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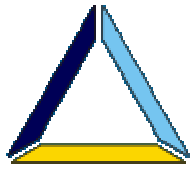

Working Paper No.7

Boris Dodonov, Petra Opitz and Wolfgang Pfaffenberger

How Much Do Electricity Tariff Increases in Ukraine Hurt the Poor?

May 2001

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How Much Do Electricity Tariff Increases in Ukraine Hurt the Poor?

Boris Dodonov, Petra Opitz and Wolfgang Pfaffenberger*

1 Introduction

After ten years of economic reforms, the electricity tariffs applicable to private households are still a very sensitive subject in Ukraine. Although initial steps to reform the power sector were introduced in 1993 and in 1994, these reforms are now stagnating. Same as in all other transition countries, electricity was treated as a public good or even a human right during Soviet times. Tariffs were set by the state, did not cover costs and were much higher for industrial customers than for households and other final consumers. The impact of these price distortions on the energy sector has been widely discussed in the transition literature (Kennedy, 1999; Stern and Davis 1998; Freund and Wallich 1997). Empirical research made it obvious that these price distortions did not only set the wrong incentives for the allocation of energy resources but also seemed to protect the wrong people. High-income households benefited most from subsidised prices because they were consuming more electricity and the income elasticity of such households was substantially higher (Freud and Wallich, 1997, p. 46).

Although in Ukraine tariffs have been increased several times since 1991 they still remain far below cost covering levels, and cross subsidisation of private households and agrarian customers by industry still takes place. Expected negative social consequences and lacking political acceptance are the main arguments usually used by political decision makers to explain why the necessary corrections to the tariff structure have not been implemented so far.

The purpose of this paper is first, to analyse what levels the tariff increases for private households in Ukraine need to reach in order to end price distortions and secondly, to evaluate what welfare impacts they would have on different social groups.

The structure of the paper is as follows: Section 2 describes the main problems with the electricity price policies inherited from the past, section 3 explains the current methods of determining electricity tariffs for households in Ukraine, section 4 evaluates the impact of possible tariff increases on household expenditures for different income groups, and section 5 presents conclusions and policy implications.

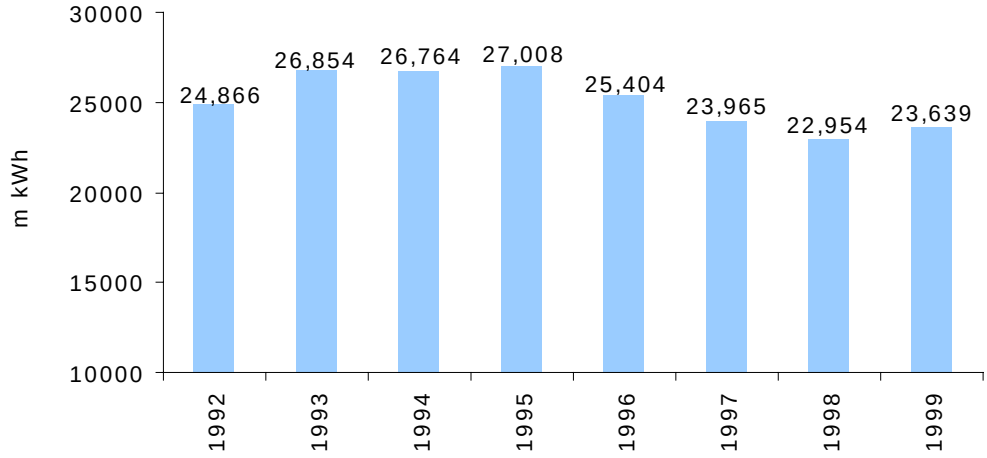
* Acknowledgements: The authors thank Olena Kostyshena, Roman Kutsak and Arno Bletzinger for having carried out the interviews within Power Consumption Survey.

2 The legacy of the past

From Soviet times Ukraine inherited a rather well developed electricity network and some excess generating capacity. The installed generating capacity totalled nearly 54.5 GW (67% thermal, 24% nuclear and 9% hydro), while the share of nuclear power in total electricity production was about 45% in 1999 and 2000. The network density is relatively high. The Ukrainian transmission and distribution system covers the whole country and its total length is about one million km. The capital equipment is outdated; during the last ten years practically no investment has gone into the power sector.

Electricity production has declined sharply from 279 TWh in 1991 to about 170.7 TWh in 2000. Although in 1998 electricity intensity of GDP was among the highest in Europe (1.88 kW/USD PPP) electricity consumption per capita was rather low at 2,825 kWh.[1] In spite of the already rather low level of private household consumption in 1992, consumption further declined by 5% until 1999 (see Graph 1). The share of private households in total electricity consumption was only about 15%.

Graph 1
Electricity consumption of private households (1992-1999 in m kWh)



Source: Ministry of Fuel and Energy of Ukraine

However, excess generating capacity did not guarantee security of electricity supply to Ukrainian customers. Non-payment of the electricity consumed led to serious cash shortages in the sector and hence to fuel supply shortages and frequent interruptions of the electricity supply. To improve the reliability of the electricity supply and to modernise the power sector, tariff policy has to play a crucial role.

[1] IEA/OECD, Key World Energy Statistics 2000. The relevant figures for the total OECD at the same time were 0.43 kWh/USD PPP and 7751 kWh/per capita.

As far as electricity tariffs are concerned Ukraine is still lagging behind other transition economies in making significant progress.[2] This is true both concerning the general level of tariffs and tariff level differentiation between customer groups (See Table 1). Although in 1999 the electricity tariff for private households in urban and rural areas had increased by 227% as compared to 1992, it is still much lower than the tariff for industrial customers (see Table 2); also, it does not cover true costs.

Table 1
Electricity tariffs in selected countries in 1999

Country	Industrial price USD / kWh	Household price USD / kWh	Ratio of household to industrial price
Czech Republic	0.1195	0.1267	1.0603
Hungary	0.1267	0.1673	1.3204
Poland	0.0817	0.1422	1.7405
Slovak Republic	0.0450	0.0350	0.7778
Kazakhstan	0.0180	0.0310	1.7222
United Kingdom	0.0597	0.1088	1.8224
Germany**	0.0592	0.1397	2.3598
Romania**	0.0500	0.0360	0.7200
Ukraine*	0.0249	0.0239	0.9608
OECD Europe	0.0444	0.1310	2.9505
OECD	0.0380	0.0958	2.5211
United States	0.0395	0.0817	2.0684

Source: IEA, Energy Prices & Taxes, Quarterly Statistics, First Quarter 2000, pp. 378-379, 460-461, NERC, and own calculations

**Data for Romania and Germany is available only for 1998

* Ukraine – NERC data

[2] Primarily those CEE countries which plan to join the EU in the near future have made some progress toward creating price structures for electricity which reflect true costs.

Table 2
Electricity tariffs for industry, rural and urban households in Ukraine (without VAT)

Period	Price for industry		Price for urban households		Urban households / industry price ratio	Price for rural households		Rural households / industry price ratio
	UAH/kWh	USD/kWh	UAH/kWh	USD/kWh		UAH/kWh	USD/kWh	
1/1/98	0.071		0.090	0.000	1.269	0.080	0.043	1.128
1/5/98	0.077	0.038	0.110	0.054	1.423	0.100	0.049	1.294
1/6/98	0.082	0.040	0.110	0.053	1.338	0.100	0.049	1.217
1/9/98	0.090	0.040	0.110	0.049	1.222	0.100	0.044	1.111
1/10/98	0.140	0.041	0.110	0.032	0.786	0.100	0.029	0.714
1/12/98	0.140	0.041	0.110	0.032	0.786	0.100	0.029	0.714
1/1/99	0.128	0.037	0.110	0.032	0.859	0.100	0.029	0.781
1/2/99	0.130	0.038	0.110	0.032	0.849	0.100	0.029	0.772
1/5/99	0.121	0.031	0.130	0.033	1.075	0.120	0.031	0.993
1/9/99	0.124	0.028	0.130	0.030	1.053	0.120	0.027	0.972
1/12/99	0.135	0.029	0.130	0.028	0.964	0.120	0.025	0.890
1/1/00	0.136	0.025	0.130	0.024	0.954	0.120	0.022	0.880
1/2/00	0.135	0.024	0.130	0.023	0.960	0.120	0.022	0.886
1/3/00	0.137	0.025	0.130	0.024	0.946	0.120	0.022	0.873
1/4/00	0.140	0.026	0.130	0.024	0.931	0.120	0.022	0.859

Source: NERC and own calculations

True power costs are still being hotly debated. The Ukrainian estimations differ considerably from estimations made by Western experts, who have proposed that a good long-run marginal cost (LRMC) approximation for Ukraine might be the average North American price (Stern and Davis, 1998, p. 442.). This might indeed be useful as far as generating costs are concerned, because of the similar abundance of natural gas and hydroelectric resources. However, the similarity does not apply to the costs of transmission and distribution, which form a significant part of the total cost of the electricity supply. Because of the high density of the electricity net in Ukraine and a private household consumption far below western levels, distribution costs per kWh are likely to be much higher in Ukraine than in the US. Therefore the Ukrainian LRMC are expected to be higher than in the US and might approach the average OECD level.

3 Current pricing approaches for households in Ukraine

3.1 Regulation of the Ukrainian energy market

Ukraine started to re-organise its power sector according to the British Pool model in 1994, which until now functions only in a formal way. Generation as well as transmission and distribution are carried out by separate companies. Aside from seven generating companies, there are 27 regional distributors (oblenergos) who own the grid and the distribution lines. Due to the non-payment problem however, there is in practice no competition between the generation companies. The Ukrainian government still owns the majority of the established companies. Only thirteen of the regional distributors have so far been partly or fully privatised. A National Electricity Regulation Commission (NERC) has been created[3], which is mainly responsible for tariff setting and licensing.

At present there are tariffs for 7 different consumer groups: industrial and other consumers with a capacity of 750 kVA or higher, industrial and other consumers with a capacity lower than 750 kVA, agricultural producers, electrical railway transport, electrical city transport, non-industrial consumers and households. Household tariffs in turn are divided into one for rural households, and two for urban households, those with an electric stove and those with a gas stove.

Tariffs for transmission and distribution are set for each oblenergo taking into account regional differences. For some regions they contain an ecological part, which was introduced in order to decrease the damage to the environment and/or to finance new generation capacities in these regions.

The wholesale electricity price is calculated for every hour, and then an average price is estimated. In compliance with the official methodology this average wholesale generating price is the basis for the tariff which the NERC sets for each oblenergo for the next month adding the costs for transmission, distribution and supply.

3.2 Cost structure and tariff design

In general, electricity tariffs consist of prices for generation, transmission, distribution and supply. Prices for generation are time dependent because of differing load periods. The prices of transmission depend on the load and the feed out point, thus differ for the various consumer groups. Distribution prices are also different for various voltage levels and load curves. Thus, there is a huge variability in electricity tariffs for different customers. Supply of

[3] Presidential decree No. 738/94, of December 8, 1994 and No. 335/98, of April 21, 1998.

electricity to private households is, in principle, more costly than to industrial customers.

In order to set prices, the NERC currently uses a cost based methodology, which came into force in 1998. According to this methodology the retail price for the 1st (highest) voltage level is calculated in the following way:

$$P_{i1}^{p} = \frac{P^{av}}{(1 - C_{p1}^{m})} * C_c + T_1^t + T_i^d \qquad (1)$$

The retail price for the 2nd (lowest) voltage level is calculated in the following way

$$P_{i2}^{p} = \frac{P^{av}}{(1 - C_{p1}^{m}) * (1 - C_{p2}^{m})} * C_c + T_2^t + T_i^d \text{ , where} \qquad (2)$$

P_{ij}^{p} - retail price for the j voltage level, j = 1 or 2

P^{av} - average price of electricity bought on the wholesale electricity market and/or from non-members of the wholesale electricity market weighted by the amount of electricity bought from these sources plus/minus the deviation between real and forecast data for tariff calculation.

T_j^t - tariff for electrical energy transmission for different voltage levels.

T_i^d - tariff for energy distribution by a local network for different consumer groups

C_{p1}^{m} - coefficient for transmission losses at the first voltage level

C_{p2}^{m} - coefficient for transmission losses at the second voltage level

C_c - correction coefficient[4], which is calculated by each distribution company and approved by the NERC

In the process of tariff calculation, all of these variables are calculated using specific formulas, but these will not be reviewed in our discussion of the average price formula.

The average wholesale price P^{av} is calculated in the following way:

[4] This coefficient has been equal to one and has been used since the NERC methodology had been approved in 1998. It was designed in order to compensate for differences between forecast and actual prices. However, as noted above, every month the NERC sets a new price for the coming month (the forecast price in this methodology is equal to the actual price for the current month) based on the oblenergo's expenditures during the current month.

$$P^{av} = \frac{\left(P_i^w * Q_i^w\right) + \left(P^n * Q^n\right)}{Q_i^w + Q^n}, \text{ where} \quad (3)$$

P_i^w - price at the wholesale electricity market at period i

Q_i^w - quantity of electricity bought at the wholesale electricity market at period i

P^n - price of the electricity bought outside of the wholesale electricity market

Q^n - quantity of electricity bought outside of the wholesale electricity market

In practice, this method is not valid for all customer groups. A significant number of Ukrainian consumers is subsidised by paying for electricity at reduced tariffs (private households, coal mines, and agricultural producers). These subsidies are not paid by the state budget, but are included in the average wholesale price for electricity generated (P^{av} in formula 3). As a result, the official cross-subsidies in the power sector amounted to about 1.32 bn UAH (242.59 m USD)[5] in the year 2000.

Household tariffs are subsidised because of the strong belief in Ukraine that the low Ukrainian household incomes will not allow electricity charges to be based on tariffs which would cover long-run marginal costs. Thus, the NERC is obliged to fix tariffs at a level which is deemed low enough to allow households to pay their bills. However, the current system of household tariff estimation by the NERC is not based on any logical methodology, a calculation for a price-ceiling up to which households could be charged does not exist either. In addition, low-income households are protected by income subsidies. The law stipulates that expenditures for communal services cannot exceed 20% of total household income. Should actual expenditures be higher, the government has to pay the difference directly to the communal services administration.

3.3 Required tariff increases

A comparison of Tables 2 and 3 shows that current electricity tariffs for households are below the cost covering level and have not changed substantially in UAH since 1998. They even decreased in USD terms. While the current average tariff for all types of households is about 0.126 UAH/kWh[6] (see Table 2), a tariff which would cover costs according to the methodology of the regulating institution should vary between 0.145 and 0.196 UAH/kWh,

[5] Source: NERC decrees.

[6] The regulator's average tariff estimation was used in the calculation, however, as can be seen from Table 2, the actual tariffs (without VAT) for different types of households are 0.10, 0.12 and 0.13 UAH/kWh respectively in Ukraine.

depending on the region (see Table 3). This means that current tariffs should actually be raised by between 15.08% and 55.56%.[7]

Table 3
Structure of cost covering tariffs for private households in Ukraine according to the regulator's calculations (in UAH/kWh)[8]

Regional distribution company	Price on the wholesale electricity market (P^{av})	Tariff for energy transmission at the second voltage level (T_2^t)	Tariff for distribution (T_i^t)	Loss correction coefficient for the 1st voltage level C_{p1}^m	Loss correction coefficient for the 2nd voltage level C_{p2}^m	Total tariff for households (without VAT) P_{ii}
Zaporizhyaoblenergo	0.1145	0.014	0.005	0.03	0.07	0.1454
Zhytomyroblenergo	0.1145	0.036	0.014	0.05	0.18	0.1961

Source: NERC estimates

Depending on differences within the customer structure and the size of the distribution net respectively, the costs of electricity supply vary widely between different regions. Table 4 presents required price increases for different types of households in different regions. According to these figures, the lowest price increase for households should apply to the Zaporizzya region. Price increases for households with an electric stove, for rural households and for urban households with a gas stove should be about 45.35, 21.13 and 11.81% respectively. The highest price increases would apply to the Zhytomyr region, where the corresponding increases would have to be 96.11, 63.43 and 50.85% above the actual price level.

Table 4
Required tariff increases for different types of consumers in different regions[9]

Regional distribution company	Electric stove	Rural	Gas stove
Zaporizhyaoblenergo	45.35%	21.13%	11.81%
Zhytomyroblenergo	96.11%	63.43%	50.85%

Source: own estimates based on NERC data

However, according to Table 3 transmission and distribution costs amount to about 1.5 US cent/kWh at most. This value is very low and considering the high fixed cost of energy distribution on the one hand and the low consumption in the residential sector on the other, much higher costs can be expected. For the UK, Haupt and Pfaffenberger (2000, p. 11) report average distribution costs of 3.6 EUR cent/kWh in Great Britain, which is about twice as high.

[7] The minimum level is valid for the Zaporizhya region, the maximum level for the Zhytomyr region.
[8] The complete Table 3 including data for all regions can be seen in the appendix.
[9] The complete Table 4 including data for all regions can be seen in the appendix.

3.4 Payment behaviour

At present, subsidisation of household tariffs is even higher than the difference between estimated tariffs (Table 2) and cost covering tariffs (Table 3) suggests. This is due to the wide-spread practice of non-payment. According to official estimates households pay only 70 to 80% of the electricity they consume. Non-payment does not lead to any consequences such as disconnection from the energy supply or sequestration of debtors. Nor is there any legal procedure to allow a creditor to obtain a judgement against the defaulter. Until now, neither the various Ukrainian governments nor parliament have been willing to enact laws to enforce payment by private households, e.g. by power disconnection.[10] To a certain extent this is also linked to the non-fulfilment of certain of the central government's financial obligations. During the last years huge amounts of wage and pension arrears have accumulated and people often did not pay because they were not paid themselves by the government. In addition, there is a habit, inherited form Soviet times, to manipulate electrical counters and to consider electricity a public good which should be received for free. Some households do not have counters at all. Thus, in Ukraine some households have not paid for electricity for four or five years.

4 Modelling of a cost covering tariff and its results

4.1 Basic data

In Ukraine there is no coherent data available of households' expenditures for electricity consumption. The Ministry of Statistics gives only figures of total households' expenditures for utilities. Thus, in order to evaluate expected welfare changes for different income groups, which might result from tariff increases and to better understand the consumption behaviour of these groups, a small survey was carried out. The survey was based on a tested questionnaire. Five income groups were defined (see Graph 2). The determination of proper ranges of theses groups relied upon the Ministry of Statistics' distribution of households according to their total expenditures.[11]

The obtained data set contained 126 households, 98 of which were living in towns and 28 in rural regions - 78% and 22% respectively. This is rather close to the relation of urban and rural population in Ukraine in general. 119 of these households had gas stoves and 7 of them electric ones. The difference in

[10] In addition, there are some technical problems with disconnection, especially for multi-storey buildings.

[11] Source: State Statistics Committee of Ukraine: Ukrainian Households Income and Expenditures in 1999, Households Budget Survey Representative Sample.

electricity consumption of these two groups was significant. Consumption of the respondents in the group with an electric stove was more than twofold higher. Also the electric equipment which households possess varied significantly between the various household groups (see Table 5). Thus, only two households had a conditioner, however, 25 households had a new type of washing machine and a radiator, 23 a computer, 13 a microwave oven and 17 a kitchen unit. The low living standard in Ukraine could explain such a lack of electrical equipment comparatively even with other Eastern European countries.

Table 5
Households' Electrical Equipment in Different Income Groups (as % of total respondents of the group)

Equipement	Group1	Group2	Group3	Group4	Group5
Gas stove	95%	97%	98%	78%	90%
Electric stove	5%	3%	2%	22%	10%
Standard set (refrigerator, electric iron, TV set)	82%	97%	93%	100%	100%
Electric kettle	9%	13%	14%	56%	62%
Oldtype washing machine	59%	66%	67%	67%	29%
Newtype washing machine	5%	6%	12%	44%	57%
Radiator	5%	19%	12%	33%	48%
Computer	0%	9%	17%	33%	48%
Microwave oven	5%	6%	10%	11%	24%
Conditioner	0%	0%	0%	11%	5%
Kitchen unit	0%	0%	14%	56%	29%
Number of Households (% in a total sample)	22 (17.5%)	32 (24.6%)	42 (33.3%)	9 (7.1%)	21 (15.9%)

Source: IER Power Consumption Survey

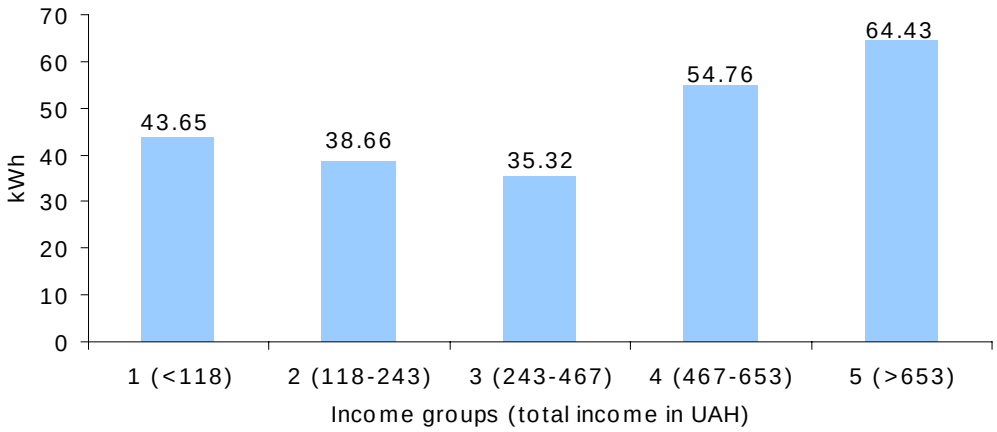
Per households' electricity consumption indicated by the respondents was surprisingly low and varied between 7 and 350 kWh per month. To a certain extent, the widespread centralised gas supply and centralised gas based heating system might be an explanation. In any case, the findings of the survey have to be interpreted with caution. For example, 19% of the respondents disclosed that they do not know even approximately their electricity consumption and some of the respondents may also have underestimated their income. However, the findings are indicating general tendencies of the private households' electricity consumption behaviour.

The structure of the sample was the following: 17.5% of the surveyed households belonged to the poorest income group (group 1), 24.6% to group 2, 33.3% to group 3, 7.1% to group 4 and 15.9% to the group of the highest income level (Group 5).

4.2 Survey results

Average consumption per capita was calculated "per equivalent adult", based on the OECD scale (1 is assigned to the first adult, 0.7 to other adults and 0.5 to children younger than 14 years). Thus, according to the survey, average consumption per capita varied between 4.12 and 145.83 kWh per month. The calculation of the average consumption per capita for the five income groups showed that the differences between the various income groups were relatively small (see Graph 2).

Graph 2
Electricity consumption per equivalent adult in different income groups (kWh per month)



Source: IER Power Consumption Survey

As can be seen from this Graph, individuals of the 1st income group (poorest people) consumed more energy than those of the comparatively richer 2nd and 3rd groups. Individuals of the 2nd income group also consumed more energy than those of the 3rd group. This contradiction between income and electricity consumption might be explained by the lower fraction of retired and unemployed persons in the 3rd group compared to 1st and 2nd groups.[12]

However, households of low-income groups (1st and 2nd income groups) had to spend a larger fraction of their income on electricity expenditures than those of higher income groups (see Table 6). In practice this burden might be lowered due to the subsidies provided by the Ukrainian state.

[12] Such people tend to spent more time at home due to the absence of work.

Table 6
Electricity expenditures per household as percent of total income of different income groups

	Group1	Group2	Group3	Group4	Group5
Ratio of electricity expenditures to total income of different income groups	10.86% <	5.94% - 12.23%	2.89 - 5.55%	3.56% - 4.98%	< 3.14%

Source: Calculations based on data of the IER Power Consumption Survey

In order to reveal peculiarities of electricity consumption with respect to income group, three levels of electricity consumption per equivalent adult were defined: high average consumption (44.71-145.83 kWh), medium average consumption (32.26-44.12 kWh) and low average consumption (4.12-31.82 kWh).[13] The analysis of consumption patterns with respect to groups did not show a very strong relationship between electricity consumption and income of the households. As was to be expected, the fifth and fourth income groups were mainly dominated by households with a high average consumption level (71% and 56% respectively). There were no households with low average consumption in these groups (see Table 7). But it was interesting to observe, that within the poorest income group (group 1) the share of households with the highest electricity consumption was considerably higher than in income groups 2 and 3.

Table 7
Share of electricity consumption levels in different income groups

Level of electricity consumption / income group	Group1	Group2	Group3	Group4	Group5
high average consumption	36%	23%	18%	56%	71%
medium average consumption	21%	35%	41%	44%	29%
low average consumption	43%	42%	41%	0%	0%
total	100%	100%	100%	100%	100%

Source: Estimations based on data of the IER Power Consumption Survey

[13] The levels were defined by dividing the total range of per capita consumption into three groups of equal numbers of respondents.

Comparatively richer people (fourth and fifth group) consume only slightly more electricity but because of their much higher income spent a smaller share of their income for electricity. This fact makes it obvious that from the current system of tariff subsidies in Ukraine the households of higher income groups benefit more then the poor households.

4.3 Evaluation of the impact of tariff increases on welfare change

As has already been shown, in order to reach the cost-covering level of electricity prices according to estimations of NERC, current tariffs would need to be increased by 15.08 or 55.56% depending on the respective region. But further increases up to 314% (from the current average tariff) would still be needed if the average OECD level were to be taken as a benchmark for LMRC for the longer term. However, these figures do not completely reflect whether such a price increase would be really sensitive to the households' budgets. Therefore, in the following their impact on the welfare of different income groups would be calculated.

The most widespread measure of welfare changes is the consumer surplus. Freud and Wallich estimated changes in the consumer surplus as a rectangle trapezoid using a linear demand curve. However, this technique might be inappropriate when large price changes are analysed. They have also used elasticity, which varies along the linear demand curve from zero to infinity. Varying elasticity might seriously change results especially if price changes were introduced in small steps. An elasticity of -1 looks very unrealistic if the possible amount of changes in electricity tariffs is taken into account. Thus, an 80% price increase should be associated with an 80% decline in electricity consumption.

Changes in consumer surplus might be an inappropriate measure of welfare changes when large electricity tariff changes are analysed as is the case in post socialist countries (Bacon, 1995). Alternative measures of losses in welfare might be compensating or equivalent variations.

Huerth and Schmitz (1982, p. 85) gave the following definitions of compensating and equivalent variations:

"Compensating variation is the amount of income which must be taken from the consumer (possibly negative) after a price and/or income change to restore the consumer's original welfare level.

…Equivalent variation is the amount of income that must be given to the consumer (again possibly negative) in lieu of price and income changes to leave the consumer as well off as with the change."

For the simplicity of our analysis we assumed that electricity and other goods could be consumed in proportions. It can be done since it is not crucial for results of the analysis and it is justified since consumption of additional electrical equipment is usually complemented with additional electricity consumption. This claim is supported with the results of the conducted survey.

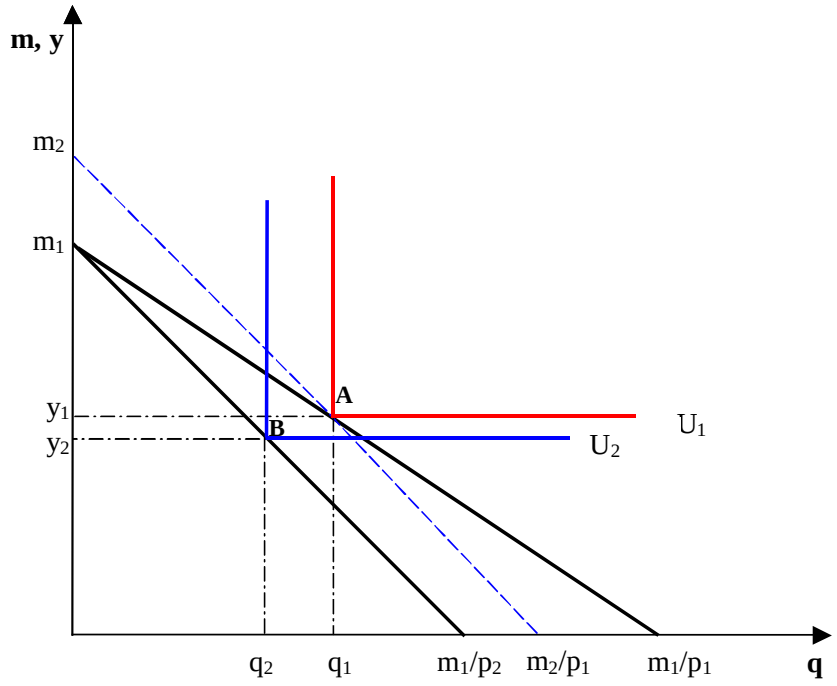
If a compensating variation is used as a measure of welfare change, it will be equal to the amount of money that a consumer will have to pay if he/she continues to consume the same amount of electricity as before the tariff change. An equivalent variation is the amount of money that should be given to a consumer after the tariff has increased and also reflects possible reduction in electricity consumption.

Estimates obtained by the compensating variation method might overestimate welfare losses because this method does not take into account a possible reduction of the households' consumption whereas estimates obtained by the equivalent variation method might underestimate them. Hence, it would be useful to estimate welfare losses by both methods.

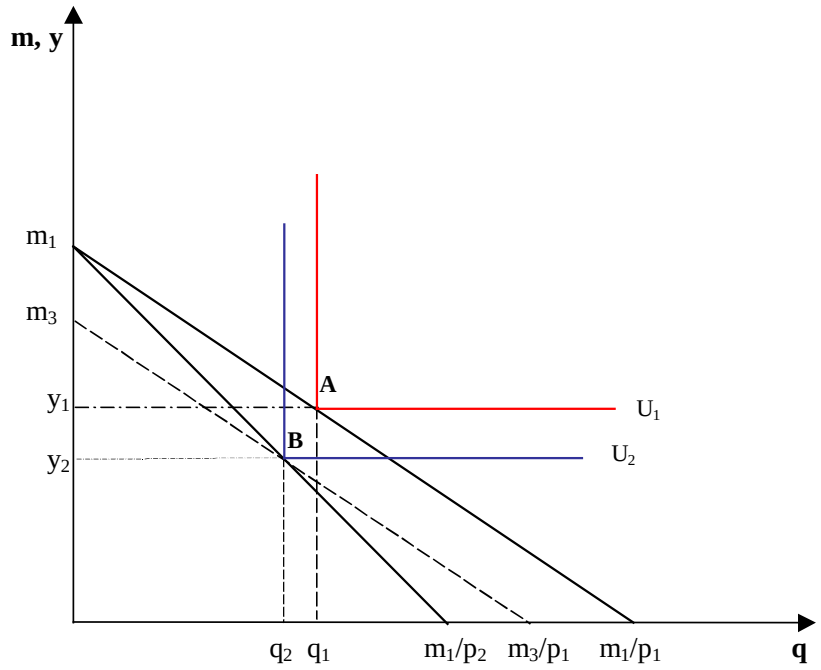
4.4 Welfare changes induced by tariff increases up to the level estimated by the NERC

As a first step we calculated welfare changes in the case if tariffs would be increased up to the cost covering level estimated by the NERC. Graphically, Graphs 3 and 4 illustrate these two explained methods of welfare measures in our case.

Graph 3
Compensating variation associated with the price rise (assumption households' consumption remains the same)



Graph 4
Equivalent variation associated with the price rise



Where q is the quantity of electricity demanded, m – household's income, y denotes all other goods. Subscript 1 denotes the initial allocation and other subscripts denote other allocations. Points A and B are the initial and final allocation respectively. Since we know the initial distribution and the new price we can calculate the quantity of electricity demanded in point B.

In Graph 3 the compensating variation associated with the price rise is the distance m_1-m_2, and the equivalent variation associated with the price increase is the distance m_3-m_1 in Graph 4. If we assume that the price of all other goods is equal to one and price changes of electricity do not have any impact on prices of all other goods, compensating and equivalent variations might be easily estimated.

The old budget constraint line may be written as

$$p*q+z*y=m_1 \quad (4)$$

p_1 = price for electricity before change

p_2 = price for electricity after change

z= price for other goods (good y)

If we assume that price of all other goods is equal to one (z in formula 4) the budget line has the form

$$y = m_1-p_1*q \quad (5)$$

If a price increase takes place the new budget line has a form

$$y = m_1 - p_2 * q \quad (6)$$

In order to estimate welfare changes using the compensating variation (m_2-m_1) in Graph 3, information is needed concerning the initial income of the household (m_1), the current electricity tariff – the slope of the old budget line ($p_{1)}$, the consumption (q_1) and the new price – the slope of the new budget line (p_2). Then y_1 can be calculated. If point (y_1,q_1) and the slopes of both budget lines (p_1 and p_2) are known, m_2 can be calculated from equation

$$y = m_2 - p_1 * q \quad (7)$$

Having used this data we estimated welfare changes for these five groups that are presented in Table 8.

Table 8
Welfare changes in different social groups

	Region	Group 1	Group2	Group3	Group4	Group5
Compensating variation (change in electricity expenditures of the equivalent adult in UAH)	Zaporizhya region	1.0	0.9	0.8	1.3	1.5
	Zhytomyr region	3.7	3.2	3.0	4.6	5.4
Compensating variation (change in electricity expenditures of the equivalent adult as a percent of total income)	Zaporizhya region	>0.9%	0.4% - 0.8%	0.2% - 0.3%	0.2% - 0.3%	<0.3%
	Zhytomyr region	>3.1%	1.2% - 2.8%	0.6% - 1.2%	0.5% - 0.6%	<0.8%

Source: Estimations based on data of the IER Power Consumption Surveys

Though the figures in UAH seem rather small they do not completely reflect whether these price increases would be severe to the respective households' budgets. Therefore, we also calculated the ratio of the change in electricity expenditures per equivalent adult compared to the total household expenditures of the correspondent income group (see Table 8).

As can be seen from this table, the poorest households (1st and 2nd income groups) would suffer more from the calculated tariff increases than households of other income groups. However, they are to a certain extent protected by the present Ukrainian system of subsidies. The losses in their welfare would be compensated by the state. For comparatively rich people (4th and 5th income groups) expenditures on electricity are practically insignificant according to the results of the survey. Hence, the only group that could really suffer are the households of the third income group.

In order to estimate welfare changes by equivalent variation (m_3-m_1), needed information is the initial income of the household (m_1), the current electricity tariff (slope of the budget old line – p_1), the initial consumption (q_1) and the new quantity of consumed electricity (q_2). Then we can calculate y_2 and if point (y_2,q_2) and slopes of both budget lines (p_1 and p_2) are known m_3 can be easily calculated

In order to reveal the minimum level to which electricity consumption of group 3 could be reduced the consumption level of representatives of this group were taken, which currently pay for only part of the utilities because they obtained subsidies from the state. The presented survey has shown that these households tried to achieve the minimum possible amount of electricity consumption. It was also assumed that the consumption behaviour of the representatives of group 3 in the survey would be valid for all customers belonging to this income group in Ukraine.

As result of the welfare losses estimated by equivalent variation it turned out that expenditures on electricity per equivalent adult of this group might increase only between 0.14% (in Zaporizhya region) and 0.94% (in Zhytomyr region) of total income.[14] Thus, from obtained results we may conclude that tariff increases to the cost covering level estimated by NERC should not cause significant loss of welfare for all groups of consumers – poor people would be protected through the system of subsidies and for households of higher income groups electricity expenditures would not be sensitive even after price increases. Representatives of the third group are hurt the most but, as was shown, the welfare losses of this group are not large and some of the respective households would be able to obtain subsidies from the state.

4.5 Evaluation of welfare changes resulting from price increases to the OECD level

As already mentioned, a price increase up to the level estimated by the NERC might not be sufficient in the long run. Assuming that the total cost of supplying electricity to households in the Ukraine is close to the average OECD price for residential electricity customers (0.0958 USD/kWh), this price was used as a benchmark for further tariff increases in an additional calculation. Having estimated welfare changes under the assumption that households' electricity consumption would remain the same the following results were obtained.

[14] The lowest and the highest price increases were observed in these two regions.

Table 9
Welfare losses of different income groups as a result of tariff increases up to the average OECD level

	Group1	Group2	Group3	Group4	Group5
Compensating variation (change in electricity expenditures of the equivalent adult as a percent of total income)	13.68% <	5.89% - 12.12%	2.80% - 5.38%	3.10% - 4.34%	<3.65%
Possible ratio of electricity expenditures of the household to total income of different income groups	44.92% <	24.57% - 50.59%	11.94% - 22.96%	14.73% - 20.59%	< 13.01%

Source: Estimations based on data of the IER Power Consumption Survey

As can be seen from this table the welfare loss would be highly significant for households in all income groups. Obviously, such an increase of tariffs up to the average OECD level could be achieved only stepwise.

5 Conclusions and policy implications

Among transition countries Ukraine still lags behind as far as re-balancing of electricity tariffs between industries and households and raising prices to LRMC levels is concerned. Even compared to the officially used cost plus tariff setting methodology, current electricity tariffs for private households do not cover costs. Obtained results of an evaluation of the welfare changes have shown, that tariff increases up to the level estimated by the NERC would not cause significant losses to households' welfare. This is due, firstly, to the low level of electricity consumption of Ukrainian households and, secondly, to the existing system of safeguarding low-income households. Therefore, a tariff increase up to the official cost covering level estimated by the regulator NERC could and should be implemented. This would be a first important step towards abolishing cross-subsidisation. It would help to overcome distortions of the system of price incentives still prevailing.

In a further step, a revision of the calculation of costs of transmission and distribution is needed in order to bring cost based price calculations closer to reality. We suggest that the level of true costs would be close to the average OECD level. If true costs of electricity supply were to have been evaluated then a new method of price regulation focusing on incentives for cost reductions should be implemented. A price cap regulation would be appropriate in order to bring tariffs close to LRMC.

Indeed, if tariffs were to be raised up to the OECD level, welfare losses would be substantial. Then relying only on the currently implemented system of subsidies for low-income households would not be sufficient any longer. Introduction of a super-lifeline tariff covering only operating costs might be an appropriate method for reducing the economic burden for lower-income groups. For consumption above the super-lifeline households should pay full LRMC prices. Even if the introduction of a super-lifeline should also be considered an economic subsidy to households, this method would be more transparent and incentives to save electricity would be set. Financing of this subsidy should be solved directly from the state budget or as proposed in Stern and Davis (1998, p. 449): "by setting up transitional 'back-to-back' contracts between distribution companies and generators for supplying the customers at the super-lifeline."

In addition, tariff increases to cost covering levels would yield expected results only if soft budget constraints cease to exist. That's why the government also need to pay more attention to the modernisation of the accounting system. The partial introduction of a new accounting system in selected districts of the Ukrainian capital has shown that consumers' behaviour might be changed very quickly.

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Appendix

Table 3
Structure of cost covering tariffs for private households in Ukraine according to the regulator's calculations (in UAH/kWh) (complete version)

Regional distribution company	Price of the wholesale electricity market (P^{av})	Tariff of energy transmission to the 2 voltage level (T_2^t)	Tariff on distribution (T_i^t)	Loss correction coefficient for the 1st voltage level C_{p1}^m	Loss correction coefficient for the 2nd voltage level C_{p2}^m	Tariff for house-holds (without VAT) P_{ij}
Vinnitsaoblenergo	0.1145	0.036	0.011	0.04	0.15	0.1862
Volynoblenergo	0.1145	0.032	0.011	0.03	0.12	0.1767
Dniprooblenergo	0.1145	0.017	0.006	0.03	0.1	0.1536
Donetskoblenergo	0.1145	0.016	0.003	0.04	0.11	0.1529
Zhytomyroblenergo	0.1145	0.036	0.014	0.05	0.18	0.1961
Zakarpattyaoblenergo	0.1145	0.032	0.008	0.07	0.18	0.1902
Zaporizzyaoblenergo	0.1145	0.014	0.005	0.03	0.07	0.1454
Kyivoblenergo	0.1145	0.029	0.011	0.08	0.13	0.1842
Kirovogradoblenergo	0.1145	0.043	0.012	0.04	0.10	0.1881
Krymoblenergo	0.1145	0.027	0.009	0.06	0.12	0.1748
Lvivoblenergo	0.1145	0.033	0.009	0.07	0.15	0.1867
Luganskoblenergo	0.1145	0.020	0.004	0.05	0.08	0.1552
Mykolaivoblenergo	0.1145	0.030	0.009	0.04	0.15	0.1807
Odessaoblenergo	0.1145	0.029	0.011	0.04	0.13	0.1768
Poltavaoblenergo	0.1145	0.033	0.013	0.04	0.11	0.1791
Prykarpattyaoblenergo	0.1145	0.036	0.008	0.04	0.14	0.1819
Rivneoblenergo	0.1145	0.033	0.013	0.04	0.12	0.1824
Sevastopoloblenergo	0.1145	0.024	0.006	0.03	0.12	0.1641
Sumyoblenergo	0.1145	0.035	0.013	0.04	0.15	0.1879
Ternopiloblenergo	0.1145	0.032	0.009	0.04	0.16	0.1836
Kharkivoblenergo	0.1145	0.028	0.009	0.05	0.17	0.1817
Khersonoblenergo	0.1145	0.032	0.011	0.05	0.13	0.1815
Khmelnytskoblenergo	0.1145	0.036	0.013	0.05	0.15	0.1903
Cherkassyoblenergo	0.1145	0.033	0.014	0.05	0.10	0.1824
Chernivzioblenergo	0.1145	0.028	0.008	0.06	0.17	0.1820
Chernigivoblenergo	0.1145	0.034	0.009	0.06	0.12	0.1804

Source: NERC estimates

Table 4
Required tariff increases for different types of consumers in different regions

Regional distribution company	Electric stove	Rural	Gas stove
Vinnitsaoblenergo	86.18%	55.15%	43.22%
Volynoblenergo	76.72%	47.27%	35.94%
Dniprooblenergo	53.57%	27.98%	18.13%
Donetskoblenergo	52.87%	27.39%	17.59%
Zhytomyroblenergo	96.11%	63.43%	50.85%
Zakarpattyaoblenergo	90.23%	58.53%	46.33%
Zaporizzyaoblenergo	45.35%	21.13%	11.81%
Kyivoblenergo	84.16%	53.47%	41.66%
Kirovogradoblenergo	88.05%	56.71%	44.65%
Krymoblenergo	74.80%	45.67%	34.46%
Lvivoblenergo	86.71%	55.59%	43.62%
Luganskoblenergo	55.21%	29.34%	19.39%
Mykolaivoblenergo	80.71%	50.59%	39.01%
Odessaoblenergo	76.75%	47.29%	35.96%
Poltavaoblenergo	79.10%	49.25%	37.77%
Prykarpattyaoblenergo	81.93%	51.61%	39.95%
Rivneoblenergo	82.37%	51.98%	40.28%
Sevastopoloblenergo	64.12%	36.77%	26.25%
Sumyoblenergo	87.89%	56.58%	44.53%
Ternopiloblenergo	83.56%	52.97%	41.20%
Kharkivoblenergo	81.71%	51.43%	39.78%
Khersonoblenergo	81.50%	51.25%	39.62%
Khmelnytskoblenergo	90.31%	58.59%	46.39%
Cherkassyoblenergo	82.35%	51.96%	40.27%
Chernivzioblenergo	82.00%	51.67%	40.00%
Chernigivoblenergo	80.36%	50.30%	38.74%

Source: own estimates based on NERC data