ALLOCATION OF FREE ELECTRICITY TO COUNTER FUEL POVERTY: GOOD OR BAD POLICY?

AN ASSESSMENT OF THE FLEMISH EXAMPLE IN BELGUIM

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Abstract

This paper provides an assessment of the "free kWh" measure in the Flanders Region in Belgium. Much debate is ongoing between advocates and opponents of this measure. The main arguments in favor are that it stimulates energy savings and creates a redistribution in favor of the poor. In this paper, we investigate the validity of these arguments and the objectives initially formulated to motivate the introduction of the measure. We look in greater detail to the effects on consumption levels for an average household and explore the different financial transfers between households as well as to which extend these transfers contribute to a fair social redistribution in favor of the poor households. Our analysis shows that neither of the arguments used by proponents are entirely valid, the ecological objective is not necessarily met given the uncertainty and the household size is not a good social indicator for prosperity. A rejection of the measure seems appropriate since the measure furthermore has important other implications for the electricity market. We finally formulate some recommendations for the policy makers.

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1. Introduction

Energy becomes more expensive and more households experience an increasing energy bill. Because energy related costs have increased stronger than income levels in Flanders, these expenses continue to take a larger portion in the total expenditures. The Flanders Region in Belgium has one of the most extended social measures to cope with the increasing number of fuel poor households. One of the measures that should counter fuel poverty is the allocation of a free amount of electricity for **all** household, rich and poor. This paper provides an assessment of this "free kWh" measure. Much debate is ongoing between advocates and opponents of this measure. The main arguments in favor are that it stimulates energy savings and creates a redistribution in favor of the poor. Our analysis shows however that neither of these arguments are entirely valid and supports a rejection of the measure since it moreover has important other implications for the electricity market. We therefore recommend the policy makers to induce a wider debate and evaluation of the social and ecological energy policy. Moreover further research is needed and should include the evaluation of (potential) alternative measures that counter energy poverty and stimulate energy savings.

2. The free kWh measure

2.1. Legal framework

A Flemish law prescribes that, starting 1 January 2002[2], each household connected to the distribution grid in Flanders in principle[3] enjoys a *free*[4] amount of electricity, i.e. 100 kWh, each year. This amount is increased by 100 kWh for each member of the household that has his legal domicile corresponding with the address. For single access points with multiple households, such as certain apartment buildings or retirement homes, the free amount is calculated as: 100 kWh + 100 kWh per each person with a legal domicile in that building. The building manager has to divide the advantage over the different inhabitants of the building.

2.2. Practical implementation

In practice the "free amount of electricity" is **not for free** as the measure is financed by electricity consumers connected to the electricity distribution grid, i.e. households and SME's. Therefore, it has a **redistribution effect**. The Distribution System Operators (DSO's) inform the electricity suppliers about the number of inhabitants having a legal domicile on the corresponding address (by the 1st of April). Next, the suppliers subtract the free allocated amount of electricity as a discount on the yearly final invoice (on the first billing invoice after the 1st of May). The monetary equivalent of the free allocated amount of electricity is fixed for all suppliers and calculated by the Flemish Energy Regulator (VREG). The total subtracted amount on an invoice can never exceed the yearly consumption of electricity. Households consuming less than the allocated free amount of electricity, will not collect the full advantage of the measure. The suppliers can recover the costs from the Distribution System Operator (DSO) as the measure is imposed as a Public Service Obligation (PSO) on the DSO's. The DSO's include these costs in their distribution tariffs, paid by the households **and commercial clients** connected to the distribution network (cfr. infra) in function of their electricity consumption (c€/kWh), excluding the free volume of electricity. To put things in perspective, we mention here that the **volume** of **free electricity** amount **4.25%** [2] **to 4.5%**[10:25] of the **total volume** of electricity tapped off from the low-voltage distribution grid. If we only take the electricity use of households (on which the right of the free kWh discount applies) into account, the volume of free electricity takes about 8.2% [2:11] of the total volume consumed by the residential households.

However, in practice, **not all households** or household members are **reached** by the measure. The households that are not reached pay higher distribution tariffs due to the financing of the measure without taking the advantage of the measure to their benefit. (cfr. Section 6.4.)

We finally note that a yearly survey conducted by the VREG shows that 66% of the questioned households know about the existence of the measure[13]. This means that 34% of the households does not know the measure exists. Moreover, the same survey shows that much **misunderstanding** concerning the **financing** of the measure exists. For instance: more than 10% believes the measure is paid by the supplier and about 27% thinks the measure is financed by taxes. Only 37% of the households knows the measure is paid by the households themselves.

[2] Before this date, and after 22 December 1999, households received a free amount of electricity per household. The expansion for each household member was introduced in 2002.
[3] Not everyone receives the free amount of electricity, cfr. infra.
[4] The measure is financed by distribution tariffs imposed on all low voltage distribution grid users and is therefore not for free. Cfr. section 2.2.

2.3. The cost of the measure

The 'cost' of the measure, i.e. what is paid through the DSO's, amounted in 2010 about **118 million Euros**. For 2011, this amount is budgeted on 124.5 million Euros [10:24]. This number **excludes the administrative costs** (staff, ICT, administration…) borne by the DSO's, the suppliers, the ombudsman and the regulator. The administrative costs for the DSO's alone would amount 313 773 Euros in 2010 and 361 808 euro in 2011 [10:25]. A more outdated report [12] of the Flemish regulator for Energy (VREG) shows that suppliers and DSO's bear yearly costs amounting nearly 1 million Euros excluding the initial investment costs of nearly 1.36 million Euros due to the implementation of the measure.

However, in the following part of this paper, we will not take into account these additional administrative costs. We will however discuss the impact of this administrative burden under section 7.1. For the following part, we will only take into account the cost included as a PSO (about 125 million Euros) by the DSO's.

2.4. Net benefit for the households

Each household receives a monetary equivalent each year which can be deducted from the payment amount on the energy bill. Because other components (such as distribution tariffs) of the energy bill are also reduced to zero for the free amount of electricity, the calculation of the net benefit for each household type (i.e. number of family members) is very straightforward and given by the following formula:

$$\pi = (1+n) \times 100 \times p - \Delta p \times (q - ((1+n) \times 100)) \qquad \text{if } q > (1+n) \times 100$$
$$\pi = q \times p \qquad \text{if } q \leq (1+n) \times 100$$

Where π = net benefit
n = number of family members
p = the price of the free kWh's
Δp = difference in price due to PSO of the DSO
q = consumed kWh

Figure 1: formula net benefit household

The price of the free kWh's is fixed and published every year by the VREG. For 2011, the unit price of the free kWh amounted 0.15821 €/kWh. The price difference due to the additional PSO (Δp) is applied per kWh to all users of the low-voltage distribution grid (including SME and the residential 10% non-receivers of the discount; cfr. 6.4.). This figure varies[5] depending the consulted source. Eandis, the largest DSO in Flanders gives a number of 0.004667 €/kWh for 2011 [10:35]. The Belgian Federal Regulator of Energy (CREG) mentions 0.006744 €/kWh in his report [2] on the financing of the measure. We will take the latter number in our calculation. We further assume only one tariff is applied at any time and do not take into account for simplicity the dual (day-night) tariff that is widely applied[6] in Flanders [1:6].

Figure 2 shows the net benefit for each type of household (i.e. increasing number of members) based on the above formula. The reason why the curves start in the intersection of the horizontal and vertical axis is that households consuming less electricity than the free amount of electricity can only receive a discount that corresponds to their actual consumption. In other words, if one consumes less electricity than the free allocated amount, the difference is lost.

[5] A possible explanation of the difference is the amount of residential users in the work area of the DSO and the average amount of family members. The CREG used in his analysis the numbers provided by Imewo, a DSO under the working company of Eandis. The number provided by Eandis applies to an average Flemish household with 2 children consuming 3500 kWh yearly. Another explanation of the difference could be the corresponding year. The number of CREG applies to 2010 while the one of Eandis relates to 2011.

[6] About 1/3 of the Belgian households has a dual (day-night) meter. [1:6]

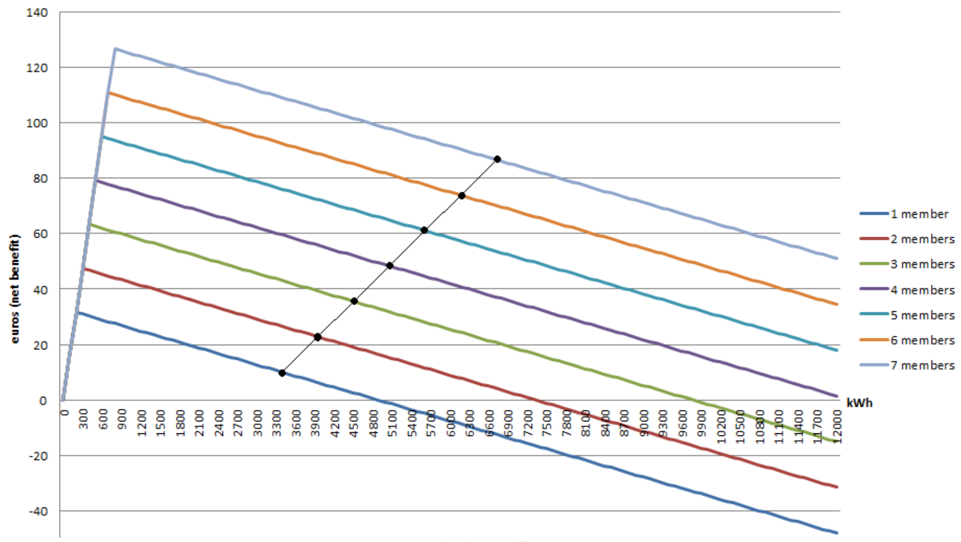

Figure 2: net benefit for different households

It is obvious that the larger the number of household members, the larger the net benefit, as was to be expected. The black line connecting the dots in figure 2 shows a possible approximation of average consumption levels for the different household sizes (cfr. infra; section 6.1.).

3. Assessment of the measure

Three objectives were initially mentioned by the Flemish government to motivate the measure:

- **(i) Security of supply**: "The free kWh guarantees a minimal right of electricity. Electricity is considered these days as an elementary utility good. By providing a free amount of electricity, a minimal supply of electricity during all times is guaranteed."
- **(ii) Energy savings**: "The free kWh stimulates rational energy use due to the relatively large advantage for households consuming little amounts of energy. The measure moreover creates a progressive tariff favoring small consumers."
- **(iii) Social redistribution**: "The free kWh is a social measure that favors the households with a low incomes and households with many children. The advantage of the free amount of electricity is relatively large for households with a low electricity consumption – which are mainly households with a low income – and for households with many children."

In the rest of this paper, we examine whether these three objectives that the government are fulfilled in reality. We furthermore point at some other side-effects. We end our paper with a conclusion and a set of policy recommendations.

4. Minimal supply objective

Concerning the minimal delivery objective (cfr. supra), we can briefly state the following. A fundamental difference exists between the service 'access to electricity' and the product 'electricity'[5]. The former relates both on the connection to the distribution grid and to the guaranty of uninterrupted delivery of power to vulnerable clients with payment difficulties. The uninterrupted delivery is well implemented in Flanders through the Public Service Obligations (PSO) of the Distribution System Operators (DSO) to counter energy poverty. For instance, households that do not pay their bills are dropped from their commercial supplier and delivered by the DSO that acts as social supplier. If the client is still not able to pay the bills, he or she gets a 'budget meter' installed that works with pre-payments. The clients can use a credit (over his charged budget) programmed in the meter. After that, the DSO can provide a 'minimum delivery' of power at 10 Ampere. The client cannot be disconnected during the winter period and can only be disconnected during the rest of the year after a co-decision of the social welfare workers (together with the DSO's). The free electricity measure does not counter energy poverty but rather handles fuel poverty by decreasing the price of electricity (for **all** households, poor and rich)[7].

[7] Although the measure is referred to as a fuel poverty measure, we will show that the price does not necessarily decreases due to the measure.

The opposite is also true. Giving a yearly amount of electricity for free does not mean that one cannot be disconnected from the grid. Access to the grid is thus not equal to access to electricity and free electricity does not mean guaranteed access to the grid.

5. Ecological objective[8]

In this section we will investigate whether the measure stimulates rational energy use due to the relatively large advantage for households consuming little amounts of energy.

5.1. The income effect and its impact on energy savings

As shown under section 2.4, households receive an advantage (i.e. discount) through the measure. The effect of this advantage is that the net income increases making an increase in consumption possible. Thus additional income may lead to additional electricity consumption contradicting the energy saving objective of the measure. However, empirical data show that this effect is not very large (cfr. infra).

Pepermans [6] shows in his analysis that the allocation of the yearly free amount of electricity corresponds with a benefit in kind. The consequences of benefits in kind are comparable with an income transfer. This is shown in the left panel of figure 3.

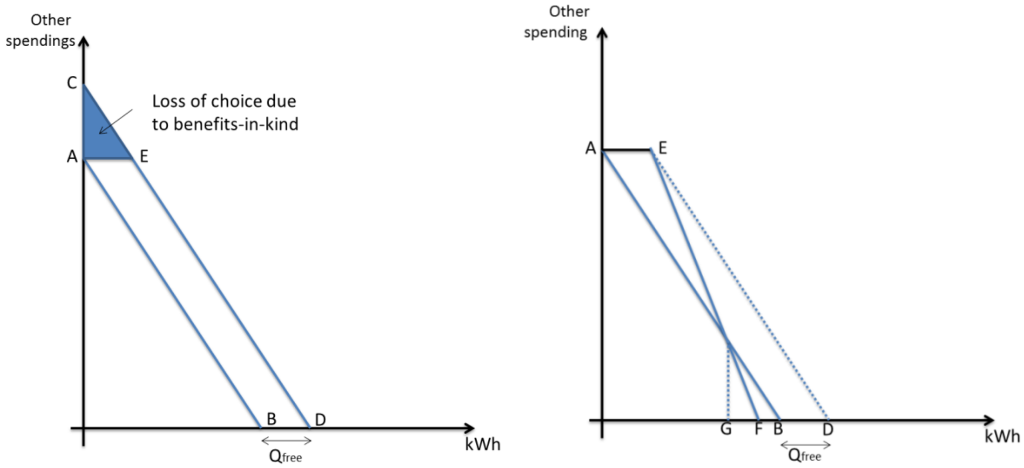

Figure 3: ***left*: Income effect: choice possibilities under income transfer and benefits-in-kind; *right*: price effect due to increase in price [6]**

Figure 3 shows the budget line and the impact of the measure on the budget line. Figure 4 uses a different framework to show the impact of the measure. Figure 4 consists of the demand-supply curve for electricity.

Let us first look at the budget line in the left panel of figure 3. Before the measure came into force, households were able to choose all combination (between electricity and other spending options) left of the line AB. After the measure takes effect, the income transfer (due to the benefits-of-kind) increases the choice options by the area AEDB. This is referred to as the **income effect** of the measure. The reason why the area ACE is not included is because the benefit in kind in the form of free electricity cannot be transferred to other spending options. If one does not use the benefit in kind, he will lose it. In figure 4, the price for electricity is given and not depending on the consumed volume for households, this is shown by curve S1. The income effect is shown by the shifting of the demand curve to the right. The free electricity creates an additional budget for the households to spend (shown by light blue area on figure 4). Part of this budget may be spent on electricity increasing the consumed volume of electricity. This is shown on figure 4 by the shift of the Demand curve from D1 to D2. As a result, electricity consumption increases from Q1 to Q2. This income effect corresponds with the first part of the formula in figure 1, i.e. $(1 + n) \times 100 \times p$, and is shown in figure 2 by the maximum of the curves for each household size.

The level of increase of the electricity use depends on the **income elasticity of electricity**. The income elasticity of electricity measures how much the electricity consumption would increase (in %) if income increases (with 1%). The shift of the demand curve in figure 4 depends on the income elasticity. The larger the elasticity, the larger the shift and the more the D2 curve will be shifted to the right compared to D1. Empirically, we have indications of the level of income elasticity provided by the National Statistical Institute (NIS[9]) of Belgium based on household

[8] This part of the paper is based on the analysis of Guido Pepermans, ([5] and [6]), researcher at the University of Leuven in Belgium, and the analysis made by Van Humbeeck and Bollen [7], staff members of the Social Economic Council of Flanders in Brussels.

[9] The NIS calculated the elasticity's based on the Huishoudbudgetenquête, a yearly survey measuring the expenditures of households. The 'huishoudbudgetenenquete (HBO)' is a yearly survey conducted by the Belgian *FPS Economy, SMEs, Self-Employed and Energy* since 1978 in

surveys. Income elasticity for electric heating would amount 1.3088[10] while income elasticity for other electricity spending amounts in the order of 0.4742 [7]. Because only 8.4% of the residential buildings use electricity as main heating medium in 2009 in Flanders [9], we assume elasticity's for electric heating as minor in our analysis.

5.2. Price effect and its impact on energy savings

The above discussed consumption effect would be correct if the price of electricity would not change, for example if the measure is financed by the treasury. In reality, the measure is financed through the distribution tariffs increasing the overall electricity price which discourages consumption. The costs of the measure are uniformly distributed over the remaining consumption (cfr. second part of formula in figure 1) which means that the price per kWh electricity will increase by x € (= Δp in figure 1). The more one consumes, the more unfavorable the measure is. This issue is referred to as the **price effect** of the measure. We illustrate this effect in the right panel of figure 3 and in figure 4.

The right panel of figure 3 shows that the slope of line ED changes to form line EF. Households will have to give up more 'other goods' per kWh of electricity. Because prices increase, people will decrease their electricity consumption (EF compared to ED on right panel of figure 3). In figure 4, the 'free electricity' measure increases the price for $Q>Q_{free}$ caused by the increase in the distribution tariffs forming S2. As a result, one would expect the volume would decrease from Q2 to Q3. Thus, the price effect stimulates energy savings.

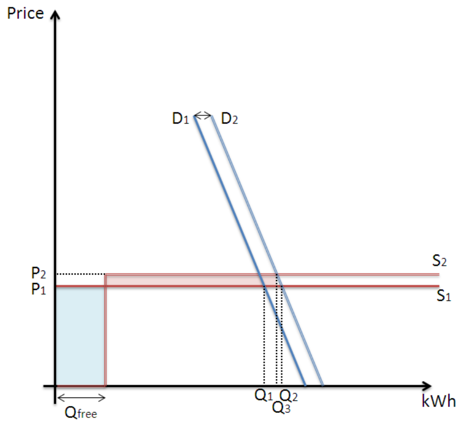

Figure 4: demand and supply curve electricity [7]

This decrease in consumption depends on the **price elasticity of electricity**. This is translated in the slopes of both the budget line in the right panel of figure 3 and the demand curve in figure 4. The change of slope of the budget line in figure 3 (EF compared to ED) depends on the price elasticity of electricity. The higher the price elasticity, the more the slope of the curve will change. The same holds for the slope of the demand curve in figure 4, i.e. the price elasticity of electricity determines the slope of the demand curve (D). The lower the price elasticity for electricity, the higher the slope of the curve and the lower the decrease in volume consumed if prices increase. Based on the same data provided by the NIS, price elasticity's of -0.05 for electric heating and -0.15 for other electricity expenses are found [7]. We may conclude that price elasticity for electricity is very low meaning electricity is a price inelastic good. We may further assume that both income and price elasticity's are low (< 1) although income elasticity is higher compared to price elasticity.

Advocates of the measure put forward that the measure would create a progressive tariff favoring small electricity consumers. We showed however that, whether a household will **consume more or less** compared with the situation without the measure, **depends on two things**[11]: (i) the *income effect* realizing an increase in electricity use and (ii) the *price effect* realizing a decrease in electricity use

These two effects counteract making the net-effect unclear which makes the measure less attractive as an energy savings measure. Moreover, the progressive character of the tariff is very small (only two tariffs of which the first one is 0). Mostly, one cannot reduce his consumption below the free kWh level and moreover, the increase in price for the remaining part is very limited. The progressive character of the price due to the measure will furthermore be

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which on average 3700 households (of which on average 1750 in Flanders) are extensively questioned concerning their expenditure behavior. E.g. [16] and [17]

[10] Meaning for an increase of 1% in income, the electricity consumption for heating purposes will increase with 1.3088%.

[11] We also point out that whether a household will consume more or less electricity after the measure came into force can also be seen in the right panel of figure 3. The cross-point of the budget lines (shown by point G) determines if a household will consume more or less electricity. If the household consumed more than G before the measure (located right from point G on the line AB toward point B), the household will consume less after the measure came into force. If, on the other hand (and which is more likely to be the case according to [6]), the household consumed less than G (located left from point G on the line AB towards point A), their electricity consumption would increase due to the measure. [5]

probably overcompensated by the income effect, certainly given the subsidization of the SME (cfr. infra) lowering the overall price. Pepermans [5] stated that one may assume that even though the price effect softens the income effect, overall consumption will increase probably due to the measure. **This contradicts the energy savings objective**.

5.3. Empirical data on rational energy use effects

Since the liberalization of the market, the VREG conducts yearly surveys for households and companies. Some of the questions relate to the free kWh measure. The energy savings effects are asked for as well. The results of the survey show that 70% of the questioned families say they have not used more nor less since the measure. 27% claim the measure stimulated them to consume less while a few families claim they started to consume more because a part is for free [11]. These results show that the energy savings effects of the measure are very limited. However, the results are based on perceptions of the families and not on actual consumption levels.

6. Social objective

As stated before, one of the main objectives of the measure is the social correction of the measure. The accompanying note of the minister mentioned that "the advantage of the free amount of electricity is relatively large for households with a low electricity consumption – which are mainly households with a low income – and for households with many children."

The social redistribution is caused by different transfers. More specific, the measure creates 3 types of transfer in the redistribution:

A: From small businesses and commercial clients to households

B: From large consumers to small consumers

C: From small families to large families

In the following part, we will discuss the different transfers and evaluate them, i.e. investigating if it concerns a justifiable social redistribution.

6.1. Financing of the measure: co-financing of SME's and households (A)

The measure is financed by all electricity users connected to the low-voltage distribution grid, including the SME. The CREG calculated that the **non-domestic clients contributed** for **51.62%** of the total **financing** of the measure[2]. The households, which received the free amount of electricity contributed for the remaining 48.38%.[12] However, a substantial part of the population (10%) does not receive the advantage while contributing to the costs. Thus, the SME's and 10% of the households contribute to the costs without taking an advantage to their benefit.

According to the above mentioned CREG-report, all households enjoy a net benefit corresponding to the measure. This is due to the large contribution of SME's, as the regulator has calculated. This is shown in figure 2 where the black curve connecting the dots and crossing the curves represents the average consumption for the different households as used in the study of the CREG. They assume in their calculation that the electricity consumption for households increases linearly with 550 kWh per additional household member starting at 3350 kWh for a single person household. The positive net benefit for each household size is clearly shown in figure 2 where all the crossing points of the black curve are situated in the positive section of the vertical axis. This means that 'on average' all households receive a net influx from the SME due to the redistribution caused by the measure. The larger the number of family members, the larger the net benefit for the household. This is already shown on figure 2. Although the CREG-analysis gives interesting insights on the financing of the measure, we formulate some remarks on the analysis.

First of all, it is **not certain** that **all families** win a net **advantage**. This is due to the large variation in energy costs between the families of the same size. The problem with the above (e.g. the black dotted in figure 2) analyses is the use of **averages**. Behind averages, massive **variance** can shelter. Unfortunately, no data is available to point out the level of variance. However, following illustrative example shows that large variations are possible and occur.

Household A consists of 2 retired persons that receive a relatively small welfare allowance. Furthermore, they live in an over-dimensioned flat which is poorly insulated and make use of electric heating and cooking. Moreover, because of their relatively low income, they make use of old and non-efficient appliances. Because of their

[12] This conclusion contradicts the figures given in [11]. This report states that SME-users of the low-voltage grid consume 30% of the total volume and therefore contribute for 30% to the 'costs' of the measure.

retirement, they will stay most of the time at home, making use of electric appliances when needed and desired. Household B on the contrary, exists of 2 full time working young adults. Because of their relatively high income, they own a relatively energy efficient house with good insulation levels and efficient electric appliances. Moreover, household B invested in solar panels that produce part of their electricity consumption. The difference in electricity consumption (and income in this case) between the two illustrative households is very large while both do receive 300 kWh for free.

An illustration of simplifying and misleading conclusions based on averages is the following recent statement of the Flemish minister of Energy: "*an average household contributes for €30 to the measure while enjoying a net benefit of €50*" [4]

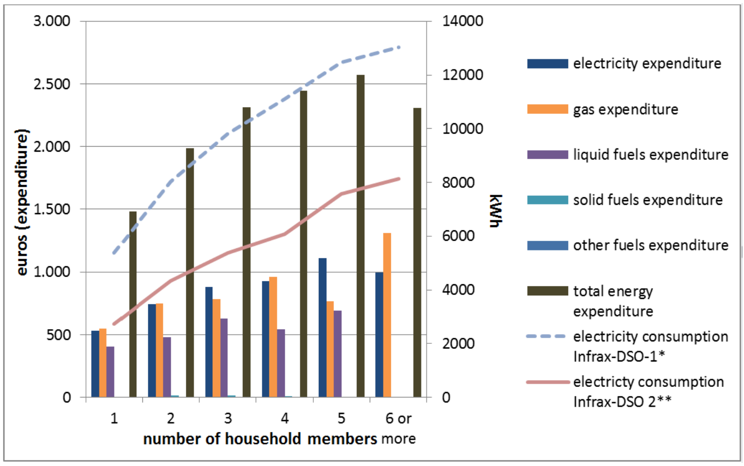

Figure 5: energy expenditure and electricity consumption (source: expenditures: [17]; consumption: Infrax-DSO[13])

A second remark concerns the assumed linearly increasing average consumption curve (see figure 2) which seems too simplistic and non-realistic. We may agree that consumption does increase as the household gets larger, but a linear increase does not take into account the **economies of scale**. Larger families can 'share'[14] a larger part of their consumption, which is confirmed by figure 5. Because data on electricity consumption in function of household size is not available, the comparison of the **electricity expenditures** for the different household sizes does only give us a cautious approximation of the difference in electricity consumption. Expenditures are not equal to consumption and depend on the price as well. Given that the market is liberalized and prices may differ[15] significantly between suppliers, we cannot extract the electricity consumption based on the electricity costs. Moreover, looking at just the electricity consumption may give biased conclusions. The different energy carriers are substitutes to a certain part, especially for heating purposes. One may cook using electrically or gas. Heating can be obtained by using solid fuels (such as coal or biomass), liquid fuels (such diesel fuel), gas or electricity. Given the large part heating takes in the energy consumption of households in Flanders (70 to75% of the total kWh consumed for space heating [3:17]), it may be well interesting to look at the different energy carriers together. When total energy expenditures are considered, these expenditures tend to rise digressively with growing family sizes. This digressive increase is confirmed for exclusive electricity consumption by numbers provided by Infrax, a Flemish DSO (see full and dotted line in figure 5). These approximations by the DSO of electricity consumptions per household size have their limitations (as explained in footnote 13). Lastly, although this paragraph contradicts the simplistic assumption of linear increase of consumption, the same criticism concerning averages applies here as well.

Although the first transfer (A) from SME's to households is explained above, it is not questioned in this paper. It may be a choice of policy makers to induce transfers from companies and commercial clients to households. One option could be through their energy bills. This discussion is not addressed here. We are more interested in the transfers between households. These will be discussed in the following sections. However, one may wonder if the

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[13] The curves in figure 5 are obtained by an active DSO in Flanders of which the working area corresponds with 20% of the Flanders Region. The numbers should be used with appropriate care. The dotted curve is the electricity consumption of all access point on the distribution grid, including non-residential clients with sometimes consumption levels up to a few 100.000 kWh such as bakeries. The dotted line is therefore seriously overestimated but does include all clients in the working region of the DSO. It does however show a digressive rising curve. The full line, on the other hand, does only include residential electricity consumption (excluding households with solar panel and private production). The disadvantage of this curve is that it only includes a limited sample of 4610 access points in a medium sized municipality (Lummen) which may be biased. Both lines should therefore be used carefully.

[14] For example: more members can watch TV together, diner together using one light source, wash their clothes together …

[15] See the V-test provided by the Flemish Regulator for Energy which allows comparing the prices for the different suppliers. http://www.vreg.be/vergelijk-doe-de-v-test-en-vind-uw-ideale-leverancier

spending of about 60 million Euros[16] from SME's towards households is the best way to realize energy savings and the aimed social effects.

6.2. Relation between income level and energy consumption (B)

As shown before, the lower the consumption, the lower the contribution to the financing of the measure (cfr. second part of the formula in figure 1). Given that low income families consume small amounts of energy, this would mean that low income families would contribute relatively little to the financing which justifies the measure. The Flemish minister of energy recently stated in defense of the free electricity measure that "in any case a strong correlation between the amount of energy consumed and the family income exists"[4]. Intuitively, one may counter this statement by referring to the fact that low income families may inhabit poor quality housing units with low insulation levels and may use old and energy consuming appliances. The minister and other advocates of the measure reply to that statement by pointing to the fact that low income families have much less appliances than high-income families. Data analysis is required to gain more evidence on the relation.

Connecting income levels with electricity (or energy) consumption is not obvious. Data from the DSO's (which on itself is difficult to gather) should be connected to an income database which is not done today. What can be done is linking family income with energy expenditure provided by the annual surveys. The most recent found data is shown in table 1.

Average household expenditure (euro)	**Flemish region**	**Quartile 1**	**Quartile 2**	**Quartile 3**	**Quartile 4**
Body care	669	366	590	765	953
Communication	898	532	826	1070	1163
Other	1353	702	905	1481	2320
Health	1583	1169	1531	1677	1953
Clothes, shoes	1592	653	1028	1762	2920
Financial services, assurances	1675	1057	1538	1914	2192
Heating, lighting and water	***1852***	***1680***	***1548***	***2019***	***2161***
Touristic travel	1915	728	1740	2234	2954
Horeca	1940	1177	1659	2288	2633
Furniture, household equipment, garden	2115	1119	1650	2346	3339
Culture and leisure	2489	1196	1917	2935	3905
Transport	4582	1992	4129	5064	7132
Food, drinks, tobacco	5218	3364	4394	5853	7255
Rent and estimated equivalent rent for home owners	6193	4683	5665	6499	7917
Total consumption	34075	20419	29121	37907	48796

Table 1: average household expenditure per income quartile for Flanders 2008 [16]

Table 1 shows that the above mentioned statement that low income families consume less energy is not always valid. The table shows that families from the second income quartile consume on average less energy (and water)[17] than the families from the first income quartile.[18] Furthermore, it is interesting to note that for all other expenditure categories, the expenditures increase with increasing income. Only energy (and water) expenditures decrease in the second quartile. A possible explanation could be that the families in the lowest income quartile inhabit housing units with minor quality or use non-efficient appliances. It may also be caused by occupation or behavior aspects. Low income families may consist (partly) of unemployed or ill persons staying for a largest part at home and possible consuming more energy. People with a disease may furthermore require specific and energy consuming equipment. A well-known fact is however, that the higher the income, the more one can invest in energy efficiency. Furthermore, high income families may invest in their own energy production (solar energy as most obvious example) as well, decreasing the energy expenditures. It should be noted that households with their own power production have a low net power consumption. The distribution tariffs only apply to the this net consumption. This means households with own renewable electricity production have a relatively small contribution in the financing of the measure (cfr. 7.3.).

[16] This number is obtained by multiplying 51.62% (volume of non-residential consumption contributing to the measure in 2010 [2]) with 124.5 million Euros (budgeted PSO for 2011 [11])

[17] Water expenses amount on average only 10% of the total energy and water expenditures. The remaining 90% consists of energy expenditure. [17]

[18] It would be more correct to say: families from income quartile 2 have lower energy expenditures compared to families from income quartile 1. Lower expenditure does not necessarily coincide with lower consumption. Average prices may differ and create a bias.

To summarize: energy efficient consumers[19] win most but are not necessarily the lowest income groups. Although there is no information available on the relation between mean income level and mean energy (and electricity) consumption, we however showed that the often assumed positive correlation between income and energy consumption is not necessarily true. During the writing of this paper, research with updated data (year 2011) is ongoing. The provided data is gathered in function of the EU-SILC[20] survey and allows the linking of energy expenditures with income levels to calculate the correlation. Unfortunately the data is not available yet during this writing.

6.3. Relation between income level and household size (C)

The main research question in this section is whether **family size** is a good social indicator to measure prosperity and financial capacity of a family. In other words, is the use of family size as an allocation key justifiable? We will show that the summing of the number of family members is **not a good indicator** to measure the prosperity of a family. Each household size contains rich and poor families and the number of family members does not give any insight into that matter.

A much used misconception is that large families are relatively poor compared to families with no or few children. This would justify the transfer from small families to large families. Large families receive more free electricity (see figure 2) compared to small families. If we take the net benefits from figure 2 and divide that by the number of household members (for the assumed average consumption as defined by the CREG) we even notice a (small) increase per family member for rising family sizes. Although the additional free amount of electricity per household contributes larger for small households than large households, it is overcompensated by the economies of scale for energy consumption that applies for larger households. Certainly if one takes into account a digressive rising curve (cfr. supra).

The transfer from small to large families is also shown in table 2. Table 2 shows both the share each household size takes in the population and the share each household size takes in the total net benefit according to the CREG-analysis[21] [2: 15].

Size	*1*	*2*	*3*	*4*	*5*	*6 or more*
share of population	29.92%	34.24%	15.64%	13.64%	4.67%	1.89%
net benefit share	18%	30%	19%	20%	8%	4%

Table 2: share of population and share of net benefit [17] and [2]

The above table shows that the transfer flows from relatively small households (1 to 2 members) to relatively large households (3+ members). The table also shows that most households in Flanders are relatively small (1 to 3 sized households take up to 78% of the total).

In the following, we will explore if the number of household members is a good indicator for the prosperity and financial capacity of a family.

Size	*1*	*2*	*3*	*4*	*5*	*6 or more*
net available income	€ 18.593,89	€ 33.791,70	€ 44.872,69	€ 55.720,19	€ 57.257,47	€ 55.755,06
energy and water expenditure	€ 1.477,87	€ 2.090,55	€ 2.346,10	€ 2.668,06	€ 2.739,06	€ 3.172,89
fuel poverty indicator	7,95%	6,19%	5,23%	4,79%	4,78%	5,69%

Table 3: net income and energy (and water) expenditure for different family sizes in Flanders [15]

The data in table 3 is obtained from the EU-SILC survey and relate to the situation in Flanders Region. The table shows the different income levels for rising family sizes. It is clear that the statement that large households are relatively poor is not valid. The opposite seems true. This trend is also clearly shown in figure 6. Income levels rise digressively with family size and only decrease again for very large families (6 and more). To put things in more perspective, we included the energy (and water)[22] expenditures for the different family sizes as well. If we divide both, we obtain an indicator for fuel poverty. As may be seen in figure 6, the smallest families are relatively most vulnerable to fuel poverty by spending relatively the largest part of their income on energy. Fuel poverty decreases with rising family sizes but starts to increase again for very large families (6 or more members). However, as table 2

[19] Or consumers with green power production having low net power consumption.
[20] EU-SILC stands for *EU statistics on income and living conditions*. It is an annual survey conducted in all member states of the European Union. For Flanders, about 6000 households are questioned every year.
[21] The results of the CREG-analysis should be nuanced as shown in the remarks under "6.1. Financing of the measure"
[22] Water expenses amount on average only 10% of the total energy and water expenditures. The remaining 90% consists of energy expenditure. [17]

shows, less than 2% of the Flemish population consists of households with 6 or more members making this group marginally small.

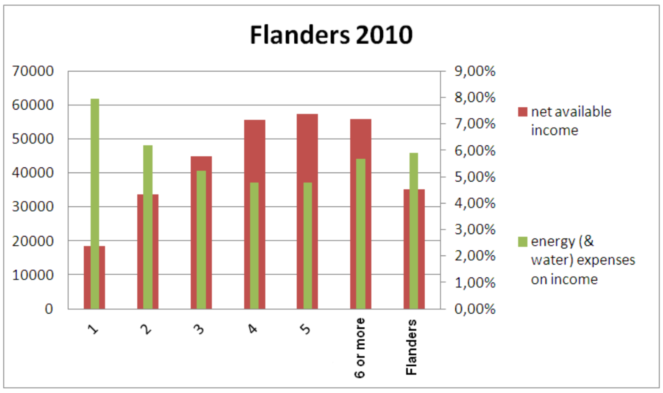

Figure 6: net available income and fuel poverty approximation [15]

Concerning the last transfer (C), we may thus state that large households win most, but do not correspond necessary with the lowest income groups. A transfer from small to large families seems therefore not justifiable, certainly not if a social objective is aimed for. In the following frame, we will discuss in greater detail why the use of family size as an indicator for social redistribution should be rejected.

Family size: good social indicator?

a. Averages hide the spread

First of all, although the relation between family size and net available income seems positive, it does not take into account the variances behind the averages used per family size. A family member could be full time working or a little child. This has different implications on the net available income of the family. The **first shortcoming** is the lack of taking into account the already mentioned **variance** within a specific household size. This aspect is shown in the figure below.

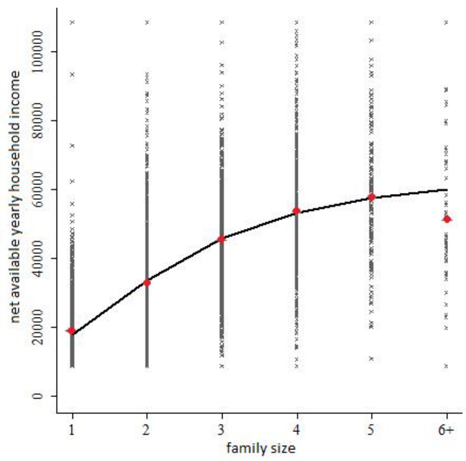

Figure 7: net available income per household size, average and spread [8][23]

The averages are shown in figure 7 by the red dots and the variance is shown by the vertical black lines. The thicker the line is, the more families. The black line connecting the vertical lines is the regression line of *all* observations in the data (not of the averages). The correlation between net available income and family size is positive and significant[24]. The variance is however very large and means that in Flanders, al family sizes have very rich and very poor families. The free electricity measure is to blind and does not take this variance into account. Moreover, the measure is applied for **all** families, without differentiating to income levels.

A more interesting division instead of family members would be the **classification** that is used for the **EU-SILC survey**. This classification does take into account family composition and is shown in the right part of figure 8. Figure 8 shows multiple trends: (i) firstly, the share of the different household types in the total population are shown (horizontal axis); (ii) secondly, an indicator for fuel poverty, i.e. the proportion of energy (and water) expenses in the total available income, is shown for the different household type and (iii) finally, the number of the household members for each household type is shown between brackets.

[23] Figure 7 uses the same source (EU-SILC survey) as the above analysis but does relate to a different year, the year 2009 [15].
[24] characteristics: $r = 0{,}58$ and $p < 0.05$

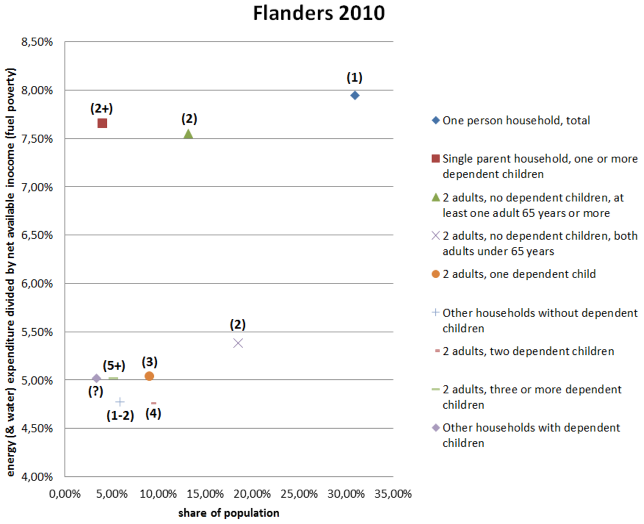

Figure 8: share of population and fuel poverty indicator according to EU-SILC classification [15]

Figure 8 allows us to conclude the following:

- By looking at the vertical dimension of the graph, it becomes clear that smaller households are relatively higher ranked on the graph meaning they have the highest risk of fuel poverty. This is in line with the above discussed figure 6. This counters the justification for the transfer from small to large households.
- More interesting, however, is that household sizes are somewhat intermixed with each other. Put differently, some small households have low fuel poverty risks and some large households have high fuel poverty risks. The opposite is true as well (cfr. supra). This explains partly the above mentioned variance within the same household size.

If we look at the share within the population, we observe that the most **problematic** household type which needs the most attention is the **one person household**. This household size is the smallest possible, takes the largest part of the population (30%) and has the highest fuel poverty risk of the below shown categories. This seems inconsistent and even opposite to the statement that transfers from the small to large families is justifiable.

b. Economies of scale and standardized income

However, the above numbers and analysis deal with net available income which has its shortcomings[25]. Larger families seem to have larger income levels but need to divide the income between a larger group. A **second shortcoming** relates to the **economies of scale**. The fact that larger families have larger incomes is logical: the more individuals with an income (how small it may be), the larger the collective income that can be used by the family. The economies of scale does not only imply the clustering of incomes but includes the sharing of expenses (e.g. rent, heating, electricity, etc.) as well. To correct the aspects related to the economies of scale, the '**standardized incomes**[26]' are used. This is the net available income on yearly basis corrected for family size and composition. This is shown in figure 9.

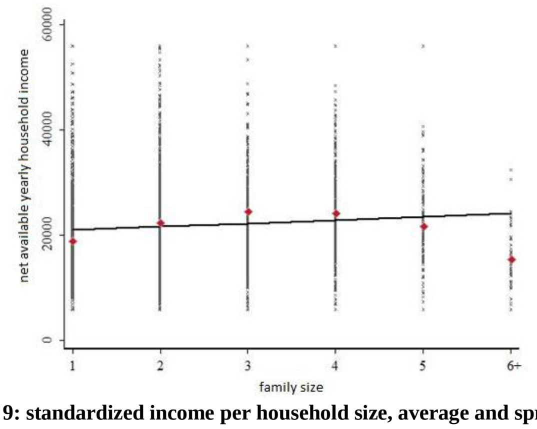

Figure 9: standardized income per household size, average and spread [8]

If we use standardized incomes, the relation between standardized incomes and family size vanishes[27]. We can no longer state that the available income increases with family size. We can only state that the prosperity is the weakest for the smallest and largest families, although much variance lies behind the averages (which are shown as red bullets on the figure). Here

[25] We would like to thank Wim Van Lancker from the *Centre for Social Policy Herman Deleeck* (University of Antwerp) for providing us with the following analysis. He used EU-SILC 2009 data for Flanders.

[26] Income is standardized according to the internationally used modified OECD-scale. Household income is standardized as follows: the first adult gets a full weight of 1, the other adults are multiplied with the weight factor 0.5. Each child up to 14 years is multiplies with a factor 0.3.These weight factors are summed to form the equivalence factor. The available income is then divided by this equivalence factor.

[27] characteristics: $r = 0.04$ and $p < 0.05$

again, we can state that the free electricity measure is too blind for social redistribution.

c. Employment and children

The **third shortcoming** concerns the lack of taking the role of household types and **employment** into account. As mentioned before, a household consisting of 2 retired persons has different prosperity aspects compared to a household consisting of 2 full time employed adults. Employment is of crucial importance as we will show in the table 4. Pensioners are compared with households with active workforce members (a family with at least one adult between 18 and 64 years) where the latter category is further split in unemployed families and families with at least one adult actively working.

Family size	*Pensioners*	*Active workforce*	
		Unemployed	*Employed*
1	15.429	15.784	23.413
2	16.922	18.038	27.075
3		14.797	24.925
4+		13.782	22.390

Table 4: illustration of the influence of employment on income (standardized incomes levels).[8]

The relation for pensioners is not very strong[28]. In general, when two pensioners live together, their financial capacity is larger than when they live alone. For households with active workforce members there is no significant relation between size and income[29]. The financial capacity is the largest for two member households and decreases as more family members are added, for both employed and unemployed families. This is probably driven by the presence of children (cfr. infra). An important conclusion following from table 3 is that the prosperity level of pensioners and unemployed families is much lower than that of families with active working members, regardless the family size. This is a partial explanation of the observed variance within the same family size in figure 8. The free electricity measure again fails to tackle this issue.

The **fourth** and last discussed **shortcoming** is the blindness for the impact of **children**. Table 5 shows that the relation between the available income and the number of children is negative[30].

Number of children	*Single parent family*	*Couple*
0	20.442	25.138
1	16.702	24.134
2	15.965	23.259
3+	14.989	19.783

Table 5: illustration of the influence of children on income (standardized incomes levels). [8]

The above table shows 2 important things: (i) the financial capacity of single parent families is significantly lower than that of couples and (ii) the financial capacity decreases with rising number of children for both household types. When looking at the number of household members, it is therefore important to explore if these family members are adults that can contribute to the family income or rather children that rather correspond (monetarily) to a cost. The free electricity measure fails partly to take this into account. It does give higher compensations for larger families, often meaning more children, but does not look in further detail how that family is composed. For instance, a single parent family with 2 children (yearly average standardized income: 15 965 €) will receive the same amount as a couple with one child (yearly average standardized income: 24 134 €).

To conclude, we may state that the above analysis clearly show that the summing of the number of family members is **not a good indicator** to measure the prosperity of a family. Each household size contains rich and poor families and the number of family members does not give any insight in that matter.

6.4. Range of the measure

About 10% of the people that should receive the discount miss it. [11:23]. The main reason for the mismatch is **inaccurate data** on the number of household member on each access point. Especially household removals between 1 January, the closing date for information on household size,[31] and 15 April, the reference date to allocate the free electricity[32], cause a large part of this mismatch. In that regard, it should be noted that **poor households**, which move relatively more and are in most need of the measure, miss the measure more often. The part of the population that don’t receive the advantage contribute nevertheless to the measure by paying higher distribution tariffs which is applied to all consumers.

[28] characteristics: $r = 0.10$ and $p < 0.05$
[29] Characteristics: $r = -0.01$, $p > 0.05$
[30] Characteristics: $r = -0.14$, $p < 0.05$
[31] Date when data is collected from the National Register (to figure out the number of domiciles on the specific address)
[32] Date that the DSO have to provide the data to the suppliers which then can calculate the discount (that he reclaims from the DSO later)

7. Other effects of the measure

The measure also causes other effects that would not be realized with other and more effective measures. We sum a few.

7.1. Effects on competition

Due to this additional administrative cost (cfr. section 1.4.), we can state that the measure does have an impact on small and new suppliers that enter or entered the Flemish market. This is confirmed by the survey conducted by the VREG questioning the suppliers about the costs related to the measure. The figures show that the average cost per client is significantly lower for the historical and large (incumbent) supplier compared to the new suppliers [12]. This points out that the economies of scale favor the large and historical supplier. Another issue is the burden on data management that is required to allocate the correct number of free kWh. Moreover, if suppliers would acquire direct entrance to the National Register to counter the above mentioned mismatching problems (cfr. section 6.4), additional requirements concerning privacy and protection measures will be imposed by the Privacy Commission. These additional protection measures mean additional financial and organizational burdens that small suppliers possibly cannot bear. Problems will furthermore primary happen with new suppliers which can damage their image which can have an impact on the switching behavior of the clients. The measure thus has a negative impact on the competition in the market disfavoring small and new entrants. Finally we note that not only new and small suppliers undergo negative effects of the measure. The regulator has to invest a lot of time in dealing with complaints[33] about the measure (e.g. people that have not received the free kWh's). This jeopardizes the regulators capacity and creates a shift from real regulating tasks endangering a proper market functioning.

7.2. Effects on renewable energy development

The measure can also have implications on the renewable energy development. Because households with intentions to install solar panels on their roofs would not be willing to miss using the advantage of the measure to their benefit, they use their yearly electricity consumption **excluding the free amount of electricity** as a reference for the capacity planning of their solar panels. If the free kWh measure would be cancelled, the PV-production will not be sufficient to meet the yearly consumption. As a result, the available roofs are not optimally used leaving a non used potential that might be needed to counter the renewable energy objectives in the long term.

7.3. The Matthew effect

Because financing through distribution tariffs is chosen, some perverse effects may occur. In Flanders, much discussion is ongoing on the financing of renewable energy. Solar energy production is highly subsidized and partly[34] financed by the DSO's through PSO. The controversy relates to the transfer from those that don't have solar panels to those that have solar panels on their roofs. The latter have small net electricity consumption (cfr. the "q" in part to of the formula in figure 1) and as a result don't pay much distribution costs. The regular clients have relatively high consumption levels on which they pay distribution costs. Thus, the impression exists that the *poor* that can't afford solar panels pay for the subsidies of the *rich* neighbor that is wealthy enough to buy solar panels. This Matthew effect[35] is strengthened by the free kWh measure and other PSO[36] that are included in the distribution tariffs. The households with solar panels and low consumption levels have low contribution levels for the measure making the net benefit of the measure high.

8. Conclusions and recommendations

Although much debate is ongoing between advocates and opponents of the free kWh measure, most arguments used by the promoters are not (entirely) valid. The main arguments in favor are that it stimulates energy savings and creates a redistribution in favor of the poor. Moreover, the measure would maintain a minimal delivery of electricity. However, access to the grid is not equal to access to electricity and free electricity does not mean guaranteed access

[33] The VREG provided us with the following information: for the year 2011, 86 complaints were deposited concerning the free kWh measure. In 2012, until June, 50 complaints have been received. Most complaints take about 30 min processing time while some complex complaints easily require 1.5 hours of processing. Moreover, suppliers appeal to the regulator as well concerning questions whether specific cases have the right to receive the discount. The regulator also has to process many questions about the measure posed by citizens. In 2012 (only January to July), 344 questions have been recorded and processed consuming large amounts of time.

[34] The difference between the market price of green certificates and the minimum subsidy for solar energy.

[35] The Matthew effect refers to saying: the rich get richer while the poor get poorer. In this context it means the poor finance the subsidies for the rich.

[36] The numbers provided by Eandis (largest DSO group in Flanders) [10:35] in 2011 show that the PSO for the financing of the certificates for green power in the distribution net tariffs amounted about 4 times as much as the PSO for the financing of the free kWh measure for an average household. This number is an underestimation given the increased number of installed PV-panels since the moment of the calculation and the very large amount of certificates that DSO's keep ("banking") in their possession because selling on the market is not opportune provided the estimated surplus of certificates on the market amounting 2.1 million. Thus, the above mentioned proportion of 4 on 1 is an underestimation of the real number.

to the grid. Concerning the energy savings objective, we showed that whether a household will consume more or less compared with the situation without the measure, depends on both the income effect that increases the electricity consumption and the price effect that decreases the electricity consumption. These two effects counteract making the net-effect unclear. The social redistribution objective depends on two transfers, from large consumers to small consumers and from small households to large households. We showed that energy efficient consumers indeed win most but do not necessarily correspond to the lowest income groups. The often assumed positive correlation between income and energy consumption is not necessarily true. The transfer from small to large households fails to contribute to a fair social redistribution. We showed that summing the number of family members is not a good indicator to measure the prosperity of a family. Each household size contains rich and poor families and the number of family members does not give any insight in that matter. Moreover, the most problematic household requiring the most attention is the one person household: the smallest possible household that takes the largest part of the population and has the highest fuel poverty risk. Another social issue is that 10% of the population does not receive the measure, probably being the vulnerable and poor households that generally move often. Finally we pointed out that the measure has important other implications for the electricity market such as the competition. Given the analysis in this paper, we support a **rejection of the measure** and formulate the following **recommendations** for the policy makers.

8.1. Wider debate required

The measure needs a wider evaluation fed by a broad debate. The debate needs to take place based on data and not prejudices. The debate should include how energy savings policy needs to be shaped as well as the wider debate on how to counter the fuel-poverty problem. On both domains, a vision is required (and still missing today) for Flanders.

8.2. Further research is needed

As noted before, more data and research is required on the relation between income and consumption level. A widespread accepted assumption is that people in poverty consume less energy. We have shown that this is not necessary true but failed in showing advanced data analysis linking energy (and electricity more specific) use with income levels. As mentioned before under section 6.2., research on this matter is ongoing.

A correct evaluation of the free kWh measure should include a **coupling** of the **energy use** and **income data** on household level (taking family sizes into account) to investigate the impact of the measure on the social redistribution of financial flows. This way, the variance in income levels and energy consumption is included to provide a clear insight on flows between households. A simulation model[37] can be used and may show for instance the average gain by income decile, the change in numbers of people in poverty and the change in income inequality (Gini-coefficient) due to a policy measure.

8.3. Evaluation of alternatives is needed

Other and probably better **alternatives** can be adopted to **stimulate energy savings**. These alternatives should be included in the evaluation of alternatives. Moreover, given the budget connected to the measure (125 million Euros), much energy savings can be realized. This number is significant compared to the current budgets available for energy savings policy.[38] The progressive character of the tariffs should furthermore be much reinforced given the low price elasticity's.

The same is true for the social objectives. **Alternatives** to **encounter fuel poverty** need to be explored and evaluated on effectiveness and efficiency. The current measure is a **price** measure which is applied to all consumers. It should be fine-tuned and if applied, it should only be applied for those with low income levels. Furthermore, it should be implemented automatically without requests given the typically weak level of education of the vulnerable consumers. However, more effectively would probably be to counter the causes of the high energy cost, i.e. to **invest** in **energy efficiency**. This way, **preventive** actions can lead to **both energy savings and counter fuel poverty**. Examples are low quality houses with high heating bills. Given the poor quality, these units are mainly cheap rented to the bottom part of the society typically consisting of mostly low income families. The alternative aid measures should therefore **link income variables** with **energy use variables**. Those living in poor quality housing units and have low income levels should receive more aid than those living in social housing units with a high energy performance having the same income levels. A potential indicator for the energy characteristics is the Energy Performance Certificate (EPC)-label of the housing unit.

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[37] An interesting simulation model that might investigate this matter is the MEFISTO-model (MEFISTO stands for Modelling and Evaluating Flanders' FIscal and Social Tomorrow). More info on: http://www.flemosi.be/easycms/modellen

[38] For example, the budged used through the PSO of the DSO for energy savings amounted about 51 million Euros in 2009. The total Flemish budget for energy efficiency amounts somewhere in the order of 150 million Euro.

Finally, the measure should include the wide range of energy carriers. The current measure only considers electricity while the largest part of energy costs is realized by heating costs which are typically non-electricity expenses (cfr. supra).

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Survey databases:

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[15] EU-SILC data, year 2010

[16] HBO data, year 2008

[17] HBO data, year 2009