending WEK

So far, rising markets 1 and 2 and the descending market WEK as well as their interrelations have been (on the PPTE2050 platform) treated only indicatively. For the given below deepened (and at the same time considerably shortened) description of this architecture made for pretenders-innovators, introduced is the deepening of calibration of demand balances for gross electric energy from RES sources in the final state B for the characteristic front-ends OK (.) – as well as the deepening of the markets' interrelations description with the use of front-ends OK (..).

**8.1.** First of all it is emphasized that the principle of KSE resources sharing does not reduce any of the markets (rising markets 1 and 2 as well as the descending WEK one) by using the territorial criterion. In accordance with this principle the rising market 1 is determined by the principle of KSE resources sharing inside the network front-end OK (⩽ 110 kV) and the rising market 2 by the principle of KSE resources sharing in the network front-end OK (NN) on the whole territory of Poland. The rules of sharing the KSE resources inside network front-ends OK (⩽110 kV) and OK (EHV) are in the *Electricity Act* (as a target, over the whole transformation trajectory) differentiated in conformity with the KSE system physical properties (operators' solutions), ownership relations and market (commercial) solutions inside front-ends.

**8.2.** In particular, it means that the illustrative structure of markets presented so far ( in a very simplified way) on the PPTE2050 platform (**Fig. 1**) will quickly evolve under the influence of the KSE resources sharing principle differentiation in diverse but standardized front-ends. For instance, in case of OK(JST) front-ends the KSE resources are compulsorily guaranteed until 2050 for towns over 500.000 residents inhabiting the JST unit. The list of these units includes: GZM metropolis (2 mln inhabitants), the capital city of Warsaw (1,8 mln), Tri-City (1 mln) as well as Kraków, Wrocław, Łódź and Poznań (with the number of citizens, descendingly: 800.000-550.000). The annual electrical energy consumption equals (in descending order) from about 13 TWh to about 2,6 TWh, but the last case – city of Poznań – shows that its access to the EHV network in 2050 (i.e. to offshore sources) is of no critical meaning. For the 40% share of EWL power plants in the RES generation resources technological mix, the quantity limit of 6 MW power plants is not more than 50. It is not an irrational value, even for the present perspective and – as the time goes – this perspective wil become more and more friendly.

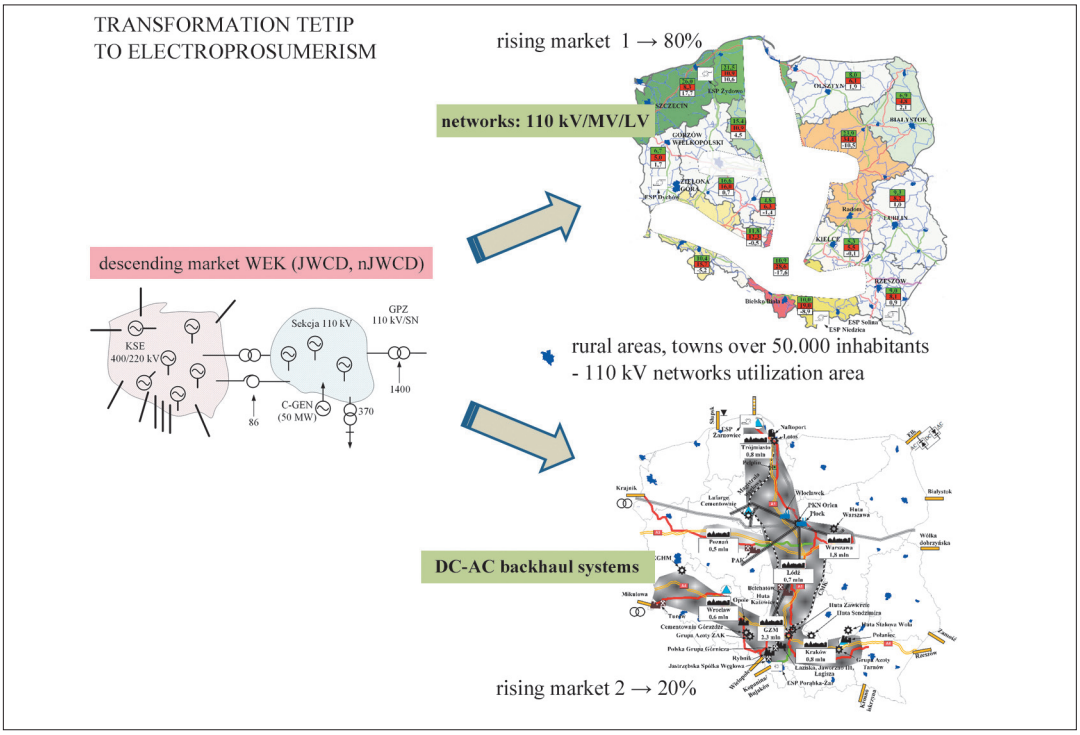


Fig. 1. Electric energy markets: rising 1 and 2, descending WEK

**8.3.** The KSE network resources in front-ends OK (≤110 kV) – i.e. in operator front-ends of the present-day OSD operators on the WEK descending market – are made available (guaranteed compulsorily) to 2050 for the rising market 1 in the whole range (comprising separately every one of the LV, MV and 110 kV networks) for self-governmental front-ends OK(JST) with the number of inhabitants 50.000-500.000. These front-ends in 2050 will match the annual demand for gross electrical energy from RES sources in descending order: from about 2,6 TWh to about 260 GWh. The lowest, boundary case of a 50.000 town shows, though, that its access to the 110 kV network in 2050 is practically of no critical importance. That is why the boundary number of 6 MW EWL plants, requiring potential connection to 110 kV network, is not higher than 5. So, the technological mix of RES generation sources with 3 MW EWL power plants (that can be connected to the MV network) is rational. Then the number of such plants grows to 12 which is a rational solution.

**8.4.** Compulsorily guaranteed access to the KSE resources until 2050 through the 110 kV network (in the formula of the rising market 1) is sufficient for all industrial prosumers in territorially cohesive prosumer front-ends OK(P) located beyond OK(JST) front-ends. In particular, this is because in 2050 there will be no industrial prosumers of total annual electrical energy consumption even if only close to the boundary value of 2,5 TWh (this is exactly that KGHM consumes now but in 2050 there will be no such types of enterprises).

**8.5.** For front-ends OK(JST) with less than 50.000 inhabitants, i.e. for rural or rur-urban municipalities and for small towns it is completely sufficient to have – over the whole TETIP transformation trajectory – an access to KSE resources through network front-ends OK (≤ SN). Also, it is highly probable that electrical systems inside these front-ends will be (at least they may be), even still before 2050, the autonomous systems (off-grid) functioning on the LV-MV network infrastructure.

**8.6.** Rural areas with settlement units (villages, remote settlements, colonies, hamlets) inhabited by less than 1.000 residents (not less than 40.000 units of officially defined names of places) need RES re-electrification to systems autonomous for these units, functioning on the LV (at the most) network infrastructure i.e. to systems being off-grid in relation to MV networks and to the whole KSE. This segment of "energy industry" transformation is the most difficult one, considering the scale of necessary application of the principle of subsidiarity already on the lowest level (rural commune). From the other side, it is much easier to solve this problem in the electroprosumerism environment, including the help of its non-network markets, than in the environment of the WEK fossil fuels energy industry and, above all, electrical energy industry WEK based on fossil fuels. In such sense, transformation to electroprosumerism can, in this case, support two main goals from the area of subsidiarity and governance i.e. social reconstruction and urban planning order of such rural areas.

## 9. TPA+ principle of access to KSE resources on the descending WEK market

Though, up to the present, the principle TPA+ has been (on the PPTE2050 platform) treated (temporarily) as an entry, but always in connection with concepts (ideas, categories) anchored in paradigms; in an open way, first of all in the virtualization paradigm but also in the prosumer one, and covertly in the exergetic

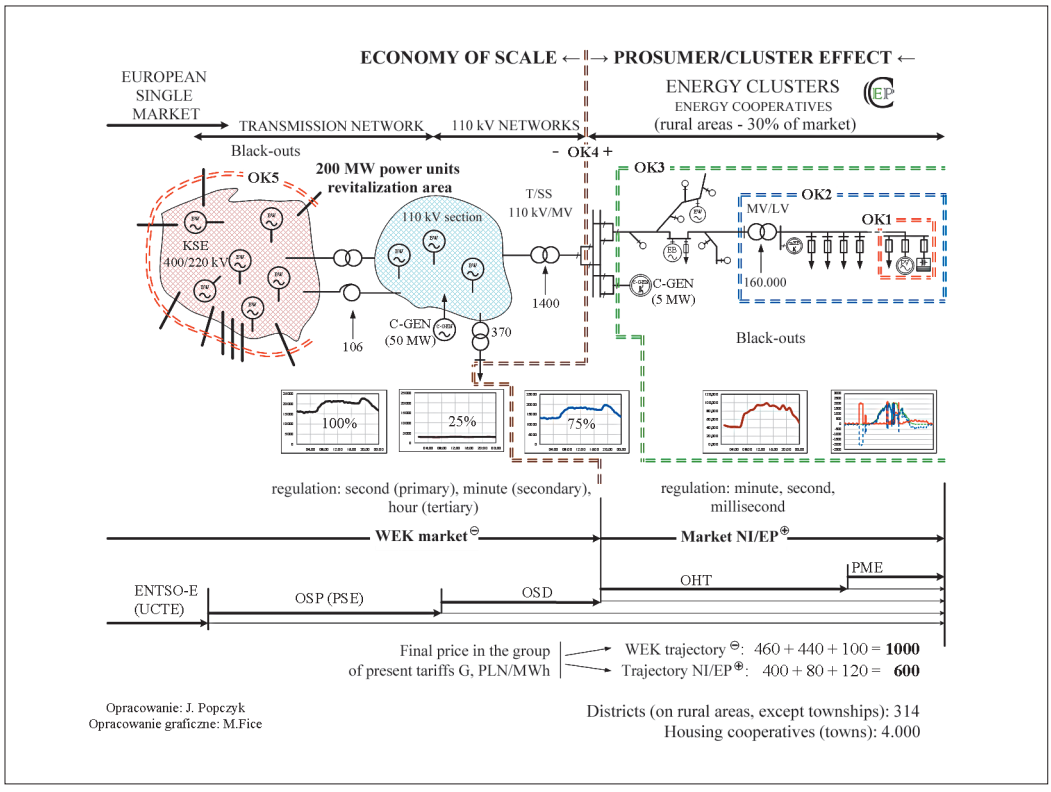


Fig. 2. Synthesis of issues connected with transformation of KSE operator system from the centralised one (OSP, OSD) to the distributed one in front-ends OK(R) and OK(W)

paradigm. In this context, numerous references of the TPA+ principle to the TPA one are very important, but also (and above all else) the conclusions from comparative analyses of these principles leading to the change of the entry "TPA+ principle" into a denomination "principle of KSE resources sharing".

**9.1.** TPA principle was the principle of access – targeted to end-users (totally passive) – to networks in the real connection nodes. The criterion of the access was (in the first application in Great Britain) a consumer capacity (agreed) and in later applications (Finland, ..., and above all the EU directives referring to the European single market) it was the energy. In the simplest understanding of the TPA+ principle that what counts it is the access of (the already active) prosumers to KSE resources comprising networks and regulation services (particularly the frequency regulation) and in general – that the access to these KSE resources is available to virtual WSE electrical systems including the RES distributed sources.

**9.2.** And here emerges the first essential difference. In the TPA principle the task was to start competition between large-scale producers i.e. coordination of the technical KSE layer with the newly introduced market layer (sellers) with the help of the technical market administered by the OSP operator.

In the TPA+ principle the task is completely different: we deal with sharing of resources that is the fundamental feature of distributed systems, e.g. in computer networks it is the sharing of computer memory, transmission connectability et al.

**9.3.** So we arrive now to the root of the TPA+ principle: it consists in sharing of KSE resources (network and technical market [system services], and above all the frequency regulation) by the rising market 1 – i.e. the distributed prosumer generation resources RES organised into WSE systems on this market – and the descending WEK market. Such sharing would not be possible, in the case of rising market 1, without an intelligent infrastructure: the network access terminal STD(WSE), measurement and settlement platform OIRE(WSE) and a supervision system SCADA(WSE).

**9.4.** Therefore, it is concluded as follows: because the essence of the hitherto named TPA+ principle is close to the principle of resources sharing in computer networks, the denomination TPA+ is now replaced by the principle of KSE resources sharing.

**9.5.** Canonical system of control front-ends in KSE (**Fig. 2**) has until now been (on the PPTE2050 platform) a compromise to illustrate the TPA principle and the KSE resources sharing (TPA+ principle). The control front-end defined for the first time in frames of a compromise, serves (generally) to separate this part of the electrical energy infrastructure (IEE) which enables functioning of the rising market 1. It is a front-end having much in common with front-ends used in thermodynamics and IT (electrical monism paradigms: exergetic and virtualization ones).

Unambiguous definement of the control front-end OK(R), referring to the real infrastructure of the KSE system, is particularly necessary (just like in thermodynamics) to draw up correct balances of power and energy for the needs of operator management of technical limitations (safety of the infrastructure itself and its environment). Defining of the virtual control front-end OK(W), aiming at drawing up correct energy balances in market processes as well as billing, therefore in shaping of intelligent infrastructure of the rising market 1 (including the control one) and

in communication between participants of this market, relates to a front-end in IT (including internet). Here we are getting to the IT fundamentals of the OK(W) front-end and, further on, to its aspects: objective and, in the end, subjective, that is also to anchoring the front-end in the first paradigm of electrical monism, this is the prosumer one.

**9.6.** In the first cycle of "BŻEP Reports" on the PPTE2050 platform, five control front-ends are utilised (**Fig. 2**). They are as follows:

- OK1 – prosumer front-end crossing LV supply terminal (separating a prosumer in the dominant part from the population segment),
- OK2 – front-end crossing LV feeder bays of an MV/LV transformer substation (separating LV infrastructure supplied by the substation),
- OK3 – front-end crossing connecting bays (to MV/LV infrastructure) of sources and prosumers/consumers (separating clusters and energy cooperatives as well as virtual power plants),
- OK4 – front-end crossing MV feeder bays of 110 kV/MV transformer substation (separating MV/LV infrastructure supplied by the substation),
- OK5 – front-end crossing KSE cross-border connections with UCTE system (domestic market with the Union/European Single Market).

**9.7.** The concept of control front-ends is of a key-importance from the point of view of efficient linking together completely new technological capabilities (IT, power electronics, ...) with a completely new market architecture. A critical issue in this context is the immediate securing public (in internet) observability of profiles: first of the electrical energy demand on control front-ends OK2, OK3 and OK4, and then (as the NI and EP energy industry develops) of bi-directional exchange through these front-ends. Securing of such observability, if such will on the part of URE existed, is possible without delay, under concessions which are the basis of OSD operators functioning (if there is no such will, pretenders/innovators must exert sufficiently strong pressure on the authority).

**9.8.** An access to frequency regulation/control is the essential issue in the frames of the KSE resources sharing principle. Though it must be stressed that even in this area, absolutely critical for more than sixty years now – from the world's beginnings of the interconnected SEE systems, especially from the time of the first, big black-out in November 1964 which affected the western coast of the USA and deprived over 30 mln people of electrical energy – in the case of TETIP transformation we must take diametrically different measures. At the time of that black-out the solution was found in redundance of network resources and increasing of capacity margin (reserves) i.e. increasing of installed capacity over the peak load of the system. It was the most expensive solution (and hardly effective, taking into account the later series of historical black-outs in the USA and in Europe). The present solution, applicable thanks to new technologies (RES sources, intelligent infrastructure, but first of all – in the context of frequency regulation – power electronics) is better, because it changes the economies of scale (and gigantic building sites), redundancy and competition (leading to the second-round growth of the economies of scale) into the effect of distribution, sharing and scalability (factory).

**9.9.** It is these effects (the last ones mentioned in p. **9.8.**) which cause that the electroprosumerism is good for both Warsaw (p. **8.2.**) and off-grid WSE microsystems (p. **8.6.**). Population criterion (p. **8**) applied in the KSE resources sharing principle (an access to these resources) for a set of virtual front-ends OK(JST), extended onto the inner distributed virtual front-ends OK(W) in which the technical and sales processes are managed by (WSE) operators, makes these operators to be the most desired pretenders-innovators at the present stage of TETIP transformation.

* * *

Encyclopaedic dictionary of electroprosumerism theory and two first paragraphs of the practical catalogue of problems with basic solutions/concepts have been drawn up in the way enabling presentation (in the next six paragraphs – **10**-**15** – of this catalogue) – with the help of the electroprosumerism conceptual apparatus (theory dictionary and p. **8** and **9**) – the main practical solutions addressed to pretenders-innovators and also (but to a limited extent) to a collective pretender. Incumbent entities and the State, if they want to benefit from their already more and more historical chance to constructively join the social process which is the collective pretender – and meet this pretender's needs – must, with no outside pressure, find and learn the electroprosumerism language by themselves (of their own will and for their self-interest making the effort to learn). The share of the State in the TETIP transformation process would be also useful for transition of the gigantic cost of resistance of incumbent entities realizing energy industry transformation in the incremental modet into the most cost-effective in the XXI century historical investment of the collective pretender into the electroprosumerism.

In the hands of the State and incumbent entities lies the agreement on the TPA+ principle in the range concerning sharing of KSE resources (further called the principle of sharing ...) by the descending WEK market (hereinafter "descending market") and the electrical energy rising market 1 (hereinafter "rising market"). In other words, the principle of the KSE resources sharing by incumbent entities and pretenders-innovators according to the rules of XXI and not XX century. The principle is mutually beneficial for both sides, but above all for the collective pretender. Without this agreement, pretenders-innovators will just the same carry out the transformation of energy power industry to electroprosumerism, but the cost will be higher and will be born by the collective pretender. Incumbent entities and the State will both lose (in a "year" or in "two years"), but will not be able to obstruct the TETIP transformation any more.

* * *

## 10. Organisational restructuring of the OSD operator segment on the WEK descending market

It is the restructuring realised independently of the ownership status (environment), in which function OSD operators, in the mode of regulations constituted by URE regulation authority and the appropriate minister, ensuring separation of business models: – operator ones (operational), investment and development – of LV, MV and 110 kV networks, for the need of competition between the descending WEK market and the rising market 1. The basic goal of this restructuring is making it impossible for every one of the OSD operators to further cross-subsidise the tariffs (network charges) on the basis of a consolidated financial balance.

**10.1.** Every one of the sub-operators, that is OSD(LV), OSD(MV) and OSD(110 kV), is obliged to make their profiles available to the public in the on-line mode – every 15 minutes, starting from 1 January 2021, and every 5 minutes from the year 2025 – on their cumulative network front-ends OK(1Σ), OK(2Σ) and OK(3Σ), respectively.

**10.2.** An OSP operator – apart from the already realised obligation to publicly share balance profiles of the whole KSE (particularly on the OK5 front-end) – is obliged to publish balance profiles on the domestic front-end OK(EHV-110 kV) and on the front-end OK4 crossing transformer bays of transformer/switching stations (T/SS) on the 110 kV side.

**10.3.** Each of OSD sub-operators is obliged to make publicly available the informations about surplus and deficient areas in the range of connectability to their networks (standard of such informations is determined by the URE regulator).

**10.4.** In frames of the new management model, there is introduced an admissibility for an OSD operator to dispose against payment of a separated part of the LV network in favour of a (WSE) operator holding the concession (URS).

## 11. Equivalenting of network charges for OSD(MV-LV) operator services based on KSE resources sharing (TPA+ principle)

Network resources comprising separately the LV, MV, 110 kV and EHV networks and system services in the form of frequency regulation, constitute resources that are generally the object of the sharing principle.

**11.1.** The principles are realised by (WSE)operators on the real (nodal) dynamic control front-ends OK(R) equipped with network terminals STD, on the basis of concessions granted by URS regulation authority.

**11.2.** The charge for the regulation service is a tariff charge uniform throughout the entire area of Poland and approved by URE regulation authority.

**11.3.** The network service charge results from competition mechanisms on OK(R) front-ends agreed between (WSE) operator and the appropriate OSD one. If there is no such agreement, arbitration is obligatory on every OK(R) front-end from the side of URS regulatory authority in a homogeneous – throughout the whole territory of Poland – form of a roaming charge for purchase (deficit) and sales (surplus) transactions handled by the (WSE)operator.

**11.4.** Equivalenting of regulated charges for frequency regulation is the competence of an OSP operator but supervision over these charges is held by the URE authority.

**11.5.** Equivalenting of the apllied in arbitration charges for network sharing in a roaming model is the competence of OSD operators but supervision over these charges is held by the URS authority.

**11.6.** Equivalenting of transaction fees (in sales and purchase offers) in a competitive trade on OK(R) and OK(W) front-ends is realised (independently) by OSD and (WSE)operators according to their needs.

## 12. New balancing market RB(MV-LV)

This type of markets are the competitive and cooperative markets of OSD(MV) and (WSE)operators occurring within sandboxes (until the *Electricity Act* enters into force). It is also a good thing to say here that the overarching principle determining the way in which this market is functioning, results from the rule concerning the transfer of balancing market costs on the descending market WEK (currently the balancing market managed by an OSP operator) onto the descending market WEK on front-ends OK4 crossing the transformer bays of T/SSs, on the side of 110 kV, and onto the rising market 1 in virtual front-ends OK(W) of (WSE)operators.

**12.1.** New balancing markets RB(MV-LV) support in Poland the tasks of the balancing market which will be uniformly obligatory for all EU member countries from 1 January 2021 in frames of the European Electrical Energy Single Market. Such progressive solution is justifiable and, at the same time, indispensable due to extremely difficult crisis situation for WEK electric power industry in Europe and already substantial potential of pretenders-innovators.

**12.2.** Rising market 1 in virtual envelopes OK(W) is managed by (WSE)operators. On this market, the (WSE) operator makes use of different mechanisms (exceeding beyond the set of the existing, traditional solutions applied on balancing markets).

**12.3.** What is the most important, the (WSE)operator uses the guaranteed power supply systems UGZ in control front-ends OK(WSE); the hitherto lack of using the UGZ systems potential was a great loss for the WEK electrical energy industry.

**12.4.** The (WSE)operator also uses the mobile balancing service from the third market of the non-network electroprosumerism (non-network service market). On the existing market WEK i.e. the one which does not have the status of the descending market yet, the mobile EMDGs (Emergency Mobile Diesel Generators) belonging to OSD operators have been applied up to now only to improve SAIDI and SAIFI indicators and not on the balancing market, where the permissible limits of electric energy prices equalled +/- 50.000 PLN/MWh (it is as good example of inefficiency of the bureaucratic WEK electric power industry as of any other organization like this one).

**12.5.** The (WSE)operator agrees the applied solutions set with subjects of (WSE)systems, or vice versa – subjects of the (WSE)system decide what kind of set it is, accordingly to contractual arrangements (civil-law agreements) agreed by the (WSE)system subjects.

**12.6.** The (WSE)operator activity on the internal balancing market is supervised in the regulation mode *ex post* by the URS authority.

## 13. Operator (WSE)

It is the subject, functioning by virtue of concession granted by the URS regulation authority, which is the creator of dynamic trade front-ends OK(R) on the rising market 1 and, at the same time, serving the subjects of (WSE)system by means of certified STD terminals, OIRE (WSE)platform and SCADA (WSE)systems.

**13.1.** During the process of control front-ends (OK)R creation, buyers and sellers are allowed (obliged to apply this principle) to participate in this process on the only one (WSE)operator platform at a time.

**13.2.** The (WSE)operator possesses all required competences for which theoretical foundations are already created in the range of balances (profiles) modeling both on OK(R) front-ends and on the OK(W) ones (K.Bodzek), in connection with functioning of the intelligent (WSE)system infrastructure as well as with models of analyses for valuation of charges for using KSE resources within the limits of the principle of their sharing by the rising 1 and descending markets.

**13.3.** The founders-participants (legal entities) of the (WSE)system decide on establishing of the (WSE)operator in the mode of civil-law agreements.

**13.4.** The (WSE)operator competences focus on utilisation of the potential of the rising market 1 intelligent infrastructure – terminals (STD), platforms (OIRE), systems (SCADA) – for integration of the layers: KSE technical layer and the market layer of the rising market 1.

## 14. Conversion of the cost regulation *ex ante* into the *ex post* antitrust one on the descending market. Waning role of URE

**14.1.** In practice, however, we should be prepared for a very broad timeframe destined for realization (putting to an end) of the URE waning role: beginning with coming into force of the *Electricity Act* (for which the reasonable time-limit, from the point of view of change dynamics in the EU, is the year 2025) and ending with the transformation final state B(2050).

**14.2.** From the other side, it is urgently desirable – even prior to the *Electricity Act* coming into force – to convert the cost regulation *ex ante* into the *ex post* antitrust one on the descending WEK market. This will, from one side, improve the WEK electric power industry situation, and, from the other, dynamize the experience in the range of the rising market 1 functioning. Poland will only benefit from it.

## 15. Sandboxes – rising regulation. URS (Sandboxes Regulation Authority) – a way to *Electricity Act*

URS authority is in co-existence with URE authority, just like the rising market 1 co-exists with the descending one: incorporation of sandboxes regulation into the URE competences would be illogical, totally undermining credibility of the TETIP transformation.

**15.1.** URS is responsible for elaboration of sandboxes segmentation and the set of operators' codes (specific for individual segments) for use (under a licence) by (WSE)operators applying for establishment of a sandbox.

**15.2.** The burden of a sandbox establishment preparation (application for establishment to URS authority) rests on a (WSE) operator.

**15.3.** Operator(WSE) is created – by members-founders of the (WSE)system in the way of civil-law agreements – as an in-house body (without legal personality) of one of the (WSE)system participants or as a separate legal entity.

**15.4.** In the second (above) case it can be the entity dependent on one of the (WSE) system members-founders, on a part of them or on all of them.

**15.5.** In case of a (WSE)operator without legal personality but having appropriate competences, it is the member-founder (the one who created the (WSE)operator) who applies for a (WSE) operator concession and it is him who acquires concession rights.

## Conclusions

1. The clash between heuristics of the A→B(TETIP) transformation basing on the electrical monism (and its three paradigms) and the cognitive errors of power industry, especially referring to prognoses, is the first shocking experience for the Author.

2. Heuristics of the A→B(TETIP) transformation, presented for Poland in this elaboration (p. **6**), had to be only slightly adjusted (mainly in the descriptive section) relative to those which were for the fist time (balance heuristics 2018, cost heuristics 2019) presented by the Author on the PPTE2050 platform. It is the effect of mutual neutralization of two contradictory factors. From one side, of the faster and global technological development (in which Poland does not take any part) and drop in prices of capital goods (equipment for the potential electroprosumerism market). From the other side, of postponing the TETIP transformation.

3. The second shocking experience for the Author is the clash between the electrical energy market concept (implemented in the frames of the electric power industry fundamental reform from 1990 to interconnection of the Central European systems in 1995) and the European UCPTE system. Innovative utilization of this reform solutions is often a suggestion how to solve problems connected with the TETIP transformation. The most valuable suggestions are those which in the fundamental reform referred to the TPA principle (access to the network) and in TETIP transformation concern TPA+ principle (access to KSE resources, in other words the principle of KSE resources sharing). Further on the ones which in the fundamental reform were connected with drawing up the *Energy Law Act*, and in the TETIP transformation would concern creation of legal solutions for the *Electricity Act*. Besides, innovative utilization of old solutions in the new situation would not be possible without electrical monism and its paradigmatic triplet.

For instance, it would not be possible to transform the nodal (physical) access to the network with the use of TPA principle into the KSE resources sharing, with the help of virtual control front-ends OK(W), especially the OK(JST) front-ends within the limits of the KSE resources sharing principle. Further on, it would not be possible, either, to transform the utilization of subsidiarity principle – consisting in implementing responsibility of local and regional authorities for assumptions to plans of electric energy, heat and gaseous fuels supply in the year 1997 into the *Energy Law Act* – into the responsibility (in this elaboration at the concept level) for the access to networks of towns being in OK(JST) front-ends, into the *Electricity Act*, like for instance the population criterion for the principle of KSE resources sharing by the (WSE) operators in virtual local authority front-ends OK(JST) and the prosumer ones in the population segment OK(P).

❑