

## Hybrid low-voltage networks as the element of the lifting of the efficiency and the independence in the distribution of electricity

**Abstract:** In the report one presented technical-economic aspects of the reconstruction of distributive networks based on hybrid solutions comprising as well renewable sources as also stores of the electrical energy. One proposed the model-solution of the innovative housing estate SHHD about unattainable till now effectivity parameters.

**Streszczenie.** W artykule przedstawiono techniczno-ekonomiczne aspekty rekonstrukcji sieci dystrybucyjnych w oparciu o hybrydowe rozwiązania obejmujące zarówno źródła odnawialne jak też magazyny energii elektrycznej. Zaproponowano modelowe rozwiązanie innowacyjnego osiedla SHHD o nieosiągalnych dotychczas parametrach efektywnościowych. **Hybrydowe sieci niskiego napięcia jako element podnoszenia sprawności i niezależności w dystrybucji energii elektrycznej**

**Keywords:** power grids reconstruction, electrical efficiency, limitation of carbon dioxide emission

**Słowa kluczowe:** rekonstrukcja sieci, efektywność energetyczna, ograniczenie emisji CO<sub>2</sub>

### The introduction

For sales companies with the principal purpose it should be the elaboration of the coherent programme of the lifting of the efficiency, both in the organizational dimension and technical; in this range with the determinant should be the general rule: „to make more at smaller (the energy commitment - J.S.) - *DOING MORE WITH LESS* [8]. This is probably the most accurate and picturesque definition of the energy efficiency, describing in the complete way this issue. Poland in this area is found in the mainstream of actions, what a proof is adopted law about the energy efficiency, from the day 15 April of the year 2011, being an implementation to Polish conditions of Union [7] directives. Currently (2018) was accepted by government following with the amendment whose main objective is thrifty and effective using of the energy, the reduction of her consumption, the reduction of losses during her transmission and the reduction of the power requirement electrical. Currently Poland is characterized with the higher energy consumption of the industry than most developed countries of Europe (EU-15) [9,13]. According to data with 2017 of European Commission the indicator *intensity* almost twice exceeds European values. Indispensable becomes so the elaboration of the effective strategy resolute in the way the complex above-problem, being a direct cancellation both to the European directive of as well as Polish legislations. Proposed concept „POLAND EFFICIENCY” [20,21,23] is directed to this part of the power engineering sector which deals with the chapter of the electrical energy and to customers - power consumers. Proposals include technical actions and organizational, because only such look on the problem, guarantees the effective action. A most important segment of the discussed strategy (Energy Saving) is directed to power consumers and founding the control a behaviour of customers (DSM) at under the look of degree of the energy commitment and new solution complementary [19,20], contributing to savings of the electrical energy. Qualitative however the change in the lifting of the efficiency of the transporting an electrical energy can provide new Technologies; this are solution from the range of Smart Grids - the development of the power engineering network based on the row of modern concepts [3,4,20,]. Previous analyses indicate also on the legitimacy of appeasement of crooked of the load, (investigations of the co-author -J.S.) indicate that possible is the reduction of losses in the distributional network about approx. 7-10%, what in the scale of the country gives savings of the line 100 millions zloty in the year [23].

An additional technological element supporting the strategy of the lifting of the efficiency of the farming an electrical energy are stores of the energy and they are a factor which permits the considerable improvement of classical DSM, across innovative solutions SDSM® (Smart Demand Side Management), creating the simultaneously new concept POLAND EFFICIENCY THE PLUS [17]. In this solution is not already the necessary decisive part of power consumers - SDSM® introduces the new quality of the demand management. Across stores of the energy and the specialistic software one obtains the desired effect - the change of line-characteristicses of the load. The new concept POLAND EFFICIENCY THE PLUS puts on the extended model of the cooperation with users of the electrical energy. One proposes the development of the network based on the hybrid low-voltage network using stores of the electrical energy, one foresees two types of this network:

- the hybrid low-voltage network centralized - the store of the energy is situated in the powered station supplying this network,

- the hybrid low-voltage network decentralized - stores {magazines} of the energy are situated at individual recipients.

The use of stores of the electrical energy contributes to the increase, in the fundamental way, the energy efficiency both the distributional (the equation of the curve shape of the load) system, and at his recipients - consumers of the electrical energy. The management with the consumption of energy of electrical and her optimization lead to the reduction of charges for the electrical energy, what has an essential economic dimension for users of the electrical energy.

### Infrastructural ecological conditionings

All actions in the area of energy have a direct influence on the environment, are from here - European settlements in the figure of numerous directives which trace directions of solutions from now on. The more and more greater part, in these solutions play ecological conditionings which should be taken into consideration in the greater degree so far. In this area too essential one ought to notice which elaborations as [6,14,25], formative developmental trends. One carried out also extensive searches concerning of the Model of the evaluation of the maturity Smart of the Polish cities in which one took into account such factors as: the balanced development, the energy efficiency and also the social responsibility [22].

The current trend in the low energy building is putting GREEN BUILDING [6] - „the ecological building” this is solution reducing his negative impact on the health of the man and on the surrounding natural environment, across:

- the improvement of the wholesomeness of buildings, that is the minimization of the unhealthy potential,
- the minimization of pollutions to the environment, that is the considerable reduction of the natural load caused through buildings and their groups,
- the avoidance of burdensome materials for the natural environment,
- the effective energy utilization of renewable, waters and other raw materials during raising and the exploitation of the building,
- the use of the natural vegetation as the cloak of the biological building,
- the health protection of inhabitants and the improvement of the efficiency of workers,
- the reduction of the quantity of waste and pollutions and the protection against the deterioration of the environment.

One ought with the recognition to notice that Polish experiences in this area are already perceptible. To such undertaking one ought to number the initiative of the transmission of the new standard GBS through the Ogólnopolskie Stowarzyszenie Wspierania Budownictwa Zrównoważonego [10]. For purposes of the Certification GBS is the promotion of buildings in which one applied project-solutions providing to:

- the comfort of the user,
- the creation of friendly conditions of the internal environment,
- the elaboration of procedures permitting the maintenance of friendly conditions of the internal environment during the exploitation,
- additional conveniences for users,
- the rationalization of the consumption of energy in the building,
- the elaboration of procedures ensuring the maintenance of the rational consumption of energy during the exploitation,
- the inclusion of users into concreting of the comfortable internal environment at the rational consumption of energy across their training.

The certificate GBS is a certificate admitted without time limit. After the minimum 12 months counted from the legally valid permission on the utilization the Investor/the Owner of the building can procure the obtainment of the Certificate GBSA (Green Building the Standard Achieved) confirming the obtainment of founded effects on the stage of the exploitation of the building.

### The proposal of solution

Currently led by authors works aim to the elaboration not only technical (the cooperation with ZPUE Włoszczowa, APA GROUP, THE ML the System) – but solutions and the specialistic software permitting the management with the electrical energy in circuits of the low-voltage network. Proposed solution is the „Intelligent settlement of the future with the system of the hybrid energy feed” - Smart Hybrid Housing Development (SHHD). This solution concentrates all kinds of intelligent solutions, namely this is the specific technological Consortium into the composition which they enter: Smart the City, Green Building, Smart Home, Smart Demand Site Management. Within the framework of these solutions one will endeavour to solutions which will transform the today's low-voltage network into the network of the future - the hybrid network. The drawing no 1 presents the centralized network, the drawing no 2 the decentralized network.



Fig. 1. Centralized the hybrid low-voltage network. The source: the own elaboration [13]

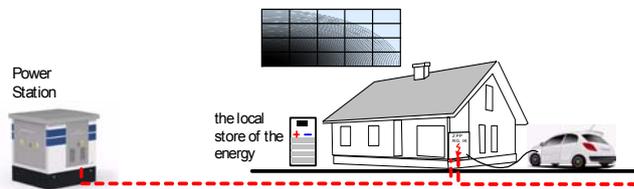


Fig. 2. Decentralized the hybrid low-voltage network. The source: the own elaboration [13]

The fundamental difference among fig. 1 and the 2 is the way of the storage of the electrical energy; in the first variant this is the store in the station (in the large dimension), in second stores are in every from buildings settles. In the network centralized one does not exclude the application, in objects, local small stores of the energy. The feed of the settlement SHHD to take place will be from the station Smart Power Station (SPS) [16], however stores in individual buildings one can lean for solutions [5,24], however remaining systems are the domain of leading partners of the project [1,2,15], and own experiences [11]. On authors of the present article will rest the intention of the elaboration of the overall concept and the project SHHD of including all his elements components. Currently, to be performed are already works [12,13], they constitute the good base to actions promotional and informational.

A justification for proposed solutions, are analyses permitting to evaluate their influence on the independence of the feed of buildings in the function of levels of the participation in the feed of renewable sources and thermal pumps. A point of departure is elaborated coefficient of the energy independence of the building  $W_{ne}$  - defined in the following way (the own elaboration Malinowski, Szkutnik):

$$(1) \quad W_{ne} = \frac{E_{zOZE}}{E_{zSD}}$$

where:  $W_{ne}$  - the coefficient of energy independence of the building,  $E_{zOZE}$  - the electrical energy by the building ordered with the regard of the energy coming from renewable [kWk] sources,  $E_{zSD}$  - the electrical energy ordered by the building supplied only from the distributional network [kWh]

For research purposes this coefficient was subordinated from the function about the figure:

$$(2) \quad W_{ne} = f(W_{POZE}, W_{PPC})$$

where:  $W_{POZE}$  - the indicator of the participation of the electrical energy ordered by the building of coming from renewable sources, (0 ÷ 1);  $W_{PPC}$  - the indicator of the participation of the thermal pump in want of the electrical energy ordered by the building on heating purposes, (0 ÷ 1).

Calculations were carried out at following foundations: the total annual demand 18 000 kWhs, in this 12 000 kWhs

on heating purposes, the air heat pump about the ind. COP = 3, the visualization of results shows the drawing 3. It gets out of him that the use of renewable sources, together with thermal pumps (the small consumption of the electrical energy) changes substantially the character of the recipient: from completely dependent on the supplier, on the recipient of practically independent (the ind.  $W_{ne} = 0,97$ ).

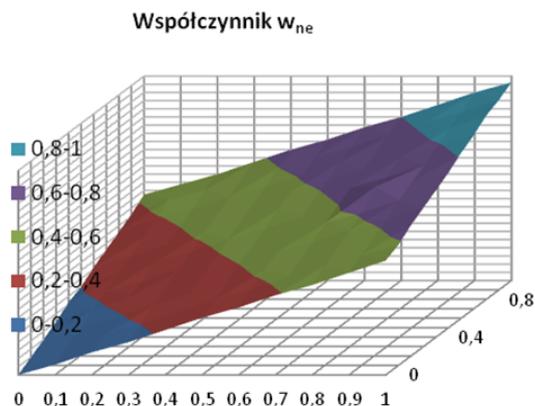


Fig 3 The coefficient of the energy independence of the building  
The source: The own elaboration.

### Conclusions

Presented in the article the model of the energy-saving building across initiating to the broad practice of recommended by authors of solution SHHD contains in himself two undeniable advantages, namely the radical reduction of the consumption of the electrical energy and through this considerable reduction costs exploitive, and furthermore, in the wider perspective, the positive influence on the run of power engineering, providing to the smaller power electrical requirement, and what this is going the reduction of CO<sub>2</sub>.

*Authors express the hope that at an early date the uprising in Poland pilotage solution which will permit the further improvement of the reference project.*

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