SELECTED HIGH-IMPACT MEASURES

Phasing-Out Consumer Subsidies. Prospects and Challenges for Ukraine's Natural Gas and Electricity Sector

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Low Carbon Ukraine

Implemented by Berlin Economics

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based on a decision of the German Bundestag

Motivation and project background

This policy proposal is part of a series which was elaborated in the framework of the project Low Carbon Ukraine (LCU) supporting more ambitious paths for selected energy and climate policy areas.

The idea to develop the present ten “Policy Proposals” arose in the course of LCU’s support for the Ministry of Energy of Ukraine in setting up a National Energy and Climate Plan for Ukraine. While Ukraine’s climate targets are partially very ambitious, we often observed a lack of underlying analysis and concrete policy measures to achieve those targets. For the most crucial topics, we provide a comprehensive analysis and propose concrete policy measures based on international experience.

Each Policy Proposal was written in a multi-stage process: a first draft of LCU experts or invited professionals was discussed over summer and early autumn 2020 with Ukrainian experts and stakeholders. Results of those discussions were taken into account when updating the Policy Proposals. It is important to note, that the presented results reflect the view of the authors and not necessarily the position of the BMU (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety).

We hope that the present analysis and proposals will contribute to a fruitful and constructive discussion and help Ukraine to develop ambitious, yet realistic energy and climate policies.

Dr. Georg Zachmann, project leader
Ina Rumiantseva, project manager

Low Carbon Ukraine is a project with the mission to continuously support the Ukrainian government with demand-driven analysis and policy proposals to promote the transition towards a low-carbon economy. It is part of the International Climate Initiative (IKI) and is funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) on the basis of a decision adopted by the German Bundestag. The project is implemented by BE Berlin Economics GmbH.

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Executive summary

Fossil fuel subsidies have been a popular measure for governments all around the globe. However, subsidies can have a range of adverse effects on the economy, which is why large international organisations, like the World Bank, the OECD as well as the IMF, advice to phase-out these subsidies.

By promoting wasteful consumption and discouraging the implementation of low-emission production technologies, energy subsidies can lead to an increase in Greenhouse Gas (GHG) emissions. Further, the IEA (2019) demonstrated that they rather benefit wealthy recipients and that only a small portion arrives at low-income households, thus they can even promote income inequalities. Further, subsidies can pose a substantial burden to government budgets – and consequently taxpayers.

This paper focusses on consumer subsidies in the natural gas and electricity sector. Producer subsidies in the coal sector are covered in a separate proposal and are proposed to be phased-out in accordance with the coal transition.

Substantial steps were pursued in Ukraine's gas market, leading to (nearly)[1] market-based pricing. While the gas market Public Service Obligations (PSO) regime was abandoned in 2020 (ICIS, 2020), there is a threat of returning to politically determined prices when gas prices pick up and/or the economic situation deteriorates, as was demonstrated by actions taken by the Government in light of the COVID-19 pandemic (CMU, 2021). In line with the IMF recommendations, prices should be permanently de-politized. Still, the progress in this sector demonstrates that if a subsidy phase-out is accompanied by appropriate measures, it is publicly accepted and can lead to a functioning market.

The electricity sector is yet to follow, which is why a gradual phase-out of consumer subsidies – i.e. an elimination of the price gap between actual and efficient prices – until 2022 is proposed and discussed here. The phase-out should happen in the form of a liberalisation of final consumer prices together with a phase-out of the PSO scheme. It should be accompanied by a clear energy sector strategy and by increasing the support for the Housing and Utilities Subsidies (HUS) programme. Overall, economic savings from the phase-out of consumer subsidies in the electricity sector could reach on average EUR 1.6 bn annually over the next ten years, whereas the increase in HUS payments is estimated to amount to an average of EUR 285 m annually.

This paper is part of a series of policy proposals which pose the potential of having a high impact for reaching Ukraine's energy and climate goals. It presents a first proposition as well as first back-of-the-envelope calculations. For a detailed evaluation of the consequences for Ukraine's economy and emissions, more detailed modelling is required. All ten propositions of the policy paper series should then be considered to take reciprocal effects into account.

[1] In past years, natural gas prices fully reflected market prices for certain months and years (IEA, 2020). However, this was not always accurately transferred to households or transferred with delay, thus the natural gas pricing mechanism did not work perfectly.

Current state of energy subsidies in Ukraine

I. Preliminary considerations

Fossil fuel subsidies cause a range of inefficiencies and can present a burden to public finances.

Energy subsidies have been a popular measure for governments all around the globe to address job creation, energy access and poverty. However, fossil-fuel subsidies encourage wasteful consumption, slow down technological innovation and renewable energy development and can potentially present a burden to government budgets – and therefore to taxpayers. Accordingly, the OECD (2019) names energy subsidies as an important reason for (1) limited investments in the energy system and (2) low levels of energy efficiency as well as a burden on public finances in Ukraine. Moreover, the efficient introduction of carbon pricing – as proposed in the policy proposition "A Revision of Ukraine's Carbon Tax" (part of the policy paper series) – calls for a phase-out of subsidies to achieve responsiveness to price signals. The Box on page 5 summarizes the main arguments of why Ukraine should phase-out energy subsidies.

Subsidies can take on many different forms; hundreds of different measures were identified as subsidies by the OECD.

However, the identification of fossil fuel subsidies can be very complex. The OECD "Inventory of Support Measures for Fossil Fuels" (2015) identified about 800 different measures as fossil fuel subsidies. They base their inventory on the cross-sectoral definition of subsidies set in the Agreement on Subsidies and Counterveiling Measures (WTO, 1996)[2]. This subsidy definition sets a standard for all WTO members. However, not all of the measures characterised as subsidies by this definition are classified as such under Ukrainian national law (OECD, 2018a). The OECD "Inventory of Energy Subsidies in EU's Eastern Partnership Countries" (2018) presents estimates for energy subsidies in Ukraine on the basis of the WTO definition. The Bottom-up inventory classifies subsidies into four different categories: direct transfers, tax expenditure and other government revenue forgone, induced transfers and transfers of risk to government. The most straightforward types of mechanism – direct transfers and tax breaks – directly affect government budgets. However, this is not necessarily always the case. A demonstration of the complexity of measures is given by the overview of examples for measures belonging to the four categories presented in Table 2 in the Annex.

Subsidies can benefit energy producers and/or consumers.

Apart from categorising subsidies according to the type of mechanism, subsidies can also be categorised along the type of energy subsidised or along the beneficiary – i.e. producer or consumer subsidies. This is reflected in the IEA's (1999, p.43) definition of energy subsidies: "An energy subsidy is any government action that concerns primarily the energy sector and that lowers the costs of energy production, raises the price received by energy producers, or lowers the price paid by energy consumers".

Only subsidies affecting consumer prices are regarded here.

Instead of using a bottom-up inventory approach, here, a more pragmatic, top-down approach is used. The IEA's (1999) price-gap approach is applied, which compares consumer prices to a reference price[3]. It only captures those subsidies that reduce observable, cumulative prices for consumers. It thus only refers to the third part of the IEA's definition. Moreover, it does not allow to draw any conclusion about the source of the subsidy or whether it affects government budget. Still, the approach is able to identify the costs for the economy which is caused by an inefficient level of consumption due to under-pricing of energy[4].

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[2] According to Article 1.1. a subsidy exists if 1) there are direct transfers of funds by the government, 2) there is government revenue forgone or not collected, 3) the government provides goods or services (other than general infrastructure) or purchases them, or 4) the government provides price support, and hereby a benefit is conferred.

[3] In contrast to the IMF, the IEA's estimations do not include externalities, such as CO_2 emissions that are not internalised due to a lack of proper CO_2 pricing. It is also refrained from including externalities in this paper as a) environmental costs – which constitute the main form of non-internalised costs – are covered in the proposal on CO_2 pricing, and b) it is controversially discussed whether subsidies estimates should include the costs of externalities.

[4] Efficiency costs result from pricing below opportunity costs, which leads to a misperception of scarcity of energy and thus to a level of consumption above economic efficiency. When evaluating the justification of a subsidy, these costs need to be compared

Furthermore, the price gap approach is able to capture effects on energy intensity as well as on the choice of technologies and thus the effects on CO_2 emissions, which is at the heart of this policy paper series.

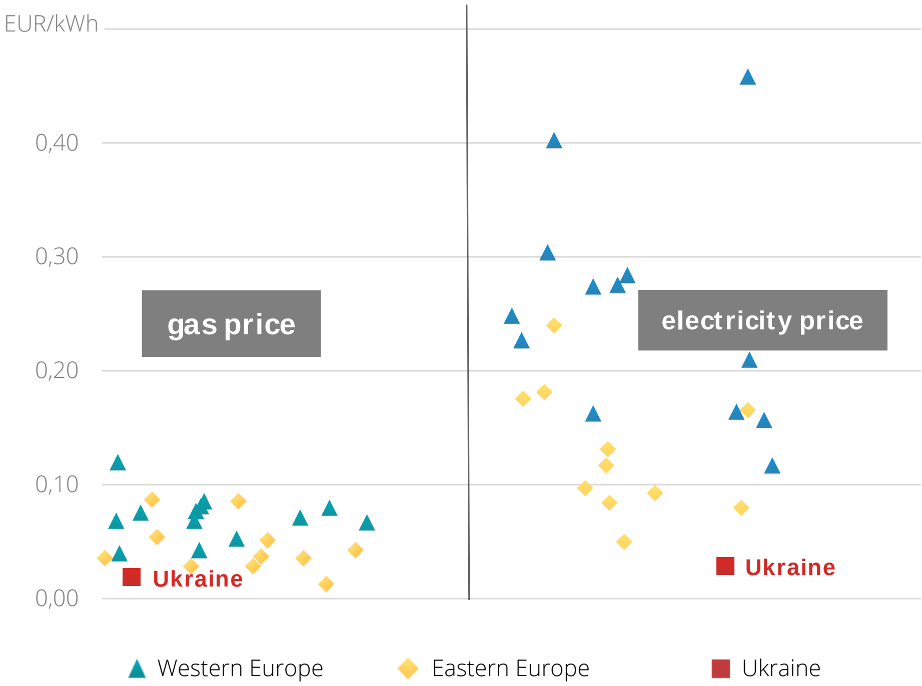
Ukraine ranks the 20th among the countries with the highest energy subsidies globally.

According to the IEA's estimations, Ukraine's energy subsidies rank the 20th globally with subsidies of EUR 1.9 bn, making up 1.4% of its GDP. The subsidies identified by the IEA in Ukraine solely comprise the electricity sector. However, in past years, there were subsidies present also for natural gas (IEA, 2020). Therefore, this paper focuses on subsidies for electricity as well as natural gas consumption. Oil prices are fully liberalised in Ukraine (OECD, 2018a). Subsidies directed to the coal sector are analysed in Policy Paper "A socially sustainable coal phase-out in Ukraine" (Zachmann, Temel, von Mettenheim, 2021).

in the coal sector, producers instead of consumers are subsidized. Subsidies amounted to EUR 407 m in 2019. However, a bottom-up inventory approach was used to quantify these subsidies, thus the magnitude of subsidies identified cannot be compared directly to the results presented in this paper.

Figure 1 illustrates that Ukrainian consumer prices are low in European comparison for both natural gas and electricity. Reasons for that can be differences in taxes (which were excluded in the graph, though)[5], tariffs or underlying energy prices. In the following, the reason for the price difference will be analysed.

Figure 1: Gas and electricity prices for households in Ukraine - among the lowest in Europe (excluding taxes, 2018)



Note: 2018 prices are presented for illustrative purposes, as the IEA does not identify any subsidies for natural gas for 2019 in Ukraine.

Source: European Commission (2020)

to the public-good benefits. Furthermore, in economic theory these efficiency costs should only be accepted if subsidising energy is the most efficient way to reach a certain public policy goal, which is however hard to prove in reality (IEA, 1999).

[5] Different energy or carbon taxes can also result in differences in prices. However, this topic is addressed in the paper "A Revision of Ukraine's carbon tax".

Background info

Why should fossil fuel subsidies be phased-out?

Apart from encouraging wasteful consumption, slowing down technological innovation and renewable energy development and potentially presenting a burden to government budgets, energy subsidies are also often inefficient in achieving their re-distributional policy objective (IEA, 1999). They are often badly targeted and further reinforce existing inequalities (IMF, 2020). Estimations of the IEA (2019) show that in 2019, global fuel subsidies amounted to USD 400 bn. However, only 8% of these subsidies reached the poorest 20% of the population.

Additionally, subsidies emphasise dead-weight losses in the subsidised sector (ESMAP, 2010). Also, in the case of Ukraine, consumer subsidies in the gas and electricity sector are badly targeted. They do not only benefit vulnerable consumers – in the sense of low-income households – but benefit all households. Consequently, even wealthy households are subsidized, who commonly consume more energy and thus benefit more from these subsidies than low-income households.

Moreover, energy subsidies increase emissions, decrease the responsiveness of demand to price changes (which is inter alia required for efficient carbon pricing) and can lead to losses for energy companies due to under-priced commodities resulting in under-investment.

Phasing-out subsidies can present substantial benefits for the economy. By phasing-out fuel subsidies, Ukraine could incentivise households to reduce energy consumption, which would lead to a decreased dependency on energy imports. Further, there would be higher incentives to improve efficiencies, presenting environmental benefits in the form of reduced GHG emissions. Additionally, the phase-out could lead to fiscal and welfare benefits and if designed thoughtful, even reduce inequalities.

But phasing-out subsidies also presents challenges. Energy prices will increase, which is not only politically unpopular, but could also be regressive, if no additional policies to offset this effect are implemented. Compensating vulnerable groups of the population with cash or non-cash transfers, can not only help to address adverse effects of a subsidy removal but also improve public acceptance of the reform.

II. Sector analysis

The IEA's price gap methodology is adopted to identify subsidies.

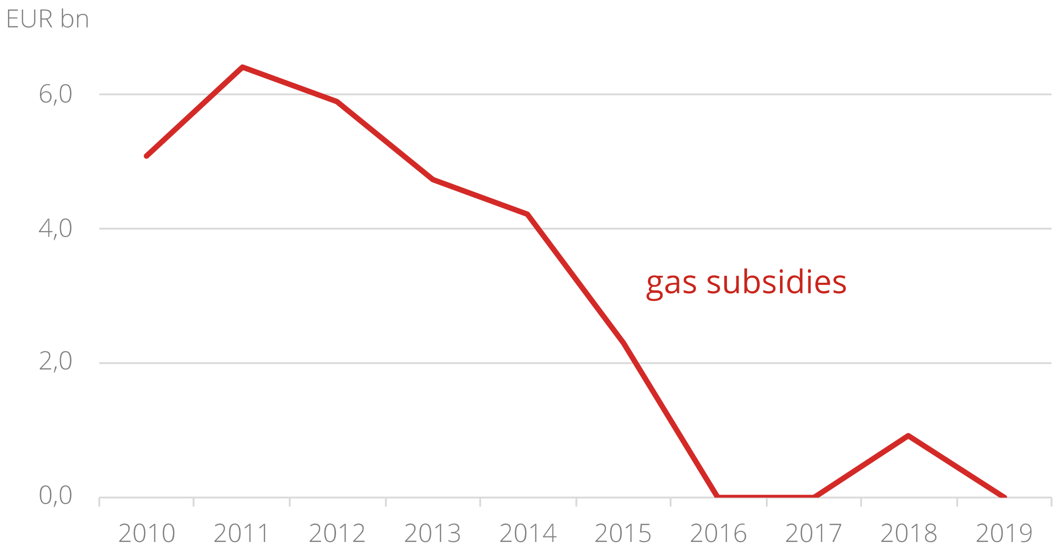
In this paper, subsidies are approximated via the price-gap-approach, as proposed by the IEA (1999) and applied to Ukraine by Ogarenko and Hubacek (2013). The "price gap" is defined as the difference between end-user prices and a reference price that would prevail in competitive, undistorted markets where no subsidies are provided. A detailed description of the methodology and data used can be found in chapter 5.2.2 of the Annex. While the price gap approach likely understates fossil fuel subsidies, as it only captures those that affect consumer prices (IEA, 2020), applying this approach can be justified by the following: first, this approach is able to identify emission savings from removing subsidies, which is of main concern in this policy paper series. Second, underpriced natural gas and electricity for households were/are the main reasons for inefficiencies in both sectors, as regulation, market design, taxation and laws enabling the subsidies are shaping revenue streams in the system (see the subsequent analysis).

In the following, subsidy estimates by the IEA for past years are presented and regulatory developments that shaped these subsidies are addressed. In the end, own estimates for subsidies in the electricity sector are given for 2019, to evaluate the effects of phasing out these subsidies in the subsequent sections. For natural gas, the IEA does not identify consumer subsidies for 2019 anymore.

a. Natural gas

The main challenge in the price gap approach is to find a good reference point – as in different countries, different sharing of cost/benefit in the sector are hardwired through regulation and it is not clear which one is the most cost-reflective. Natural gas is extensively traded in Ukraine with other countries and Ukraine is a net-importer of natural gas (Ukrstat, 2020). Thus, the import parity price is used as a reference price in this case, adjusted by transportation and distribution costs. Figure 2 presents the IEA estimates until 2019.

Figure 2: Natural gas subsidies in Ukraine significantly decreased over the last decade



Source: IEA (2020)

Natural gas price subsidies substantially declined in past years.

In 2014, households paid around EUR 22 for thousand cubic meters. In contrast, industrial consumers paid EUR 222[6] (Bayramov and Marusyk, 2019). Since then, the graph depicts a steep decline in subsidies for naturals gas due to a combination of factors: A decrease in gas prices at the international market, reduced domestic consumption and revision of tariffs.

But the subsidisation left its marks: it costs the government billions of Euros between 2012 and 2015.

The drastic consequences of such high subsidies that were previously in place could be illustrated on the example of Naftogaz, which received compensation with a complex mechanism of inter-budget transfers (subvention) until 2012 (OECD, 2018). These transfers were not sufficient to maintain liquidity and recover the deficit resulting from the difference of import prices and consumer prices. In order to timely pay for imported gas, the company had to take on loans. However, Naftogaz would not have been able to pay back loans without government support. Therefore, the Cabinet of Ministers developed special state bonds, that were issued from 2012 to 2015, to recapitalise Naftogaz (OECD, 2018a). All in all, bonds worth UAH 142 bn (EUR 5 bn) were issued for capital injection into Naftogaz. This demonstrates that subsidies are not only counterproductive for the energy transition, but that they can also present a high financial burden to governments.

[6] Conversion based on 2014 exchange rates.

Consequently, the IMF set the deregulation of natural gas prices as a precondition to receive loans.

Nonetheless, in 2015 the government took steps to deregulate pricing in wholesale and retail gas markets and raised tariffs for regulated consumers. This was a precondition to receive IMF loans. To reduce the burden for households, the reforms were accompanied by progressive changes to the Housing and Utilities Subsidies (HUS) mechanism. By the redesign, the coverage of poorer households was increased (Dodonov, 2018).

While large subsidies were abolished and import-parity pricing was introduced in 2016, the revision of tariffs for households to reflect price increases at the international market was often delayed for political reasons. Since then, there have been several attempts to further reform gas prices. In May 2019, it was decided on a regulation for residential gas prices consisting of two options. Under the first option, gas prices were determined by a PSO-formula, whereby a 20% discount was applied as a price cap to an import parity price average for the period of November 2018 to January 2020. Under the second option, prices were determined by current import prices.

The government of Ukraine could switch between both options and choose the option that presented the smaller prices for end-consumers. This allowed to benefit from low international gas prices in summer 2019 and to switch back to the price cap as soon as import prices picked up.

In the beginning of January 2020, the first option was replaced by a temporary guaranteed gas price, which was set at UAH 5500 /tcm (around EUR 200 /tcm). At the end of January, the temporary guaranteed gas price was changed again to a price cap determined by four components; The average end-of-day prices at TTF and NCG gas hubs for the first 22 days of the gas delivery month, the spread between average end-of-day and actual prices at these hubs, the Ukrainian gas entry fee at the European border and a regulated Naftogaz mark-up (Naftogaz, 2020). In summer 2020, the PSO scheme for gas supplied to households (not yet for district heating purposes) was removed (ICIS, 2020). Still, due to the COVID-19 pandemic and the related quarantine measures, the government returned to regulated prices at the beginning of 2021, which it set below market prices and hereby returned to gas price subsidies (CMU, 2021). Nonetheless, the government emphasized that this was a short-term, quarantine-related measure only.

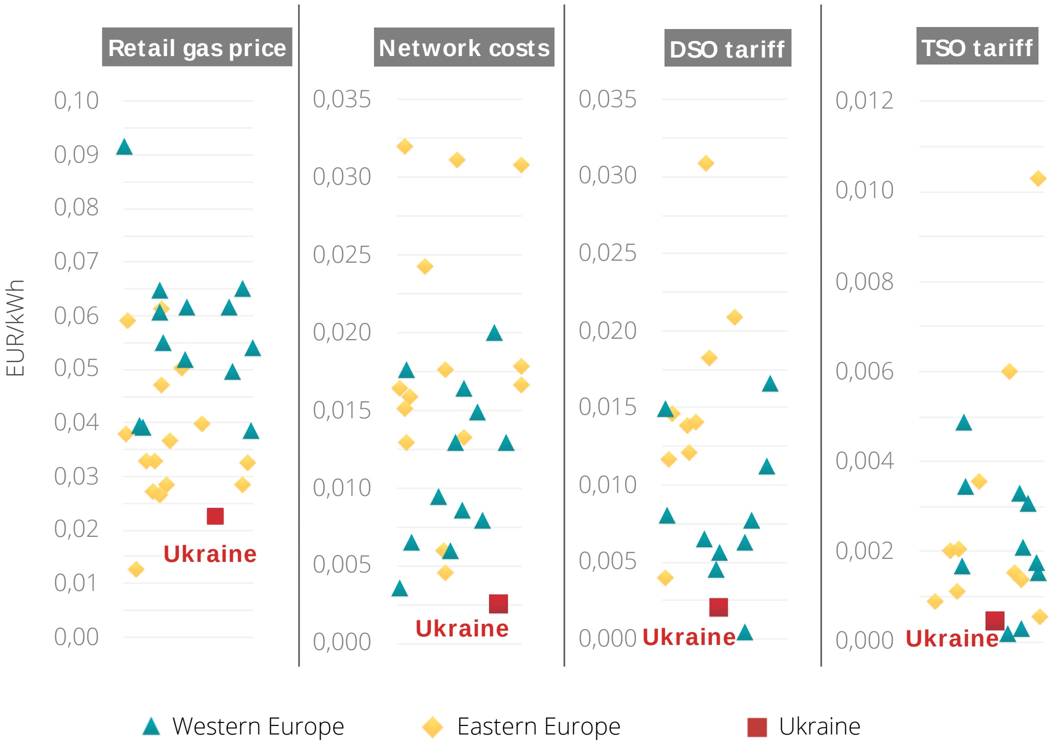
In 2019, the IEA did not identify any natural gas price subsidies.

For the most recent year – 2019 – the IEA (2020) does not find any consumer subsidies for natural gas. Still, Figure 3 illustrates that the retail household gas price is below European levels, which could result from lower network costs. Low TSO and DSO tariffs could lead to under-investments into the pipeline system, which could on the one hand pose a risk to security and on the other lead to higher costs of supplying gas in the future. The median European margin between wholesale and retail prices is EUR 31.5/ MWh (Own calculation based on European Commission, 2020). In contrast, the Ukrainian margin corresponded to EUR 4.3/ MWh in 2019. As the same technological costs of supplying gas should apply in European countries and in Ukraine, there might still be implicit subsidies.

Natural gas price components are still low in European comparison.

However, Dixi (2017) illustrate that labour costs made up around 30% of DSO tariffs in 2017. As these are considerably lower in Ukraine than in other European countries, wages might be the source of lower tariffs. To take this into account, it is differentiated between western and eastern European countries in the graph. Nonetheless, data was retrieved from European Commission (2020), where consistent data is mainly available only for EU countries. Eastern European countries being part of the EU still present higher wages than Ukraine or its direct non-EU neighbours Moldova or Belarus. To control for country-specific effects, such as wages, a detailed benchmarking analysis would be required, which exceeds the scope of this policy note.

Figure 3: Gas price components are among the lowest in Europe (for households, 2019)



Source: European Commission (2020), NERC (2019) and NERC (2020)[7]

Summarizing, the reforms in the gas market demonstrate that liberalising energy markets is possible in a socially sustainable way. In addition to cost covering prices the reforms also helped to fight corruption and set new rules to the game. The sector hereby sets an example for the electricity market. It has to be noted, though, that a shift to import-parity was politically eased by the favourable circumstance that gas prices were low at the international market (compared to previous years) and thus these changes did not imply drastic price increases for the population. Moreover, the sector is still missing sufficient competition in the retail segment and the praise of the progress in the gas sector should only be kept up, if the recent moves back towards subsidization truly are only a temporary measure.

b. Electricity

Before the market opening, electricity prices were cross-subsidized. This means that certain consumer groups – in the case of Ukraine non-household consumers as industry, railway transport and state-funded institutions – pay a higher price to subsidise preferential consumer groups, like households. In 2019, the average price for non-households was 78% (28 EUR/MWh) higher than the average regulated household price (Ukrstat, 2020). Consequently, neither group payed the "correct" price, in the sense of the true opportunity costs, as the former payed a price supposedly exceeding the costs of supply and the latter a price lower than costs of supply. This can distort the market and obstruct competition in the retail segment. Also, the higher price that has to be borne by the industry can be regarded as an implicit tax, which increases production costs. The burden, that has to be carried by the industry, is likely to be distributed between the demand and supply side, depending on the relevant elasticities. This can in turn again negatively affect

[7] Network costs is the sum of DSO and TSO tariffs.

households. In Belarus, for example, the cross-subsidisation of residential heat-prices had a regressive impact (Grainger, Zhang and Schreiber, 2015).

A complicated Public Service Obligations (PSO) scheme to finance consumer subsidies is still in place in the electricity sector.

Steps towards market liberalisation were taken with the liberalisation of wholesale markets in July 2019. Nevertheless, there is no full competitive market structure yet[8]. To enable low rates of electricity supply for households, the Resolution No. 483 from June 2019 (CMU, 2019c) established the following PSO scheme:

i. The Guaranteed Buyer (GB) buys a regulated share of electricity from Ukrhydroenergo (UHE) (35%) and Energoatom (EA) (85%) at regulated rates. He then sells power required to cover household demand to the Universal Service Suppliers (USSs) who sell to households. However, this only holds in the IPS-zone. In Burshtyn Energy Island (BEI) neither UHE nor EA have power plants. Instead, the GB has to buy electricity from privately owned coal power plants. As these do not belong to the PSO, the GB has to buy electricity at much higher prices here.

ii. Households pay a regulated rate to USSs, while the USSs buy it from the GB for:

iii. average household price – (TSO tariff + DSO tariff + USS margin), where all four components are regulated. Some USSs pay to the GB and some receive money due to differences in DSO tariffs. Moreover, The GB incurs losses here, because the total average price he receives from the USSs is below what he pays for electricity (see Figure 4).

iv. To cover the losses accrued for selling at regulated rates to households, the GB sells excess power on the wholesale market. In 2019, the GB made enough profits to cover these losses, however since January 2020, the revenues made at the wholesale market are no longer sufficient to cover all losses. Therefore, some losses remained at this stage.

v. After some regulatory changes, the law obliges Ukrenergo to not only finance the green tariffs via transmission tariffs but also to fund the remaining losses incurred by the GB (CMU, 2019a). The tariff increase is set by the regulator and affects final electricity prices for non-residential consumers.

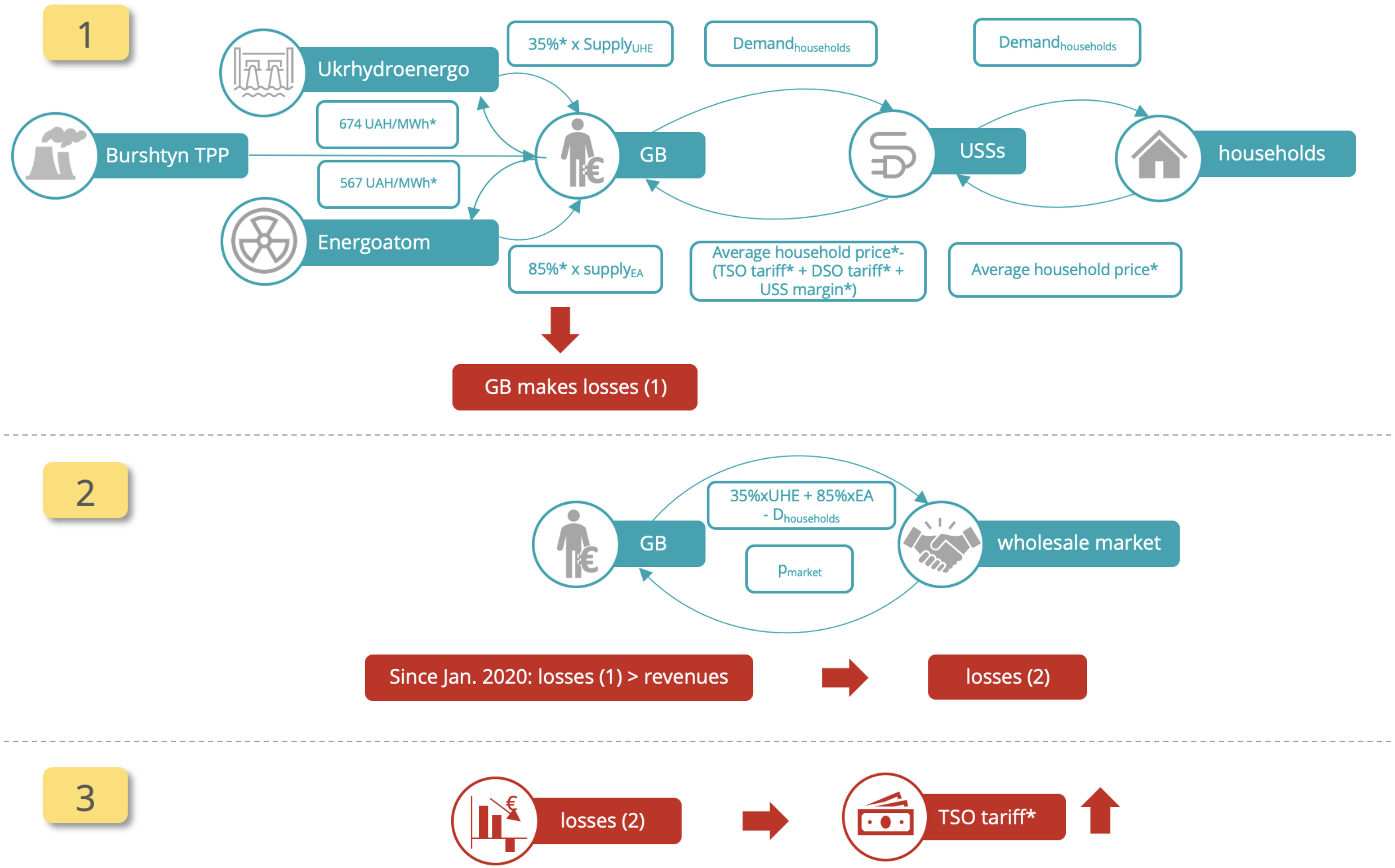
The increase in TSO tariffs, does not only lead to higher costs faced by non-regulated consumer groups, but also to a decrease in revenue of the GB in step 1). Additionally, the TSO tariff increase does not necessarily cover all losses of the GB, as was the case in recent months, where the GB failed to pay EA (Zachmann, Mykhailenko, Meissner, *et al.*, 2020). Household subsidies are consequently financed a) by the low, regulated rates from which the GB bought electricity from UHE and EA, b) by the increase in TSO tariffs, borne by non-household consumers, and c) by the government in case the debt accumulated in the system leads to the failure of the GB, Ukrenergo, UHE or EA.

The PSO scheme causes a range of inefficiencies in the Ukrainian electricity market.

This complicated scheme of redistributing flows in the electricity system also negatively affects other segments as it virtually separated the market into self-contained territories (Zachmann, Mykhailenko, Vereshchynska, *et al.*, 2020). Figure 5 illustrates all flows in Ukraine's electricity market. Thermal Power Plants (TPPs) sell the largest share of their power with little to no competition via bilateral agreements. The organised market segments – day-ahead (DAM), intraday (IDM) and balancing market (BM) – are dominated by nuclear power from the two main players EA and the GB. This limits competition. Moreover, the PSO scheme withholds demand from the organised market segments as around one third of the market is determined by bilateral contracts between the GB and USSs.

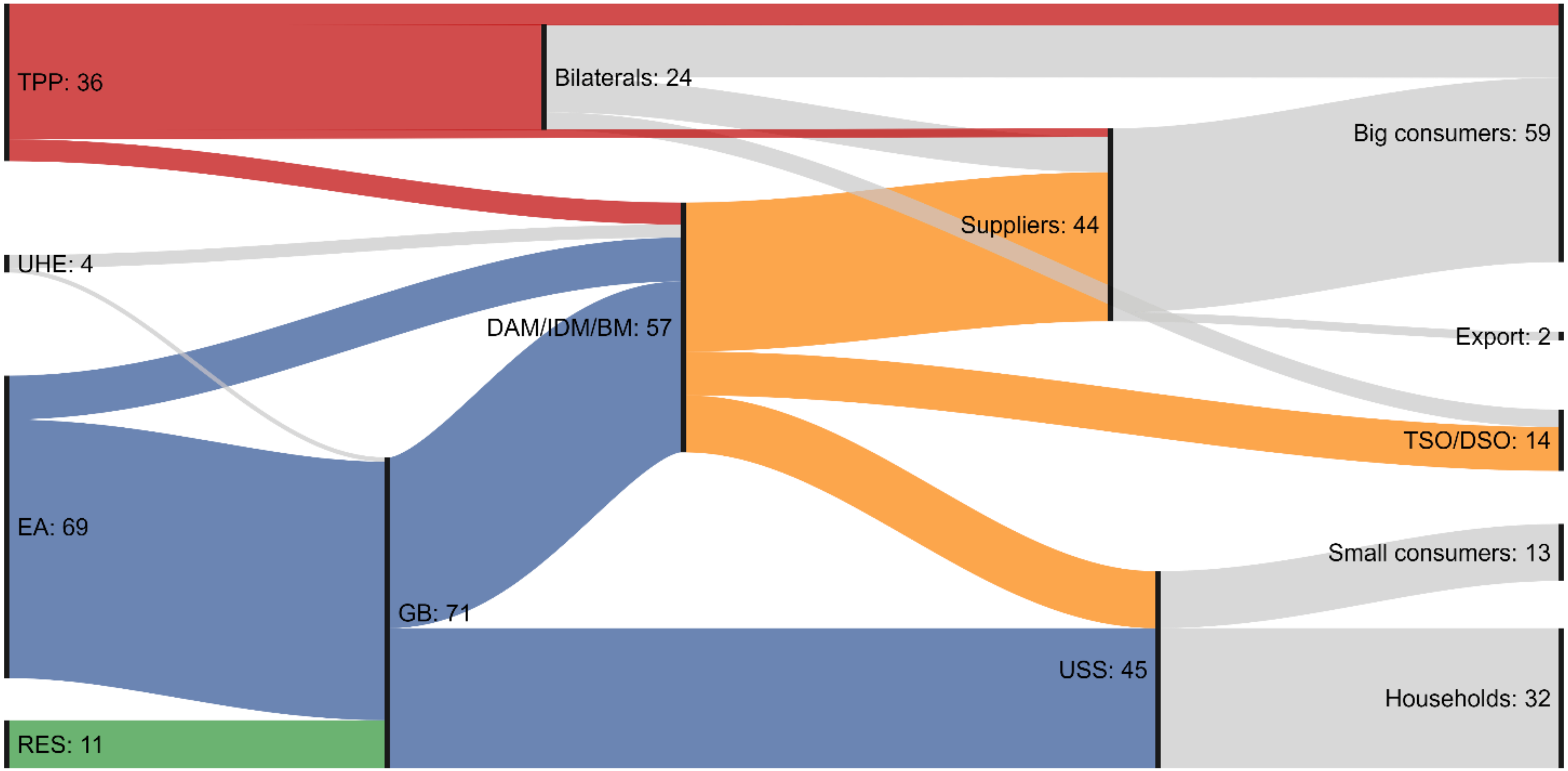
[8] For a detailed analysis of the wholesale market since its opening, see Zachmann *et al.* (2020).

Figure 4: How the PSO scheme for households led to losses and increased non-household tariffs (before May 2020)



Source: Own illustration based on CMU (2019) and Zachmann *et al.* (2020)

Figure 5: Electricity volume flows in the IPS market [TWh]



Note: The flowchart is read from left to right. On the left, energy producers are shown, followed by market segments and intermediaries where electricity is sold to, and on the right final consumers. The size of the lines corresponds to volumes

Source: Zachmann *et al.* (2020)

All in all, the PSO scheme created a string of debts, massive distortions to the market, and non-functioning organised market segments due to the lack of competition. Consequently, the true costs of the subsidies likely substantially exceed the economic costs that result from overconsumption caused by inefficient household pricing.

Moreover, the current form of Ukraine's PSO scheme contradicts the rules to PSOs, set by Article 3 in the EU's Electricity Directive (European Commission, 2009). Here it states, that the public service obligation shouldn't affect the liberalisation process in the electricity market. This is even captured by CMU (2019), which established the PSO, as it acknowledges that ensuring the special obligations should not compromise the primary goal of creating an electricity market based on free competition. Free competition is, however, hard to achieve under the above stated market conditions.

Additionally, it contradicts the rules to the PSO themselves.

To address competition issues, improve liquidity, reduce imbalances and reduce the financial burden of EA, GB and others, changes to the PSO Resolution were made in May 2020 (CMU, 2020b). The compulsory sale of power by EA was reduced from 85% to 80%. Additionally, the changes allowed EA to sell up to 5% of its forecasted supply under bilaterals at special sessions of electronic auctions. In August 2020, a transitional PSO was adopted (CMU, 2020a). EA is now only obliged to sell the volumes claimed by the USSs for household consumption to the GB, while UHE is obliged to sell 30% to the GB. UHE sells at UAH 10/MWh (around EUR 0.3/MWh) whereas EA sells at UAH 150/MWh (around EUR 5/MWh) to the GB. However, UHE and EA have to make sure that their overall average selling price (including prices achieved at the market) is not below their cost of supply, which virtually sets a minimum price cap.

Several changes to the PSO were made to address its flaws.

Nonetheless, the PSO mechanism is still in place and the time scope of the "transition" is not defined. While the regulated prices will likely stop debt being accumulated further by the GB, it is not clear how old debt will be repaid. Additionally, this will likely drive the price for other market participants up as it sets a minimum price cap for EA and UHE. Summarizing, as household tariffs are still subsidized, these costs will have to be borne somewhere along the supply chain or by the government. To approximate the costs of these subsidies, the price gap approach will be applied to the electricity sector next.

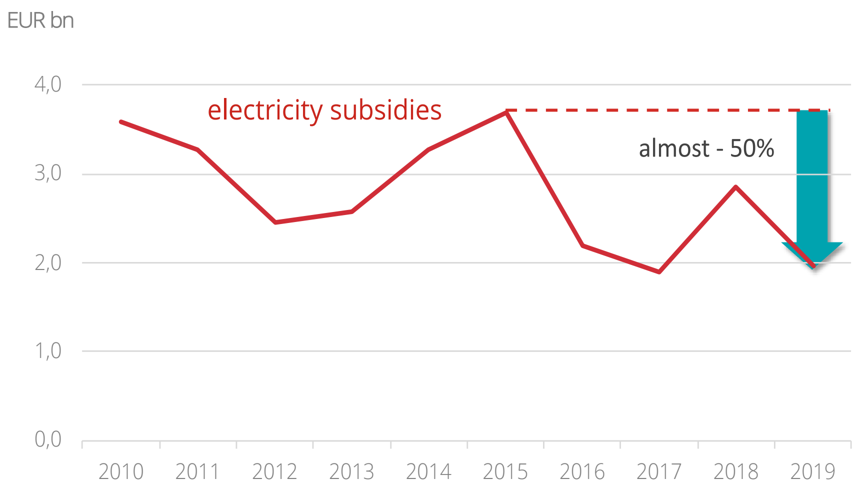
But these will likely not solve the underlying problem and subsidies should be abolished.

SUBSIDY ESTIMATES

In contrast to natural gas, subsidies in the electricity sector were not reduced as much. Figure 6 illustrates the IEA's (2020) estimates for consumer subsidies for electricity. Subsidies still amounted to EUR 2 bn in 2019.

The IEA estimates EUR 2 bn in electricity price subsidies for 2019.

Figure 6: Electricity subsidies in Ukraine almost halved over the last decade, but are still substantial



Source: IEA (2020)

Therefore, the consequences of phasing-out these subsidies will be evaluated in this policy note. The price-gap methodology employed by the IEA is adopted here. Electricity is not extensively traded across-borders. Therefore, the reference price is based on annual average-cost pricing of electricity, weighted according to output levels. The annual average-cost pricing takes reference prices for fossil fuels and efficiencies of power generation into account (IEA, 2020). A price of EUR 47 /MWh is obtained. A detailed description of how the average-cost pricing is obtained is given in the Annex.

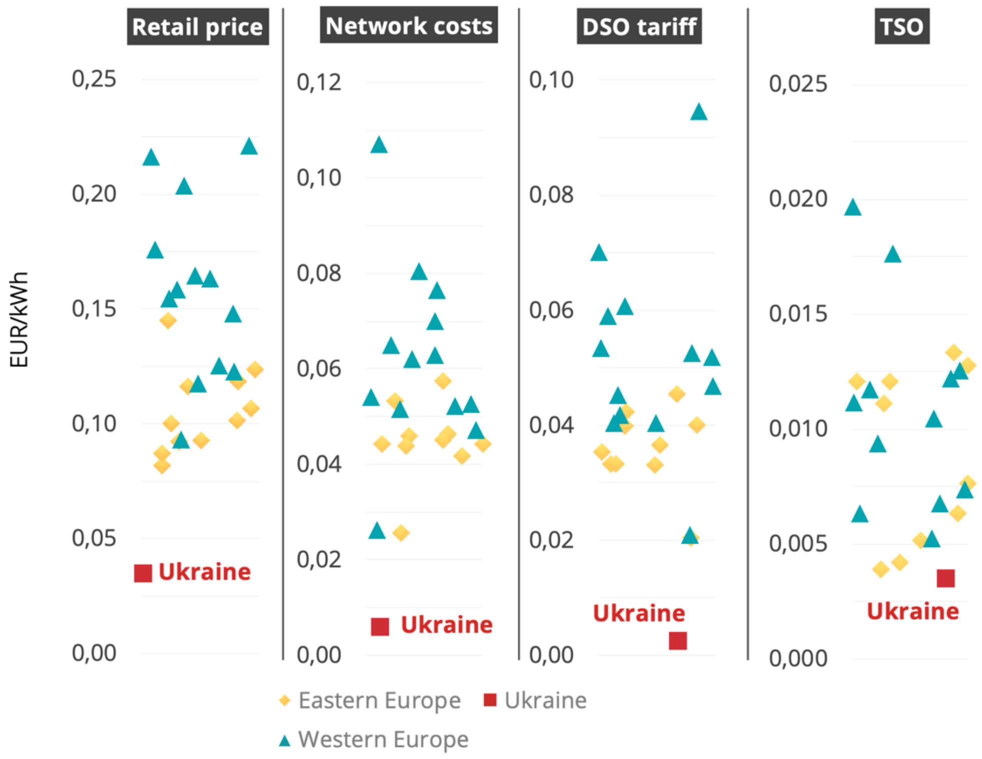
Comparing the different price components of household electricity prices reveals that not only final electricity prices for households are substantially below the level of other European countries, but also network costs.

This could be an indicator that DSO/TSO tariffs are also below efficient prices and contain implicit subsidies. Consequently, the IEA's approach of including an allowance for transmission and distribution costs of USD 40 /MWh (EUR 35 /MWh) for household and USD 15 /MWh (EUR 13 /MWh)[9] for industry is adapted instead of relying on current domestic DSO/TSO tariffs.

Consumer subsidies of EUR 1.4 bn are estimated, from which EUR 200 m are financed via cross-subsidisation by industry.

Based on these assumptions, consumer subsidies of EUR 1.4 bn are obtained. Parts of it (EUR 200 m) were financed through cross-subsidisation by industry prices, which were EUR 4 /MWh above the reference price. The subsidy estimation is 30% below the IEA estimations which may result from different assumptions used for calculating the average-cost pricing.

Figure 7: Electricity price components are the lowest in Europe (for households)



Source: European Commission (2020), NERC (2019) and NERC (2020)[10]

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[9] As industry commonly purchases larger volumes of electricity, it can be supplied at higher voltages, which is more efficient. Therefore, supply costs for industry are less than for households and industry prices are usually closer to wholesale prices (eia, 2020).

[10] Network costs is the sum of DSO and TSO tariffs.

c. Other subsidies

Subsidies directly affecting final consumer prices constitute only one form of energy subsidies in Ukraine. Producer subsidies present a second category. These are not the focus of this policy note but will be quickly addressed in the following. Thermal heat and power producers were recipients of de-facto subsidies due to the formation of the forecasted wholesale market price of electricity – a procedure popularly known as "Rotterdam+". For a more detailed description of "Rotterdam+", please refer to the Policy Paper "A socially sustainable coal phase-out in Ukraine" (Zachmann, Temel, von Mettenheim, 2021).

Not only consumers, but also producers are subsidised in Ukraine's electricity sector.

Also, renewable energy is subsidized. Since 2009 there are subsidies for certain types of renewable energy installations in the form of feed-in tariffs (FIT). Since July 2019, eligible producers sell their electricity to the Guaranteed Buyer for FIT, who then resells RES electricity at the organised market segments. Therefore, the actual subsidy is variable and depends on the difference between the FIT level and the average GB selling price on organised market segments.

Renewable energy subsidies correct a market failure instead of creating one and should thus not be abolished.

While inefficient fossil-fuel subsidies that were addressed above contribute to CO2 emissions, this is not the case for renewable energy subsidies. Furthermore, there are valid arguments for renewable energy subsidies, as long as related technologies are not yet competitive due to high upfront investment costs. Apart from improving the competitiveness of clean energy technologies, RES subsidies also correct for market failure. Social benefits of clean energy in the form of lower GHG emissions and cleaner air are disregarded in the investment decision of private investors, leading to an underinvestment in RES technologies.

Consequently, a phase-out of renewable energy subsidies is not proposed. Instead, a redesign of renewable energy support that aims at improving the efficiency and reducing costs for consumers is covered in Chapter "Increase RES electricity generation through competitive auctioning of FIPs".

Background info

IMF reform plan

The IMF (2020) presents recommendations for a reform plan to phase-out energy subsidies, derived from country experiences:

i. Comprehensive energy sector plan

ii. Phase-in of price increases over time

iii. Measures to protect low-income households, e.g. near-cash transfers or expansion of existing, targeted programmes

iv. De-politisation of energy prices, e.g. automatic pricing mechanisms

Also, the process should be accompanied by transparent communication and consultation with stakeholders.

Phasing out energy subsidies

The previous section illustrated some estimates for energy subsidies in Ukraine. Now it will be addressed, how the Ukrainian government can abolish energy subsidies in a socially sustainable way.

The government has pursued steps to liberalise the natural gas market that are close to IMF recommendations and phased-out natural gas subsidies over time. Only a full de-politisation of prices should be achieved, to impede a return to subsidised household prices once international gas prices pick up or the economic situation deteriorates. In contrast, the electricity sector is yet to follow. In line with the IMF-recommendations, the following steps are proposed.

I. Comprehensive energy sector plan

Along with subsidies, the PSO scheme should be phased-out.

Subsidised household prices and the connected PSO scheme are the root of several inefficiencies in the electricity market. Consequently, the redistribution of financial flows between the Guaranteed Buyer and other market players should be faded out along with a phase-out of subsidies itself. One proposal, how this can be achieved, is given by USAID (2020) and presented in the Box on page 15. However, as this is a large topic, it will not be covered in detail here and should be part of a separate analysis.

Background info

PSO phase-out: USAID proposal

USAID (2020) proposed an improved financial PSO-structure in response to a proposal made by the Energy Community. Under USAID's proposal, the state-owned company EnergoAtom should sell all its electricity on the wholesale market in contrast to the current scheme of selling a volume corresponding to household demand to the Guaranteed Buyer at fixed prices.

In the proposal, volumes would be sold on the market. The USSs would then sell electricity to households, who pay a fixed rate. Energoatom would be obliged to compensate the USSs by "quasi" swaps for the difference of the market price and fixed rates, while the fixed price increases and gradually reaches market prices by 2028. Consequently, the proposition of USAID implies a subsidy phase-out in the electricity sector.

II. Phase-out over time

Subsidy phase-out until 2022

For the time scope of the subsidy phase-out there is a trade-off between choosing a time scope long enough to allow for households to adapt, minimise negative welfare effects and enable reforms in the market and between choosing a time scope short enough to allow for a credible commitment by the government that is not threatened by a shift in the political agenda. The analysis in section 3 (Assessment of the effects of a phase-out) shows that negative effects for households are likely not substantiate, even if a shorter time scope is envisioned. Therefore, a time scope of 2 years is proposed. Household prices should be increased linearly each month starting in 2022 until the reference price is reached in 2023. When the final price is reached, households would need to attribute EUR 9 additionally to electricity bills per month which corresponds to approximately 0.5% of the average household income.

III. Compensation schemes

As electricity bills are covered under the HUS mechanism (CMU, 2020c), which has been improved in light of the phase-out of subsidies in the gas sector, low-income households would be protected from an energy price increase. Under the HUS, the difference between norm-based consumption and the household contribution share is covered by the state, while the obligatory contribution depends on household income.

Low-income households would be compensated by Housing and Utilities Subsidies (HUS).

The subsidy (S) granted to a household under the HUS is determined by the difference between the payment within the social norm (SP) and the share of contribution multiplied with the household income (HI). The share of contribution depends on the household income per number of people living in the household (N), as well as on the subsistence level (SL) (CMU, 2020c):

$$S = SP - \frac{HI/_{N}}{2 * SL} * 20\% * HI$$

The subsidies paid by the state increase with energy prices. Consequently, households eligible for these subsidies – 37% of households in 2019 (Ukrstat, 2020) – will be largely compensated for the price increase. Moreover, an increase in power prices is likely to increase the number of households receiving subsidies, because those households that were close to thresholds before are likely to be pushed above. However, an increase in income during the next decade could mitigate this. Section 3 (Assessment of the effects of a phase-out) investigates this in more detail. Due to norm-based payments and monetisation of the subsidies in March 2019 (DiXi Group, 2019), the incentives for energy savings are kept intact with this compensation scheme as the recipient has unused subsidies at his/her own disposal.

IV. De-politisation of energy prices

The goal of the sector should be market-based prices. As for natural gas, electricity prices should be fully detached from governmental influence. Prices should be allowed to fluctuate freely as soon as they reach the market level. This would also support the introduction of carbon pricing, as this requires that the price signal depending on the carbon content of fuels is forwarded to consumers so that these are incentivised to adapt their consumption behaviour.

Moreover, electricity – but also natural gas – prices should be fully de-politized.

Assessment of the effects of a phase-out

I. Costs of subsidies

To quantify effects, a phase-out scenario is compared to a reference scenario where electricity prices are still subsidized.

To quantify potential effects of the subsidy phase-out, a scenario with price subsidies and one with a gradual phase-out are compared. In the reference scenario, household prices are kept constant at the subsidised levels. In the phase-out scenario, subsidies in the electricity sector are phased out linearly thus consumer prices approach the benchmark price by 2023. As natural gas prices were close to market levels already before the recent, temporary changes, no phase-out is regarded here. Nonetheless, it should be noted that the phase-out of subsidies for natural gas was accompanied by favourable conditions of low international gas prices in past years. The IEA (2018b) projects an increase in natural gas prices until 2030, thus there is a threat of permanently returning to subsidised prices once gas prices pick up. Still, it is assumed here that the government will adhere to its long-term strategy for natural gas prices.

The benchmark price for electricity is kept constant.

The benchmark price for electricity is kept constant at the 2019 level despite a projected increase in natural gas and coal prices, which could lead to higher power prices in the coming years. However, power prices depend on several, uncertain factors – such as the generation mix, investment costs of new capacities and renewable subsidies. As these can also work in opposite directions, making an educated guess about future electricity prices in Ukraine would not be appropriate. Still, it should be kept in mind that a change in power prices could increase or decrease the costs of subsidies in the reference scenario.

Future electricity demand trajectories are retrieved from the NDC Scenario 2. This scenario was developed within the drafting process of Ukraine's second NDC in 2020. It describes Ukraine's development for a timely implementation of all drafted and passed climate-related legislation. It takes current as well as planned climate measures into account. It projects an increase in electricity demand by 29% compared to 2019 levels.

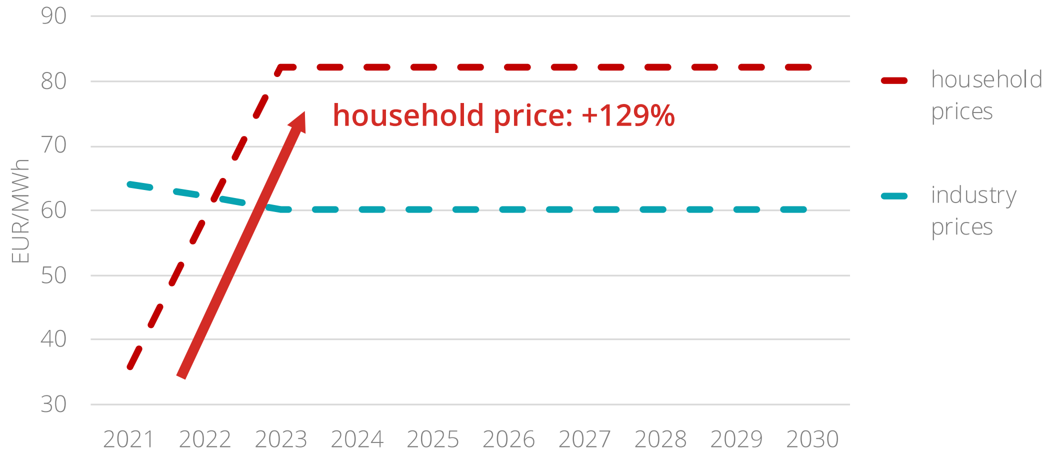
Costs of subsidies would increase to nearly EUR 2 bn in 2030 if they are not phased-out.

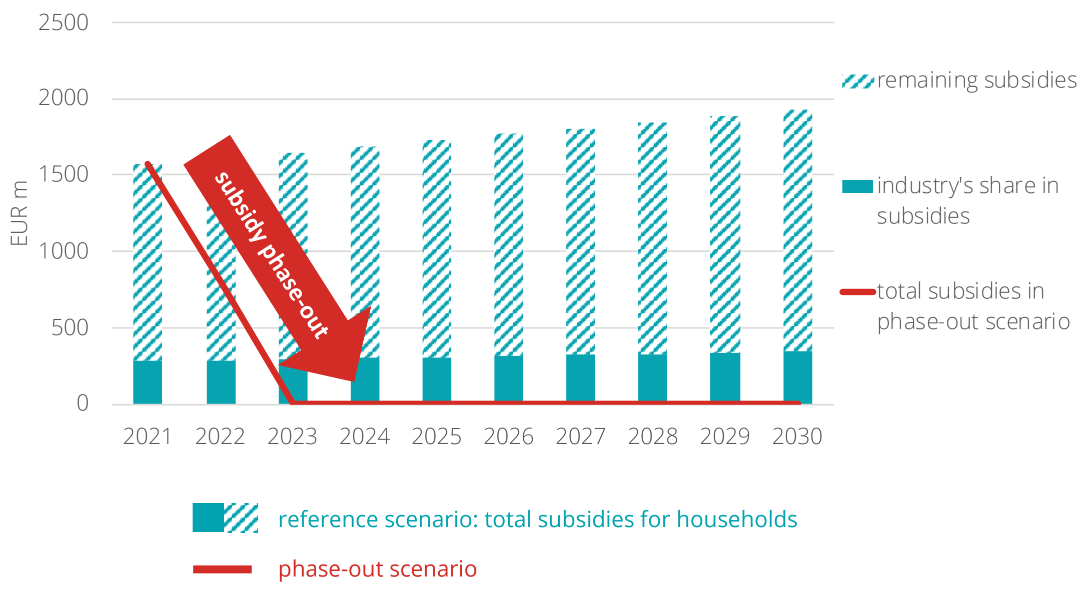
In the subsidy phase-out scenario, subsidies are gradually removed. Figure 8 displays the costs of the subsidies as well as electricity prices for industry and households. Industry prices are already close to their reference price thus the majority of the costs of the subsidies are borne by revenue shifts in the electricity market. Due to the assumed increase in electricity demand, these costs would increase from EUR 1.5 bn in 2021 to nearly EUR 2 bn in 2030. These costs could be avoided by 2023 if electricity price subsidies are phased-out. 20% of the costs of subsidies would be covered by the cross-subsidisation through industry. As discussed in Section II ("Electricity"), it is virtually impossible to pin down who exactly bears what share of the remaining 80% of the costs. Nonetheless, it is likely that some costs are borne by the state, as EnergoAtom and the Guaranteed Buyer would finally be backed by the state.

Household prices need to increase to around EUR 80/MWh.

Electricity prices would more than double until 2023 to reach the reference price. Also, instead of having cheaper retail prices, households would pay EUR 22 /MWh more than industry. Nonetheless, with EUR 82 /MWh (EUR 0.08 /kWh), Ukraine would still have the cheapest household electricity prices compared to European countries (Figure 1, section 1.1.2). Industry prices would slightly decrease to EUR 60/MWh.

Figure 8: Phase-out of electricity price subsidies for households would cause an increase of 129% in household electricity prices, but the costs for the economy are substantially reduced





Source: Own calculation

II. Effects

The increase in household prices will affect household's current spending level but will also influence their future investment decisions.

The effects of a subsidy phase-out can be classified in two categories; direct and indirect effects. In the short run, the phase-out directly affects consumer income and spending. By the increase in prices, consumer will decide to spend less for certain fuels, depending on their short-run price sensitivity. Short-run price sensitivities thus reflect consumer's immediate response to higher energy prices within one year. A description of the methodology to evaluate the effects is presented in the Annex.

While in the short-run, this directly leads to a decrease in GHG emissions through decreased consumption, in the long-run consumers tend to adopt their behaviour. These responses are likely to be more pronounced as they take gradual changes in the capital stock over several years into account (Huntington, Barrios and Arora, 2019). Hereby further GHG emission reductions can be achieved. This effect can be quantified by long-run price elasticities.

The presented estimates should be regarded as first approximations instead of a final analysis. As this paper is part of a series of ten policy proposals, all measures should be modelled simultaneously to account for reciprocal effects.

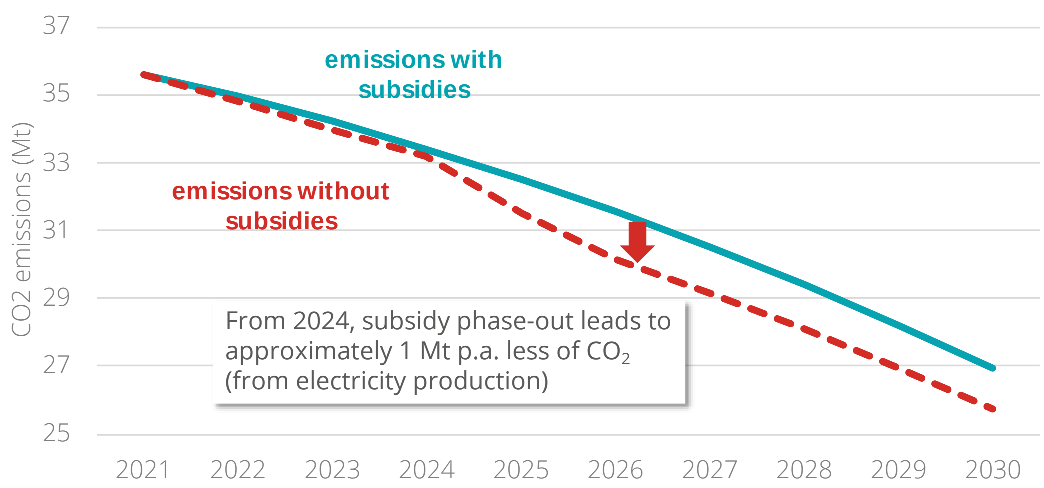
a. Decarbonisation

The following estimations for GHG emission reductions take short-run as well as long-run price sensitivities of energy demand into account. The time scope of the expression "long-term" is not predefined though and varies between studies. It should allow for the time necessary to do significant capital investments, i.e. several years. Here, we define the long-run as 3 years, as in Deryugina, MacKay and Reif (2017). However, this should rather be seen as a lower bound and depending on the sector, adjustments might take considerably longer. Further, it should be noted that only price effects are regarded here and no income or substitution effects.

CO_2 emissions of up to 1.2 Mt could be saved by 2030. This could be intensified through complementary measures like a more ambitious carbon tax.

Since demand for energy, especially for electricity, is rather inelastic, and only one third of Ukraine's electricity is produced from carbon-intensive fuels (Ukrenergo, 2020) the emission reductions are likely to be small. Based on the presented calculations a reduction of up to 1.2 Mt in CO_2 emissions in 2030 is estimated. However, the subsidy phase-out is necessary for the efficient introduction of carbon pricing, which in turn likely leads to substantial emission reductions.

Figure 9: CO_2 emissions from natural gas consumption and electricity production



Source: Own calculation

b. Consumer costs

Due to the nearly perfectly inelastic residential electricity demand, in the short-run households will only slightly react to the price increase by a reduction in demand. Instead, the subsidy phase-out will mainly increase the cost-of-living. Formerly regulated electricity prices would increase by 130% over two years. This substantial increase emphasizes the drastic subsidisation of current residential power prices.

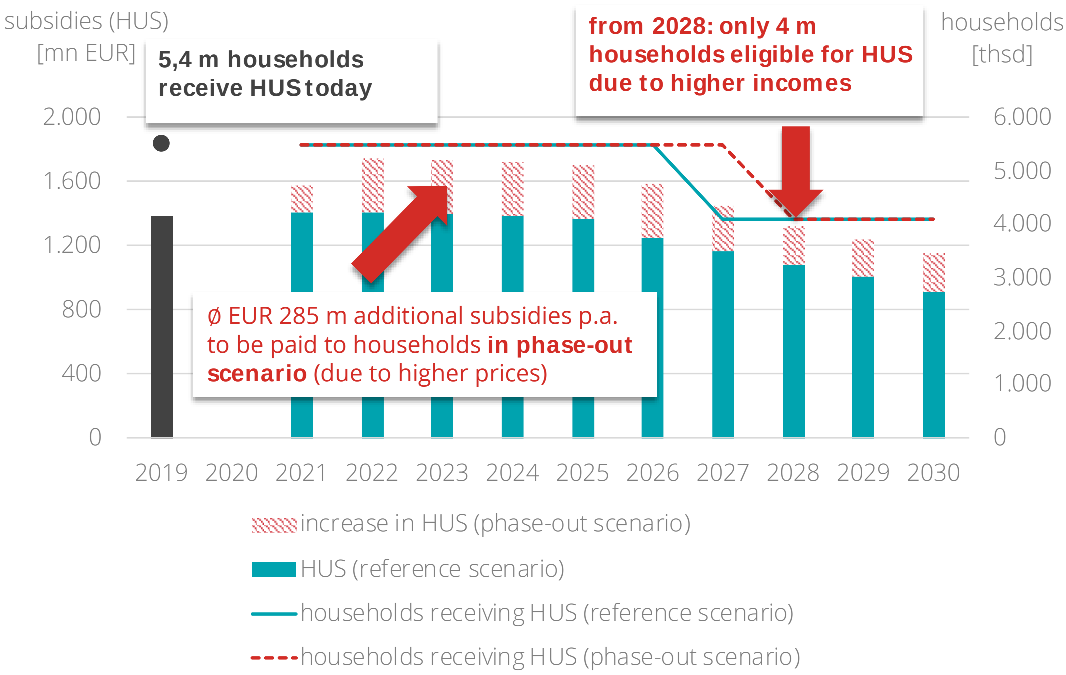
Low-income households are protected by the HUS. But an increase in household income likely offsets increased HUS from the electricity price subsidy phase-out.

Low-income households would be protected by the HUS scheme. A detailed description of how the HUS works is given in chapter 5.3 of the Annex. Figure 10 compares payments under the HUS as well as the number of households receiving subsidies for the reference and the phase-out scenario. Natural gas price assumptions are based on IEA (2018). Heat prices are assumed change with natural gas prices while the remaining utilities costs covered by the HUS are assumed to be constant. For household income, the NDC Baseline Macroeconomic Scenario assumption that household income increases by 5-6% annually is adopted. Until 2025, natural gas prices increase by 30% compared to 2020. However, afterwards the effect of rising natural gas prices diminishes with an assumed annual increase of 1%. This is more than compensated by the increase in income, thus less subsidies would need to be paid under the reference scenario in 2030. The increase in income even offsets the increase in payments resulting from increased electricity prices.

EUR 338 m would need to be attributed additionally to the HUS in 2023.

In 2023, EUR 338 m would need to be attributed *additionally* to the HUS due to the phase-out of electricity prices subsidies. This would decrease to EUR 233 m by 2030, as less households would be eligible for HUS resulting from the increase in household income. However, it should be noted that the results are based on the assumption that each income group benefits equally from the increase in income. An increase in inequality could alter the results. On average, EUR 285 m would need to be attributed additionally to the HUS in the next ten years under the phase-out scenario. This corresponds to 20% of the average increase in household expenditure until 2030.

Figure 10: Annual HUS payments under the subsidy phase-out scenario



Source: Own calculation

Taking the HUS into account, household expenditure would increase by EUR 600 m in 2022 and EUR 1.2 bn in 2023. This corresponds to EUR 5/month in 2022 and EUR 10/month in 2023 for households not eligible for the HUS.

c. Employment effects

No direct negative effects on employment are expected.

As there are no subsidies for industrial gas prices and industrial electricity prices would even decrease when cross-subsidisation is removed, there are no direct implications for input costs of production in the industry. Therefore, no adjustments to labour input are required. However, households are likely to spend less for non-essential goods when energy bills increase, which may pose a threat to certain industries and consequently to employment in these industries. To evaluate these effects, comprehensive modelling of cumulative effects is needed.

d. Energy Efficiency

Efficiency improvements of up to 12% are estimated for electricity by 2030.

A removal of energy subsidies leads to an improvement of energy efficiency via price signals. Through an increase in energy prices, households are incentivised to take measures that improve energy efficiencies in order to decrease expenditure for electricity. This effect is deepened by a transparent and gradual phase-out of subsidies as well as by tax (or in the case of the HUS, subsidy) shifting programs that enable investments also for low-income households. The effects on energy efficiency are represented by the long-run price elasticities presented in Table 1. Basing the estimation on these elasticity assumptions, efficiency improvements of up to 12% can be realised for electricity by 2030.

Table 1: Price elasticities of demand

Energy type		Short-run	Long-run
Electricity	residential	-0.03	-0.16
	Non-residential	-0.01	-0.04

Source: Liu (2004)

III. Energy security

Additionally, the phase-out could help improve energy security.

Achieving market-based prices would allow energy companies to make profits again sector. This would in turn enable investments in capacities and infrastructure, which suffered from severe under-investments due to the highly subsidised prices. Consequently, the reliability of electricity systems would be improved, and the risk of outages reduced.

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Annex

I. Types of subsidies

Table 2: Types of subsidy – OECD

	Types of subsidies	Examples
Direct transfer of funds	direct spending	earmarks and agency appropriations: Targeted spending on the sector through government budgets of different levels and budgets of individual government agencies
		research and development support
		contracts and government procurement of energy at above-market rates
	Government ownership of energy-related enterprises if on terms and conditions more favourable for business than in case of private ownership	equity injection in the energy sector from government budgets (e.g. strategic petroleum reserve, electricity plants...)
		Government ownership of strategic and other energy assets that otherwise would not be viable
Tax expenditure and other government revenue forgone	Tax breaks	Tax expenditures: foregone tax revenues due to special exemptions, deductions, rate reductions, rebates, credits and deferrals
		Reduced overall tax burden by industry: marginal tax rates lower than for other industries (e.g. non-application of VAT)
		Exemptions from excise taxes/special taxes
	Foregone revenue from government-owned energy resources	Process for energy resource leasing: Auctions for larger sites; sole source for many smaller sites
		Royalty relief or reductions in other taxes due on extraction: Reduced, delayed or eliminated royalties
		Process of paying royalties due: Allowable methods to estimate and pay public owners for energy minerals extracted from public lands
	Foregone revenue from non-energy government-owned natural resources or land	Access to government-owned natural resources such as water and land: At no charge or for below fair-market rate

	Foregone revenue from government-owned infrastructure	Use of government-provided infrastructure: At no charge or below fair-market rate
	Foregone revenue from other government-provided goods or services	Government-provided goods or services at below-market rates
Induced transfers (income or price support)	Income or price support and market regulation	Consumption mandates and mandated feed-in tariffs: fixed consumption shares for use of a specific energy type
		Border protection or restrictions: controls (tariff and non-tariff measures) on imports or exports leading to unfair advantages
		Regulated (consumer) prices set at below-market rates
		Regulated (producer) prices set at above-market rates
		Cross-subsidies in the electricity sector
Transfer of risk to government	Credit support	Government loans: Below-market lending to energy-related enterprises, including loans to energy exporters
		Loan guarantees: At below-market rates
	Insurance and indemnification	Government insurance/indemnification: Market or below-market risk management/risk shifting services
		Statutory caps on commercial liability: Can confer substantial subsidies if set well below plausible damage scenarios
	Occupational health and accidents	Assumption of occupational health and accident liabilities
	Environmental costs	Responsibility for closure and post-closure risks: Facility decommissioning and clean-up; long-term monitoring; remediation of contaminated sites
		Waste management and environmental damages: Avoidance of fees payable to deal with waste

Source: OECD (2018a, p.33)

II. Evaluating the impact of a subsidy phase-out

An energy subsidy phase-out affects behaviour by increasing fuel prices. Therefore, at the heart of the evaluation is a determination of the increase in prices through the subsidy removal and the change in consumer behaviour due to this increase in prices. From this, important figures on revenue, change in household expenditure and CO_2 emissions can be estimated.

Data

The calculations are based on assumptions about future energy demand. Energy demand projections are retrieved from Scenario 2 in the NDC. The NDC-Scenario 2 builds on the assumption that all legislation adopted as of September 1st, 2019, as well as drafted climate related legislation will be implemented. A summary of electricity demand and prices is presented in Table 3.

Table 3: Assumptions about energy demand

Energy type			2021	2025	2030
electricity	price [EUR/MWh]	residential	40.5	59.0	82.0
		non-residential	63.7	62.0	60.0
	demand [TWh]	residential	33.9	37.2	41.5
		industry	72.4	117.0	130.3

Source: NDC, Ukrstat (2020) and Own calculation

Another key parameter in the calculations is the elasticity of demand. Unfortunately, there is a lack of reliable data for price elasticities of energy demand in Ukraine. This issues was also addressed by The World Bank (2005), who argues that average OECD elasticities can be used for Ukraine instead. Following this approach, average OECD elasticities for residential and non-residential demand are retrieved from Burke and Liao (2015) and Liu (2004).

Demand for each energy type is inelastic, but there are differences between energy types. Residential demand for gasoline for example presents a comparably higher elasticity. This can be drawn back to the fact that for this energy type it is easier to switch to alternatives. For high gasoline prices, consumers might switch to public transport for distances they would have travelled by car otherwise. The price elasticity of the electricity demand presents the lowest value, demonstrating that an increase in the electricity price is likely to have only very limited effects on demand, at least in the short run.

Table 4: Price elasticities of demand

Energy type		short-run	long-run
Electricity	residential	-0.03	-0.16
	non-residential	-0.01	-0.04
Natural Gas	residential	-0.10	-0.36
	non-residential	-0.07	-0.24
Petroleum	residential (gasoline)	-0.19	-0.60
	non-residential (diesel)	-0.09	-0.17
Coal		-0.23	-0.40

Source: Liu (2004), Burke and Liao (2015)

Price-gap approach

The estimation of consumer subsidies in the electricity and gas sector is based on the price-gap approach, used by the IEA, which has already been applied to the case of Ukraine in 2013 by Ogarenko and Hubacek (2013). Hereby, end-user prices by fuel are compared to a reference price:

$$Subsidy = P_{ref} - P_{act} \quad (1)$$

A subsidy removal corresponds to an elimination of this difference – or price gap.

For net importers, the reference price is based on the import parity price at the border, adjusted for any transportation, distribution and supply fees as well as general consumption taxes. If a product is imported, the price-gap approach presents explicit subsidies, because products are sold at a lower rate than they are bought.

For an exporter, on the other hand, the price gap approach presents implicit subsidies, because it largely captures revenue loss for producers. In this case, the price gap represents the opportunity costs of selling the gas in the domestic market at the level of exported energy prices . When a product is imported as well as exported, the price gap can represent both actual budgetary expenses as well as opportunity costs (OECD, 2018b).

For products that are not extensively traded internationally, like electricity, the IEA bases the reference price on generation-weighted annual average-cost pricing. The reference price reflects the costs of production, transmission and distribution and incorporate a margin.

Average-cost prices are based on fuel costs, plant efficiencies, operation and maintenance costs, carbon prices, and investment costs. Assumptions about plant efficiencies and technology costs are based on technology assumptions from the JRC POTEnCIA Central Scenario (European Commission, 2020a). Due to the age of nuclear, thermal and combined heat and power plants in Ukraine, it is assumed that their costs only comprise variable costs and no fix costs. In contrast, the average costs of hydro power mainly consist of fixed costs from annuities, as their variable costs are close to zero. For the annuities, an interest rate of 12% is assumed, based on current bond rates (Cbonds, 2020). The average costs of RES are approximated by the average green tariff paid in 2019 (NERC, 2019). Finally, the average costs of the different production technologies are weighted according to their power generation share based on data published by Ukrenergo (2020).

Change in demand

Based on the fuel demand of the baseline scenario and after-tax prices, the change in demand due to the removal of energy subsidies can be calculated. The methodology refers to Ouyang and Lin (2014). A constant-elasticity inverse demand function is assumed, as proposed by the IEA (1999):

$$q_t = {p_t}^{\varepsilon} \qquad 2$$

where q_t is energy demand in t, p_t the price for energy in t and ε is the price elasticity of demand. The change in demand can then be calculated by:

$$\Delta q_t = Q_{0,t} - Q_{1,t} \qquad 3$$

with

$$Q_{1,t} = \exp\left(\varepsilon \times (\ln P_{1,t} - \ln P_{0,t}) + \ln Q_{0,t}\right) \qquad 4$$

where the index 0 indicates that the quantity/ price corresponds to the baseline scenario including energy subsidies, while the index 1 indicates the quantity/ price corresponds to the energy subsidy phase-out levels.

CO_2 Emissions

Once, the change in demand has been calculated, the difference in CO_2 emissions between Scenario 1 and 2 can be calculated by:

$$\Delta CO_2 = \sum_t \Delta CO_{2,t} \text{ with } \Delta CO_{2,t} = \sum_i \Delta q_{i,t} \times CO_2EF_i \qquad 5$$

III. Change in Housing and Utilities Subsidies

The HUS protects vulnerable groups of the population from energy price increases by subsidising a share of the utility bill exceeding a certain income share. Subsidies are calculated by the following formula:

$$S = SP - \frac{HI/N}{2 * SL} * 20\% * HI \qquad 7$$

Where S represents the subsidy, SP the payment under the social norm, HI the household income and SL the subsistence level. The subsidy phase-out increases the payment under the social norm and would increase the subsidies paid. However, the assumed increase in household income more than offsets this on a nationally aggregated level.

The HUS covers expenses for electricity, gas, heat, cold and hot water, waste and building maintenance. The social norm is defined by housing characteristics. Table 5 summarizes the different increments for the relevant category affected by subsidy phase-out, namely electricity.

Table 5: Social norm consumption

Category	Housing characteristics	base	additional for each person	max
Electricity [kWh/month]	no stove, centralised hot water	70	30	190
	electric stove, centralised hot water	110	30	230
	electric stove, no centralised hot water	130	30	250
	no stove, no centralised hot water	100	30	220

Source: CMU (2019a)

Consequently, in order to determine the increase in subsidies resulting from the subsidy phase-out, requires knowledge about the distribution of housing characteristics in the Ukrainian population. This information is made public by the State Statistic Service (Ukrstat, 2020). However, this information is only available for the total population and not differentiated between income groups. Lower income households are more likely to be equipped with less advanced technologies, thus it should be noted that the presented estimations only reflect approximations.

As the payment under the social norm depends on the number of persons living in a household, the average household size (2.58) is retrieved from the State Statistic Service of Ukraine. Further, heat consumption is defined per square meter, thus information on the amount of heat consumed per square meter are required. The average weighted consumption for an apartment building is 156 kWh/sqm per year and for an individual house 240 kWh/sqm per year. As 51% of Ukraine's population is living in an individual house (or as part of an individual house) and 49% in an apartment building, the overall weighted average consumption is 198 kWh/sqm per year.

Based on the distribution of household characteristics, the average social norm consumption for a household is 134 kWh of electricity, 9 cm of gas and 1'ooo kWh of heat per month. These are multiplied with the respective fuel prices. Further, the cost for water supply, waste and building maintenance are taken into account. In total, in 2019 the payment for housing and utilities based on social norm amounts to EUR 61 per month.

A share of these costs has to be carried by household. This share depends on the household income and the legally determined subsistence level. Both information are retrieved from the State Statistics Service. The projection of the HUS for the next ten years is based on energy price forecasts by (IEA, 2018) and income assumptions. The social norm consumption is assumed to remain constant. Under the phase-out scenario, an increase in household electricity prices is taken into account.

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We are grateful for your feedback on this Policy Proposal. Please get in touch via info@LowCarbonUkraine.com.

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