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EFFICIENT USE OF ELECTRICITY: POLICY APPLICATION OF ENERGY CONSERVATION MEASURES IN UKRAINE

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ABSTRACT

Efficient allocation of goods and factors of production is a principle that should be addressed by all economies. Economic regulation creates preconditions for the existence of significant system distortions, misallocation of goods and of production factors and a tendency to their overuse. However, these allocative inefficiencies can be successfully corrected by an apropos conservation policy.

This thesis is aimed at a policy analysis in the field of energy (electricity) conservation. Within its framework economic measures, such as price-induced and rationing (periodic disconnection from the line) policies of electricity conservation, are examined with respect to existing non-payments. Special attention is given to the applications of major theoretical developments for Ukrainian electricity market.

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CONTENTS

INTRODUCTION

The concept of economic efficiency is an acute concept of economics that can be applied to the use of inputs in production of goods and/or their consumption. The latter usually refers to the efficiency in exchange: it ensures efficient allocation of goods between consumers. This paper will mostly address the efficient use of electricity viewed under the angle of `efficiency in exchange` criterion. And, therefore, it will deal mainly with `demand-side management` policies[1] because "energy conservation policies that have the support of the consumer-citizen are more likely to get enacted and, once enacted, more likely to have their intended effect" (Bennett and Moore 1981, 313).

This thesis is dedicated to policy analysis in the field of conservation[2] of electricity and is closely related to the concept of economic efficiency. Enforcement of efficient use of electricity, cet. par., can be provided by an increase in electricity rates, when previously the electricity market was under to severe price controls. As a result of a price increase, the amount of consumed electricity is expected to decrease thereby encouraging its conservation. However, higher prices would lead to more non-payments which will affect energy demand and production. Hence, following this discussion, sections 1 through 4 are dedicated to the analysis of the possible influence of non-payments on the success of energy conservation measures in Ukraine as well as in other transition economies.

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[1] Demand-side management is usually defined as a set of activities initiated by the utility(ies) and targeted at the demand (consumer) side.

[2] Energy "conservation program is defined as activities that are aimed at all or a major subsets of utility` s customers and have the objective of shaping the pattern of consumption or demand to the utilities ability to supply power with minimum impact on the customer` s quality of life" (Sawhill and Cotton 1986, 137). Hereafter we will refer to the energy conservation policy as the one that incorporates in itself a conservation of electricity.

Major developments of this thesis are presented in four sections. The first section constitutes the body of the argument. It represents a theoretical layout of a problem that arises in Ukraine, for example, while implementing energy conservation measures: non-payments. The review of literature that was carried out with respect to this issue shows that most economists recognize the existence of the `barriers` to energy conservation. Moreover, they state that the reason for this is hidden in market imperfections, such as, for example, the lack of information (Sawhill Cotton 1986, 9).

However, other authors suggest different arguments for the existence of such barriers. Peck and Beggs (Op. cit., 10) stress the relative insignificance of energy costs as a proportion of total costs of an entity. Sametz (Op. cit., 11), in his turn, discusses difficulties encountered in obtaining financing for conservation programs. And, in addition, Hemphill and Myers (Loc. Cit.) frequently refer in their works to the necessity of complicated planning that usually arises while implementing these programs. While all of these points mentioned above appear reasonable in one or other cases, they still do not account for a number of institutional problems that are very important for the countries with a transition economy and should be given due attention.

In the next section (section 2) two alternative approaches to the graphical representation of non-payments are tested. One of them is based on a concept of `soft budget constraint` and another - on a `multiple pricing` concept. The first approach indicates that non-payments could be represented as causing an increase in a demand for electricity and another approach suggests that the price elasticity of demand changes as a result of non-payments. Testing procedure that is developed in this section allows us to select one approach that is (relatively) superior to the another and to use it in a policy analysis section (section 4).

Due to a number of considerations that will be discussed in the next paragraph, this thesis does not address closely the question raised by Horace Herring in his paper dated July 1998: “Does energy efficiency save energy?” The core of this issue is a dispute that has heated the economic opinion starting from early 1990-ties. The main `conflicting` parties in this debate are the proponents of energy conservation and the proponents of an improvement in energy (conversion) efficiency. While the first promoted a reduction in energy consumption as a means of encouraging energy efficiency, another argued that this measure could be undertaken only at the expense of a lower economic output. In contrast, the proponents of conversion efficiency supported fully the Khazzoom-Brookes postulate (Herring 1998, 3) that was independently formulated by Leonard Brookes and Daniel Khazzoom within the same time period of the late 1970-ties – early 1980-ties. Its essence consists in the following:

> “Energy efficiency improvement that are economically justified at the micro-level lead to higher level of energy consumption at the macro-level than in the absence of such improvements” (Loc. cit.).

KB postulate reveals that the initial reduction in energy demand induced by higher prices will be significantly cushioned by the accompanying improvement in energy efficiency. This outcome has a lot in common with the effect of increasing the price of a Giffen good on the amount of its consumption. Let us assume that consumers` preferences are located in electricity - non-electricity commodity space, so that they reflect the superiority of non-electricity goods over electricity. Then also assume that the price of electricity increases. Then, according to the previously specified assumptions, we should expect that, as a result of substitution effect, consumption of energy will fall and, following the consequences of income effect, it could expand even more than it was initially. However, it is still questionable how long the substitution effect lasts and whether a counteracting income effect (income contraction) will not subsequently offset the impact of the former.

Finally, section 3, as an intermediate part, bridges theoretical and practical (policy analysis) sections. It describes the situation in Ukrainian electricity sector as a special case where energy conservation finds its direct application. At the present stage of development, the necessity of conservation policies in the electricity industry of Ukraine is not very urgent. Nevertheless, this policy option has a relatively high chance of being crucial in the near future given that other policy options may be considered as inappropriate. In that case, price-induced conservation of electricity[3] will most probably be hindered by non-payments. To facilitate the development of these programs in future, all current `barriers` to the implementation of energy conservation policy should be eliminated in Ukraine.

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[3] Hereafter we will associate conservation policy with the increase in electricity rates because not only the price-induced conservation measures but also the policy of rationing will lead to an increase in electricity prices.

Section 1. Non-payments as an impediment to the successful implementation of energy conservation policy in Ukraine

Within this section two alternative approaches will be examined allowing us to analyze the influence of non-payments on the resulting effect of energy conservation policies. One of them relies on the concept of `soft budget constraint` and will be discussed first. Another approach that we will analyze later in this section - `multiple pricing` - implies that there exists a possibility of paying different prices for electricity.[4]

Let us start with the considerations of microeconomic issues underlying the representation of non-payments within the framework of a consumer choice model[5] (Figure 1). We will assume that in our model:

1) an individual spends his/her budget on two types of goods (electricity and non-electricity),
2) electricity is a final good and if needed, it can be easily represented as an amount of useful energy generated by various (home) electric appliances, [6]
3) both types of goods (electricity and non-electricity) are normal.

As can be seen, his/her utility is maximized at point A (E_1 ,NE_1) where initially prices for both types of goods are P_E^1 and P_{NE}^1 given (disposable) income *I* (budget line I_1):

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[4] Within this paper price differentials on electricity that arise with its transportation will not be considered.

[5] Indeed, the same flow of logic can be reconstructed for a producer` s model, where electricity and non-electricity inputs are used in a production process.

[6] For that purpose, we will exclude electric appliances from a non-electricity group in order to avoid double accounting. To the extent that electricity is an intermediate good, this model is an approximation.

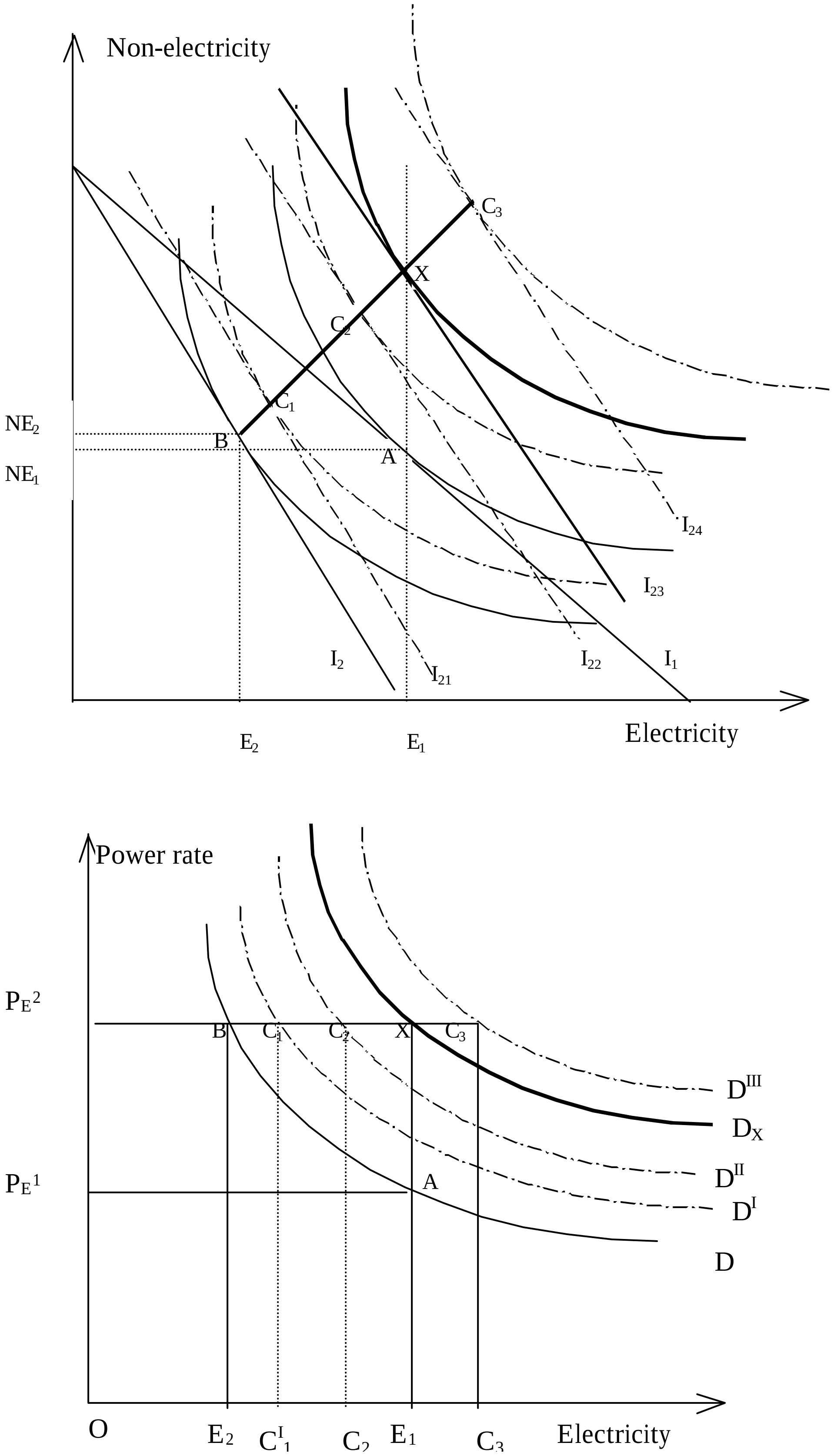

Figure 1. *Derivation of actual and virtual demand schedules*

$$I=P_E^1*E+P_{NE}^1*NE.$$

Then suppose that the price of electricity (power rate) is increased from P_E^1 and P_E^2. Keeping other things constant – the level of income is still *I* – budget line (I_1) should make a pivot and take the allocation of I_2:

$$I=P_E^2*E+P_{NE}^1*NE.$$

Now, consumer` s utility will be maximized at point B (NE_2 ,E_2). Given that the electricity is a normal good, we should expect $E_2<E_1$ and $NE_2>NE_1$ reflecting the fact that consumption of a relatively cheaper good (NE) will be increased and consumption of a relatively expensive good (E) should go down. Consequently, a compensated demand curve that corresponds to this price change is indicated by a curve D (points A and B represent two combinations of power rates and amounts of electric power that is consumed).

That is a point were usually a story about consumer ends. However, allowing for the non-payments to exist will cause this picture to change. If we assume that I_2 depicts actual earnings paid to an individual in cash, then a budget line I_{21} (Figure 1) that should represent the income earned by individual should lay somewhere above I_2. This approach reminds us of a concept of ‘soft budget constraint’. It suggests that the consumer’s “budget constraint…is based on expectations concerning his future financial situation when the actual expenditure will occur” (Kornai 1986, 4).

While choosing between two budget lines (I_2 and I_{21}), we suppose that the individual will make his/her decision according to I_{21} curve.[7] Doing so, individual expects that sooner or later he/she will receive all amounts (of wages) owed to him. Otherwise, there will be no incentive for him/her to work any more and this type of activity will be ceased. Thus, on a figure below D represents demand for electricity that can be paid for by a consumer and D^I – demand for electricity that will be indeed consumed. The gap between the two curves represents the amount of non-payments.[8]

In order to define the resulting effect of a price-induced conservation of power under the non-payment constraint, we need to find two allocations (consumption points) in a two-good space. One of them (point B) corresponds to the consumption of power under the actual budget constraint and determines the amount of money that is actually paid for it (rectangle $OP_E^2BE_2$). On the other hand, point C_1[9] stands for the amount of power energy that is consumed (rectangle $OP_E^2C_1C^I_1$). Therefore, it is obvious that power arrears are going to appear (difference between rectangles $OP_E^2BE_2$ and $OP_E^2C_1C^I_1$).

As a result, the effect of the measures targeted at conservation of power is lessened. It means that this type of policy turns out to be less efficient under the non-payments

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[7] Hereafter we will distinguish between actual budget constraint and virtual (or decision) budget constraint. We will define actual budget constraint (I_2) as an amount of money that a consumer has at his disposal and can spend to purchase goods (in our case good E and good NE). Also, we will employ virtual budget constraint (I_{2I}) to indicate an amount of money that consumer has indeed earned but could not spend it because of arrears (non-payments). Hence we will assume that the total cash earnings of an individual can be presented as a sum of a paid cash earnings and arrears (A_i). Consequently, we can define a set of virtual budget constraints (I_{21}, I_{22}, I_{23} I_{24} and etc.):
$I_{2i}=I_2+A_i$.

[8] It should be clear that arrears are not obligatory translated into electricity non-payments for electricity by one-to-one relationship. The weaker is the system (lower contract enforcement), the higher is its softness and lower is a shift of a budget constraint.

[9] $C_1 \in \{C_i: I_{2i}=I_2+A_i., \forall i\}$.

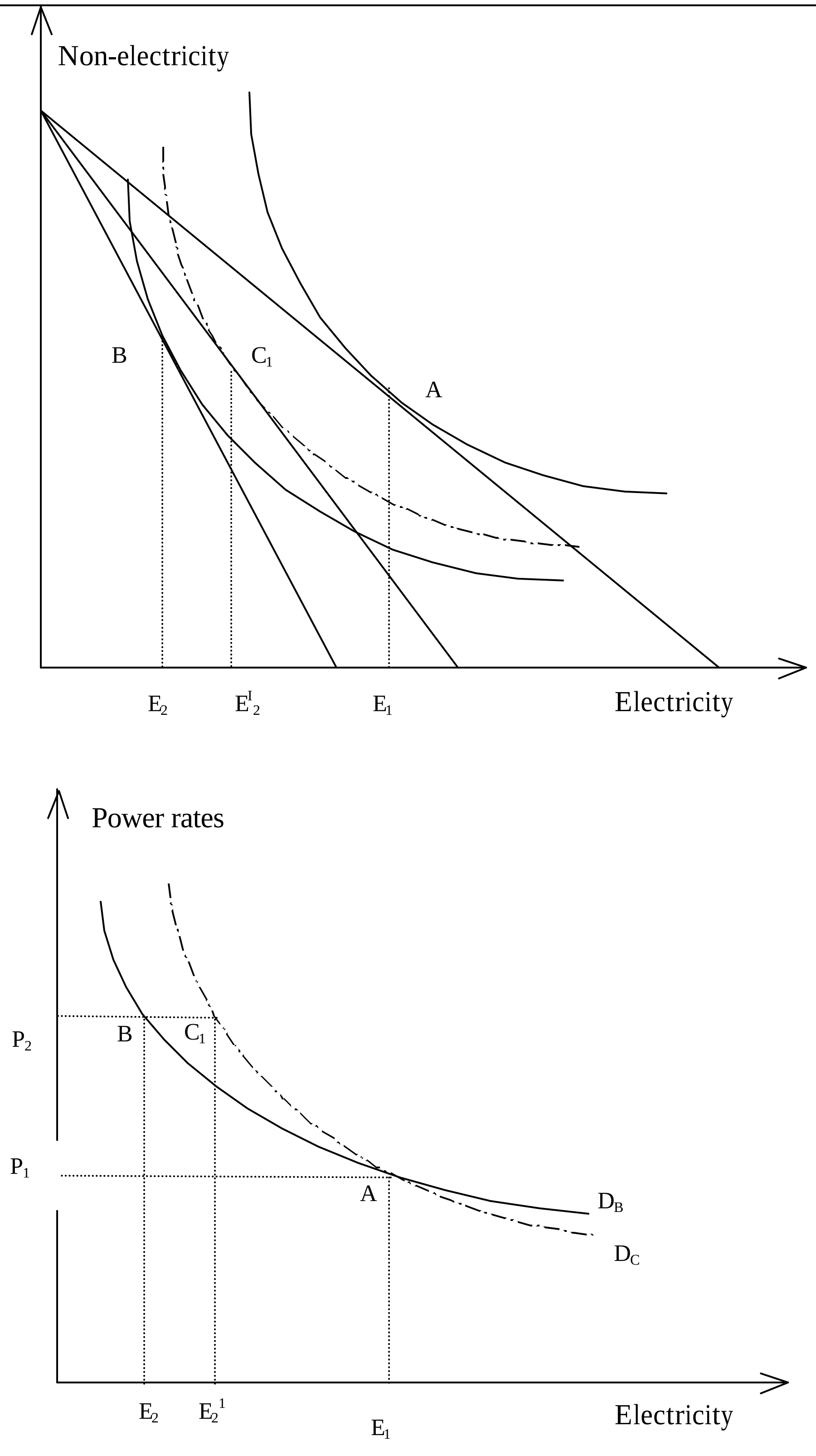

***Figure 2** Representation of non-payments: alternative approach*

than without them: for the given difference between pre-regulatory and (expected) after-regulatory volumes of power consumed (E_1 and E_2, respectively), the greater is the effect of non-payments ($E_2C^I_1$), the smaller is the residual impact of initial conservation of power. Finally, we can find such point X - an interception of income expansion path (curve $BC_1C_2C_3$) and a vertical line stuck at E_1 - that brings consumers to the pre-regulatory amount of power energy consumed, thereby eliminating expected policy benefits.

The same outcomes, however, can be presented while assuming that instead of income expansion, non-payments result in different prices charged from consumers according to their ability to pay for services in cash. Hence, different amounts of arrears that most of the consumers are facing could be viewed as if they were paying different prices for electricity. Individuals that pay a full amount indicated in their electricity bill, will be assumed to pay a full price for electricity. Those paying only a part of an indicated amount, will, correspondingly, pay lower price. Finally, the rest of consumers will not pay for electricity at all. This group of consumers will be assumed to consume electricity at a zero price. Hereafter, we will refer to this phenomenon as a `multiple pricing` (Figure 2).

For the purpose of analysis we will divide all customers into two groups: those that incur wage arrears and those that do not. The only difference between these consumers` groups is the occurrence of arrears. Also we will assume that all consumers possess identical preferences and identical initial incomes. In addition, we will continue our analysis within the framework of a two-goods model (electricity and other goods).

Initially, the allocation of electricity and non-electricity goods for the representatives of both groups will be indicated by point A in Figure 2. Then, power rates are supposed to increase and a new efficient allocation of goods is expected to be reached at point B and will correspond to the demand schedule D_B. However, this will be true only for a part of consumers, those that do not face arrears. For the rest of consumers, this new allocation in fact will be achieved elsewhere at point C_1 (demand schedule D_C).[10] This new allocation represents the fact that the second group of consumers, encountering non-payments in any source of receivable income, will further create arrears in their accounts payable.

Within the `multiple pricing` approach we will assume that the second group of consumers, instead of paying full amounts for the consumed electricity, will not pay its full price. Consequently, two groups of consumers, those that incur arrears and those that do not, will face two different prices. We can also see, that under this representation the amount of arrears in electricity will be presented by the rectangle $E_2BC_1E^1{}_2$ (Figure 2).

Under the second approach to the non-payments we have recognized the existence of different prices for electricity. However, given that the electricity is a homogeneous

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[10] The greater the amount of wage arrears, the flatter is a budget constraint. It is obvious that the effect of initial increase of power rates can even be reversed.

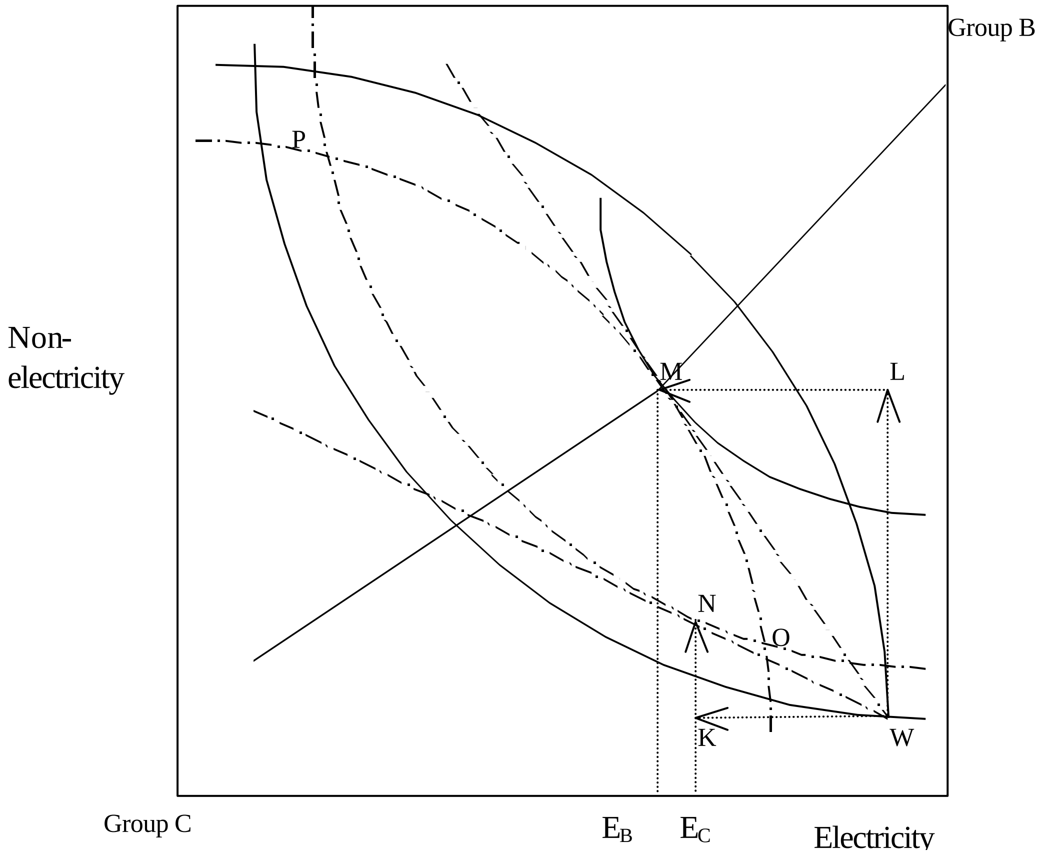

Figure 3. *Edgeworth box representation of inefficient use of energy*

good we will expect that, owing to the non-payments, allocative inefficiency will arise. Let us examine the second approach within the framework of Edgeworth box representation (Figure 3).

Now we will also assume that there are two groups of consumers – those that encounter non-payments (group C) and those that do not (group B). Initial combination of goods (electricity and non-electricity) endowed by both groups of consumers is indicated by point W. And, as a result of a free exchange, both types of goods now will be combined by two groups of consumers at a new point (point M).

At the same time, however, allowing for non-payments to exist will lead to a different outcome. Consumers from group C will encounter non-payments and, consequently, will pay a lower price. This group of consumers will maximize their utility at point N instead of point M, where consumers of group B are willing to move from point W. Hence, two groups of consumers (B and C) will face different relative price ratios (MW and NW, correspondingly) and, as can be seen, an inefficiency (region ONPM) will arise.

It becomes clear that non-payments will create an `implicit` variety of electricity rates thereby causing an excessive use of electricity. More precisely, while moving from point W to point M, group B will exchange LW units of non-electricity goods for LM units of electricity. At the same time, group C is willing to sacrifice KW units of electricity to gain KN units of non-electricity goods. As a result, within this particular system, an excess demand for electricity (ML minus KW) as well as an excess supply of non-electricity goods (LW minus NK) will be generated. Hence, as long as consumer will be in effect allowed to exchange goods according to different relative price ratios (MW and NW), an excessive use of power energy will have been produced (efficiency losses = ML-KW) and non-payments will counteract the public effort targeted at efficient use of electricity.

Section 2. Statistical evaluation of approaches

The previous section was dedicated to the development of theoretical background under which the issue of efficient use of energy that is subjected to non-payments can be studied. And, consequently, two alternative approaches were suggested to tackle this problem. One of them refers to the non-payments as if they were causing a shift of power demand schedule and another – as if a change of its slope has occurred. Hence, it appears natural to test both of them on available Ukrainian data.

The necessity of a testing procedure for the purpose of this work is apparent. Statistical estimation allows us to capture the impact of non-payments on the allocation and/or the shape of a demand schedule (see Figure 1 and Figure 2). Figures show that the same policy measure under both approaches will imply different patterns of wealth distribution.

In order to perform a test for two alternative approaches, particular model specifications have to be developed. The latter should distinguish between peculiarities of each approach and incorporate them properly. Therefore, as far as the first approach – a shift of demand schedule – is considered, we can suggest the following relationship:

$$D=f_1(P, A),$$

where D is a demand for power energy,

P – price of power energy (power rate), and

A – any type of arrears.

Alternatively, we can develop a specification for the second approach that represents a change in the slope of demand schedule caused by non-payments (arrears):

$$D=f_2(P, A*P).$$[11]

Also, we can carry out testing in two possible ways. First, we can estimate specified equations separately and then inspect the outcomes of equations. Or, secondly, we can develop only one equation and then try to exclude some variables. More specifically, in the first case, we will run regressions that were indicated in the above paragraph. In the second case, however, we will need to combine all variables in the following equation

$$D=f_2(P, A*P, A)$$

and then run a Wald test on omitted variables.

In order to avoid a misspecification problem that frequently arises while estimating demand functions separately, we will run a system of simultaneous equations:

$$D=g_1(P, A) \text{ or } D=g_2(P, A*P)$$

$$S=f(P, P_{coal})$$

$$D=S-NX,$$

where S is a supply of power energy,

NX – net exports of electric power, and

P_{coal} – price of coal.

As a result, two systems of equations need to be estimated. One would present the

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[11] The difference between two specifications can be easily grasped after the following explanation. Assume that initially $D=\alpha+\beta*P$. The specifics of second approach implies that with an imposition of arrears slope of the demand curve (β) changes. That is $\beta=g(A)=\gamma+\delta*A$. Then, it can be seen that $D=\alpha+\gamma*P+\delta*A*P$.

first approach to the non-payments – shifting demand curve (first specification of demand function within the above system) and another – pivoting demand curve (second specification of demand function). For the purpose of convenient interpretation of signs, we will run a log-log specification for demand and supply functions.

Also it is necessary to mention that we will carry out calculations on the basis of quarterly observations starting from 1995 till 1998 (including). This period was chosen because of its relative economic stability, so that no imposition of a structural change in estimated coefficients is needed. Data were obtained from the State Committee of Statistics, Ministry of Power Engineering and National Electricity Regulatory Committee.

We start the estimation procedure with running a system of equations that is designed to test a 'shift' approach to the non-payments. Estimated system is presented below (t-statistics is indicated in parentheses):

$$\log(D)=10.956-0.202*\log(P)+0.030*\log(A)$$

$$(14.025)\quad(-0.696)\quad(0.34)$$

$R^2 = 0.037$ DW stat. = 1.71

Adj. $R^2 = -0.112$

$$\log(S)=10.841+0.094*\log(P)-0.103*\log(P_{coal})$$

$$(12.794)\quad(0.212)\quad(-0.559)$$

$R^2 = 0.047$ DW stat. = 1.88

Adj. $R^2 = -0.099$

$$\log(D)=\log(S-NX).$$

As can be seen, of the above system appears to be inadequate. This can be explained either by the wrong log-log specification of demand and supply functions or by insufficient number of observations.

Second system of equations that represents the second approach to the non-payments problem – 'slope' approach – was also estimated and the results of this estimation are presented below:

$$\log(D)=11.326-0.250*\log(P)+1.85(10^{-6})*A*\log(P)$$

(12.432) (-0.825 (0.548)

$R^2 = 0.050$ DW stat. = 1.65

Adj. $R^2 = -0.096$

$$\log(S)=10.841+0.094*\log(P)-0.103*\log(P_{coal})$$

(12.794) (0.212) (-0.559)

$R^2 = 0.047$ DW stat. = 1.88

Adj. $R^2 = -0.099$

$$\log(D)=\log(S-NX).$$

As can be seen, statistical output for the estimations of second approach identify an inadequacy of the estimated system. The same set of reasons (number of observations and function specification) can be applied while explaining low value of R^2.

In order to test two approaches against each other, Wald tests were run on both specification of demand function testing the significance of a coefficient related to the arrears. The results of two tests are summarized in the following table:

Test	Null hypothesis	Alternative hypothesis	F-statistics	p-value
1	$B_A= 0$	$B_A \neq 0$	1.555	0.212
2	$B_{A*P}=0$	$B_{A*P} \neq 0$	0.301	0.584

As a table shows, both tests cannot be treated as appropriate even at a 10%-level of significance. While choosing between two approaches, we can use the first approach (‘shift’ approach) as more adequate in comparison to the second approach. We would prefer this choice because, for example, at 25% significance level we will reject first null hypothesis but will accept the second null hypothesis. Hence, we will use a ‘shif
chapters.

Section 3. Description of Ukrainian electricity market and a practice of its conservation in Ukraine

Prior to the privatization of 1990-ties, Ukrainian electricity sector was in a 100% state ownership. With the adoption of Presidential Decree “On the Market Transformation of the Power Sector of Ukraine” in 1994 the process of industry unbundling started that already introduced a certain degree of decentralization. Within the course of measures undertaken towards establishing market environment, all agents of electricity market are now subject to licensing.

However, instead of major developments in the field of reforming electric power industry, electricity rates in Ukraine remain heavily regulated. At the meantime ‘market price mechanism’ finds its application with the wholesale electricity purchase prices for thermal electric stations (TES). For other agents of electricity sector rates on transmission and delivery of electric power, as well as a subsidy weights in a wholesale electricity rate, are defined by National Electricity Regulatory Commission (NERC), an independent regulatory institution that was established in 1995.

In order to see that the distortions of market prices cause an over- consumption on regulated market, we will addressed the concept of economic efficiency (see Figure 4). Suppose that initially, under the free market arrangement (P_E – market price of electricity and P_{NE} – market price of non-electricity goods), an equilibrium consumption of electricity and non-electricity goods was defined at point A (NE_1, E_1). Let us assume that, following that fact, electricity industry was exposed to the

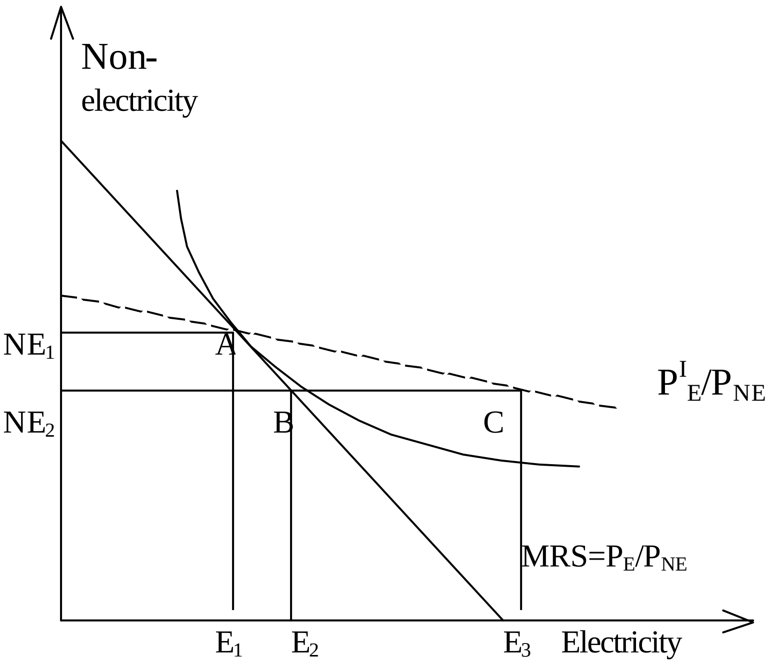

Figure 4. *Non-market price distortions*

regulation. As the result of this, electricity price reduced from P_E to P^I_E. After the introduction of this change, we could find that now the slope of new price level P^I_E/P_{NE} (at point B) becomes smaller than the MRS (at point C). Hence, it appears that electricity becomes cheaper and it appears beneficial to buy more of it than of non-electricity goods.

While consumer` s benefits of price ceiling policy are apparent, its overall impact on the economic system could be drastic. The most vivid example in this case could be Ukraine. While the required level of profitability of Ukrainian power energy sector is 20-25%, this figure has significantly reduced during 1990-1996. During this period profitability has decreased from 22.2% to 1.5% and then to minus 2.55% in 1997 (Kilnitzkiy 1997, 86). This severe fall stems most probably from the fact that the growth rate of fuel prices exceeded significantly the growth of power rates (prices) while the number of privileged consumers increased greatly while the source of their financing remained undefined and amounts of unpaid electricity bills accelerated. Then it appears quite natural to raise a question regarding the necessity of such regulation.

Following privatization, a Law “On Energy Conservation” was passed at the beginning of 1994. According to the information provided by Ministry of power engineering, this law, in particular, encourages investments in energy conservation measures that will improve technology of electricity supply, such as, for example, reduction of transportation costs and efficient use of fuel. Most of these investment incentives consist of embarked loans and credits. Hence, as can be seen, none of the demand-side management possibilities was mentioned either in the Law or kind intentions of the State Committee for Energy Conservation, which was created in 1995.

It appears, at least at the first sight, that it is not necessary to conserve electricity in Ukraine:

> “Ukrainian electric industry possesses 280-bln kWt/h capacities, but produces currently 170 bln kWt/h. Hence, it has generated over 100 bln kWt/h of energy reserves…In 2010, at most 210-220 bln kWt/h of energy will be needed” (Vlasenko 1998,6).

Nowadays, not strategic conservation, but only load shifting[12] only is needed in Ukraine. However, there is one important fact that cannot be skipped. By 2010 most of Ukrainian nuclear electric stations (NES) will exhaust their resource (Op. cit., 7).

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[12] Load shifting is one of the demand-side management policies that is aimed at the reduction of energy consumption during the daytime and shifting it to the late and early hours. This policy is carried out by the means of differentiated rate structure (daytime and night rates).

Another alarming fact is that NES constitute about 50% of Ukrainian installed capacities. Consequently, it becomes obvious that either a sound investment into the construction of new production facilities and/or into the promotion of energy efficient techniques or conservation of electricity will be needed in the nearest future. So, given these complicating restrictions, three possibilities can be evaluated: improvement of energy efficiency, reliance on imports of electricity from abroad and promotion of energy conservation.

Section 4. Analysis of energy conservation policies

Previous section, as an introductory part to the policy application, was dealing with Ukrainian practice in the field of energy conservation. It was shown that a heavily regulated electricity sector is only a precondition for implementing energy conservation policy. The most crucial condition that gives a push to its introduction is an inability of existing system to function further. And, as a result, the system is moved towards its further transformation.[13]

While comparing three policy options that were specified at the end of the previous section, we will leave aside the case of improving energy efficiency as the most obvious one. It is clear that the effect of this policy will depend mainly on the significance of technological invention that could actually have no impact, only a

partial impact or an outstanding impact that could compensate completely initial outcomes only in the remaining two cases - reliance on imports of electricity from abroad and promotion of energy conservation – assuming that technological improvement of energy efficiency is unfeasible at least for some short period of time.

In order to simplify this procedure, we will apply the same kind of analysis that was rigorously displayed by David Tarr in his article “Quantifying Second Best Effects in Grossly Distorted Markets: The Case of the Butter Market in Poland” (Tarr 1989). This framework appears the most convenient as far as its underlying assumptions are concerned:

- Controlled domestic prices

- Government subsidies to producers[14]
- Imports are allowed to cover the excess demand.

Additional assumptions to this model deal mainly with magnitudes of domestic rate (P_H), neighboring country` s rate (P_N) and world rate on electricity (P_W): $P_H<P_N<P_W$.[15]

Let us deal first with the reliance on imports of electricity (Figure 5).[16] The starting point of the analysis is a reduction in the supply of electricity from S_{UD} to S^I_{UD}. This change represents a shift in undistorted level of supply, while the corresponding dashed line reflects the same shift in distorted (subsidized) levels. As can be seen, this policy results in a loss of domestic consumers (MNPK) and producers (RQPN) welfare surpluses. Hence, the policy of imports` reliance leads to the unfavorable outcome for the whole home economy.

The same kind of analysis can be performed for the energy conservation policy (Figure 6). In that case we will start again with lower supply schedule S^I and will impose higher domestic rate P^I_H: $P_H<P^I_H<P_N$.[17] Under this policy option we expect that domestic producers will gain $TNP_HP^I_H$ due to the higher domestic electricity rates.

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[13] The above interpretation of a conservation practice represents a kind of consensus between proponents and opponents of energy conservation policies. And the whole thesis appears to follow this major guideline.

[14] In the reality, there are no direct subsidies to producers of electricity. Indeed, only privileged groups of consumers receive government subsidies. However, the payment mechanism is such that government `reimbursement` is paid to producers and, hence, can be considered as a subsidy to producers.

[15] We will also assume that domestic electricity rates are lower than market equilibrium rates as a result of regulation.

[16] As far as we deal now with end-of-the-pipe consumption of electricity, we will not treat the distributor of power energy as a natural monopolist. This stage of electricity production allows for a competitive arrangement. For that reason we will assume that the supply schedule for electricity is an upward sloping curve.

[17] P^I_H is supposed to be still lower than a market clearance price of electricity. Otherwise, increasing power rates will cause allocative inefficiency instead of its improvement.

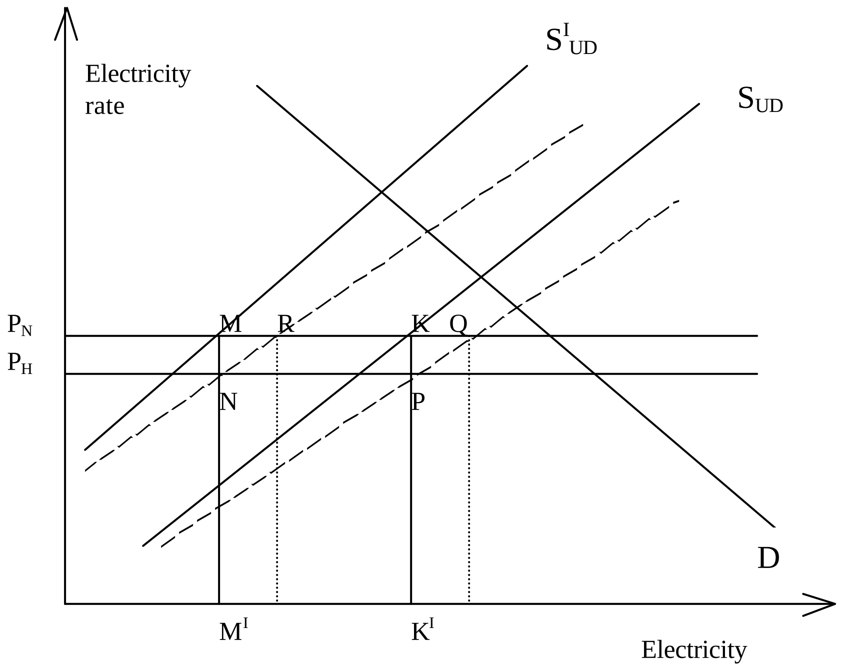

Figure 5. *Reduction of domestic supply: import expansion*

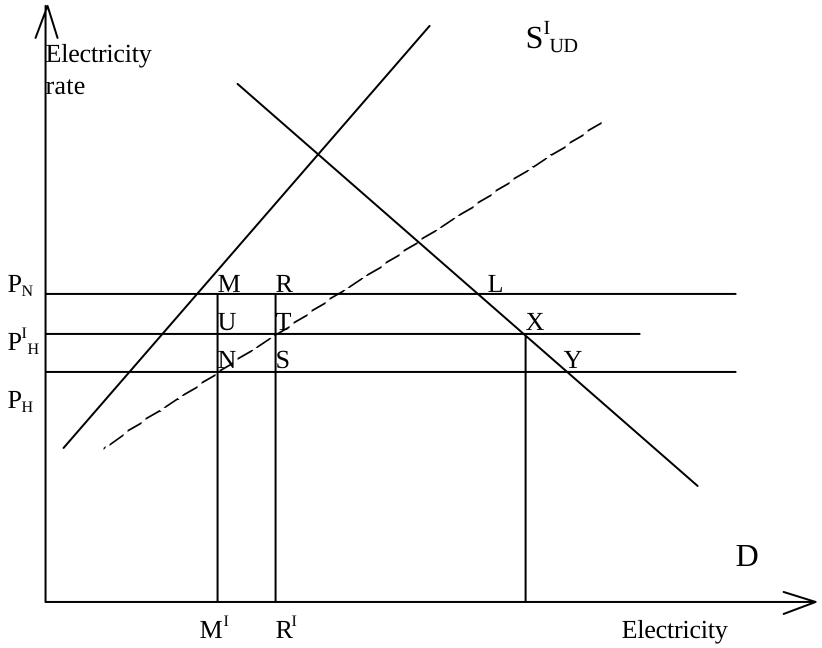

Figure 6. *Reduction of domestic supply: energy conservation*

Domestic consumers, however, will be expected to loose $TSP_HP^I_H$ because of higher domestic prices and to gain MRTP as a result of lower imports of electricity. The total impact of the policy could generate positive gains only if the square of rectangle MRTP will be greater than the square of triangle NST. Hence, it can be seen, that unless there is a sound investment in the renewal of electricity generation facilities, conservation of electricity could be considered as the best out of feasible policy options.

While referring to energy conservation, we can specify different stages of its implementation: generation, transmission and final (end-of-the-pipe) consumption. Clearly, it is important to introduce conservation/efficiency measures at the first two stages, however, the third of them appears to be crucially important. This situation is due to the fact that all efforts undertaken to improve energy efficiency could be diminished by inefficient end-of-the-pipe use of electricity. Hence, a demand side management acquires a leading role in promoting energy efficiency.

As defined previously, "demand-side management is a utility-based systems approach for the joint control of energy supply and energy efficiency measures" that "include load management, conservation, electrification, and strategic growth of market share" (Bjõrkqvist 1997, 26). The sphere of our particular interest is conservation. With this respect, we will analyze welfare consequences of increasing power rates (price-induced energy conservation) and will also examine outcomes of electricity rationing.

Let us start with a price-induced energy conservation (Figure 7). Let us assume that the target level of consumption is Q^I_D. At the beginning of this section we have already found that the net outcome of this policy is ambiguous (the sign depends on the difference between MRTP and NST). Now suppose that non-payments in the whole economy occur so that the demand curve for electricity moves up from D to D^I causing unpaid bills for electric power to arise ($XWQ_DQ^I_D$). As a result, domestic consumers are expected to loose KLVX due to the expansion of imports. Hence, the total impact of a price- per kWt*h an excess demand for electricity will appear. Due to this fact, induced energy conservation policy will be as follows: square of rectangle MRTP less sum of squares of triangle NST and rectangle KLVX. Rationing the total amount of electricity supplied (domestic supplies plus imports of electricity) until Q^I_D (Figure 8) will imply that at the price of P_H consumers will try to outbid each other and, consequently, electricity rates will rise till P^I_H.[18]

In the case of a demand schedule movement from D to D^I that is due to the non-payments, domestic price will rise till P_N and consumers will loose MNP_HP_N of their welfare because of a higher domestic price and KLVX because of a higher imports of electricity. At the same time, higher domestic prices will benefit producers by P_HNTRP_N. Hence, the net policy gain will be MNTR less KLVX that will total to TNP.

Allowing for a much higher amount of non-payments will lead to a greater expansion of demand for electricity. Let us suppose that now demand increases till D^{II}. In the case of a price-induced conservation, consumer losses are expected to be even higher

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[18] It is clear that in the case if domestic electricity rates will not be allowed to increase, amounts of electric power imports from abroad should increase to cover the gap between domestic supply and

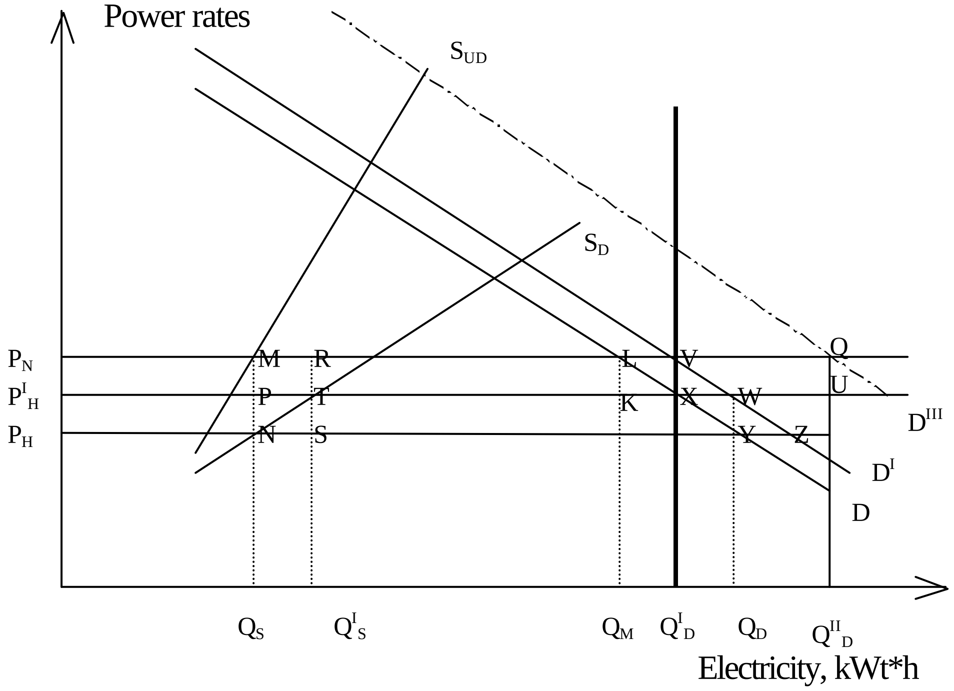

Figure 7 *The impact of non-payments on price-induced conservation policy*

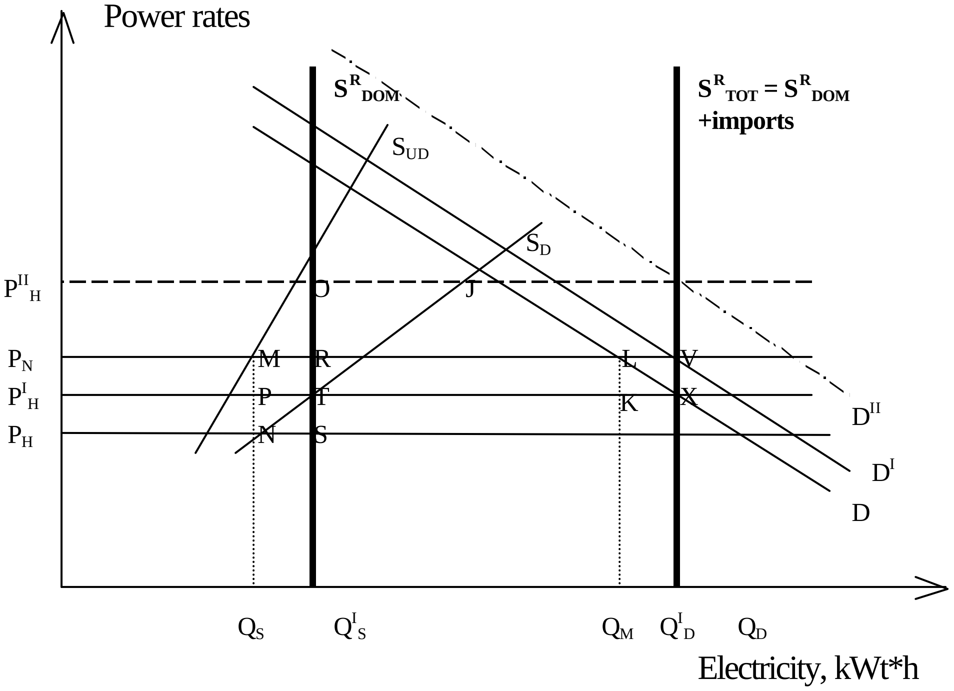

Figure 8. *The impact of non-payments on a conservation policy of rationing*

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demand.

– KLQU instead of KLVX – by QUXV (see Figure 7). Target level of consumption will be missed by the difference between $Q^{II}D$ and $Q^{I}D$.

On the other hand, demand expansion (from D^{I} to D^{II}) in the instance of rationing will cause domestic prices to rise till P^{II}_{H} instead of P^{I}_{H}. As a result, consumers will incur even more losses because of higher domestic prices (rectangles $P_{H}NMP_{N}$ and $P_{N}ROP^{II}_{H}$) and an increase of electricity imports from abroad (KLVX). At the same time producers will gain $P_{H}P^{II}_{H}OJ$, so that the total consumption (Q^{I}_{D}) will be preserved.

Hence, it can be seen that under a non-payments constraint rationing policy of energy conservation appears to be more consistent with its prior goals than its alternative – price-induced conservation. The former ensures that the target level of consumption (Q^{I}_{D}) is reached and also it produces the same amount of net policy gains (TNP). On the contrast, price-induced energy conservation produces higher net policy losses the higher non-payments in the economy are encountered and the higher the demand schedule is moved upward. Additionally, this type of energy conservation policy produces the amount of electricity consumption that is inconsistent with its target level.

It is necessary also to stress that so far no any other factor or reasoning was taken into the account. Accounting, for example, for the social consequences of each policy could apparently lead to a quite different policy ranking. It could be argued, as a matter of fact, that shutting consumers off the line is less desirable because it is ‘anti-human’. Therefore, non-payments will be allowed to exist even if in their absence it will be much easier to reach desirable goals.

CONCLUSIONS

The discussion of energy conservation issues usually starts with a questioning whether it is indeed needed. It is widely recognized that conservation forces individuals to consume less energy/electricity thereby making them worse off. While the logics of this argument is clear, in reality thing are much less obvious. That is, the exact outcome of any restrictive policy will still heavily depend on consumers` preferences and should be investigated further.

In 1990ties the most heated and discussible issue in the field of energy economics was a debate between proponents of energy conservation and of energy (conversion) efficiency. The essence of this dispute is as follows: energy conservation indeed is useless because, in the effect, it encourages technical improvements in the use of energy and even leads to the higher level of its consumption. It is impossible to disagree with this strong argument. Nevertheless, it should be clear that each policy, even the most popular one, has certain preconditions as well as limitations.

As a matter of fact, the adherents of these two points of view on energy and its efficient use have two different focuses of their theories. Conservationists care more about demand and consumption pattern, while their opponents stress the importance of a supply side. Hence, while discussing any kind of inefficiency along the whole line of electricity production process, it is natural to consider its later stages more carefully. It means, in particular, that even if efficiency is enforced along the supply side of electricity production, it could not guarantee that it still will be preserved on a demand side. Thus, as far as efficient use of electricity is considered, demand-side management becomes crucially important.

Technical problems with the implementation of energy conservation usually arise as a result of market failures: lack of information, riskiness of investments, long payback period and others. However, if efficient use of electricity (its allocative efficiency) is considered, it will be needed to address the issue of government failure such as, for example, price regulation and lack of contract enforcement. As we have already seen (section 2, Figure 4), economic regulation created distortions in the pattern of electricity consumption and low electricity rates encourage high consumption of electric power.

Conservation policy, as a rule, is focused on or leads to the increase of electricity rates and is expected to reduce excessively high level of electricity consumption. However, while encountering non-payments, the achievement of initially defined goals becomes increasingly complicated and actually can have unexpected outcomes. Arrears appear owing to the drawbacks of legal environment and then are ‘supported’ by a lack of contract enforcement. Non-payments spread over the whole economy and tend to generate a multiplier effect throughout different sectors. That is, being originated somewhere outside of electric power industry, they will result in acceleration of unpaid electricity bills and will, in their turn, affect, for example, coal and gas industries.

Referring to the efficient use of electricity, it can be easily seen (Figure 3) that non-payments bring us again to the inefficiency region. Initially, due to the government regulation, economy is located somewhere aside of Pareto optimal set of allocations. Then, following this situation, conservation comes into the effect allowing to move towards economic efficiency. This movement, however, is constrained by the interference of non-payments. Finally, instead of its efforts, economy is still left in inefficiency region.

A good illustration of all previously discussed issues is Ukraine. It possesses a rich regulatory practice that creates a favorable precondition for the excessive (inefficient) use of electricity. Also Ukraine is accustomed to the existence of a huge non-payments that appear to be purposely designed to maintain inefficiency in the use of electricity.

At the meantime, more attention is given to the technical side of a question. Low-quality fuel and its shortages, depreciation of equipment, high commercial losses of electricity in the network constitute the reality faced by Ukrainian power sector. Ukrainian officials, in their turn, recognize the problem of energy efficiency and are open to the introduction of technological modifications that will allow saving more energy. At the same time, less attention is given to the ability to raise funds for these projects.

Currently, Ukrainian power sector is able to satisfy existing demand for electricity. However, this problem will become more acute in the future because it is expected that its production (generating) capacities are going to be reduced by 40-50%. Then it will be impossible to cope with a problem only by the means of load shifting and more radical measures such as strategic conservation should be undertaken.

In this respect it should be clear that conservation should never be considered as the only goal along the path of improving energy efficiency. It is rather a short-term measure than a long-term goal and has to be combined with other activities such as investments in the renewal of existing capacities and technological development (innovations). However, in the absence of the last two options or their unfeasibility, energy (electricity) conservation appears to be a more attractive possibility if compared to the reliance on imports of electric power from abroad.

While choosing between the way of reaching the desired conservation outcome, two possibilities can be considered. One of them is a price-induced conservation. It consists in the increase of electricity rates till the target level of electricity consumption is achieved. Another option is a (direct) rationing that allows consumers to use only a predefined amount of electricity. By the way, this policy is frequently employed in Ukraine but in a slightly different context: inability to manage properly electricity network (to shift loads).

Both of these policies per se have the same welfare benefits and lead to the target level of electricity consumption. However, in the presence of non-payments both of them have different resulting effects. Price-induced policy will result in a higher than a target level of consumption. Hence, in comparison to the rationing policy, it appears to be less favorable. Nevertheless, rationing will also result in higher domestic electricity rates and given that the tendency of increasing power rates is restricted by local authorities, could actually lead to the same outcome as its alternative. Thus, keeping aside other evaluation criteria, such as, for example, social consequences, we can state that the first-best outcome is to implement a conservation policy having already got rid of non-payments. The second-best decision is to implement rationing of electricity supply and less favorable measure is to increase electricity rates while allowing for the non-payments.

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