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Abstract

Energy sector reforms have for a long time been viewed as one of the most important challenges facing Ukraine. The most visible manifestation of reforms so far has been the steep hikes in energy tariffs for households to 'market' levels, above all for natural gas and central heating. The magnitude of gas tariff hikes in Ukraine and the short time span over which they have been implemented have been unprecedented: they rose nearly ten times within less than two and a half years. Partly due to this, between 2013 and 2015 residential gas consumption in Ukraine declined by about one third and will probably fall by another 9% in 2016 according to our estimations, essentially meaning sacrifice of households' living standards. Because of the higher energy payments, private consumption of other (non-energy) items has suffered as well. This is a disturbing development: the suppressed demand for non-energy consumer goods represents a clear social loss in an economy which has been suffering from a persistent inadequacy of aggregate demand.

At the same time, our analysis demonstrates that the magnitude of gas tariff hikes implemented in Ukraine has been clearly excessive when viewed from the production (cost) side. Under plausible assumptions regarding the dynamics of domestic gas production, residential consumption and gas import prices in the years to come, we come to the conclusion that the state-owned gas monopolist Naftogaz (and, via higher tax revenues, the government at large) will be accruing rents to the tune of at least 2% of GDP – essentially at the expense of the population. The source of this rent is the fact that the wholesale price for largely domestically produced gas has been set now on par with imported gas, which – after the recent sharp reduction in gas demand – is now needed only in limited quantities to cover the households' needs. To amend the situation in the short run, the government should either extend the scope of energy subsidies to poor households or, even better, roll back the energy tariffs. The latter task should be relatively easy to accomplish as long as Naftogaz remains state-owned.

In the longer run, various measures may be contemplated to improve energy efficiency in the household sector. In this vein, the government may consider extending the scope of subsidies, e.g. by providing lower interest rates and a higher reimbursement rate for energy-efficient loans, especially for the purpose of installation of heating meters in residential buildings. Government subsidies along these lines would be crucial in solving the long-term structural problem of excessive energy consumption, and should enjoy priority over the short-term task of fiscal consolidation.

Keywords: energy demand, energy prices, Almost Ideal Demand System (AIDS)

JEL classification: D12, Q4

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Executive summary

Given that Ukraine's economy is extremely energy-inefficient and its energy sector has been notoriously corrupt for years, it is no surprise that energy sector reforms have for a long time been viewed as one of the most important challenges facing the country. The most visible manifestation of reforms so far has been the steep hikes in energy tariffs for households to 'market' levels, above all for natural gas and central heating. One declared motivation behind the implemented tariff hikes has been to provide energy-saving incentives. Besides, they have been demanded by the IMF as a condition for its loan programmes extended to Ukraine since 2014, primarily because of their importance for budget consolidation.

The magnitude of gas tariff hikes in Ukraine and the short time span over which they have been implemented have been unprecedented: they rose nearly ten times within less than two and a half years (e.g., in Poland in the early 1990s, tariff hikes were of a similar magnitude but extended over four years and were accompanied by growing household incomes). Parallel to that, the government has markedly upgraded the system of direct energy subsidies for poor households, which are supposed to cushion the impact of the tariff hikes. In 2015, one third of Ukrainian households were eligible for these subsidies, and this share is reportedly projected to go up to two thirds in 2016.

Partly due to the steep rise in the gas price, between 2013 and 2015 residential gas consumption in Ukraine declined by about one third. Following another tariff hike effectively enacted in spring 2016, residential energy consumption will probably fall by another 9% this year according to our estimations – despite the extensive energy subsidies to poor households. This reduction in energy consumption essentially means sacrifice of households' living standards, since improvements in energy efficiency via energy-saving investments are constrained by the shortage of funds and would in any case take time to materialise. Because of the higher energy payments, private consumption of other (non-energy) items has suffered as well and – despite some recovery expected this year – will be still below the 2011 mark. This is a disturbing development. The suppressed demand for non-energy consumer goods represents a clear social loss in an economy which has been suffering from a persistent inadequacy of aggregate demand (showing itself in the relatively high rate of unemployment and the fact that millions of Ukrainians have been forced to leave the country in search of work abroad).

At the same time, our analysis demonstrates that the magnitude of gas tariff hikes implemented in Ukraine has been clearly excessive when viewed from the production (cost) side. Under plausible assumptions regarding the dynamics of domestic gas production, residential consumption and gas import prices in the years to come, we come to the conclusion that the first two rounds of gas tariff hikes implemented in 2014-2015 should have been more than sufficient to restore the 'financial health' of the state-owned gas monopolist Naftogaz and eliminate its needs for government subsidies in the longer term. The latest tariff hike implemented in spring 2016 will only increase the rents accruing to Naftogaz (and, via higher tax revenues, of the government at large) still further – essentially at the expense of the population. Our estimations suggest that the windfall annual rent, which is likely to be appropriated by Naftogaz and the government thanks to the implemented tariff hikes, will likely amount to some 2% of

GDP, and may prove to be even higher if the gas import price (to which the domestic gas tariff for households is tied) goes up from its currently low level.

The source of this rent is essentially the fact that the wholesale price for largely domestically produced gas has been set now on par with imported gas, which – after the recent sharp reduction in gas demand – is now needed only in limited quantities to cover the households' needs. Although the absolute level of the gas tariff for households in Ukraine is lower than in most European countries, our calculations show that in relative terms (i.e. with respect to prices of non-energy items), it is already at a level typical of countries at a comparable – or even higher – GDP level.

Two policy options seem possible to amend the situation in the short run. The first, already being implemented, stipulates the government somehow compensating the rising energy prices to the poor households in the form of energy subsidies. This approach is recommended to be continued. However, the provision of energy subsidies is likely to be rather costly and difficult to administer efficiently – the more so as it tends to extend in scope. Besides, as is well known from experience, a universal distribution of subsidies may likely disturb the income differentials across firms, sectors and employees' qualifications and thus have negative supply-side effects. Moreover, it is difficult to grasp the rationale for a policy which imposes high energy prices – and then compensates the rising costs of living by covering parts of households' increased energy bills.

The alternative policy would be to try to roll back the energy tariffs imposed on the household sector. As long as Naftogaz profits permit, the authorities may order reductions in the prices charged. This would be consistent with normal practices well established in the mature market economies where various public institutions mediate between the mass of powerless consumers and a few giant – and mighty – corporations which always tend to exploit the inelasticity of demand for their products by hiking the prices into stratosphere to earn undeserved monopolistic rents. In Ukraine's case, it should be relatively easy to roll back energy tariffs as long as Naftogaz remains state-owned. A privatisation of the gas sector in line with the EU Third Energy Package would make this task more difficult, with realistic prospects of emerging private monopolies which will be more difficult to regulate.

In the longer run, various measures may be contemplated to reduce household demand for energy – without sacrificing the satisfaction of the basic needs requiring the use of energy. This boils down to the issue of energy efficiency improvements. The wisdom of front-loaded tariff hikes is questionable unless they will be accompanied by more vigorous government efforts aimed at promoting energy-saving investments. Such efforts could complement, for instance, the recent EBRD programmes in Ukraine which have gained major traction in energy efficiency results, and draw on the past successful experience in Central European countries. Given the shortage of funds within Ukraine, a welcome solution could be e.g. a combination of grants provided to Ukraine by the EU and/or its Member States, alongside loans and investments from the EBRD and EIB.

In this vein, the government may consider extending the scope of subsidies, e.g. by providing lower interest rates and a higher reimbursement rate for energy-efficient loans already in operation and/or establishing new lines of targeted support. Also, the government may consider granting subsidies for the purchase of energy-saving equipment and the implementation of energy-saving measures irrespective of whether a loan is needed or the related expenses are covered from the household's own pocket. One important area of government involvement could be, for instance, the installation of heating meters in

residential buildings, which may be unaffordable for the vast majority of poorer households without targeted subsidies from the government. As long as half of the households using central heating lack meters and cannot regulate the room temperature, any hopes for a substantial reduction in energy consumption in this segment in response to gas tariff hikes may be elusive.

Government subsidies along these lines would be crucial in solving the long-term structural problem of excessive energy consumption, and should enjoy priority over the short-term task of fiscal consolidation. In fact, they could be financed from the enacted gas tariff hikes. For instance, the additional rent appropriated by Naftogaz and the government thanks to recent tariff hikes – if used to finance energy-saving subsidies – could cover more than half of the officially acknowledged annual investment needs for energy efficiency purposes. Such an approach would be in line with the earlier (successful) experience of Central European countries, where the increased revenues of energy suppliers due to tariff hikes were used to finance energy-efficiency investments. However, it should be the government – or ideally a new government unit created specifically for this purpose – rather than Naftogaz which should be in charge of administering such energy-efficiency subsidies; this would reduce the risks of embezzlement and misappropriation of funds involved.

Background

In Ukraine, natural gas is by far the most important energy source for the household sector. It accounts for up to 80% of household energy consumption: some 60% directly (for heating, hot water and cooking) and another 20% in the form of central heating and hot water supplied by district heating companies (DHC) to residential buildings. Gas is also widely used in industry, both as a source of energy and an intermediate input. In electricity generation its role is however far less important than that of nuclear power and coal. The main company which produces, imports, transports and distributes natural gas in Ukraine is the state-owned monopolist Naftogaz. Through its subsidiaries Ukrgazvydobuvannia and Ukrnafta, it accounts for some 80% of Ukrainian gas production[1] and 95% of its gas imports.[2] Besides, Naftogaz is the only company which supplies gas directly to households and to DHC (which are in many cases privately-owned, often privatised under dubious circumstances).

Given that Ukraine's economy has one of the world's highest energy intensities (and the potential for improving energy efficiency is accordingly large),[3] and that the country's energy sector has been notoriously corrupt for years, it is no surprise that energy sector reforms have been for a long time viewed as one of the most important challenges facing the country. The importance of this challenge was recognised well before the Maidan revolution of February 2014. For instance, in 2010 Ukraine joined the EU Energy Community (EC) – an international organisation which is supposed to facilitate the adoption of EU energy regulations in non-Member States: countries of the Western Balkans, Moldova and Ukraine. Ukraine's commitments as an EC member include in particular the reform of its gas and electricity sectors, including the implementation of the EU Third Energy Package which requires inter alia price liberalisation, provision of access to energy infrastructure for independent producers, and unbundling of energy production from transportation and distribution.

Following the Maidan revolution of February 2014, the rhetoric surrounding energy sector reforms in Ukraine gained a new momentum. This rhetoric has been shaped to a large extent by western advice and the requirements of the Deep and Comprehensive Free Trade Agreement (DCFTA) with the EU which entered into force in January 2016 and is part of a broader EU-Ukraine Association Agreement.[4] However, their actual implementation is still lagging. The most visible manifestation of reforms so far have been the steep hikes in retail energy tariffs to 'market' levels, first of all for gas and utilities supplied by DHC, but also for electricity and water supply.

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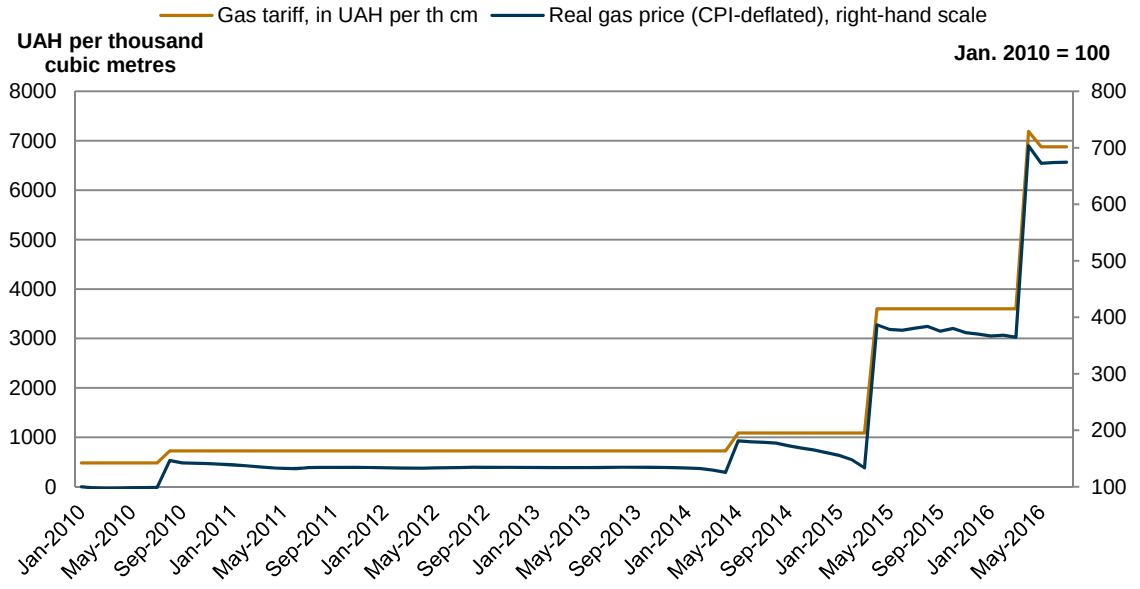
1 The rest is accounted for by independent producers belonging to Ukrainian 'oligarchs': Poltava Petroleum Company/JKX Oil &Gas (I. Kolomoyskiy), Naftogazvydobuvannia/DTEK (R. Ahkmetov), Geo Alliance (V. Pinchuk), Burisma and KUB-Gas (O. Zlochevskiy), Karpatygaz/Misen Energy (presumably Yu. Boyko and D. Firtash) and Regal Petroleum/Smart Energy (V. Novinskiy) – see Zachmann (2016).

2 The largest buyers of privately imported gas in 2015 were ERA Trading and ArcelorMittal (ibid).

3 With 0.4 kg of oil equivalent per 1 USD of GDP (at PPP), Ukraine's energy intensity is comparable to that of Russia but is twice as high as that of the USA and three times as high as that of Germany and Japan – see Emerson and Shimkin (2015).

4 For instance, a reform agenda for Ukraine's energy sector was elaborated in detail in Atlantic Council (2014).

Figure 1 / Retail gas tariffs for households in 2010-2016



Note: Tariff for the consumption band less than 2,500 cm per year, with meters.
Source: Naftogaz, wiiw Monthly Database, own calculations.

One declared motivation behind the implemented tariff hikes has been to provide energy-saving incentives. Besides, they have been demanded by the IMF as a condition for its loan programmes extended to Ukraine since 2014, primarily because of their importance for budget consolidation. The initial target agreed with the IMF was to raise retail gas tariffs to 'cost-recovery' levels (i.e. reflecting the cost of imported gas) by 2017. However, since gas prices in Europe have in the meantime declined markedly following the drop in the oil price, this target was reached already in May 2016 – one year ahead of schedule. Since May 2016, the wholesale price of natural gas used for residential purposes in Ukraine (which underlies the retail end-user tariff – see Figure 7 below) has been set at the price level at a German gas hub plus the costs of its transportation to Ukraine's border; this corresponds to USD 196 per thousand cubic metres (th cm).

The magnitude of gas tariff hikes for households and the short time span over which they have been implemented have been unprecedented. In nominal hryvnia (UAH) terms, tariffs were raised from UAH 725 per th cm at the beginning of 2014 to UAH 6,879 as of May 2016, i.e. 9.5 times within less than two and a half years (Figure 1).[5] In real (CPI-deflated) terms, the increase was somewhat less spectacular but still enormous (5.4 times). In addition, real terms may not be very telling in this context, since the nominal incomes of many households – particularly salaries in the public sector and pensions – have not been fully indexed in line with inflation.[6]

[5] This tariff applied to the most representative consumption band: less than 2,500 cm per year (in other periods alternatively defined as 200 cm per month or 1,200 cm per heating season), with meters. Tariffs for higher consumption bands and without meters were higher, but their dynamics over time closely followed the dynamics of the above tariff. Since May 2016, there is a single tariff for all types of consumers.

[6] For instance, in Poland the tariff hike for residential gas and heating in 1990-1994 was of a similar magnitude as in Ukraine but extended over a longer time period: four years rather than two. In addition, real household incomes in Poland were growing rather than falling over the same time period – see Buchan (2010).

The enacted hikes in gas tariffs for DHC, which supply heating and hot water to around one third of all households, have been of a similar magnitude, causing the price of these utilities for households to go up as well. Tariffs for central heating and hot water supplied by DHC, which are also set administratively, vary by provider, but the magnitude of tariff hikes over the past two years has been broadly similar across the country. For instance, the heating tariffs of Kyivenergo went up from UAH 253 per 1 GCal at the beginning of 2014 to UAH 1,345 as of June 2016, i.e. 5.3 times in nominal terms. In the following, wherever we speak of residential gas consumption, we implicitly include gas consumption by DHC (unless specified otherwise).

Parallel to energy tariff hikes, the government has markedly upgraded direct subsidies for the poor households, which are supposed to cushion the impact of the hikes. In 2015, one third of Ukrainian households were eligible for these subsidies, and this share is projected to go up to two thirds in 2016.

This study assesses the impact of the recent energy tariff reform on residential energy consumption (which accounts for one third of total energy consumption in Ukraine) and the financial standing of Naftogaz (and the government at large), and assesses various policy options, partly drawing on the earlier experience of other Central and East European countries in the area of energy sector reforms.[7]

[7] This study focuses exclusively on the household segment, given that the recent tariff reform has been largely confined to households: gas tariffs for industry have been at 'cost-recovery' levels already for a number of years.

Assessing household demand for residential energy

ESTIMATING THE PARAMETERS OF DEMAND FUNCTIONS: DATA ISSUES

Assessing the consumer demand for any specific item requires applied work on patterns of demand formation. Such work is possible provided reasonably numerous (and reliable) data on price and income developments are available. This study focuses on estimating the effects of changing prices on the demand for household (residential) energy in Ukraine. The Ukrainian statistical data available appear to be of limited use. The essential difficulty lies in the absence of easily accessible time series on real quantities, expenditure and price indices for residential energy consumed by the household sector. The consumer price indices for energy (and its various forms) are available from the State Statistics Service for the years 2002 through 2015 – but these are hard to square with the respective quantities (and expenditure) data. Energy spending is included in the broad aggregate category *Housing (including imputed rents), its maintenance and repair, water, sewage collection, electricity, gas and other fuels*. Tracking the actual volumes or values (in money terms) of energy consumed is also fraught with difficulties if one were to work with the input-output tables (at consumer prices, available for the years 2009-2010) and energy balances (available for the years 2007-2014). The latter source reports quantities consumed by households of various types of energy – however, all quantities are expressed in tonnes of oil equivalent. Even if in principle it should be possible to convert the 'oil equivalents' of various energy types into monetary (expenditure) terms, the resulting time series would be rather too short for a reliable assessment of the parameters of the demand function.[8] Another problem with the national energy data relates to the incidence (and severity) of energy supply shortages that have possibly affected eventual consumption. Arguably, to some (*ex ante* unknown) extent the recorded consumption of energy may represent available supply rather than actual demand.

Some of the above-considered problems over data for the estimation of the demand function for household energy in Ukraine can be made less troublesome in the framework of the alternative approach pioneered and developed by Henri Theil in a number of contributions, including Theil and Suhm (1981), Theil and Clements (1987), Fiebig, Seale and Theil (1988) and Clements and Selvanathan (1994). The approach hypothesises the existence of a universal system of demand functions characterising different national 'representative consumers'. For the approach to work it is necessary that quantities and prices for various items are expressed in easily comparable measurement units. Such data are of course available from the World Bank's International Comparison Projects (ICP),

[8] The Household Budget Survey data for any year provide very large samples, with large variation in income/expenditure level. However, these surveys also do not distinguish between energy and other items included in the *Housing* aggregate. Besides, estimating the demand functions' parameters with the HBS data for any given year can hardly elicit the price effects. In reality the prices faced by different households (e.g. urban vs. rural) may be different. In statistical practice these differences may be hard to allow for. In addition, the aggregate (national account's) household consumption data are usually very difficult to square with the aggregates from the Household Budget Surveys.

covering almost all world countries (and territories) – including Ukraine. The most recent ICP data released in 2014 refer to year 2011.[9]

In practical terms the Theil approach stipulates the estimation of cross-country consumer demand functions (or systems of such functions) with national price and quantity data for a given year taken from the ICP.

One advantage of this is that ICP data display large cross-country variations in both income levels and relative prices. The diversity in the cross-section data available from the comparison projects (and the internal consistency of those data and their cross-country comparability) comes at a cost, however. It must be accepted that comparison projects produce their final results on purchasing power parities and on 'real' quantities consumed based upon a labour-intensive gathering and processing of national data, and upon the application of elaborate computational algorithms (which are not entirely free of some subjective judgements) to the national data. Also, provided the decisive number of data come from countries unlikely to have suffered from serious shortages, it may be assumed that the impact of such shortages on the eventual estimates of the parameters of the demand functions may be negligible.[10]

ICP DATA FOR 2011

The ICP2011 results encompass a wealth of basic and detailed information for 179 countries. Assuming that the African, Asiatic and Latin American countries may be too different from Ukraine on climatic and other criteria, it has been decided to consider the data for only 55 out of the 179 countries (including only 3 Asian and 2 Latin American countries). The sample selected includes 9 countries classified as belonging to the Commonwealth of Independent States (still including Ukraine) and 46 countries included in the Eurostat-OECD Comparison Project. The latter group comprises all European countries, Australia, Chile, Israel, Japan, Korea, Mexico, New Zealand, Turkey, the United States and the Russian Federation. (The data for the Russian Federation come in two versions. These versions do not differ yet as far as the relevant indicators are concerned.)

Out of the mass of information on purchasing power parities and real quantities consumed of various aggregates of goods and services only three items were considered: (1) *individual consumption expenditure by households*; (2) *housing, water, electricity, gas and other fuels*; (3) *individual consumption expenditure by households without housing*. The latter aggregate excludes from (2) the actual and imputed rents. Thus, (3) consists of the non-rent part of expenditures in (2) – primarily the energy consumed (but also inclusive of non-energy items: water supply, sewage, maintenance and repair of housing facilities).[11]

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9 http://siteresources.worldbank.org/ICPEXT/Resources/ICP_2011.html
Eurostat's European Comparison Project provides comparable detailed data for more recent years. However, ECP does not cover Ukraine (although it covers the Russian Federation).

10 In actual fact the parameters of the demand functions based on cross-country comparisons may be used for the assessment of shortages in supply-constrained economies (e.g. in the former planned economies), see Podkaminer (1982, 1988); Podkaminer, Theil and Finke (1984).

11 Clearly, in practice it may be rather hard to split the expenditure on housing into its constituent sub-categories. Depending on the tenant arrangements, water supply, sewage collection – or even heating – may or may not be included in the rent (on a fixed rate, independent of the actual volume of these items consumed).

The original ICP data for the selected countries for the 3 categories are presented in Table 1.

Table 1 / Basic ICP data for selected countries, 2011

	Real expenditures per capita (thous. PPP USD)			PPP (USD = 1)		
	Individual consumption expenditure by households	Housing, water, electricity, gas and other fuels	Individual consumption expenditure by households without housing	Individual consumption expenditure by households	Housing, water, electricity, gas and other fuels	Individual consumption expenditure by households without housing
Armenia	5,704	1,972	4,353	183.780	45.532	232.422
Azerbaijan	6,507	2,169	5,223	0.329	0.087	0.398
Belarus	8,160	3,170	6,535	1832.435	434.660	2210.871
Kazakhstan	8,518	3,098	7,292	83.612	56.286	80.998
Kyrgyzstan	2,586	1,096	2,042	17.538	3.431	21.786
Moldova	4,097	1,381	3,208	5.451	2.425	6.588
Russia.	11,429	3,279	9,369	16.769	6.688	19.430
Tajikistan	2,215	790	1,786	1.883	0.346	2.298
Ukraine	5,785	2,468	4,530	3.311	0.982	3.967
Albania	6,251	1,182	5,297	58.168	39.923	63.141
Romania	8,274	2,023	6,964	2.001	1.771	2.055
Latvia	10,700	3,282	8,499	0.403	0.303	0.440
Lithuania	12,416	3,022	10,322	1.786	1.203	2.007
Bosnia and Herzegovina	6,667	1,864	5,386	0.867	0.443	1.002
Bulgaria	8,358	2,595	6,406	0.765	0.442	0.891
Turkey	10,729	3,264	8,177	1.164	0.772	1.300
Poland	12,519	4,207	10,476	1.936	1.395	2.152

Source: ICP 2014.

ICP data do not provide, explicitly, information on per capita real household consumption of energy and the purchasing power parities for household consumption of energy. But that information can be calculated from the information in Table 1. First the PPP_r for the rent item is calculated according to the formula[12]:

$$PPP_r = \exp((\ln(PPP_1)-s\ln(PPP_3))/(1-s))$$

where exp(x) is e (the base of natural logarithm) to power x; ln is the natural logarithm, PPP_1 is the PPP for the whole individual consumption; PPP_3 is the PPP for individual consumption without housing and s the share of the latter category in the nominal individual expenditure.

Once the PPP for rent is established, also the PPP for energy and then PPP for all consumption items excluding energy are calculated, using properly re-specified formulae of the above type. Table 2 presents the data for selected countries eventually used for the estimation of the parameters of the cross-country demand function for household energy.

[12] This formula is derived from the formula first proposed by Stone (1954). Alternatively the calculation of additional PPPs for sub-categories (such as rent or energy) would require the application of the so-called EKS method. That would imply enormous amount of auxiliary calculations. The formula used produces PPPs not much different from those achieved by the EKS method in most instances (excluding the cases differing 'too much' from the cross-country averages in terms of expenditure structures).

Table 2 / Eventual data used for estimating the demand for energy function for selected countries, 2011

	Nominal expenditure pc (domestic currency)	Real cons pc energy PPP US$	Real cons pc non-energy PPP US$	PPP energy US$=1	PPP non-energy US$=1
Armenia	1048205.6	3020.6	4774.3	17.662	208.377
Azerbaijan	2143.5	2798.8	5408.5	0.045	0.373
Belarus	14952416.5	4588.3	6675.2	190.555	2109.011
Kazakhstan	712215.2	2368.6	7094.2	22.298	92.949
Kyrgyzstan	45349.9	1367.5	2094.8	2.123	20.263
Moldova	22333.5	1384.7	3239.2	1.552	6.231
Russia	191650.8	3751.8	9561.2	3.283	18.757
Tajikistan	4169.7	1034.3	1873.0	0.199	2.116
Ukraine	19156.7	3990.9	4594.8	0.310	3.900
Albania	363591.0	820.6	5646.4	21.979	61.199
Romania	16552.3	921.7	7393.4	1.454	2.058
Bosnia & Herzegovina	5780.1	1773.8	5556.2	0.248	0.961
Bulgaria	6394.7	2297.4	6988.2	0.201	0.849
Latvia	4314.0	2003.4	9003.6	0.209	0.433
Lithuania	22173.6	2345.4	10426.4	0.929	1.918
Turkey	12492.7	2578.9	9339.3	0.256	1.267
Poland	24240.5	3407.8	9420.6	1.226	2.130

Source: Own calculations.

ESTIMATING THE PARAMETERS OF THE DEMAND FUNCTION FOR HOUSEHOLD ENERGY

The (microeconomic) theory of consumer behaviour sets certain requirements on acceptable functional forms of the demand functions. Minimally, such functions must be homogenous of degree zero in nominal income and prices of goods considered. There are many functional forms possessing those (and many other desirable) properties proposed (and tried in practice). Of course not all of these forms 'fit' the actual data equally well. In our case the standard forms such as the Constant Elasticity of Substitution perform quite poorly. The Linear Expenditure System and Constant Price-and-Income Elasticity System perform moderately well. However, the best 'fit' is offered by the widely used Almost Ideal Demand System (AIDS), introduced by Deaton and Muellbauer (1980).[13]

The real demand for household energy (E) consistent with AIDS has the following form:

$$E = (c_1 + c_2(\ln(Y/34238.73) - c_1\ln(PPPe) - (1-c_1)\ln(PPPn) - 0.5c_3(\ln(PPPe/PPPn))^2) + c_3\ln(PPPe/PPPn)Y/PPPe \quad (1)$$

where c_1, c_2, c_3 are parameters (to be estimated); ln stands for the natural logarithm; PPPe and PPPn are purchasing power parities for energy and non-energy respectively (compare Table 2); Y is the nominal per capita individual consumption expenditure (in the national currency). The number 34238.73 is a scaling constant (equal per capita nominal individual consumption expenditure in the USA).

[13] A simplified AIDS (LA-AIDS) performs much worse that AIDS proper while an extended AIDS (QUAIDS) does not provide any statistical advantages (the additional parameters introduced prove insignificant).

Table 3 / Estimation output

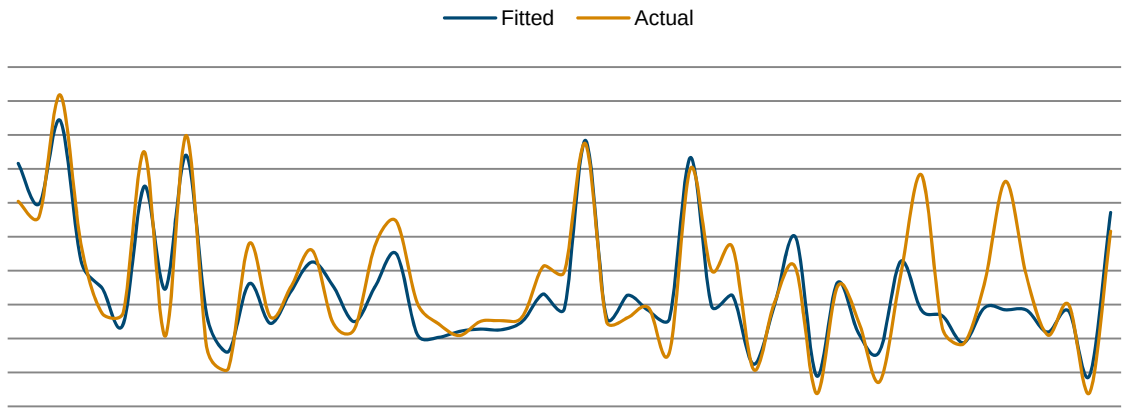
Dependent Variable: E
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 07/20/16 Time: 14:10
Sample: 1 43 45 47 49 55
Included observations: 53
Convergence achieved after 4 iterations
Coefficient covariance computed using outer product of gradients
E=(C(1)+C(2)*(LOG(Y/34238.73)-C(1)*LOG(PPPE)-(1-C(1))*LOG(PPPN)-.5
*C(3)*LOG(PPPE/PPPN)*LOG(PPPE/PPPN))+C(3)*LOG(PPPE/PPPN))*Y/PPE

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.056081	0.003645	15.38730	0.0000
C(2)	-0.022392	0.004215	-5.312711	0.0000
C(3)	0.014649	0.002810	5.212951	0.0000

R-squared	0.865191	Mean dependent var	1722.426
Adjusted R-squared	0.859799	S.D. dependent var	987.8405
S.E. of regression	369.8817	Akaike info criterion	14.71918
Sum squared resid	6840625.	Schwarz criterion	14.83071
Log likelihood	-387.0583	Hannan-Quinn criter.	14.76207
Durbin-Watson stat	1.591313		

Source: Own calculations.

Figure 2 / Actual and fitted values from estimations in Table 3



Source: Own calculations.

The interesting thing to notice is the negativity of the c_2 parameter. The implication of this is that energy turns out to be an 'Engel' commodity. At unchanged prices the *share* of energy expenditure in total

expenditure *falls* with rising income. This is the property exhibited also by expenditure on foodstuffs (and also the aggregate consisting of tradable goods).[14]

With the AIDS system the price and income elasticities are generally variable – they depend on income (or total expenditure) and price levels (and their structures). The income elasticity of demand for energy implied by the data (as exemplified in Table 2) and the estimates from Table 3 range between 0.3267 (for the US) and 0.7602 (for Slovenia). For Ukraine that income elasticity is assessed to be 0.6545 – close to the average for 55 countries (0.6445). Thus energy is a 'normal' (but not a 'luxury') good (in the terminology of the consumer demand theory). The elasticity of demand for energy with respect to the energy price varies between -0.5371 (for the US) and -0.8449 (for the Czech Republic). For Ukraine that price elasticity is -0.7509 (fairly close to the average for 55 countries which equals -0.7461). Thus the demand for energy is relatively price-inelastic. This indicates that the (large oligopolistic or monopolistic) energy suppliers are always inclined to press for higher prices – as this always raises their revenues (and profits). In view of that it is essential that the authorities conduct active regulatory policies (e.g. encourage competition, fight suppliers' and distributors' cartels, or even institute some forms of price, or mark-up, controls).

The non-energy individual consumption aggregate turns out to be almost unit price elastic. The own-price elasticity of demand for non-energy, calculated for the 55 countries, varies between -0.9953 and -0.9928.

Observe that the non-energy and energy aggregates are necessarily substitutes (because the total expenditure is divided, by definition, into energy and non-energy expenditure). The elasticity of substitution is rather high as it ranges between 0.926 (for Mexico) and 0.706 (for Iceland). The average elasticity of substitution for 55 countries (0.838) is close to Ukraine's (0.806). An increase in the *relative* price (of energy vs. non-energy) brings about quite significant decreases in the quantities demanded of both energy and non-energy.

The AIDS formula has some limitations. First, if the formula applies (with the same parameter values) to population subgroups distinguished by the income level, then averaging the demand estimates across these subgroups will result in an estimate different from the estimate obtained upon the application of the formula to the *average* income. Second, it must be observed that the AIDS formula must not be applied outside 'reasonable' values for income (in relation to prices). For income being too high in relation to prices the AIDS formula envisages the share of energy in total expenditure becoming *negative* – and correspondingly also the assessed demand for energy becoming negative. For income being too small in relation to prices the AIDS formula envisages the share of energy rising above 1 – thus implying that the share of non-energy in total expenditure (and the demand for non-energy) becomes negative.

In a situation when prices are becoming too high in relation to the disposable income, the AIDS formula is no longer valid. Some other formulae may need to be applied – for instance as far as very low income groups are concerned. For such groups the satisfaction of minimum (subsistence) levels of consumption of energy may be a priority.

[14] See e.g. Podkaminer (2004).

EXTRAPOLATING THE PRICE AND PPP DATA FOR UKRAINE FOR 2012-2015

To use the AIDS formula (1) specified with the estimates for c_1, c_2 and c_3 for assessing the Ukrainian household demand for residential energy in 2016 (and beyond) it is necessary to 'feed in' the probable values for the expected total per capita nominal expenditure (Y) for 2016 and the expected PPPs for energy and non-energy aggregates. While predicting Y does not seem to be a very complex activity, predicting the PPPs in question is a bit troublesome. The reason is that the price indices (2016 over 2011) for our energy and non-energy aggregates (P_e and P_n respectively) are not reported. If they were, the PPPs for 2016 would be calculated as

$PPP_e(2016) = P_e PPP_e$ and $PPP_n(2016) = P_n PPP_n$.

Assessing the price indices P_e and P_n is not quite an easy matter, if only because the Ukrainian consumer price statistics leave something to be desired. For example, the consumer price indices for the *housing etc.* aggregate differ from the respective consumer price deflators reported in the national accounts chapter (on final household consumption expenditure). The NA source is more adequate for our purposes. The trouble is that the NA source does not distinguish rent from other items (primarily energy) included in the housing aggregate – while the consumer price statistics do distinguish. Taking over the consumer price indices for rent and the NA deflators for the remaining items it is possible to consistently assess, through recursive calculations, the probable values of the price indices for energy (of course inclusive of water supply, repair and maintenance) and non-energy. These indices appear in Table 4.

Table 4 / Price indices for energy, non-energy and all items (previous year = 1)

	2012	2013	2014	2015
Energy	1.001	1.040	1.203	2.749
Non-energy	1.022	1.0325	1.165	1.392
All items	1.021	1.033	1.167	1.481

Source: Own calculations.

ASSESSING HOUSEHOLD DEMAND FOR ENERGY IN 2012-2015

Table 4 shows a big jump – almost threefold – in the price level for residential energy in 2015. But the *average* total individual household consumption expenditure per capita grew by a mere 18.2% nominally. There was no doubt that the low-income groups (and especially those whose incomes did not even rise at an 18.2% rate) were faced with rather unprecedented hardship. That was acknowledged by the government which has been covering parts of the increased households' energy bills. The average (divided by the entire population) per capita government-financed energy bill (which might be called an energy subsidy, or rebate) was about UAH 509 in 2015 per year (and about UAH 1,018 is expected in 2016). The size of the rebate depends on the disposable income of individual households: the lower the income, the larger (within some limits) the part of the energy bill covered by the government. The intention is that the most elementary energy needs can be satisfied, at least at a subsistence level. Of course, the subsidy thus received is all spent on satisfying such elementary energy needs – without necessarily altering the behaviour of the average (representative) Ukrainian inhabitant. In other words, it is assumed that the *actual* household consumption of energy consists of two components: 1) individual

household consumption consistent with individual nominal income (expenditure) and prices, and 2) government-financed consumption (realised by the poor).[15]

To estimate part 1) of the energy consumption we apply the AIDS formula (1) specified with the parameter estimates from Table 3, the updates of the purchasing power parities for energy and non-energy for 2012-2015 and the (available) data on the per capita total nominal household consumption expenditure. (The recent revisions of Ukrainian national account data update the per capita total nominal expenditure for 2011 to UAH 19,836. The AIDS formula was also slightly 'updated' – to account for the residual (178.1) to equation 1 in 2011. The same corrective constant is added to all energy demand estimates for other years.) The resulting estimates are shown in Table 5.

Table 5 / Estimated per capita consumption of energy and non-energy, 2011-2015

	Total exp[1] p.c.(Y) thous. UAH	PPPe (2011) USD = 1	PPPn (2011) USD = 1	Demand for energy at 2011 PPPe	Demand for non-energy at 2011 PPPn
2011	19836	0.310	3.899	3991	4769
2012	22046	0.311	3.987	4256	4769
2013	24300	0.323	4.117	4398	5198
2014	28450	0.388	4.794	4313	5585
2015	33640	1.068	6.672	2874[1]	4658

1) Including the PPP equivalent (476.7) of the UAH 509 in energy consumed out of the energy subsidy.
Source: Own calculations.

THE DYNAMICS OF ENERGY AND NON-ENERGY DEMAND

According to Tables 4 and 5, energy prices experienced a series of drastic shocks in 2014 and 2015. The assessed consequences of these shocks shown in Tables 5 and 6 are rather grave, in the first place for the level of household demand (and thus consumption) of energy. Of course, cuts in energy consumption may be the result of some efficiency gains. But true efficiency gains are unlikely to emerge quickly. Thus the cuts in energy consumption primarily represent declining levels of satisfaction of the essential household needs (more on that, see below). Our estimates suggest that per capita demand energy fell by close to 2% in 2014 (year-on-year). Without the energy subsidy another decline would have followed (by a dramatic 44%) in 2015. Due to the government-financed energy consumption by the poor, the *average* per capita consumption of energy fell by only some 33%.[16] However, it appears that the energy subsidy helps, quite strongly, restrict the scale of decline in the demand for non-energy.

[15] National Accounts (and ICP) distinguish between 'individual consumption expenditure by households' and 'individual consumption expenditure by government'. The latter category is defined as 'total value of actual and imputed final consumption expenditure incurred by the general government on individual goods and services'. Clearly, the energy subsidy to the poor belongs to the latter category.

[16] The dramatic decline in the consumption of energy following the estimations turns out to be quite consistent with the Ukrainian NA data for final household consumption in 2015. According to that source the volume (i.e. the real quantity) of housing (energy, rent etc. combined) fell by 27.3% in that year. Assuming that the volume of rent could not fall within one year, the overall fall in energy consumption, consistent with the 27.3% figure, must have been, according to some auxiliary calculations, about 34%.

Table 6 / Indices of per capita real demand for household energy and non-energy, 2012-2015 (previous year = 1)

	Demand for energy with subsidy	Demand for energy without subsidy	Demand for non-energy	Real cons. total with subsidy[1]	Real cons. total without subsidy[1]
2012	1.067	1.067	1.090	1.088	1.088
2013	1.033	1.033	1.069	1.067	1.067
2014	0.981	0.981	1.005	1.003	1.003
2015	0.666	0.556	0.834	0.824	0.818

1) At constant prices of previous year.
Source: Own calculations.

The volume of *total* per capita household consumption (energy plus non-energy consumption) would have fallen by 18.2% in 2015 (when not accounting for the government-financed energy consumption) or 17.6% (when accounting for the government-financed consumption).[17] By 2015 the real total individual household consumption per capita (including the estimated effects of the energy subsidy) was still more than 4.1% lower than in 2011.

WHAT TO EXPECT IN 2016?

For 2016 the Vienna Institute for International Economic Studies forecasts for Ukraine a further slight decline in population, consumer price inflation of 15.5% and zero growth in real household consumption. In per capita terms, nominal household expenditure is expected to rise by 15.7%, reaching UAH 38,920, and in real terms by about 0.2%.

Data for the first 6 months of 2016 show a rather fast decline in inflation. The annual CPI inflation rate for the first quarter stood at 30.8%, and at 18.1% for the first 6 months. The price index for housing fell from 102.8% to 42.3% respectively. For gas the decline in the inflation rate was even more pronounced: from 273% to 39%. One observes the 'base' effects (of price hikes introduced in the early months of 2015), not any actual decline in prices or tariffs. But another big hike in energy prices, introduced in April 2016, will be raising the price indices in the second half of the year again.

Clearly, expectations concerning the developments in prices (but also nominal incomes) over the remaining months of 2016 are rather uncertain. The working assumption made here sets the increase in the energy price at 50% for the year as a whole. This number is to be matched by a price index for non-energy of 10.8% and an expected overall inflation of 15.5%. (Should the overall inflation be substantially higher in 2016, the calculated price index for the non-energy aggregate would be correspondingly higher and the consumption of *both* items correspondingly lower.)

The assessed consequences of the assumptions on nominal per capita household consumption and price developments are summarised in Table 7.

[17] According to the National Accounts, the volume of final consumption expenditure fell by 20.2% in 2015 (at constant prices of 2010).

Table 7 / Scenario for 2016, in comparison with 2011 and 2015

	Total exp.[1] p.c. (Y) thous. UAH	PPPe (2011) USD = 1	PPPn (2011) USD = 1	Demand for energy at 2011 PPPe with subsidy	Demand for energy at 2011 PPPe w/o subsidy	Demand for non-energy at 2011 PPPn	Total real consumption with subsidy 2011 = 1	Total real consumption w/o subsidy 2011 = 1
2011	19836	0.310	3.900	3991	3991	4769	1	1
2015	33640 (508)	1.068	6.672	2874	2397	4658	0.956	0.952
2016	38920 (1018)	1.602	7.393	2615	1979	4836	0.985	0.959
2016/2011	1.69 (1.716)[2]	3.442	1.711	0.655	0.496	1.014	0.985	0.959
2016/2015	1.156 (1.17)[2]	1.50	1.108	0.910	0.826	1.038	1.027	1.007

1) Average per capita nominal energy-related subsidies for 2015 and 2016 (UAH 508 and 1,018 respectively) are in brackets. – 2) Growth rates of nominal per capita income include energy-related subsidies.
Source: Own calculations.

As can be seen, both the demand for as well as actual consumption of the residential energy item can be expected to fall further in 2016. The energy subsidy will moderate the decline in energy consumption quite significantly. Overall, the level of per capita total real household consumption remains depressed – even allowing for the energy subsidy. However, the energy subsidy strengthens the demand for non-energy considerably. In effect, total real household consumption is expected to rise more perceptibly in 2016 than would be the case if household consumption were to be financed exclusively out of households' own incomes.

Fiscal implications of energy tariff reform

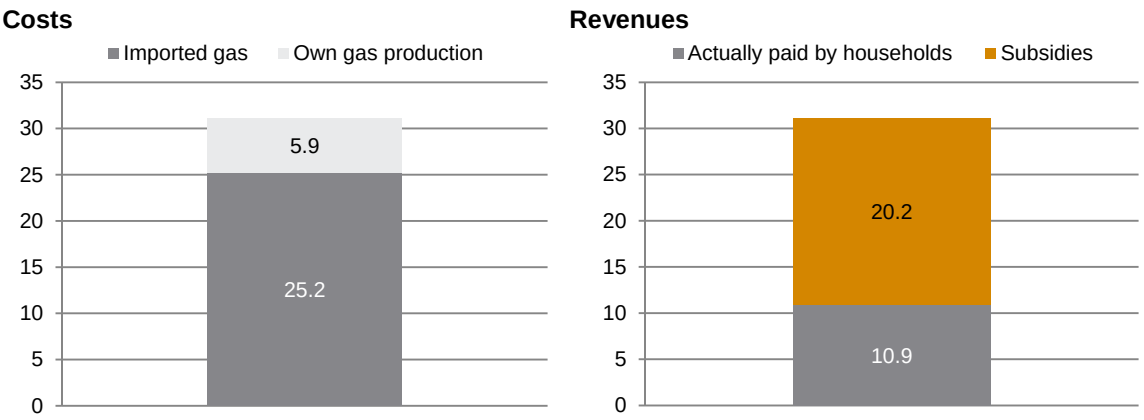
LOW IMPORT NEEDS: A NEW STRUCTURAL FEATURE OF UKRAINE'S GAS MARKET

Probably the most important motivation behind the implemented gas tariff hikes has been fiscal. The argument advocated by the government went as follows: hiking artificially low retail gas tariffs to 'cost-recovery' levels would eliminate the need for government subsidies – and thus help fiscal consolidation, which has been also a key IMF requirement.[18]

Historically, a look at Figure 3, which presents the structure of Naftogaz costs and revenues *in the household segment* over the period 2006-2015 (cumulated, in US dollar terms), indeed provides strong support to this point of view. On average, only around one third of Naftogaz gas sales to households and DHC have been paid from the households' own pockets. The remaining two thirds were subsidised from the government budget – primarily in the form of compensation for the low retail tariffs, although direct subsidies played some role as well.

The main reason for this was the high dependence on imported gas to fully cover households' needs. Although by law, which was in place until October 2015, all domestic gas production by state-owned companies was to be used to cover the needs of households, it was not sufficient, and the rest was imported (primarily from Russia, although more recently also from the West) – see Figure 4. On average, these gas imports stood at around 10 billion cubic metres (bcm) per year, accounting for around one third of household gas consumption but for as much as 80% of Naftogaz costs in the household segment (Figure 3).

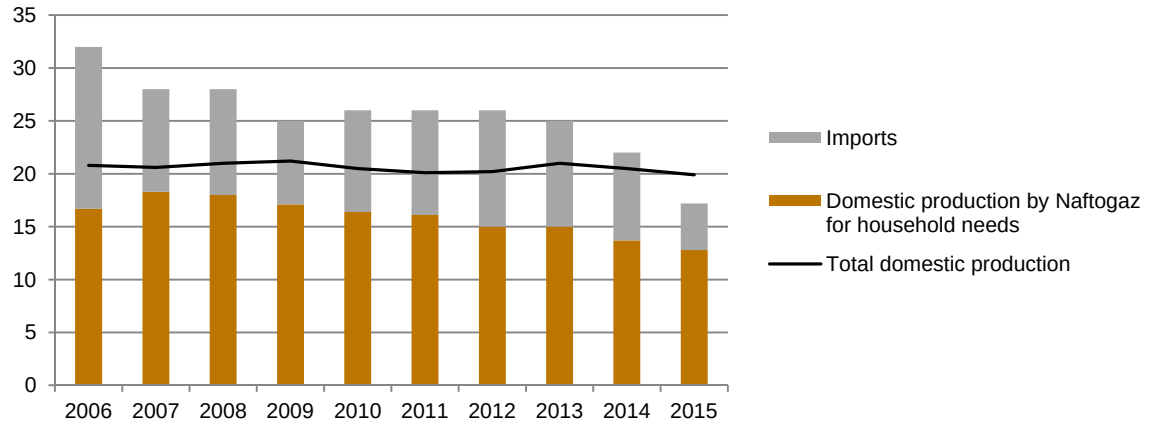
Figure 3 / Naftogaz balances in the household segment in 2006-2015, cumulated, in billion USD



Note: Including district heating companies.
Source: Naftogaz.

[18] Subsidies to Naftogaz have not been included in the headline budget deficit figure reported by the Ministry of Finance.

Figure 4 / Residential gas consumption, production and imports in 2006-2015, bcm per year



Source: Naftogaz.

However, the situation changed dramatically over the past two years. A combination of factors – of which the two most important were the territorial break-up (loss of Crimea and parts of Donbas) and energy savings in response to gas tariff hikes – brought about a sharp drop in residential gas demand (for the contribution of individual factors, see Table 8). All in all, between 2013 and 2015 residential gas consumption in Ukraine (including DHC) fell from 25 to 17 bcm, i.e. by about one third. At the same time, domestic production has been generally stable at around 20 bcm per year: production losses due to the secession of Crimea have been relatively limited. As a result, in 2015 for the first time residential gas consumption was in principle fully covered by domestic production (Figure 4). In reality though, not all of it was actually channelled to households, so that 4.4 bcm of imported gas was still needed last year.

Table 8 / Factors behind the reduction in household gas consumption in 2014-2015, mcm per year[1)]

	2014	2015	*Total*
Crimea, parts of Donbas	.	.	*-2,000*[2)]
Warm winter	-630	63	*-567*
Reduced 'norms' of gas consumption[3)]	-84	-520	*-604*
Switch from 'norms' to meter-based consumption	-34	-40	*-74*
Other factors (including gas tariff hikes)	-549	-2,123	*-2,672*
Total	.	.	***ca. -5,900***

Notes:
1) Without DHC. - 2) Naftogaz estimate. - 3) For gas consumers without meters (which account for 5% of total gas consumption). These are mostly households using gas for cooking and heating water.
Source: Khabatyuk (2016), own calculations.

The sharply reduced gas import needs have been the most important development over the past two years, which has radically reshaped Ukraine's gas market in the household segment and is likely to remain its new 'structural feature' for the years to come. Most of the above-mentioned factors which have been responsible for the recent drop in gas imports (with the exception of warm winters) are likely to be in place over a long period of time. Gas for households will remain expensive, keeping the residential demand at bay, which is unlikely to be boosted much by economic growth. Similarly, neither

Crimea nor parts of Donbass will be realistically returned under Ukraine's control in the foreseeable future. Finally, domestic gas production will be probably at least sustained at its current level.

Gas import needs would decline even more if all domestically produced gas were directed for the needs of households. At least gas produced by the state-owned Naftogaz could be used in the residential sector, which would reduce import needs by another 2-3 bcm per year. Deciding upon that is ultimately a question of political will of the government. In the longer run, Ukraine's gas consumption (and imports) may go down dramatically in line with energy efficiency improvements. Official estimates suggest that such improvements – if actually realised – could save up to 12 bcm of gas per year (more on that see below).

NAFTOGAZ DEFICIT TURNS INTO SURPLUS

What does this new constellation of Ukraine's gas market in the household segment potentially mean for Naftogaz finances and its need for government subsidies in the long run? Figure 3 may provide a useful starting point for such estimates. It captures the structure of Naftogaz costs and revenues in the household segment over ten years, i.e. over a sufficiently long period of time, and thus arguably reflects the 'structural features' not affected by the short-run volatility of individual factors (such as the weather or the gas import price).

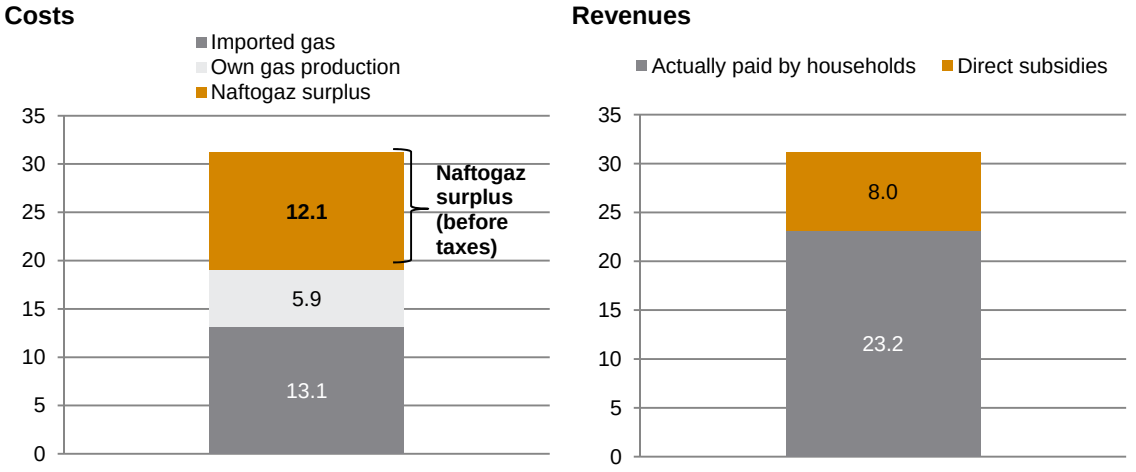
Figure 5 takes Figure 3 as a starting point, but projects into the future (over a ten-year period) the actual developments observed over the past two years. On the costs side, it adjusts for the recently observed sharp reduction in gas import volumes, which are projected to roughly stay at the level of 2015 (we only allow for the possibility that warm winters will in all likelihood not last forever, adding some 600 million cm (mcm) of gas imports per year). As argued above, this is a realistic scenario since most of the factors which have been responsible for the drastic reduction in residential gas consumption over the past two years are likely to be of a lasting nature. On the revenue side, Figure 5 adjusts for the increased collection of payments for gas from households thanks to the enacted tariff hikes (again adjusted for the weather) and the amount of direct government subsidies to the poor (assumed to stay at the level of 2015: UAH 19.9 billion). The projections also assume that the costs of domestically produced gas will remain unchanged in US dollar terms (which is a rather conservative assumption, given the current hryvnia weakness) and that the exchange rate stays at the level of 25 UAH/USD.

Scenario 5a assumes that the import price will be at the level observed over the past decade. In this case, Naftogaz expenditures on imported gas will fall in line with the reduced import volumes and can be calculated as follows:

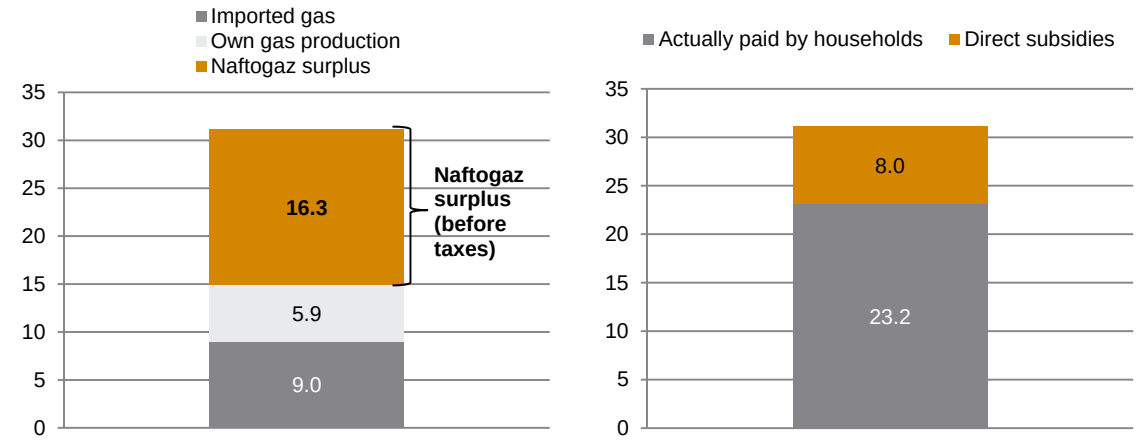
$$Import\ bill^{5a} = Import\ bill\ (2006-2015) * \frac{Imports(2015) adjusted\ for\ weather}{Average\ imports(2006-2015)}$$
$$= USD\ 25.2\ bn * \frac{5\ bcm}{9.6\ bcm} = USD\ 13.1\ bn$$

Figure 5 / Estimated effects of the 2014-2015 tariff reform on Naftogaz finances for the upcoming ten-year period, cumulated, in billion USD

5a - 'High price scenario' (import gas price at the level of the past decade: USD 262 per th cm)



5b - 'Low price scenario' (import gas price at the mid-2016 level: ca. USD 180 per th cm)



Note: Including district heating companies.
Source: Own calculations.

Thus, if the low gas import volumes are sustained in the longer run and the import price stays high, Naftogaz' import bill will go down nearly twice from its past level.

Obviously, the gas import bill will go down even more if the currently low gas import price persists for a longer period of time (scenario 5b). Given the current glut in global energy markets and the supply potential resulting from the recent 'shale revolution', this is plausible. In this case, the Naftogaz import bill can be calculated by adjusting the calculated import bill from scenario 5a by the projected reduction in the import price:

$$Import\ bill^{5b} = Import\ bill^{5a} * \frac{Import\ price\ (expected)}{Average\ import\ price(2006-2015)} = USD\ 13.1\ bn * \frac{180\ USD\ per\ th\ cm}{262\ USD\ per\ th\ cm}$$
$$= USD\ 9\ bn$$

Assuming a gas price of USD 180 per th cm (which is not far from the factual import price of USD 184 observed in the first half of 2016), the gas import bill will fall to USD 9 billion over a ten-year period – nearly one third of that over the past decade.

On the revenue side (which is identical in both scenarios), the projected amount paid for residential gas (including gas supplied for district heating companies) can be calculated as follows:

$$Revenues^{5} = \frac{Av.weighted\ tariff(2015)^{19} * Gas\ consumption(2015) adjusted for\ weather}{ER} * 10\ years = \frac{4375\ UAH\ per\ th\ cm * 17.8\ bcm}{25\frac{UAH}{USD}} * 10 = USD\ 31.2\ bn,$$

of which USD 8 billion will be covered by direct state subsidies (assuming the level of subsidies of UAH 20 billion in 2015 is sustained in the long run), and the rest from the households' own pockets.

Both scenarios suggest a profound turnaround in Naftogaz finances. Instead of losses incurred in the past, it is likely to enjoy a sizeable net surplus – even if gas import prices recover to their past (high) level. This outcome is to a large extent driven by the sharply reduced import volumes, partly (but not exclusively) as a result of the gas tariff hikes enacted in 2014-2015. The government will benefit as well: not only will the amount of extended subsidies go down substantially (to USD 8 billion from USD 20 billion before), but the newly emerged Naftogaz surplus will indirectly benefit the state as well, given that Naftogaz is a state-owned company (and in part also directly in the form of higher rent payments on domestically produced gas and higher VAT collection). In fact, it makes little sense to separate Naftogaz from the government, and there is no explicit distinction between the two in Figure 5.

The fact that the Naftogaz surplus (USD 12 billion in scenario 5a or USD 16 billion in scenario 5b) turns out to be higher than the amount of direct subsidies (USD 8 billion) suggests that the state will be making net profits from gas sold to the domestic population. Even in the conservative scenario of high import prices, these profits will amount to some USD 4 billion over a ten-year period, or some 0.4% of GDP annually. Note that these projections are based on *actual* developments in response to tariff hikes enacted in 2014-2015, i.e. before the latest hike implemented in May 2016 (more on that below).

Needless to say, these 'back-of-the-envelope' calculations are by nature approximate and based on a number of assumptions which may or may not apply over a long time period. Probably the strongest assumption is that regarding the exchange rate: any marked currency depreciation would – ceteris paribus – 'squeeze' the revenues of Naftogaz in US dollar terms, whereas on the cost side only the part reflecting domestic production will be affected. However, our calculations suggest that the depreciation would have to be sufficiently pronounced to fully erode the Naftogaz surplus: by nearly 60% against the US dollar – even in the less favourable scenario 5a, and under the conservative assumption that the costs of domestic gas production stay intact. Given that the hryvnia is already very weak (which is rather natural under the conditions of a depressed economy and de facto war in Donbas) and the current account is largely balanced, a depreciation of this magnitude in the years to come is not very likely.

[19] Calculated as an average of the full gas tariff for households (UAH 7,188 per th cm), the reduced gas tariff for households (UAH 3,600 per th cm, applied if gas consumption is below 1,200 cm during six months), and the gas tariff for DHC (UAH 2,994 per th cm), weighted with their respective weights in total residential gas consumption (27%, 41%, and 32% during the period from April 2015 to April 2016, respectively).

Besides, even if it does occur, nothing prevents the government from hiking gas tariffs accordingly, should such a need arise in the future.

WAS THE 2016 TARIFF HIKE NECESSARY?

Against this background, the need for another tariff hike which was implemented in April-May 2016 (Figure 1) was far from obvious. In April, the 'social norm' of 1,200 cm per heating season with the reduced tariff of UAH 3,600 per th cm (which applied to 41% of gas consumers last year) was abolished, and in May the gas tariff was set at UAH 6,879 per th cm. In effective terms, the tariff hike amounted to 42%. The new retail tariff is supposed to reflect the 'market price', in the sense that it is based on a wholesale gas price on par with the price of imported gas. The wholesale tariff is calculated as the futures gas price at the German gas hub NCG plus the costs of gas transportation across Germany, the Czech Republic and Slovakia to the Ukrainian border. For the time being, it has been set at some UAH 4,900 per th cm, or USD 196 at the current exchange rate. Thus, the wholesale price for largely *domestically* produced gas has been set at the level of *imported* gas which, as demonstrated above, is now needed only in limited quantities to satisfy the residential demand. This is basically a source of rents which will accrue to Naftogaz (and the government) as a result of the tariff reform.

What will be the net impact of the 2016 tariff hike on Naftogaz (and government) finances in the long run? This impact can be illustrated with the help of Figure 6 which adjusts projections from Figure 5b for the 2016 gas tariff hike. Our model-based simulation (see the above section 'Assessing household demand for residential energy') suggests that as a result of this hike, residential gas consumption will decline by another 9% this year. Assuming that it stays at this level in the longer run (again adjusted for the weather), the Naftogaz revenues can be estimated as follows:

$$Revenues^{6} = \frac{Tariff(2016) * Estimated\ gas\ consumption(2016) adjusted for\ weather}{ER} * 10\ years$$
$$= \frac{6879\ UAH\ per\ th\ cm * 16.2\ bcm}{25\frac{UAH}{USD}} * 10 = USD\ 44.6\ bn,$$

of which USD 16 billion will be covered by direct state subsidies (assuming that the level of subsidies of UAH 40 billion reportedly earmarked for 2016 is sustained in the long run), and the rest from the households' own pockets.

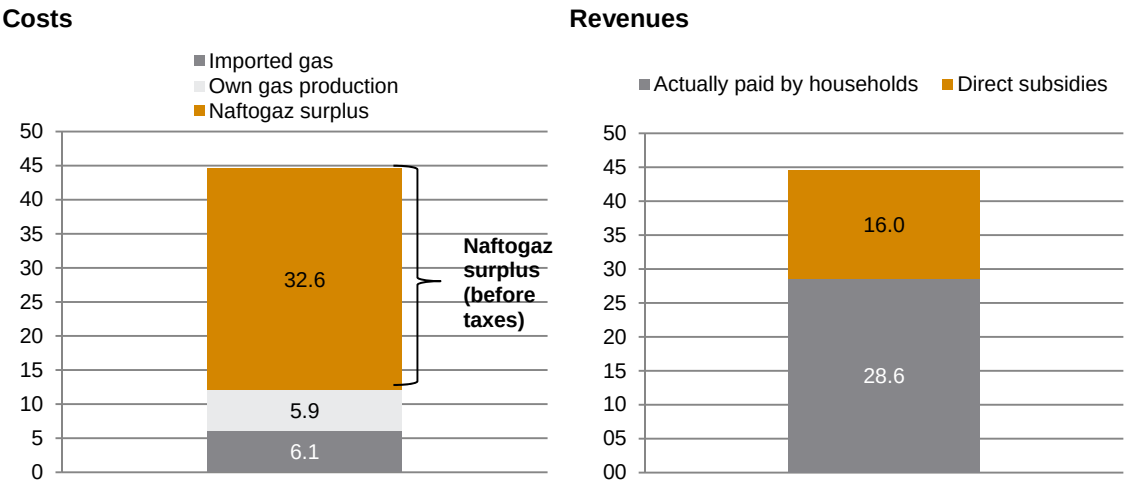
Further, assuming stable domestic gas production, the drop in gas consumption resulting from the 2016 tariff hike will result in lower annual gas import needs for household purposes: they are projected to decline by another 1.6 bcm, to a mere 3.4 bcm per year (again, after adjusting for the 'warm winter' effect). The resulting Naftogaz import bill can be calculated as follows:

$$Import\ bill^{6} = Import\ bill^{5b} * \frac{Estimated\ imports(2016) adjusted for\ weather}{Imports(2015) adjusted\ for\ weather} = USD\ 9\ bn * \frac{3.4\ bcm}{5\ bcm}$$
$$= USD\ 6.1\ bn$$

In sum, Figure 6 suggests a sky-rocketing Naftogaz surplus (before taxes) – by nearly twice compared to scenario 5a which assumes that gas tariffs for households stay at the level of 2015. On the revenue side, direct government subsidies will double, but this increase will be more than offset by the soaring

Naftogaz surplus, resulting in large net gains for the government at large. (Again, for reasons mentioned above, we make no distinction between Naftogaz and the government proper.) These gains could sum up to some USD 17 billion over the next ten-year period, corresponding to nearly 2% of GDP per year. In a high import price scenario (which is not presented here), the government gains would be even higher.[20]

Figure 6 / Estimated effects of the 2016 tariff hike on Naftogaz finances for the upcoming ten-year period, cumulated, in billion USD



Note: Including district heating companies.
Source: Own calculations.

Are these gains justified? There are several considerations which speak against Naftogaz profits being excessively high (or the existence of such profits at all, for that matter), especially in Ukraine's circumstances – unless they are used to finance energy-efficiency measures (more on that see below). Naftogaz is a state-owned monopoly rather than a commercial entity operating in a competitive environment, and there is no *a priori* theoretical reason why it should be making profits in the first place. Also, there is no guarantee that these profits will be used to invest into domestic production, as long as governance in the gas sector remains poor and corruption is pervasive.[21] In any event, it is questionable whether there is a real need for higher domestic production: energy efficiency improvements would be arguably a much better way forward (more on that see below). Of course, extra domestically produced gas can always be exported, but it is questionable whether this should be financed from the pockets of the already largely impoverished Ukrainian households.

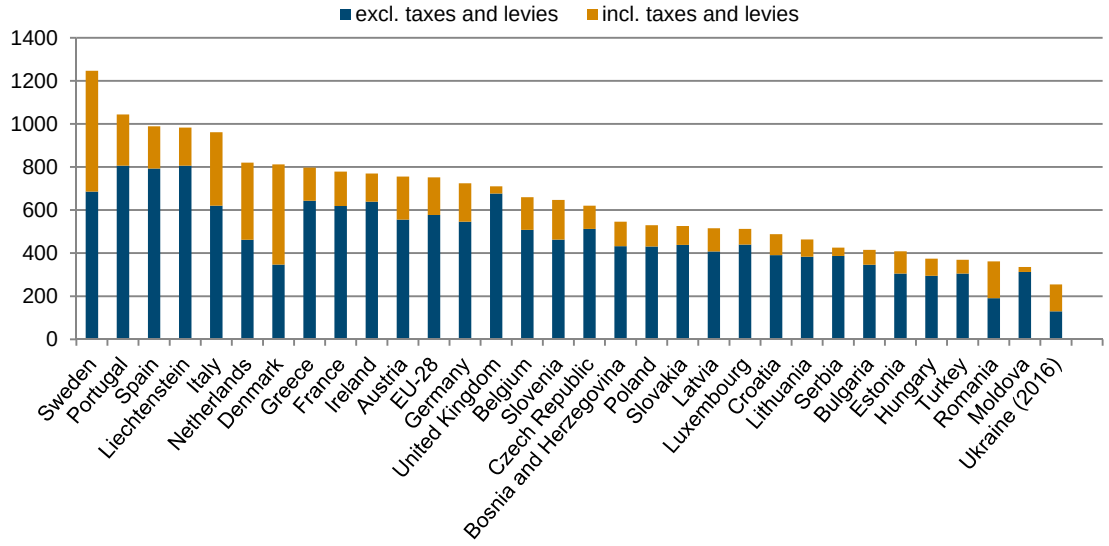
[20] If the gas import price reverts to the relatively high level observed over the past decade (in line with scenario 5a above), domestic gas tariffs for households will be adjusted accordingly via the newly introduced formula which sets the wholesale gas price on par with the price of imported gas. Since – as argued above – the bulk of gas consumed by households is in reality produced domestically, the resulting rents accruing to Naftogaz and the government will be even higher.

[21] One widely publicised argument behind the necessity to eliminate subsidies to Naftogaz was precisely the high level of corruption in the company (which is probably true, as exemplified by the recurring scandals surrounding Naftogaz top management). However, it is difficult to see how this can be squared with another argument – often advocated by the same people – that Naftogaz needs *more* money in order to invest.

BOX 1 / UKRAINE'S GAS TARIFF IN INTERNATIONAL COMPARISON

In international comparison, the newly set retail gas tariff for households in Ukraine (USD 275 per th cm) may not be particularly high: for instance, it is lower than in the EU countries – Figure 7. However, it should be borne in mind that a large part of the retail tariff is composed of 'non-tradable' components, such as the costs of local transportation and distribution (which tend to be lower in poorer countries) and local taxes (which are levied on a lower pre-tax price). These non-tradable tariff components typically correlate with the development level of a country: the higher the income level, the higher the retail tariff. This is also plausible from the demand side: richer countries can afford paying higher gas prices.

Figure 7 / Retail gas prices for households in Europe in mid-2015, EUR per th cm



Source: Eurostat, for Ukraine (2016) own calculations.

After adjusting for the country's very low income level, the retail tariff in Ukraine does not appear particularly low. For instance, in Romania and Bulgaria retail gas tariffs are only 35% and 100%, respectively, higher than in Ukraine, whereas the gaps in their GDPs per capita (at exchange rates) vis-à-vis Ukraine are much greater: 4.5 times in the case of Romania and 3.4 times in the case of Bulgaria. This conclusion squares with our calculations of the relative price of energy vs. non-energy for selected countries based on data from the International Comparison Project (2011), presented in Table 9. Our calculations show that in 2016, the relative price of energy in Ukraine is already at a level typical of countries at a comparable (or even higher) GDP level.

Another indication of the possible gas over-pricing in Ukraine may be the high share of taxes in the end-user tariff. With 51% of the retail gas tariff composed of various taxes and levies (notably the rent payment for domestically produced gas, which has been set at 50% of the wholesale gas tariff, and VAT), this share is one of the highest in Europe (Figure 7). This suggests that there is potentially a lot of room for lowering the retail tariff by reducing taxation without jeopardising the profitability of the gas producer.

Table 9 / Relative price of energy vs. non-energy in selected countries

	2011
Ukraine	0.079
Armenia	0.085
Belarus	0.090
Tajikistan	0.095
Kyrgyzstan	0.105
Azerbaijan	0.121
Russian Federation	0.178
Turkey	0.202
Bulgaria	0.235
Kazakhstan	0.240
Moldova	0.249
Bosnia& Herzegovina	0.258
Albania	0.360
Latvia	0.483
Lithuania	0.484
Poland	0.576
Romania	0.706
Ukraine 2015	**0.160**
Ukraine 2016	**0.217**

Source: Own calculations based on ICP (2011).

The current government plans for Naftogaz restructuring, including liberalisation, privatisation and the unbundling of gas production from transportation and distribution,[22] do not necessarily make the case for high rents in the energy sector stronger. If these reforms lead to the emergence of private monopolies in lieu of Naftogaz, these rents will be arguably even less justified. In addition, private monopolies will be more difficult to regulate than the state-owned one. That such a danger is real can be confirmed by past experience of some Central European countries such as the Czech Republic and Romania, where reforms of the gas sector resulted in highly monopolistic markets in the downstream gas segment.[23]

PROGRESS IN ENERGY SAVINGS, BUT NOT ENERGY EFFICIENCY

Apart from fiscal considerations, another declared objective behind the implemented gas tariff reform has been to provide energy-saving incentives. As already mentioned above, energy intensity in Ukraine – including in the household sector – is among the world's highest. For instance, Bashko (2016) found

[22] The adoption of a framework Gas Market Law in October 2015 laid the foundation for such restructuring. However, its details have not been decided upon yet (see e.g. Zachmann, 2016), and it remains to be seen whether it will really take place, given the past poor track record of reforms in Ukraine.

[23] In the Czech Republic, the gas market became dominated by Germany's RWE. In Romania, the gas market was divided into two regional monopolies, with Germany's EON Ruhrgas and Gaz de France supplying their respective region. In other Central European countries (Poland, Slovakia), the gas sector remained largely state-owned with regulated tariffs for households. In Hungary, gas tariff regulation was re-introduced following a period of liberalised prices – despite the reasonably fragmented market structure (see EIU, 2010).

that energy consumption for heating purposes per square metre of residential housing in Ukraine in 2014 was 54% higher than the EU average (after adjusting for the differences in climate).[24]

At face value, the observed reduction in residential gas consumption over the past two years due to factors other than the territorial split-up and warm winters (corresponding to the last line in Table 8) may be interpreted as evidence of improving energy efficiency in response to tariff hikes. However, Khabatiuk (2016) demonstrated that this reduction reflected almost exclusively 'behavioural response' rather than genuine energy efficiency improvements: a smaller number of rooms being heated, a lower temperature in rooms which are heated, and a shorter heating season.[25] All of this essentially meant some degree of sacrifice on the part of consumers: to save on their energy bills, they have to accept lower living standards. It is clear that going forward, the room for energy savings achieved this way will likely be constrained by health considerations, and may have been already largely exhausted by now.

Potentially much more promising would be 'technological' energy savings, e.g. via thermal insulation of buildings or installation of more energy-efficient boilers. Such gas savings could be achieved without sacrificing the households' living standards (in terms of room temperature, etc.). According to Naftogaz estimates, the implementation of energy-efficiency measures in the household sector alone could save up to 12 bcm of gas by 2025, which would correspond to two thirds of residential gas consumption in Ukraine (Table 10). The bulk of these investments would be needed for thermal insulation. It is clear that such measures would require enormous investments, estimated at over USD 30 billion over a ten-year period (USD 3 billion, or some 3% of Ukraine's GDP, annually). This largely squares with estimates done by Emerson and Shimkin (2015), who come up with overall investment needs of EUR 2 billion per year (including EUR 1.2 billion for individual houses and EUR 0.8 billion for apartment blocks) – provided energy-saving investments in the housing sector are extended over a fifty-year period.

Table 10 / Estimated potential for energy efficiency improvements in the residential sector by 2025

	Gas savings, bcm per year	Required investment, bn USD	Project scope	Required time in years
Thermo-modernisation of individual houses	5.5	10.3	7 mn households	10
Thermo-modernisation of buildings	3.4	15.9	100 th buildings	10
Alternative fuel boilers, more efficient gas boilers	3	3.7	7 mn households	3-5
Heat meters with temperature regulators	0.8	2.4	100 th buildings	3-5
Total	**12.7**	**32.3**		

Source: Naftogaz.

Expecting that the burden of these expenditures will be borne by households alone is probably unrealistic, so that some form of state support will be unavoidable. The direct energy subsidies for the poor segments of the population which are currently allocated will not facilitate any energy-saving measures: they do not provide incentives to save energy, neither is it their purpose. The key role of state

[24] In per capita terms, the gap was by far not as pronounced (only 5%), since the endowment of Ukrainians with square metres of housing is much lower than in the EU.

[25] For instance, according to Khabatiuk (2016), the reduction in room temperature from 21 to 19 degrees already results in 10% less gas consumption.

support in financing energy-efficiency measures in the household sector is also confirmed by the experience of other, including Central and East European, countries.[26] In addition, as a signatory to a DCFTA with the EU, Ukraine has committed itself to adopting over the medium term (5-8 years) the EU energy efficiency directives, including the Directive on the Energy Performance of Buildings and the Directive on Energy Efficiency.[27] These directives do not only set energy performance standards for buildings, including energy performance certificates upon sale or rental of buildings, inspections of air-conditioning systems and old boilers, and a 'nearly zero-energy' standard for new buildings, but also mention the EUR 23 billion financing facility to this end over the period 2014-2020 and an unspecified share of the EUR 315 billion 'Juncker investment package'. The Energy Efficiency Directive also explicitly requires central governments to refurbish 3% of buildings per year.

In November 2015, the Ukrainian government adopted the 'National Action Plan for Energy Efficiency up to 2020'. Within its framework, there are already two energy-efficiency programmes in operation, with a third one being in the pipeline. The first programme is the so-called 'Warm House' loan programme, according to which up to 30% of loans taken by households (40% in the case of condominiums) for energy saving purposes can be reimbursed by the state.[28] Another energy-efficiency programme launched in 2016 is the so-called 'IQ Energy' programme; it is financed by the EBRD and envisages funding of around UAH 2 billion up until 2020. The programme requires taking a credit from one of the partner banks, with credit volumes being generally much higher than those taken under the 'Warm House' programme, and also involves technical support. Finally, in summer 2016 the Ukrainian government elaborated the concept of an Energy Efficiency Fund, which should start working in spring 2017. However, many details with respect to how this fund will operate remain unclear, including whether households undertaking energy-saving investments from their own pockets rather than by taking credit will be eligible for subsidies.[29]

However, so far the real impact of these schemes has been marginal. For instance, by the end of March 2016, only 80 thousand 'warm house' loans were extended, with a total amount of UAH 1.29 billion, or USD 51 million.[30] Even assuming that these funds were fully channelled for energy-saving purposes, this corresponds to a mere 1.7% of the annual investment needs as defined in Table 10. The high interest rates (in excess of 20% p.a.) charged on such loans – just as on loans in general, for that matter – reportedly remain the main obstacle to the success of this and other (including those adopted on the regional level) state-sponsored loan programmes aimed at promoting energy efficiency.

[26] See e.g. 'Financing energy efficiency in buildings' (2010).

[27] See Emerson and Shimkin (2015).

[28] See Chubyk (2015).

[29] See http://www.epravda.com.ua/rus/columns/2016/09/13/604971/

[30] http://www.reforms.in.ua/en/reform/indicator/11683

Policy recommendations

The picture emerging from the above analysis is not very encouraging. Between 2013 and 2015, residential gas consumption in Ukraine already declined by about one third, partly because of energy savings in response to the implemented tariff hikes. Following another tariff hike enacted this year, one may expect a further decline of per capita household demand for energy. Despite the government-financed energy subsidy to low-income households, per capita residential energy consumption is going to fall by 9% in 2016. In per capita terms, residential energy consumption is still much lower than in 2011. Despite some increase in per capita consumption of non-energy items expected for 2016, the level of that consumption is only now approaching its 2011 mark. This is a disturbing development. The suppressed demand for non-energy consumer items represents a clear social loss in an economy which has been suffering from a persistent inadequacy of aggregate demand (reflected in the relatively high rate of unemployment and the fact that millions of Ukrainians have been forced to leave the country in search of work abroad).

At the same time, our analysis demonstrates that the magnitude of gas tariff hikes implemented in Ukraine has been clearly excessive when viewed from the production (cost) side. Under plausible assumptions regarding the dynamics of domestic gas production, residential consumption and gas import prices in the years to come, we come to the conclusion that the first two rounds of gas tariff hikes implemented in 2014-2015 should have been more than sufficient to restore the 'financial health' of Naftogaz and eliminate its needs for government subsidies in the longer term. The latest tariff hike in spring 2016 will only increase the monopolistic rents accruing to Naftogaz (and the state at large) still further – essentially at the expense of the population.

Two policy options seem possible to amend the situation in the short run. The first, already implemented in 2015 and 2016, stipulates the government somehow compensating the rising energy prices to the poor households in the form of energy subsidies. This approach is recommended to be continued. However, the provision of energy subsidies is likely to be rather costly and difficult to administer efficiently – the more so as it tends to extend in scope. (In 2015 it covered about one third of all households, in 2016 it will, reportedly, cover two thirds.) Besides, as is well known from experience, such a universal distribution of subsidies may likely disturb the income differentials across firms, sectors and employees' qualifications and thus have negative supply-side effects. Moreover, it is difficult to grasp the rationale for a policy which imposes high energy prices – and then compensates the rising costs of living by covering parts of households' increased energy bills.

The alternative policy would be to try to roll back the energy tariffs imposed on the household sector. As long as Naftogaz profits permit, the authorities may order a reductions in the prices charged. This would be consistent with normal practices well established in mature market economies where various public institutions mediate between the mass of powerless consumers and a few giant – and mighty – corporations which always tend to exploit the inelasticity of demand for their products by hiking the prices into stratosphere to earn undeserved monopolistic rents. In Ukraine's case, it should be relatively easy to roll back energy tariffs as long as Naftogaz remains state-owned. A privatisation of the gas

sector in line with the EU Third Energy Package would make this task more difficult, with realistic prospects of emerging private monopolies which will be more difficult to regulate.

In the longer run, various measures may be contemplated to reduce household demand for energy – without sacrificing the satisfaction of basic needs requiring the use of energy. This boils down to the issue of energy efficiency improvements. The wisdom of front-loaded tariff hikes is questionable unless they will be accompanied by more vigorous government efforts aimed at promoting energy-saving investments than those undertaken so far. Such efforts could complement, for instance, the recent EBRD programmes in Ukraine which have gained major traction in energy efficiency results, and draw on the past successful experience in Central European countries. Given the shortage of funds within Ukraine, a welcome solution could be e.g. a combination of grants provided to Ukraine by the EU and/or its Member States, alongside loans and investments from the EBRD and EIB.[31]

In this vein, the government may consider extending the scope of subsidies, e.g. by providing lower interest rates and a higher reimbursement rate for the energy-efficient loan schemes already in operation and/or establishing new lines of targeted support. Also, the government may consider granting subsidies for the purchase of energy-saving equipment and the implementation of energy-saving measures irrespective of whether a loan is needed or the related expenses are covered from the household's own pocket. One important area of government involvement could be, for instance, the installation of heating meters in residential buildings (supplied with central heating), which may be unaffordable for the vast majority of poorer households without targeted subsidies from the government. As long as half of the households supplied with central heating – unlike those using gas directly – lack meters and cannot regulate the room temperature, any hopes for a substantial reduction in energy consumption in this segment in response to tariff hikes may be elusive.

Government subsidies along these lines would be crucial in solving the long-term structural problem of excessive energy consumption, and should enjoy priority over the short-term task of fiscal consolidation. In fact, they could be financed from the enacted gas tariff hikes. For instance, the additional windfall annual rent to the tune of 2% of GDP which is likely to be appropriated by Naftogaz and the government thanks to the recent tariff hikes – if used to finance energy-saving subsidies – could cover more than half of the officially acknowledged annual investment needs for energy efficiency purposes. Such an approach would be in line with the earlier (successful) experience of Central European countries, where the increased revenues of energy suppliers due to tariff hikes were used to finance energy efficiency investments. However, it should be the government – or ideally a new government unit created specifically for this purpose – rather than Naftogaz which should be in charge of administering such energy efficiency subsidies; this would reduce the risks of embezzlement and misappropriation of funds involved.

[31] This proposal is advocated e.g. by Emerson and Shimkin (2015).

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Appendix: Distributional effects of hikes in energy prices

The total per capita nominal expenditure figuring in formula (1) and Table 5 represents the average for the entire country. The same formula could be tried with income levels being different from the average. Of course it must be assumed (here) that the prices are the same for all groups of population distinguished by the per capita income (or total consumption expenditure) level and that the income levels do not differ from the average too dramatically. This assumption is certainly problematic – but perhaps acceptable as a first approximation.

Table 11 tracks the distributional effects of price changes realised in 2015 – without yet accounting for the effects of the government's covering parts of households' increased energy bills. Thus, Table 11 shows the consequences of rising prices alone. Five income groups are considered. In addition to the group whose per capita expenditure equals the average, there are two poorer and two richer groups, with per capita nominal expenditures equal to 50%, 75%, 200% and 500% of the average in both 2014 and 2015. (Thus it is assumed that nominal per capita expenditure for all five groups rose at the same rate.)

As it turns out, despite the same rate of growth of nominal expenditure for all groups, and despite the uniformity of prices faced by these groups, the effects calculated differ across them. The first to notice is the difference in the energy shares in total expenditure. These shares are estimated to vary across the groups in both 2014 and 2015. The lower the per capita expenditure, the higher is the share of energy. The price changes of 2015 have further increased these shares for all income groups, but in absolute terms the energy share increase was the stronger the lower the total expenditure.

Non-uniform changes in the expenditure shares reflect the differences in the rate of decline in per capita real consumption of energy and non-energy. For both aggregates the rates of decline in per capita consumption are lower for the higher income groups. In other words, the higher the income (and total expenditure), the lower the consumption loss suffered as a consequence of the price changes in 2015. The rates of decline in the consumption of non-energy are relatively moderate across the income groups. But they are quite high in the case of consumption of energy: while the per capita real consumption of energy for the average income group is estimated to have declined by 44.4%, the respective rate is less than 27% for the group whose nominal per capita expenditure is five times the average.

As can be seen in the last column in Table 11, the overall volume of per capita consumption (energy and non-energy combined) for the 50% income group is calculated to have fallen by 19%. For the 500% income group the respective rate of decline equals 16.5%.

Concluding, the contents of Table 11 justify the opinion that the price changes realised in 2015 – in the absence of government subsidies – would have had more painful consequences especially for the lower

income parts of the population. This would support the policy of the government's contributing to the energy bill of the low-income households in the first place.

Table 11 / Hypothetical distributional effects of gas tariff reform in 2015 (*w/o* government subsidies)

Total p.c. nominal expenditure	Energy share in total expenditure	Energy share in total expenditure	Real demand p.c. energy 2014 = 1	Real demand p.c. non-energy 2014 = 1	Real consumption[1] total 2014 = 1
as % of average	2014	2015	2015	2015	2015
50	7.7	9.7	0.545	0.831	0.809
75	6.6	8.4	0.549	0.833	0.814
100	5.9	7.6	0.556	0.834	0.818
200	4.2	5.8	0.589	0.836	0.825
500	2.1	3.6	0.731	0.837	0.835

1) At constant prices of 2014.
Source: Own calculations.

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