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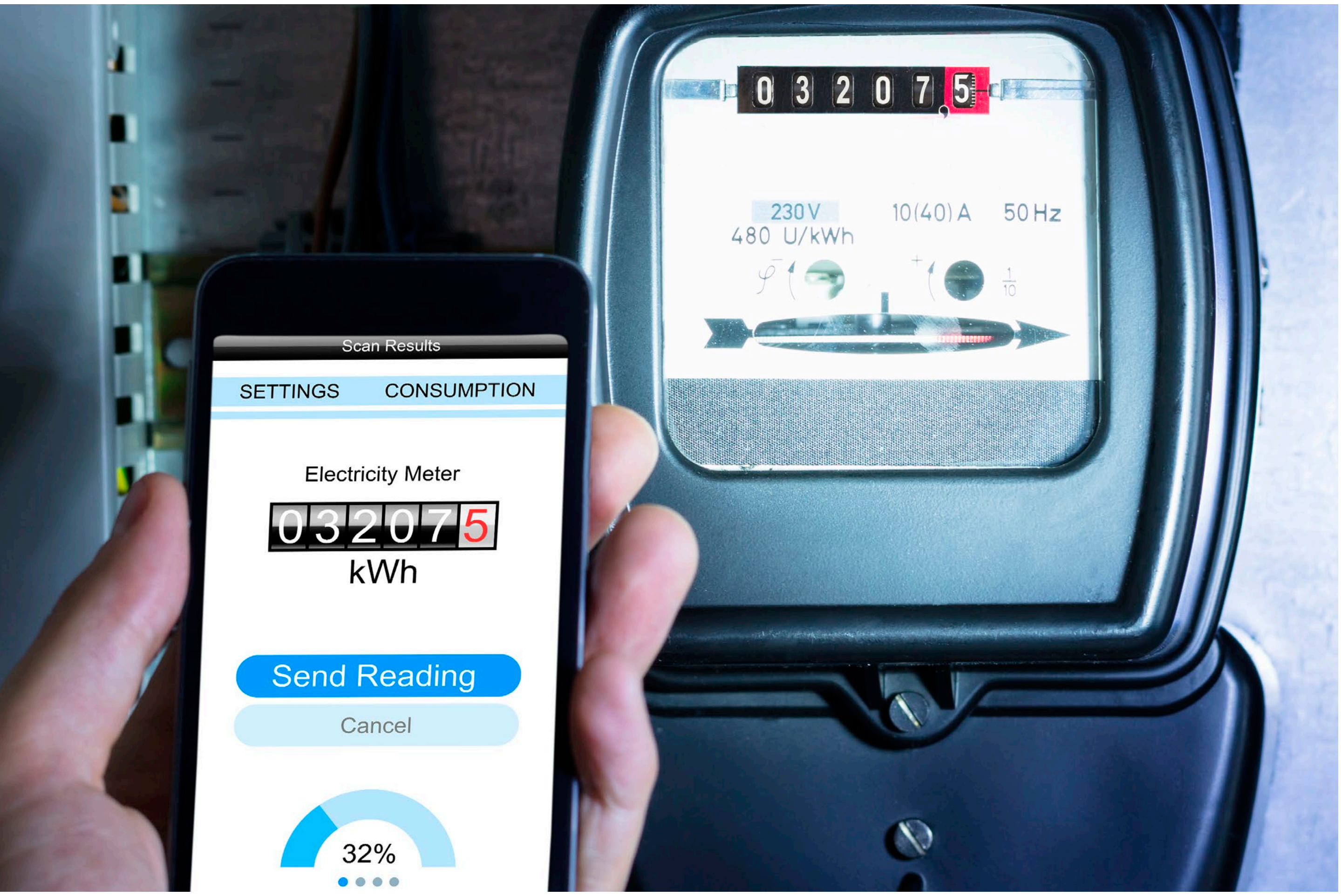

Dynamic and just

Network tariff design for the future

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Preface

When planning the modernization of the power system, we cannot rely solely on the sources of electricity generation. Energy must not only be produced, but also delivered. Grids are a key element of changes in the energy sector. The transmission and distribution system in Poland is not one of the most efficient in the European Union, therefore it is necessary to invest in its modernization and expansion. We should take advantage of new technological possibilities and adapt the system to the new energy mix. Upgrading the network in the 21st century does much more than replacing old cables and wires. It is an improvement in flexibility, digitization, an increasing dispersion of sources, active consumers and many other solutions tailored to their time. Along with the change of the mix, it is necessary to rethink the system of network charges so that they provide an impulse not only for the maintenance of the existing infrastructure, but also for its evolution—adaptation to new, active recipients and zero-emission sources.

The current tariff system is appropriate for the old energy system based on large power plants located where coal was mined. This situation will change significantly in the coming years, and for this, a new system of network tariffs is needed.

Together with the Regulatory Assistance Project, we write about the rules that must be taken into account when designing these changes.

Enjoy your read
Dr Joanna Maćkowiak-Pandera
President of Forum Energii

1. Key conclusions

- The Polish energy sector is changing fast—not only energy generation sources but also network development planning are important in this area. Investment processes spread over many years, therefore changes must take into account the vision of the energy system in 2030, when a large number of existing capacities are already withdrawn, and in 2050, when the system is to be climate neutral.
- Investment costs are, to a large extent, passed on to consumers and network charges constitute an important component of the price they pay for energy. Therefore, it is necessary to optimise capital expenditures And the necessary condition for this is a transition of the tariff design model so that it can reflect prices more dynamically.
- Time-varying price signals for consumers are necessary to shift energy consumption during peak load on the electricity grid. The introduction of volumetric energy prices and network rates, as well as the popularization of smart metres, may become an instrument for limiting capital expenditures resulting from the increasing demand for peak capacity.
- The introduction of dynamic tariffs will become inevitable due to the need to follow the increasingly variable energy market. It will constitute a substantive qualitative change compared to the existing model, in which fixed prices prevail. It will also provide the effective use of resources desired from the perspective of a decarbonised system—demand response or storage.
- Although the reform of the tariff design model in Poland is urgent, it must be carried out gradually. It is necessary to take into account the interests of customers and differentiate access to dynamic rates according to their needs. Such an offer should be available at least to active customers. It is also important to ensure the financial stability of distribution system operators.

2. Introduction

2.1. The context of the study

Energy transformation in Poland is accelerating and is becoming more and more visible at local levels. More renewable sources are being developed, the behaviour of consumers is changing as they switch to electricity production. The level of electrification of heating and transport is also growing, we are more and more willing to install heat pumps, and in the coming years the number of electric cars will increase. As a result, it is necessary to consider both the way in which distribution grids are used and how consumers should pay for using the grid.

The current tariff model has been designed with the traditional power system in mind. Therefore, it fails to reflect the challenges of transformation—ever greater changes taking place both on the generation and the consumption side. It is also not prepared to reward flexibility and shift needs depending on the supply and demand in the system, i.e. save or store energy. These disadvantages will result in increasing cost inefficiency and reduced possibility of using resources at the distribution level.

Thus, in addition to numerous necessary changes on the electricity market in Poland, the tariff model reform will be extremely significant. It is the appropriate price signals that will determine the progress of energy transformation. This is underlined by the provisions of the *Clean Energy for All Europeans* package[1]:

1 Cf. P. Wróbel, *Małymi krokami do wielkich zmian. Wpływ pakietu „Czysta energia…" na energetykę*, Forum Energii, 2019, https://forum-energii.eu/pl/analizy/male-kroki-wielkie-zmiany

Electricity prices must be non-discriminatory, efficient and competitive.

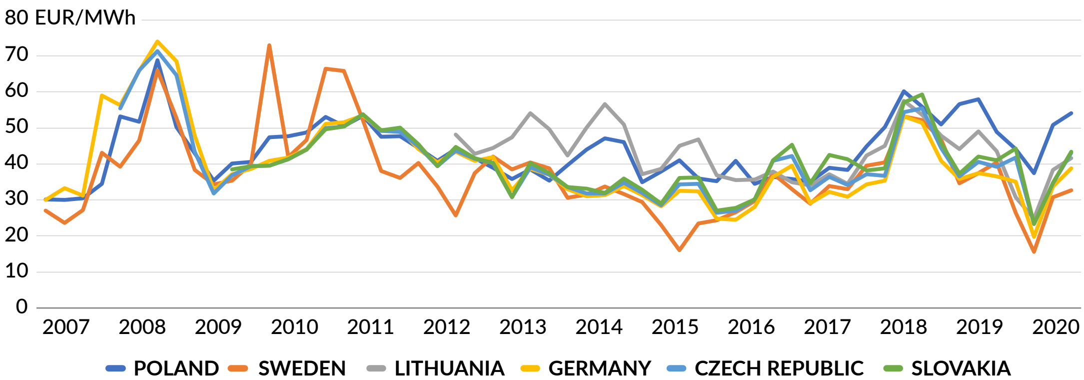
These provisions are being implemented at the moment. Therefore, it is the right time to take up the subject of tariffs in Poland and discuss with market participants their expectations and what possibilities are offered by changing the tariff system in the context of dynamic pricing. The future system must provide benefits to consumers. At the same time it cannot lead to the financial instability of distribution system operators (DSOs). All of this needs to be planned today so that prices and tariffs do not become an obstacle in the future. In this situation, the discussion on the network cost allocation, despite not being easy, may be an opportunity for the transformation of the energy system.

2.2. Why are we dealing with this topic now?

High wholesale prices

Wholesale prices of electricity in the European Union increased sharply in 2018. In Poland, the average energy prices on the Day-Ahead Market increased by over 60% compared to 2017. Although this trend was partially slowed down in other EU countries, the Polish market remained the most expensive in the region (cf. Figure 1). Large increases led to the government's decision to implement an administrative end-user price freeze in 2019. Initially, freezing transmission and distribution tariffs was planned, but the idea was abandoned under insistence of the European Commission.

Figure 1. Wholesale electricity prices in Poland and neighbouring markets



Source: own compilation based on TGE, EPEX, Nordpool, ENTSOE.

It was an unprecedented interference in the energy market. According to the Ministry of State Assets, the total cost of compensation in 2019 amounted to as much as EUR 4.6 billion[2]. It worked only temporarily, however, and did not eliminate the causes of the price increase. These in turn are related to the large share of coal in the Polish energy mix. The costs of generating electricity from this fuel grew due to increases in the prices of CO_2 emission allowances and domestic coal, as well as low competition on the Polish market that resulted in increased margins of producers[3]. In early 2020, the government planned another act to compensate consumers for the increase in energy prices, but the project was suspended due to the economic recession caused by the coronavirus pandemic.

The introduced intervention shows how sensitive electricity prices are. Meanwhile, Poland has the most expensive energy on the wholesale market in the entire European Union[4]. Energy fees account for approximately half of the end-user's bill. The remaining part is distribution fees. Their share in the bill is 39%, although these values may vary

2 80% of this amount came from the proceeds from greenhouse gas emission allowance trading. Transcript of the meeting of the Committee on Energy, Climate and State Assets (No. 9) of 17 June 2020, orka.sejm.gov.pl/zapisy9.nsf/0/AB7CA2C307526224C125859500747DA2/%24File/0037109.pdf

3 Cf. J. Maćkowiak-Pandera, J. Rączka, *Dlaczego ustawa prądowa może wywołać więcej szkody niż pożytku*, Forum Energii, 2019, https:// forum-energii.eu/pl/analizy/ustawa-pradowa

4 Ember, https://ember-climate.org/commentary/2020/10/23/polands-electricity-prices-rise-to-the-highest-in-europe/.

depending on a given group of consumers (cf. Table 1)[5]. In 2019, the highest distribution fees were paid by consumers in tariff group C (PLN 261.7/MWh), and the lowest ones in tariff group A (PLN 59/MWh)[6].

Table 1. Electricity price and distribution fee in Q4 2020

	Average selling price	Including:	
		Electricity fee	Distribution fee
Total consumers	PLN 540.7/MWh	PLN 332.1/MWh 61%	PLN 208.6/MWh 39%
Including: high voltage consumers (group A)	PLN 338.2/MWh	PLN 278.6/MWh 82%	PLN 59.7/MWh 18%
medium voltage consumers (group B)	PLN 444.5/MWh	PLN 328.7/MWh 74%	PLN 115.8/MWh 26%
low voltage consumers (group C)	PLN 697.4/MWh	PLN 416.1/MWh 60%	PLN 281.2/MWh 40%
group C consumers	PLN 547.1/MWh	PLN 310.7/MWh 57%	PLN 236.4/MWh 43%
including: households	PLN 546.2/MWh	PLN 310.7/MWh 57%	PLN 235.5/MWh 43%

*Applies to consumers with comprehensive agreements; prices and rates in net values.
Source: Agencja Rynku Energii, Sytuacja w elektroenergetyce, IV kwartały 2020, Nr 4 (113), 2020, https://www.are.waw.pl/component/phocadownload/category/7-sytuacja-w-elektroenergetyce?download=60:sytuacja-w-elektroenergetyce-nr-4-113-iv-kwartal-2020.

Distribution fees have been rising moderately in recent years. Taking into account, however, the necessary capital expenditures in distribution networks, it should be expected that network rates will increase again. Otherwise, distribution system operators will not be able to finance the necessary network upgrade or investment projects. Consumers, especially industrial ones, will look for ways to reduce the costs of using electricity, including those related to distribution fees. If building your own energy sources (including energy storage, or as part of energy communities with their own grids) turns out to be cheaper, more and more consumers will use the grid to a limited extent. In extreme cases, it will even be possible to become fully independent of it. As a result, the costs will have to be spread over a smaller number of users and will increase their bills. Therefore, it is necessary to start a discussion on changing the tariff model. The Council of European Energy Regulators indicates that implementing dynamic prices only in relation to the sale of electricity (in EU countries its share is on average 1/3 of the bill) will bring too few benefits to consumers. Therefore, it is worth introducing dynamic network tariffs[7].

Energy transition is accelerating

In Poland, the share of renewable energy in the energy mix is steadily increasing. Installed capacity in wind energy already exceeds 6 GW. Thanks to the RES auctions that have been carried out since 2019 as well as those planned in the future, in the coming years Poland will have approximately 10 GW of installed capacity in wind energy sources in the system[8].

Photovoltaics is also growing rapidly. As of 1 February 2021, its installed capacity amounted to 4.1 GW, which means more than double increase year-on-year[9]. It is expected that with further upswing in the share of photovoltaics in the

5 Energy Regulatory Office, *Sprawozdanie z działalności Prezesa Urzędu Regulacji Energetyki w 2019 r.*, https://www.ure.gov.pl/pl/urzad/informacje-ogolne/publikacje/sprawozdania-z-dzialaln/2916,Sprawozdania-z-dzialalnosci-Prezesa-URE.html

6 *Ibidem.* Consumers in group A have the lowest network rates because they are connected directly to the transmission network and do not use the distribution system

7 Council of European Energy Regulators, *Recommendations on Dynamic Price Implementation*, 2020, https://www.ceer.eu/documents/104400/-/-/2cc6dfac-8aa7-9460-ac19-4cdf96f8ccd0.

8 M. Ścigan, *Aukcje OZE w Polsce. Wyniki i trendy*, Forum Energii, 2019, https://forum-energii.eu/en/blog/aukcje-oze-2019.

9 PSE, https://twitter.com/pse_pl/status/1369599054116757505.

energy market, it will be possible to obtain over 11 GW by 2030[10]. The number of prosumers will also increase—in a decade there may be as many as a million of them[11]. Most of the new renewable generation capacity will be connected to the distribution grid, and only the largest and few sources will be connected directly to the transmission system.

A lot is also changing in terms of demand. By 2050, the demand for electricity may increase from over 170 TWh (the current use) to nearly 250 TWh[12]. This increase will result from greater consumption by the existing consumers, but also from the growing use of heat pumps in the heating sector and the development of e-mobility[13]. The energy demand in the coming years will depend on how the electrification of these sectors will proceed.

Investments in domestic distribution networks

The upward pressure on network charges will be increased by the necessary investments, the costs of which will be passed on to consumers. Therefore, it is so important to specify the future transition model in which networks play a key role. This is a great challenge for Poland—our distribution networks are obsolete and power cuts are longer than in the EU countries of Western Europe[14]. It is also necessary to increase automation and implement smart grids in Poland. Distribution network operators also bear the costs of installing smart metering systems at their customers, which is reflected in distribution rates. In the draft *Energy Policy of Poland until 2040*, capital expenditures in the next two decades are estimated at over PLN 130 billion (EUR 30 billion). This is almost 3.5 times more than investment expenditures on transmission networks[15].

Table 2. Projected capital expenditures in the electricity sector between 2016 and 2040 (in million PLN 2018)

	2016–2020	2021–2025	2025–2030	2031–2035	2036–2040	2016–2040
Total expenditures on generation capacity	92.272	52.932	55.298	107.972	103.457	319.659
Total expenditure on network infrastructure	38.438	45.309	47.635	44.188	42.895	180.026
Transmission network	6.299	7.868	13.100	10.740	10.859	42.567
Distribution network	32.139	37.441	34.535	33.447	32.036	137.459
Total expenditure in the power industry	**130.710**	**98.241**	**102.933**	**152.159**	**146.351**	**499.685**

Source: Ministerstwo Środowiska i Klimatu, *Polityka energetyczna Polski do 2040 r. Załącznik 2. Wnioski z analiz prognostycznych dla sektora energetycznego, 2021*, https://www.gov.pl/attachment/894da3e1-bb31-4b8b-a9a1-b90ce5dbe974.

Without regulatory drafts and price incentives, the transition can easily result in higher network expansion costs than necessary[16]. Another challenge for the distribution network will be the growing demand for energy, resulting from the electrification of heating and transport. Given the scale of the challenges facing the Polish distribution networks, this is the right time to investigate how to reduce these costs effectively. It is important not to invest in solutions

10 L. Bronk i in., *Jak wypełnić lukę węglową? 43% OZE w 2030 r.*, Forum Energii, 2020, https://www.forum-energii.eu/pl/analizy/jak-wypelnic-luke-weglowa.

11 Ministry of Energy *Polityka energetyczna Polski do 2040 r.*, updated document draft of 11 November 2019, https://www.gov. pl/web/aktywa-panstwowe/zaktualizowany-projekt-polityki-energetycznej-polski-do-2040-r.

12 I. Kielichowska i in., *Polska neutralna klimatycznie 2050. Elektryfikacja i integracja sektorów*, Forum Energii, 2020, https://forum-energii.eu/pl/analizy/integracja-sektorow.

13 *Ibidem.*

14 VVA, Copenhagen Economics, Neon, Deloitte, *Study on the quality of electricity market data of transmission system operators, electricity supply disruptions, and their impact on the European electricity*, 2018, https://ec.europa.eu/energy/sites/ener/files/documents/dg_ener_electricity_market_data_-_final_report_-_22032018.pdf.

15 Ministry of Energy, *Polityka energetyczna Polski do 2040 r. Załącznik 2. Conclusions of the forecasting analyses for the fuel and energy sector, updated draft document dated 11 November 2019*, https://www.gov.pl/web/aktywa-panstwowe/zaktualizowany-projekt-polityki-energetycznej-polski-do-2040-r

16 Agora Verkehrswende, *Verteilnetzausbau für die Energiewende Elektromobilität im Fokus*, 2019, https://www.agora-verkehrswende.de/fileadmin/ Projekte/2019/EV-Grid/Agora-Verkehrswende_Agora-Energiewende_EV-Grid_WEB.pdf

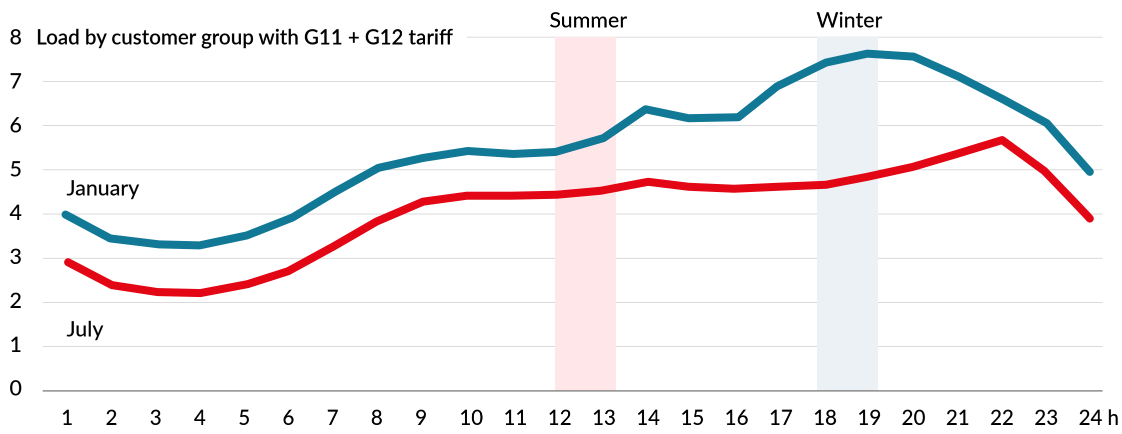
with no future. Appropriate price signals, which will encourage energy saving and shifting the demand for it in the system (*load shifting*), may reduce the costs of future investments. This will facilitate the effective use of the available financial resources and avoidance of overinvestment.

Better use of the existing infrastructure

Due to the possibility of reducing future capital expenditures, it is extremely important to increase the efficiency of using the already existing networks. Grid limitations[17] only occur for a certain number of hours a year during peak demand periods (the grids are not used to the maximum outside the network peak). In winter, the greatest load occurs in the early evening hours due to the increased demand for lighting and heating of companies and households. Although electric heating is rarely used in Poland at present, we observe a dynamic increase in the importance of heat pumps in individual heating. At the end of 2019, there were approximately 312,000 heat pumps in single-family buildings. Nearly 120,000 devices work for the needs of central heating systems. Wider dissemination of this technology will contribute to an increase in peak demand from 2.5 GW to as much as 5.4 GW by 2030 [18].

It is worth pointing out, however, that even on those days with a maximum peak demand, a typical distribution network can supply significant amounts of electricity during off-peak hours, i.e. at night and for some part of the day (Figure 2).

Figure 2. Winter and summer load on the distribution network in Poland



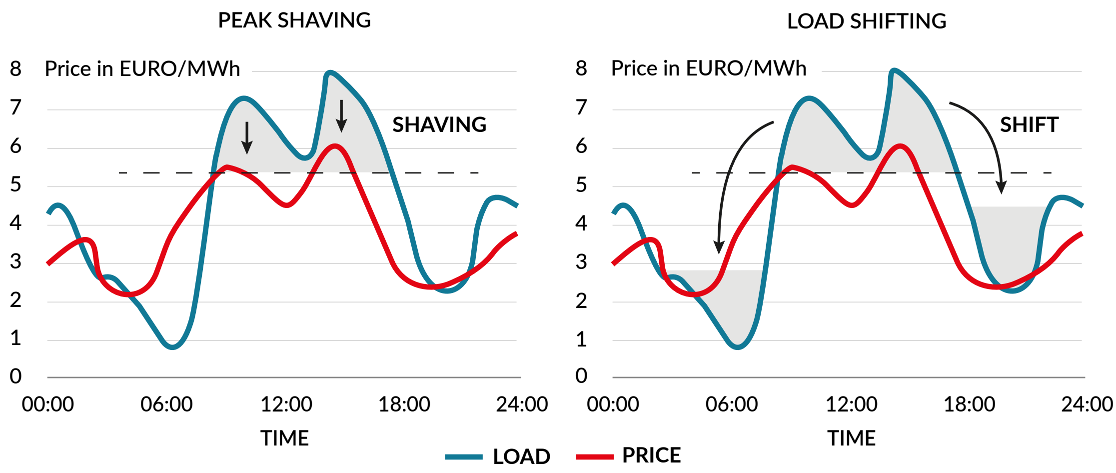
*Refers to the Enea Operator network.
Source: J. Rączka, E. Bayer, *Jak sprawić, aby konsument poprawił bezpieczeństwo systemu energetycznego i jednocześnie na tym skorzystał?*, Forum Energii, 2016, https://forum-energii.eu/pl/analizy/polak-zaoszczedzi-i-odciazy-system-energetyczny.

Even slight increases in electricity demand, reported during peak hours, will lead to an increase in the peak load and the need to expand the grid. As a result, the average cost of delivering each kilowatt hour will increase. If it is possible, however, to distribute electricity in the same network without the need to expand it, costs per consumed kWh will be reduced. The flexibility of new consumers makes it possible to cut costs for all. If they do not receive the right price signals, however, there is a risk that the fees for all network users will increase significantly.

Therefore, in many cases, a cheaper solution than grid expansion is to shift the power demand—lower it at the peak and shift it in the valley of the load curve. This is shown in Figure 3.

17 Constraints in networks occur due to peak loads (as well as emergency loads) and cause thermal overload of the line.
18 Cf. L. Bronk et al., *op.cit*

Figure 3. Peak load shifting and shaving



Source: Next Kraftverke, https://www.next-kraftwerke.pl/leksykon/peak-shaving.

Such a solution, however, is possible when there are active consumers and prosumers in the system, and the existing energy pricing method reflects its cost over time. The more system flexibility, decentralisation and the role of prosumers increase, the more the limitations of the current model will become apparent. There are already a lot of solutions in force, but it is now necessary to create the right incentives for users. For example, we know that it is beneficial for the system to charge electric vehicles during off-peak hours (e.g. at night), but if we do not introduce appropriate price signals, the cars will still be charged as soon as their owners return home. Therefore, this additional load will exacerbate the problems of the evening peak hours of the power network, increase the already existing demand and make it necessary to bear the costs of network expansion[19].

New EU regulations

The Directive on common rules for the internal market for electricity[20] provides for new solutions for network tariffs. Already in the preamble (recital 38) it is stated that Member States should assess the potential for making more dynamic or reducing the share of fixed components in electricity bills. This situation certainly applies to new consumers—owners of electric cars or those using electric heating. The changed rules of market operation, however, must also allow operators to integrate new electricity generation, especially installations generating electricity from renewable sources in the system (recital 61 of the preamble). It is up to the Member States to ensure that the amended regulations do not impede these activities, but create incentives for DSOs by adjusting network tariffs. Properly planned activities will have an impact on increasing flexibility and improving network use efficiency.

On the other hand, the regulation on the internal market for electricity[21] states it is desirable that network tariffs better reflect the real costs of electricity supply and Member States should consider introducing differentiated prices over time. Consumer groups[22] stressed that time-varying network charges were essential to ensure that consumers are properly and fairly compensated for their network-friendly behaviour and thus for the flexibility they provide.

19 Agora Verkehrswende, *op.cit.*

20 *Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU (recast), Official Journal* of the European Union | L 158/125, 14.62019.

21 *Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (recast)*, Official Journal of the European Union | L 158/54, 14.62019.

22 Centre for Competition Policy, *Designing distribution network tariffs that are fair for different consumer groups*, Report for BEUC, https://www.beuc.eu/publications/beuc-x-2018-099_designing_distribution_network_tariffs_that_are_fair_for_different_consumer_groups.pdf.

The Client Earth analysis[23] also showed that the best tariff structure to meet the requirements of the Clean Energy package consisted of two parts:

- a variable component that develops dynamically with the use of the network (different duration of use),
- a charge based on electricity consumption in the critical peak load periods.

The recently implemented rules are further specified in Article 15 of the Directive on common rules for the internal market for electricity, aimed at active consumers generating or supplying electricity. EU Member States shall also provide that active consumers are „subject to cost-reflective, transparent and non-discriminatory network charges that account separately for the electricity fed into the grid and the electricity consumed from the grid". Such consumers "shall have the possibility at any time to opt for a new scheme that accounts separately for the electricity fed into the grid and the electricity consumed from the grid as the basis for calculating network charges".

3. The current tariff structure

Network charges are commonly split into a fixed and a volumetric component. The size of the fixed charge is based on:

- the size of the customer's connection to the distribution grid,
- or the customer's peak demand over a specified period of time, typically a month or a year (usually called a demand charge).

Fixed charges are commonly denominated in PLN per period or PLN/kW per period. The volumetric (variable or usage-based) part of the bill reflects how much the consumer used and is denominated in a per-unit cost, that is, PLN/kWh[24].

The structure of distribution tariff components in Poland for end consumers in households (group G) connected to the low voltage power grid (without taxes and additional fees not related to grid operation):

Volumetric fee (PLN/kWh) – this is charged depending on the electricity consumption from the grid in a given period. It reflects the cost of grid losses and a portion of capital costs.

Quality fee (PLN/kWh) – a variable charge, depending on the electricity consumption from the grid. It covers the costs of maintaining the quality and reliability standards of the current electricity supply, which is related to the system.

Fixed network fee – for an electricity consumer in a household, it is a fixed monthly charge calculated in relation to the metering and billing system. For other consumers, it is a charge calculated per unit of contracted power (in kW for a given year); it reflects the costs of maintaining and modernizing the network, taxes, depreciation.

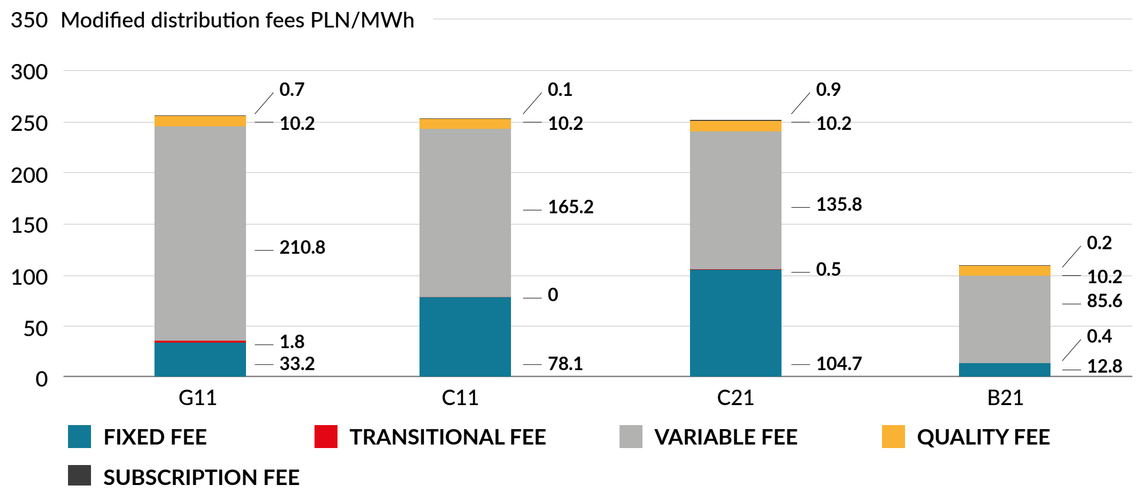
Transitional fee – it reflects the costs resulting from the early termination of the so-called long-term contracts. It is denominated in PLN per month and its rates vary for different levels of electricity consumption.

Subscription fee – a fixed monthly charge (costs of meter reading and reviewing metering and billing systems).

23 Client Earth, *Distribution network tariff design under the Clean Energy Package: legal requirements and policy impacts*, 2019, https://www.documents.clientearth.org/wp-content/uploads/library/2019-12-04-distribution-network-tariff-design-under-the-clean-energy-package-legal-requirements-and-policy-impacts-ce-en.pdf.

24 Regulatory Assistance Project, *Cleaner, smarter, cheaper: Network tariff design for a smart future*, 2018, https://www.raponline.org/knowledge-center/cleaner-smarter-cheaper-network-tariff-design-for-a-smart-future/.

Figure 4. The structure of distribution charges in selected groups of consumers (PLN/MWh)



Source: own study based on the tariff for electricity distribution services of PGE Dystrybucja S.A. for one year of supply 2021, http://bip.ure.gov.pl/download/3/13089/PGEDystrybucja.pdf.

In tariff G, traditionally most often used by Polish households, the rates are fixed in each hour of the period (as a rule—a year) for which the tariff has been approved by the President of the Energy Regulatory Office. Time-of-use tariffs are also used in Poland. They are based on the fact that in fixed periods of the day or depending on the day of the week (division of working days and weekends), the rates of fees vary. These are two-zone G12 tariffs, including the latest G12as—the so-called anti-smog tariff introduced in 2018. It was intended to encourage electrification of heating and thus reduce smog from individual coal-fired boilers thanks to lower prices at night (22.00–6.00). The three-zone G13 tariff differentiates prices in such a way that, apart from the morning and evening peak, as well as at weekends and holidays, they are lower. It also adjusts the peak to the season of the year, making it the most suited to market conditions[25].

Tariffs in Poland are established in advance, so when they are in force, they do not send price signals about the current situation in the power system. Although zone tariffs encourage consumers to reduce the load at certain times of the day, they are not used to manage the current situation in the system. Moreover, the price differences offered have been so small so far that they do not encourage consumers to change the consumption model. This applies, for example, to the anti-smog tariff, which was supposed to encourage the use of electric heating, but the benefits for consumers turned out to be insufficient[26]. Moreover, it happens that time zones are different for the same consumer in the distribution tariff and in the sales tariff.

Changing the tariff model in Poland is therefore necessary to encourage consumers to use electricity in a different way during the day.

25 Cf. J. Popczyk, K. Bodzek, M. Fice, A. Pilśniak, K. Sztymelski, R. Wójcicki, *Cenotwórstwo (2), dyfuzja dynamicznego cenotwórstwa rozproszonego do inteligentnej infrastruktury rynku wschodzącego energii elektrycznej, Biblioteka Źródłowa Energetyki Prosumenckiej*, http://klaster3x20. pl/wp-content/uploads/2018/07/4_bpep.pdf.

26 *Ibidem.*

4. Challenges of the tariff setting model reform

Pricing based on energy consumption should not expose network companies to the risk of revenue loss.

Designing network tariffs is crucial both for the efficient use of distribution networks in the short term as well as for their long-term evolution. It sets the prices consumers pay for their use of the network infrastructure and influences their consumption and investment choices (e.g. regarding the installation of photovoltaic panels or energy storage), thus influencing future network costs[27].

With regard to price signals, the consumer is dependent on the network operator. Volumetric pricing that customers respond to increases the revenue risk for the network operators[28]. Due to the increasing energy efficiency of the devices used and the increasing self-consumption, the amount of electricity drawn from the grid may decrease, and the operators will not cover the costs incurred. Paradoxically, energy savings and load shifting result in a revenue loss for DSOs in a situation where these revenues depend on consumption[29].

We are therefore dealing with the opposite expectations of market participants. For consumers, dynamic prices are the carrier of information about the value of electricity drawn from the grid at a given moment. This gives them the chance to change their hours of consumption and the related savings. For DSOs, on the other hand, the easiest solution to recover their costs is to apply fixed and consumption-independent charges. It is these structural differences that must be overcome in the new tariff model.

In the regulated area, this problem can be addressed by so-called decoupling of network revenue from what kWh will be distributed by the network[30]. The deviations of actual revenues from "allowed" revenues are recovered (or refunded) through small price adjustments in the next period. It is possible thanks to the so-called regulatory account—a mechanism allowing the regulator to settle the excess or shortfall in income of the regulated entity in the next tariff period. This is to allow DSOs to stabilize and predict revenues, and to encourage them to invest. Regulation accounts for DSOs already exist in Germany[31]; in Poland, they were introduced in November 2020[32].

While concerns have been raised that operators may use the regulation account to cover losses arising from inefficiencies in their operations, it is nevertheless a step in right direction. The introduction of zone tariffs (as in the case of the anti-smog tariff) already causes difficulties in calculation of tariffs—if there is no data on historical consumption, it is difficult to make assumptions for future charges. The ever-growing need to introduce new, time-varying fees made it necessary to develop solutions that would help to settle the tariff in the future in terms of excessive or insufficient revenues of DSOs.

Fixed charges increase network costs in the long run.

In the tariff setting process, many countries, including Poland, have adopted such a division of costs that those related to investments are reflected in the fixed (capacity-related) charges[33]. On the other hand, operating costs resulting from the day-to-day running of the distribution business form the basis for the calculation of variable

27 SEPA, *Residential Electric Vehicle Rates That Work*, 2019, https://sepapower.org/resource/residential-electric-vehicle-time-varying-rates--that-work-attributes-that-increase-enrollment/.

28 Eurelectric, *Network tariffs*, 2016, https://cdn.eurelectric.org/media/2012/network_tariffs__ position_paper_final_as-2016-030-0149-01-e-h-5AF7DC88.pdf.

29 Directorate-General for Energy, *Study on tariff design for distribution systems*, 2015, https://ec.europa.eu/energy/sites/ener/files/documents/20150313%20Tariff%20report%20fina_revREF-E.PDF.

30 Regulatory Assistance Project, *Revenue Regulation and Decoupling: A Guide to Theory and Application*, 2016, https://www.raponline.org/ wp-content/uploads/2016/11/rap-revenue-regulation-decoupling-guide-second-printing-2016-november.pdf.

31 *The German "Regulierungskonto"*, https: /www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/Netzentgelte/Strom/Regulierungskonto/RegKonto_node.html.

32 *Rozporządzenie Ministra Klimatu i Środowiska z dnia 13 listopada 2020 r. zmieniające rozporządzenie w sprawie szczegółowych zasad kształtowania i kalkulacji taryf oraz rozliczeń w obrocie energią elektryczną*, Dz.U. 2020, item 2053.

33 The tariff setting principle applied in Poland, which requires reducing the fixed component in electricity bills, is also important. Although the fixed costs of an energy distributor account for around 80% of its total costs, fixed charges can only reflect half of its total costs. This means that part of the fixed costs is already being made variable. In other words, they are covered by variable fees and not by fixed fees. This is a significant and positive fact in terms of the introduction and effectiveness of dynamic tariffs.

charges. Therefore, consumers recognise that they can only influence the variable part of their bill. This is especially relevant for distribution activities, where 80 to 90% of all costs are investments, i.e. fixed costs. In the long term, future expenses will depend on the needs identified today—in this case, the demand for power (mainly during peak periods). If consumers are not adequately incentivised to shift consumption, and especially to reduce consumption during peak hours, the system will have to be expanded.

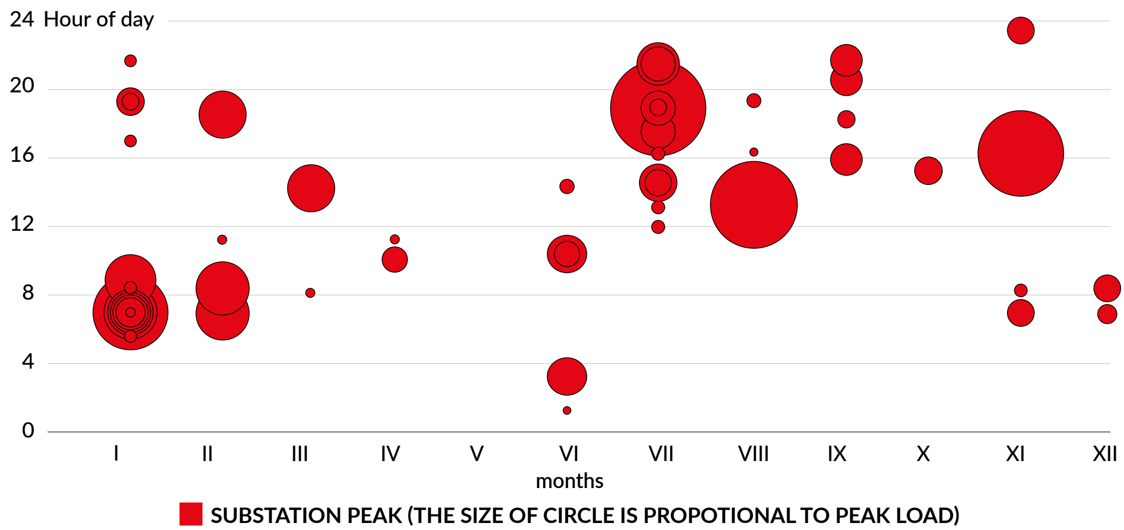
Fixed fees, as well as capacity fees, take away the power of consumers[34]. Fixed charges contradict the economic principle of pricing at marginal cost. Users do not receive price signals, paying their bills regardless of whether they purchase electricity at times of grid congestion or at times when the grid is underutilized. They also incur costs, regardless of whether they consume a lot or little, and regardless of whether they cause grid costs or help to reduce them.

When the consumer is not provided with information on the grid situation and the resulting investments, they will not be able to evaluate alternative solutions to consumption-side investments. They will use the grid based on their habits and can therefore significantly increase the evening peak load, for example by charging their electric cars when they return home. The advantage of good price incentives is that they align our habits with our financial expectations and situation in the system and its costs. To the extent that fixed fees obscure the true costs of consumption (that is, they suggest that consumption is less costly than it actually is), consumers will use more electricity than is economically efficient. Fixed fees will therefore lead to a greater expansion of the grid than is necessary and thus to higher grid costs overall. Meanwhile, the costs per kilowatt hour will rise as more network expansion is required.

The Norwegian Water Resources and Energy Directorate (NVE) studied such costs in the city of Drammen. With smart charging behaviour, i.e. taking into account price signals, the current capacity of the city's power network can meet the future demand resulting from charging electric vehicles. Uncontrolled charging could require grid investments of around PLN 400 million to 800 million (related to on-peak EV charging)[35].

The distribution grids are only moderately utilized on average. On relatively few hours per year do relevant peak loads occur. The example from the USA (Figure 5) shows that the peaks can occur at different times of the day and year in the substations of the network.

Figure 5. Substation peaks in Maryland (USA)



Source: Regulatory Assistance Project, Electric Cost Allocation for a New Area, 2020, https://www.raponline.org/wp-content/uploads/2020/01/rap-lazar-chernick-marcus-lebel-electric-cost-allocation-new-era-2020-january.pdf.

34 Regulatory Assistance Project, *Cleaner..., op.cit.*

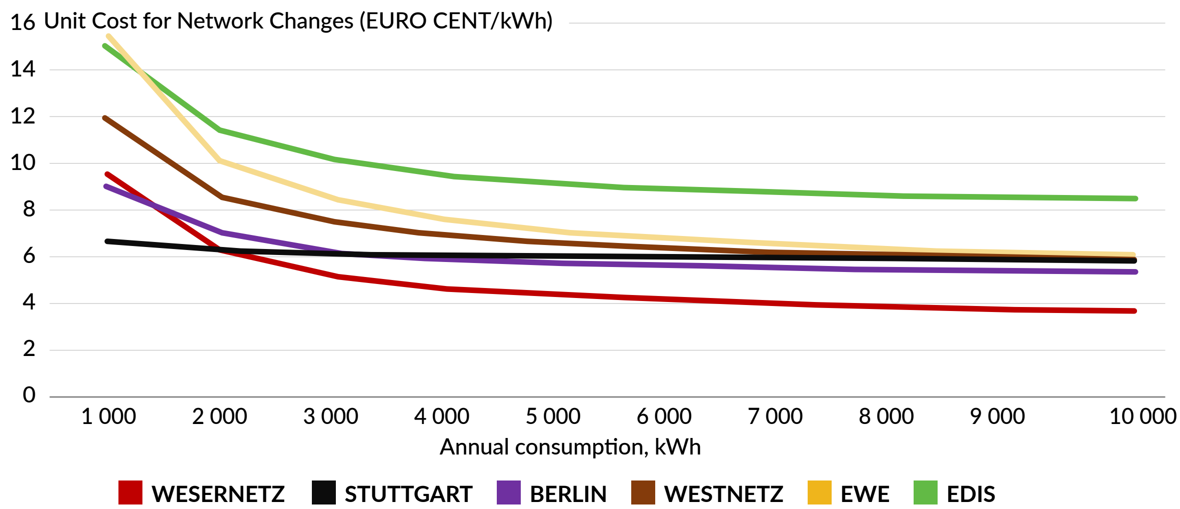
35 Regulatory Assistance Project, *Start with smart: Promising practices for integrating electric vehicles into the grid*, 2019, https://www.raponline.org/wp-content/uploads/2019/03/rap-start-with-smart-ev-integration-policies-2019-april-final.pdf.

In order to limit the future network expansion to an efficient level, knowledge of the peak load times in the distribution network is required[36]. Only then are effective methods of managing network expansion possible.

Low income customers should benefit from variable tariffs.

Low-income consumers[37] are more vulnerable to prices than other customers and should be given special consideration in social policy programs[38]. In a model where there is a single fee, independent of the moment when the user consumes electricity, low-consumption consumers are charged with costs to a much greater extent than customers using more energy. Typically, it is the financially vulnerable consumers who consume less electricity. The example from Germany (Figure 6) shows the unit costs of electricity in relation to different levels of its consumption. The presented distribution areas differ in the level of fixed fees, ranging from EUR 10 to 70. For example, in Stuttgart, fixed charges consist only of the metering costs. Low-use consumers pay only an insignificantly higher price per unit of energy than other grid customers. In grids with a fixed charge, this difference is significant. With an annual consumption of 1,000 kilowatt hours, the costs per kilowatt hour double compared to a large household customer using 5,000 kWh annually.

Figure 6. Network charges per kWh depending on annual electricity consumption



Source: Regulatory Assistance Project, Cleaner, smarter, cheaper: Network tariff design for a smart future, 2019, https://www. raponline. org/knowledge-center/cleaner-smarter-cheaper-network-tariff-design-for-a-smart-future/.

Time-differentiated fees would bring cost reduction to these customers even without demand response. By shifting the load, these customers would also benefit from corresponding time-varying charges. If we combine these considerations with the problem of heating in Poland, the effect may be even better. The electrification of heating, which must continue in Poland due to the problem of smog, will cause vulnerable customers to use more electricity for heating needs, but in this case the consumption will take place at night. The introduction of lower prices at this time, which will be reflected in dynamic tariffs, will allow users to reduce their costs.

36 CEER, *Electricity Distribution Network Tariffs, CEER Guidelines of Good Practice*, 2017, https://www.ceer.eu/documents/104400/-/-/1bdc6307-7f9a-c6de-6950-f19873959413.

37 The definition of a vulnerable customer contained in the Act of 10 April 10 1997—Energy Law Act (Official Journal 1997, No. 54, item 348) refers to persons who, pursuant to the Act of 21 June 2001 on housing allowances (Official Journal 2019, item 2133) have been granted a housing allowance and are parties to a comprehensive contract or an electricity sales contract concluded with an energy company and reside in the place of electricity supply. A person is entitled to a housing allowance if the average monthly income per household member in the period of 3 months preceding the date of application for a housing allowance does not exceed 175% of the amount of the lowest old-age pension in a single-person household and 125% of that amount in a multi-person household.

38 Urząd Regulacji Energetyki, *Sprawozdanie z działalności Prezesa Urzędu Regulacji Energetyki w 2019 r.*, https://www.ure.gov.pl/pl/urzad/informacje-ogolne/publikacje/sprawozdania-z-dzialaln/2916,Sprawozdania-z-dzialalnosci-Prezesa-URE.html.

Vulnerable consumers can therefore benefit from the introduction of price differentials and from cheaper off-peak rates. While this may, of course, not apply to all consumers in this group, it does not justify a departure from an effective tariff policy. The burden of network and energy costs for these consumers should be sustainably reduced through effective consumption reduction in the form of individual guidance loans and subsidies for energy efficiency investments[39].

5. New approach to network tariff designing

The introduction of dynamic tariffs will become inevitable due to the need to follow the increasingly volatile and flexible energy market. It will constitute a substantive qualitative change compared to the existing model, in which fixed prices prevail. Therefore, the new tariff system must be well prepared and designed. The main categories of time-varying prices are presented in the box below.

Time-of-Use Rates (TOU), in which the price changes during specific hours of the day (depending on the demand, i.e. at peak or off-peak). These may be different times depending on the season, but both the prices and the prices and the price interval hours remain constant.

Peak Time Rebate (PTR), when consumers are paid for demand reductions at peak time.

Critical Peak Pricing (CPP) reflects the higher system costs on certain days or times.

Real Time Pricing (RTP), in which the price changes in real time (usually hour by hour) depending on the balance between supply and demand. The reference price is usually the day-ahead market price.

Sources: SEPA, Residential Electric Vehicle Rates That Work, https://sepapower.org/resource/residential-electric-vehicle-time-varying- rates-that-work-attributes-that-increase-enrollment/; Regulatory Assistance Project, Start with smart. Promising practices for integrating electric vehicles into the grid, 2019, https://www.raponline.org/wp-content/uploads/2019/03/rap-start-with-smart-ev- integration-policies-2019-april-final.pdf.

Consumers should pay for grid services in proportion to how much and when they use the grid.

Despite the fact that most of the network costs are related to fixed components—asset maintenance and future capital expenditures—distribution rates that do not change over time should not be the basis for charges paid by customers. To take advantage of distributed energy sources and demand management options, but also to limit future network expansion costs, it is necessary to reflect price volatility over time so that consumers can pay in proportion to how they use it. Although flat rates are widespread (e.g. in the Netherlands), they are not cost-effective. The approach to dynamic pricing, however, is gradually changing around the world and examples of the use of time-varying prices can also be found in Europe. In Denmark, where all consumers were to be equipped with smart meters by the end of 2020, DSOs are increasingly offering this type of services (e.g. Radius in Copenhagen)[40].

Consumers who generate electricity should cover their fair share of grid costs.

If grid costs are designed according to the actual utilization of the network (high at peak times, lower at off-peak times), these active consumers will also pay according to the grid situation. In the case of those who are also prosumers, it will be important to treat their activity in the network fairly and to settle the energy they feed in and consume. The behaviour of prosumers has an impact on the distribution network, which should also be reflected in tariffs. The dynamic development of prosumer PV energy generation in Poland is improving the power balance during the summer peak load. This is possible due to the high correlation of solar energy generation with the occurrence

39 H. Thomson, S. Bouzarovski, *Addressing Energy Poverty in the European Union: State of Play and Action*, EU Com, EU Energy Poverty Observatory, 2018, https://www.energypoverty.eu/sites/default/files/downloads/publications/18-08/paneureport2018_final_v3.pdf.

40 Danish Energy Agency, *Liberalisation of the Danish Power Sector 1995–2020. An international perspective on lessons learned*, 2020, https://ens.dk/sites/ens.dk/files/Globalcooperation/liberalisation_of_the_danish_power_sector_-_report_final.pdf.

of summer peak[41]. Therefore, at such times, self-consumption should save on charges and the energy fed to the grid should be rewarded[42]. The situation is different during winter peaks. In the case of time-varying charges, this will mean that also all active consumers, including prosumers, will bear higher costs.

Different network tariffs for different consumer groups.

For many households with relatively low electricity consumption and no electric vehicles or heat pumps, a volumetric-only grid tariff is sufficient. If these consumers are able to adapt their energy consumption to price signals, they should also have access to tariffs increasingly differentiated over time. Dynamic prices, in turn, will be of great importance for consumers who have the ability to store energy, and thus reduce consumption at the peak. Also, for prosumers who actively participate in the market and have smart meters, it will be possible to adapt production and consumption volumes to price fluctuations flexibly[43].

Recommendations

Tariff design is an integral part of public policy goals that should support, and not impede, the energy transition. Soon, after the deregulation of electricity prices for household consumers, tariffs will apply only to distribution and transmission.

Smart tariffs empower consumers to take correct action. Power networks are not, in themselves, an end. They were built to supply electricity to consumers and were paid for by them. Therefore, these active consumers must also be given the opportunity to participate in determining the future costs of electricity grids through their usage preferences. For this, tariffs need to be non-discriminatory, transparent, and predictable[44]. In order to achieve these goals, active regulation is necessary, which weighs the challenges and opportunities, and translates them into the regulated network operator requirements.

The current utilization of the distribution networks is low. Tariffs can help optimize the use of existing network assets and minimise future investments. Changes supporting energy savings or demand shifting, especially by new consumers, the owners of electric cars or heat pumps, will benefit all users, not only those active ones.

But the process of implementing innovations in the tariff setting model will certainly be gradual and may require a pilot approach. Its change in Poland requires that we take into account the issue of strengthening the financial stability of distribution system operators by separating the operators' revenues from distributed energy. It is also necessary to increase access to and transparency of network data. The very process of reforming network tariffs should take into account various categories of consumers and make it possible for, above all, active consumers to choose dynamic prices.

Data on distribution networks as an essential element of planning

The condition of the grid and its importance for local distributed energy are key to the successful transformation of the system. There is a period of significant investments ahead of distributors (cf. table 2)[45]. This is due to the fact that the average age of the existing networks in Poland is high, and it is also necessary to increase the share of underground cables. There are no publicly available analyses, however, that will provide information on where, what and how expensive investments are planned. For the purpose of network tariff design needs, it would be helpful to

41 J. Maćkowiak-Pandera, *Jak sobie radzimy ze szczytami letnimi? Bilans zmian po kryzysie 2015 r.*, Forum Energii, 2018, https://www.forum-energii. eu/pl/analizy/szczyty-letnie-bilans&.

42 Future changes in tariff setting principles must take into account current support schemes for prosumers.

43 https://www.ure.gov.pl/pl/urzad/informacje-ogolne/aktualnosci/8820,Rekomendacje-Rady-Europejskich-Regulatorow-Energetyki-Council-of-European-Energy.html.

44 CEER, *Electricity Distribution Network Tariffs. CEER Guidelines of Good Practice*, 2017, https://www.ceer.eu/documents/104400/-/-/1bdc6307-7f9a-c6de-6950-f19873959413.

45 R. Tomaszewski, *Sieć do zmiany: Jak zreformować polski sektor dystrybucji energii elektrycznej*, Polityka Insight and Research, 2019, https://www.politykainsight.pl/en/_resource/multimedium/20182100.

make the data on network utilisation accessible. Based on this data only, the need for expansion and the management of a new network tariff can be discussed and adjusted with the regulator and the public.

Strengthening the financial stability of distribution system operators

The introduction of time-varying network tariffs requires distribution system operators to be involved in the preparation of the tariff system reform. One of the most important risks they stress is the lack of financial stability when linked to the volume of electricity supplied[46]. The solution should be to make DSOs' revenues independent of the volume of distributed electricity[47]. In practice, this is done by the regulatory account, which is already used in many EU countries. It has just been introduced in Poland.

Price regulation and vulnerable consumers

New EU legislation obliges all Member States to deregulate prices. An important aspect is also the appropriate protection of vulnerable customers. Therefore, Poland is facing the challenge of reforming the entire tariff system in a much more thoughtful way than the compensations introduced in 2019. Price deregulation must be accompanied by programs that provide genuine protection to vulnerable consumers—supporting energy efficiency and reducing bills permanently. Currently applied in Poland, so called energy bonuses are not a sufficient solution. The introduction of systemic solutions in Poland will facilitate the transition to dynamic prices and tariffs.

Time variable network charges

As a result of the abolition of price regulation, suppliers can begin to convert the existing, time-variable network tariffs into end-customer tariffs. At the same time, it should be ensured that time-variable tariffs are offered to all consumers with smart meters and electric vehicles, which will allow for greater cost savings compared to the flat tariff. Based on the available data on network utilisation, time-varying network tariffs could be precisely designed, and the appropriate price spread introduced.

The phased approach

Dynamic tariffs should be introduced gradually so as to make potential adjustments and changes possible. The demand response of consumers will show the effectiveness of price differentiation, which may be different for specific customer groups. Based on the results, the times and prices can then be adjusted precisely. The transfer to new tariff groups may be introduced on a voluntary basis, but it should certainly be available to customers who can flexibly shape their needs (owners of smart meters or electric vehicles).

Reduced network investment needs

The introduction of volatile energy prices and network rates, as well as the popularization of smart metres, may become an instrument for limiting capital expenditures resulting from the increasing demand for peak capacity. The more the existing network is used, the more future expansion costs can be reduced. This means that those consumers who will not use them can also benefit from the introduction of dynamic tariffs. At the same time, further investments in the networks in Poland will be necessary anyway, due to the need to improve supply parameters. Therefore, distribution grids should use EU funds, more than one-third of which must be allocated to the energy transition.

46 Euelectric, *Network tariffs…, op.cit.*

47 Regulatory Assistance Project, *Revenue Regulation…, op.cit.*

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Notes

Dynamic and just.
Network tariff design for the future

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