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Energy savings calculation methods in practice – analysis of regional utility-driven energy efficiency programme data

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EXTENDED ABSTRACT

This presentation introduces an in-depth analysis of data on electricity savings triggered by a utility-led energy efficiency programme. We developped a saving estimates assessment method that can serve as basis of a shared framework on EE information gathering and processing.

Introduction

Energy efficiency programmes (EEP) have been under close scrutiny for their use of public funds, triggering the waves of audits in the 1990s that D. Violette speaks about in this session. However, significant confusion persists on the methodologies that should be used to assess savings, amid concerns of reproducibility[1]. Indeed, D. Violette points to a need for more refinement of ex-ante verification methods and more investment into ex-post measurement and verification protocols. We make use of privileged access to detailed EEP data, and propose a method to assess different approaches against each other.

Available data

We obtained data from two main sources: the EEP database and the utility operational database. The former provides detailed information about EE measures (EEM): number and power of sources, times of use, detection etc. However, the dates of realisation of the measure are not provided, and a tedious manual work had to be done to link EEM with the utility meters that were affected. Other databases we had access to provided no field for the location of the EEM, or only the magnitude of savings in absolute terms, without any indication on the scale of affected facilities. From this experience, we suggest that standardised data collection should at least include the following relevant information, regardless from saving calculation methods: (i) an identifier of affected facilities (anonymised where required), (ii) project implementation dates, (iii) estimated consumption before and after the EEM implementation and ideally (iv) an indication of the scale of the project (number or power of installed appliances, size of facilities etc. as relevant). These are in principle readily available at the time of planning but become very cumbersome to collect later on.

If a meter identifier is provided, the data can easily be linked with the second source, utility databases. The utility database we had access to provided two kinds of consumption data: billed consumption, i.e. normalised estimates of annual consumption, is based on meter readings, providing metered consumption over variable periods of time. "Bill analysis" is often used in the literature to determine benchmark consumptions, but it is usually not specified which of both options above is available. More rigour is needed in specifying the source of used data for the determination of metered savings: (i) billed, (ii) metered through traditional meters, (iii) metered through smart meters, and (iv) metered through dedicated meters on the appliance of interest.

[1] G. M. Huebner et al., "Are We Heading towards a Replicability Crisis in Energy Efficiency Research? A Toolkit for Improving the Quality, Transparency and Replicability of Energy Efficiency Impact Evaluations." In ECEEE Summer Study Proceedings, 11. 2017, ECEEE.

Saving estimate assessment

With such data, it is always possible to plot the distribution of the energy saving deficits (ESD), defined as the normalised difference between calculated and metered savings (Fig. 1):

$$\mathrm{ESD}_c = \frac{\Delta_c E - \Delta_m E}{\Delta_c E}$$

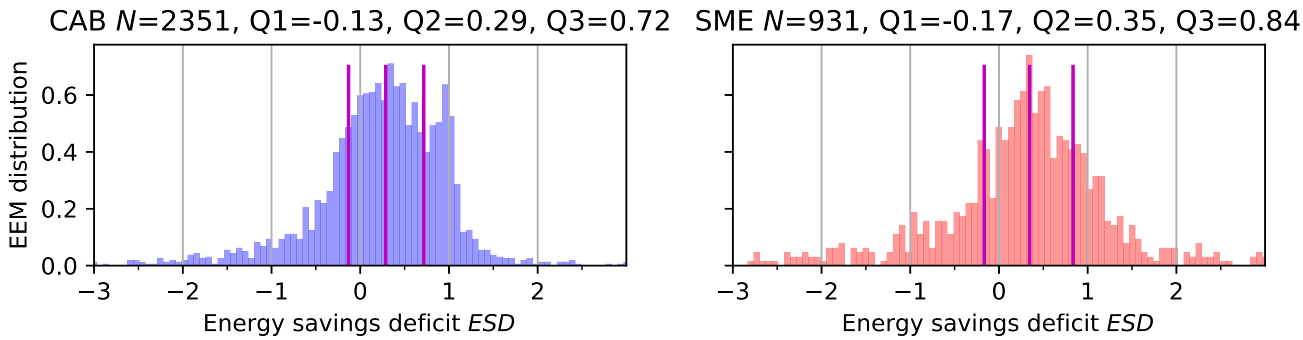

Figure 1. Energy savings deficit distributions for EEMs in common areas of residential buildings (CAB), and small and medium enterprises (SME).

The median gives information about systematic deviations, which include a rebound or activity effect impacting metered savings and an accuracy term impacting calculated savings, compared to real savings. The breadth covered by the central quartiles quantifies deviation amplitudes, which include a natural variability factor perturbating metered savings and a precision factor on calculated savings. It gives the probability that two measures generating the same real savings are assigned the same calculated savings. This probability is relatively low, even simple lighting upgrades.

This method provides a framework to compare how different stakeholder groups react to the same type of measures, provided the calculated savings are defined in the same way (even very roughly). In this case, for instance, we show that SMEs tend to show larger systematic bias than common areas of residential buildings (CABs), with larger variability. This can be explained by the lower uncertainty of calculation parameters for CABs and the smaller scope for rebound effects.

Moreover, this method provides a visual understanding of the data. In our case, the peak around ESD=1 in the distribution for CAB was found to correspond to measures which impacted facilities connected to several meters, only one of which could be reported in the data gathering interface, resulting in metered savings being much smaller than calculated savings.

We explored to what extent this assessment can be applied to EEM generating small savings. Confirming the rule of thumb provided in the literature[2], we found that a peak is apparent already as the expected savings are over 5% of the total consumption. Indeed, relatively few customers vary their consumption by more than that from year to year. However, it remains to be seen whether larger samples would allow studying the impact of even smaller EEM.

Conclusion

Our study shows the need for a basic common data structure for EEP reporting at measure level, besides standardised energy saving calculation methods. We then propose a straightforward way of using this data to compare saving estimation methods in terms of accuracy and precision and assess program impacts taking into account rebound or activity effects and natural variability.

[2] See e.g. H. Vreuls, “Evaluating Energy Efficiency Policy Measures & DSM Programmes, Volume I.”, 2005, Evaluation Guidebook. Implementing Agreement on Demand-Side Management Technologies and Programmes. International Energy Agency.