SHORT TERM SCIENTIFIC MISSION (STSM) – SCIENTIFIC REPORT

The STSM applicant submits this report for approval to the STSM coordinator

Action number: CA16232
STSM title: Methodology for quantifying energy poverty by using energy performance of the building
STSM start and end date: 12/03/2018 to 08/04/2018
Grantee name: Inigo Antepara

PURPOSE OF THE STSM/

The specific aim is to propose a methodology to evaluate which households are in energy poverty situation, by using theoretical energy costs instead of real ones. This question is relevant in many European countries, where estimations of energy needs do not exist and where energy poverty is estimated on the basis of actual energy expenses.

Real energy costs is usually the proxy for heating expenses, used in the official statistics in many countries (Rademaekers et al., 2016). This is controversial, as actual fuel spending is a poor indicator of energy poverty. Low-income households often spent significantly less on fuel than required and suffered cold homes as a consequence (Moore, 2012).

The UK doesn't have to deal with this targeting problem, as reasonable energy costs is used to calculate the energy poverty indicator; a threshold of the median modelled bill is calculated (using the data from the English Housing Survey and the Bredem modelling tool), after excluding non-space heating costs, the use of different heating regimes, and adjustment for number of occupants.

Professor Hills recommended that, within his methodology, both income and energy bills should be adjusted so that households with different numbers of occupants can be compared to a single threshold. This is known as 'equivalisation' and is commonly used in income measurement to compare households of different sizes and composition on the same scale.

Professor Hills rejected using the same equivalisation factors for energy bills on the basis that income factors were not appropriate as energy costs do not show the same relationship to household size compared to general living costs (DECC, 2013); equivalising effectively increases the costs of single person households, and decreases the costs of multiple person households. The fuel costs equivalisation factors are not intended to be reviewed on an annual basis but periodically. Adults and children are treated equally (Fuel Poverty Methodology Handbook 2016). The proposed equivalisation factors by Hills (DECC, 2013):

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Household type	Equivalisation factor
Couple with dependent children	1.15
Couple without dependent children	1.00
Lone parent	0.94
Single person	0.82
Other multi-person household	1.07

After, an alternative equivalisation was proposed:

Table 1: Proposed energy cost equivalisation factors for improved LIHC

Household size	Dwelling size –useable floor area m^2				
	< 50 m^2	50-69	70-89	90-109	110 +
Single person	0.63	0.77	0.90	0.96	1.22
Two person	0.70	0.84	1.00	1.08	1.28
Three person	0.78	0.86	1.01	1.17	1.44
Four person	0.84	0.92	1.07	1.20	1.53
Five+ persons	0.87	1.00	1.14	1.31	1.62

UK surveys are specially designed to provide the data needed for this methodology, which require a big amount of resources, i.e. it is expensive, and sometimes the data is difficult to obtain.

Socio-demographics factors can drive demand of some energy consumers above-average and this is why they're considered as vulnerable; they're more likely to suffer from a lack of access to energy than the rest of the population (Bouzarovski, 2015). Standard heating pattern does not apply for large sectors of the population, in particular the vulnerable such as the elderly and those caring for young children (Fuel Poverty Methodology Handbook 2016).

Our proposal would be something in between the complicated UK method, and the simplified approach: calculate a modelled energy bill using energy performance data of the building (energy efficiency label or the overall heat transfer coefficient of the building U). Theoretical energy needs will be also the starting point, but they will be adjusted thanks to socio-demographic variables thanks to data from Greece and France, this is, equivalisation weights will be calculated on socio-demographic basis.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

The first action was to present the proposal to N. Katsoulas, the supervisor of the STSM. Next day, the proposal was presented to rest of the group.

The rest of the week was devoted to the review of previous analysis with the PHEBUS data, in order to know what it's already done and what is the innovation of this proposal.

As stated before, additional adjustments are needed to include characteristics for vulnerability, resulting in the equivalised theoretical heating costs according to vulnerable characteristics. The amount of energy services needed for an individual or household to be able to secure a good level of capabilities will depend on household size, specific individuals' needs and circumstances – e.g. are they older, disabled, very young, or ill – and on the local environment, e.g. climate (Day et al., 2016). Vulnerability is linked to those ”specific individuals' needs and circumstances”. As explained in the first part, this was the aim of Hills when proposing equivalisation.

Finally, the following hypothesis, to be proved thanks to the data, arose from the proposal and the discussion:

HYPOTHESIS 1

An analysis to find a correlation between socio-demographic variables and actual energy bills, focusing on the variables increasing the energy needs due to:

- Higher temperatures are needed (children less than 3 year old or long term illness)
- or when staying at home longer periods of time (pensioners, people with disabilities, or unemployed)

All this will be calculated for average consumer, neither poor nor rich. To do so, the populations with the lowest and highest income will be avoided.

HYPOTHESIS 2

The variables from the above list with a positive correlation, they modify the modelled energy bills, so that they increase the final energy consumption. An econometric analysis will be performed to calculate these equivalisation weights, adjusting the actual energy expenditure thanks to those socio-demographic variables of the household linked to vulnerability. This is the proposed

econometric model for the regression:

$$Log(Actual\ energy\ bills) = Log(Modelled\ energy\ bills) + \sum_i \beta_i x_i + \varepsilon_i$$

As some of the variables are binary, e.g. employment status, multivariate regression will be used.

After the econometric analysis with average population, most suitable socio-demographic variables really increasing the energy expenditures will be pointed, and the percentage of increase due to each of the variables calculated.

A different analysis was discussed with Liberis Tsabras; based on Florio and Teissier (2015) method, a simplified approach by income and the DPE label (Diagnostic Performance Energétique, French energy performance label), whether it would be possible to compare Greek and French data. We didn’t find a away, French data is for households and in Greece is for municipalities.

A third meeting took place with L. Papada; as a way of overcoming the problem of using actual energy expenses, she uses the modelled required energy consumption as a proxy for measuring energy poverty. Additionally, sometimes declared consumed fuel is also used for transportation.

Equivalisation weights for socio-economics characteristics in Greece were also calculated using previous data from L. Papada.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

Using data from France, except PHEBUS survey, Raynaud (2014) calculated for every 1C +11% over 23C, -11% below 19C. He also calculated an elasticity of 0,2 for occupancy (individual houses). Using the ENL (Enquête National des Logements) data, Cavailhes (2011) estimated a +5% every time the age of the head of the dwelling increases 10 years. Also using the ENL, Risch & Salmon (2013) calculated an elasticity of 0,1 – 0,2 for the same.

On the review of previous analysis with PHEBUS survey, Belaïd (2018) reaches the conclusion that larger families are more fuel vulnerable, and the exposure of the unemployed to fuel poverty is higher. Other studies:

- Bair et. al (2017) reached similar results for heating temp, an elasticity of 0.52, and a +3% for an increase of 10 years of the age. In their analysis they also include occupancy; +9% per person, and -0.039 for 4-8h vs less than 4h and -0.108 for more than 8h
- Denjean (2017) calculated when the head of the household is more than 65 a +13%. For occupancy, a household of 2 people consumes +22%, if there is 3 people or more a +34%, and staying more than 8h/working day -10% and more than 8h/saturday -14%

Bair et. al (2017) and Denjean (2017) studies include energy needs due to climate conditions and physical characteristic of the buildings as separated variables for the econometric analysis. In this study, the required energy consumption will be calculated following engineering approach; in Greece, the modelled energy consumption data from a previous study from Papada (2018), and in France, a fully comparable way will be used from taken data from the DPE (EPC in French, Diagnostic Performance Energetique)

The variables from PHEBUS survey explanatory for the econometric regression:

Previous studies of the PHEBUS survey do not rely on data from collective heating, and these data is not considered. In this analysis the same assumption will be followed, and it will be taken out of the analysis thanks to variables EKMOD_2 and EKMOD_3.

Energy consumed in kWh will be used (VOL_ELEC_TOTAL_2012 for electricity, similar variables for gas, fuel oil, LPG, coal, wood, and kerosene), instead of energy bills in €, annual fuel costs set against annual income. Every of those variables has another one informing whether the data is reliable or not (TYPE_REDRESS_ELEC, TYPE_REDRESS_GAZ, etc.). Instead of using figures for kWh/m2yr, kWh per dwelling/year will be used. This yields more information about users, as heating costs depend on both the size of the dwelling and the consumption per m2 (Sunikka-Blank and Galvin, 2012). As dwelling size is a key factor in driving high energy costs, UK Gov. do not believe it is appropriate to adjust energy costs for this as it would reduce the impact this has in driving high costs (Department of Energy & Climate Change, 2013).

For the income in 2011, the income below 16 830 and over 62 980 (Les revenus - Insee).

HYPOTHESIS 1

A correlation between variables in the PHEBUS survey for a specific dwelling; on the one hand the variable describing the temperature (EGCHTP variable), and whether higher temperatures correlates with the presence of children less than 3 year old (AGE variable for every individual).

A correlation between the variables of occupancy in the PHEBUS survey (EOCCUP variables, EOCCUP1 h/working-day not occupied, EOCCUP2 Saturdays and EOCCUP3 Sundays) and being pensioners, people with disabilities, or unemployed (OCCUPA variable, takes 2 value for unemployed, 4 for pensioner, 7 for other inactive ones including handicap). Also AGE variable can be used for pensioners, as well as for children less than 3 year old. Additionally, it is possible to use some variables of those households receiving public aids because they are unemployed (ERRSAC variable), PAJE aid for new-born (ERPRE_8 variable), or PCH aid when handicapped (ERVER_2 and ERADEP_2 variables)

There is no variable for long-term illness.

HYPOTHESIS 2

$Actual\ energy\ bills$ is taken from VOL_ELEC_TOTAL_2012, etc., $Modelled\ energy\ bills$ is taken from consommation_energie (kWhep/m².an) calculated from the energy audit (DPE file), x_i are the explanatory variables (binary variables among the socio-demographic variables, e.g. employment status) and ε_i is the error term.

FUTURE COLLABORATIONS (if applicable)

Although the Lille Catholic University obtained the permission to work with the PHEBUS survey from the French Comite du Secret, during the STSM I. Antepara received the information that the access is not for free. As his contract is finished, it is unlikely that the university will pay for it. Two alternatives are being analysed:

- F. Belaïd from CSTB was contacted, as they has access to the survey.
- Two other French surveys could be used: l'Enquête Logement 2013 and/or l'enquête des ménages

If this problem is overcome, a publication on energy poverty indicators will be submitted, comparing the cases of France and Greece.

Ideally, this proposal can help to draw a European energy poverty indicator; this methodology could be exported to other countries, if the specific ways in which the energy performance of the buildings is adapted to the criteria and indicators of separate countries. This is an obstacle, as energy performance of the buildings is measured in a different way in every country, even within the EU. Sunikka-Blank and Galvin (2012) proposed for this purpose the average U-value of the building envelope as in Belgium, also comparable with the German EPR.

Adjustments for socio-economics characteristics can be also calculated using data from the EU SILC and/or Household Budget Survey (HBS), conducted in all EU countries.

Connected with this, it will be possible to calculate the proportion of the population under-consuming. Except for UK, the problem of targeting people who under-consume energy is present in most of the Member States. Lower real expenditure indicates the presence of energy restrictions, which is a form of energy poverty particularly difficult to identify (Florio and Teissier, 2015). In Belgium, as a solution to this problem, the Hidden energy poverty index is used: if energy expenditure is lower than half the national median, then those households are also considered as fuel poor. This index was 4.6% in 2013, so, not negligible. Although a new problem of targeting appears; when the building is really performant and the actual energy costs are low. In the end, trying to solve a problem, but generating a new one.