Evaluating market transformation in the residential energy market – what to measure? A case study

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Abstract

Evaluation of market transformation efforts has been used both to monitor changes in the market affected by a specific programme and to provide information and insight that can be used to refine existing or future programmes. Indicators used in the evaluation of market transformation efforts have included changes in market actors' behaviour, market development and technology development.

This paper contributes to the debate on the metrics that should be used to evaluate the policies designed to bring about market transformation in the residential energy market through consideration of a case study of research into light bulbs. Based on evidence from a small scale study of residential lighting, a variety of indicators are required to get a full understanding of installations and behaviour.

The research exercise was conducted to understand behaviour and preferences with regards to lighting and light bulb choices. Data were collected from a cross-section of homes through:

- A lighting audit – counting the number of lights installed in each room of the house and collecting data with regards to lamp type and wattage
- A self-completion survey – this focused on how lights were used within the home and household preferences with regards to lighting and lamps.

The results showed potential weaknesses in using some data in isolation and in the importance of behavioural indicators to help mitigate against overclaim of market transformation e.g. they are weaknesses in measuring number of installations as an indicator of uptake – as respondents were not always using installations.

Introduction

The term *market transformation* is the strategic process of intervening in a market to create lasting change in market behavior by removing identified barriers or exploiting opportunities to accelerate the adoption of all cost-effective energy efficiency as a matter of standard practice[1].

Market transformation has been achieved for key energy end uses by policies implementing minimum energy performance standards (MEPS). This encourages the removal of the least sustainable products from the market through either regulation or voluntary agreements. Product labeling is an additional tool to achieve market transformation. Labeling products with their energy efficiency rating means products are easier to compare. This allows consumers to make more informed choices about energy efficient products and make it easier for consumers to make a more energy efficient choice.

Internationally, the market mechanisms for transformation in the residential lighting market have included MEPS and labeling, along with financial incentives for consumers (e.g. subsidised or free CFLs), the provision of consumer information, working retailers and partnering with utilities, amongst other mechanisms.

[1] http://www.aceee.org/topics/market-transformation (last accessed March 2012)

Evaluation of market transformation efforts has been used (1) to monitor changes in the market affected by a specific market transformation programme and (2) to provide valuable information and guidance that can be used to refine a programme in progress or to improve the planning, design and implementation of other market transformation programmes. Indicators used in the evaluation of market transformation efforts have included changes in market actors' behaviour, market development and technology development.

Internationally, policy makers and evaluators have said it would be useful to have a consistent set of indicators and a consistent methodology to measure and understand the impact of market transformation policy. This paper contributes to the debate on the metrics that should be used to evaluate the progress of policies designed to bring about market transformation in the residential energy market. Based on evidence from a small scale study of residential lighting, a variety of indicators are required to get a full understanding of installations and behaviour. The findings from the study suggest that:

- Focusing on non behavioural evaluation indicators of market transformation could lead to misleading conclusions about the market
- Evaluation indicators of market transformation need to be used in an integrated way
- An evaluation that considers behavioural indicators could also uncover interesting implications for market transformation policy.

Related work

The evaluation of market transformation has been discussed by several evaluation practitioners[2]. They each propose a number of indicators or issues that should be examined in the evaluation of market transformation initiatives including, but not limited to, changes in awareness, values, and behaviour of various market participants (manufacturers, consumers etc.), variables that are assumed to be associated with energy savings, (including sales data), new market participants, new market rules and changes in market share of energy efficient products. In summary, the literature suggests the following indicators could be used to evaluate market transformation initiatives:

1. Market and technology development: changes in the mix of products and the number of products on the market, changes in market share, changes in product performance and price, changes in stocking practices and the introduction of product standards (whether formal or informal)
2. Changes in the behaviour of market participants: changes in manufacturers' commitment in the market (e.g. entry of new firms, the development of new models, changes in product lines, research and development, pricing, standardisation etc.), changes in trade allies' commitment in the market (e.g. the number of dealers, changes of dealers stocking patterns, and development of effective retail channels, pricing, promotion etc.), and changes in customer acceptance and behaviour (awareness of the product and willingness to pay).

These indicators will describe, in the short and medium term, market transformation effects and, in the long term, a permanent market transformation. Furthermore, the indicators could be used to analyse the elimination of market barriers, and achieved energy savings. The

[2] For example by Prahl and Schlegel (1993), by Feldman (1994-1996), and by Rosenberg (1995).

specific indicators chosen to evaluate a programme will depend on the aims of the programme.

Evaluation practitioners are increasingly using multiple indicators in their evaluation of market transformation initiatives. Hoefgen (2010) discusses using a variety of indicators in the evaluation of a CFL program. After citing a number of limitations in some existing data collection methods (e.g. consumers cannot accurately report the number of CFLs installed or purchased in telephone surveys and the issue of missing pieces makes use of sales and shipment data too problematic) a method is described using indicators from modelling work, telephone interviews, sales data and on-site audits. Barkett (2010) also proposes employing multiple indicators in the evaluation of market transformation programs, arguing for systematic and transparent application of different methods and data sources.

Through evidence of a small scale study of residential lighting use and behaviour, this paper also suggests that a variety of indicators are essential in the evaluation of market transformation initiatives (as some data taken in isolation could be seen as misleading) and that behavioural indicators are an essential component of the evaluation. Furthermore, that evaluation methodologies to measure behavioural indicators will also uncover useful understanding and insight for policy makers.

The remainder of the paper is organised as follows. The next Section describes the approach taken in the study to understand behaviour and preferences with regards to lighting and light bulb choices. This is followed by an outline of the key findings from the study related to energy efficiency behaviour with regards to lighting. The final section draws out implications and considerations from this work for the debate on the metrics that should be used to evaluate the progress of policies designed to bring about market transformation in the residential energy market are drawn.

Lighting behaviour survey

Study background

The study discussed here was part of efforts to gain a more complete picture of residential lighting use along with a better understanding of knowledge of, and attitudes towards, efficient lighting. The results of the study were intended to inform:

- As assessment of the effects of market transformation efforts in residential lighting through:
  - Improved modelling of domestic lighting energy consumption
  - Development of a baseline for monitoring of future lighting use
- The development of lighting policy and planning for future lighting energy reduction initiatives

The author was commissioned to conduct a small scale study to develop and test a method for understanding residential lighting use. The study specifically sought to develop approaches for:

- Understanding behaviour with regards to lighting use, i.e. when lights are used in the home;
- Testing knowledge of different light bulbs types, whether consumers recognise light bulb types correctly by name
- Exploring attitudes towards efficient lighting, including what affects the design of lighting schemes within the home and what affects purchasing behaviour with regards to lighting technology and light bulbs.

Approach

Data were collected from a cross-section of owner occupied and privately rented homes through:

- A lighting audit – a researcher counted the number of lights installed in each room of the house and collected data with regards to lamp type and wattage
- A self-completion survey by residents – this focused on how lights were used within the home and household preferences with regards to lighting and lamps.

Data were collected from 150 homes. Throughout the participant selection process for the lighting survey and associated lighting audit every attempt was made to achieve a demographic mix representative of the general population and housing type. Particular attention was paid to the individual demographic parameters that were identified as of key interest; house type and number of residents.

There were two key components of the self-completion survey:

- Establishing lighting use behaviour; questions were structured around lifestyles and behaviour rather than principally focused on the lighting. From previous studies, it can be difficult for respondents to discuss their use of lighting in isolation from their lifestyle as lighting use is often habitual (e.g. switching a light on when entering a room). Therefore, questions in this study focused on lifestyle, and how lighting use complements that. So, for example, rather than asking how many hours do you have the lights on in the evening? We asked ... what time do you typically get home in the evening? Which lights would you normally turn on then? What time do you typically go to bed? Do you always turn all the lights off then?
- Understanding attitudes and preferences. The survey explored this in two ways:
    - Understanding the reasons underlying householders' behaviour and choices
    - Exploring preferences for lighting features and how lighting complements users' lifestyles.

  Before being used as a self-completion survey, the survey form was piloted with a sample of five houses. This enabled the questionnaire to be tested and also identified any areas where there was a risk of inaccuracy e.g. through misinterpretation of the survey question.

The self-completion survey was designed so that respondents could answer all questions in approximately twenty minutes. To enable this, survey respondents were asked to nominate up to three rooms which were used the most at each period of the day (morning, afternoon, evening and night). The questions concerned with lighting use behaviour then focused on the most frequently used rooms at each time period (rather than all rooms in the house). Some results therefore relate only to the rooms nominated as most frequent used and not for the entire house. Also, preferences for changing lights and fittings relate only to the room nominated as the most often used living space. Although this aspect of the methodology focused the survey (and therefore ensured it was not unnecessarily long) it is also a source of potential limitation. There could be very highly consuming, inefficient lighting appliances in other rooms which were not included in the survey.

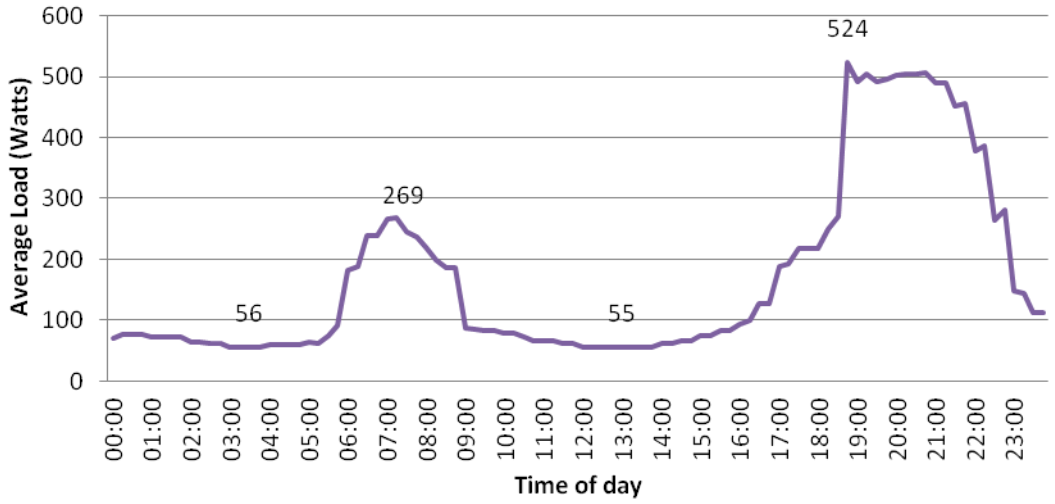
Results

Load profile

The key outcome from the self-completion survey was the ability to create a load profile for the homes that took part in the studies. Though conducting the self-completion behavioural survey at the same time as the lighting audit, results from the two studies could

be exchanged. From the self-completion survey, data were obtained on rooms that were most frequently used (and at which times of the day) and which lights were used within those rooms. This was cross-referenced with data from the lighting audit. The lighting audit determined the number of lights installed in each room of the house and the lamp type and wattage for each light. Understanding which lights were used and when and their wattage, enabled the lighting load profile for survey respondents to be estimated:

Figure 1: Lighting load profile [n=147 houses][3]



The graph shows a peak in the morning of 269W around 7.00am, followed by a reduction during the afternoon to a low of 55W. The average load then increases to a high of 524W at 6.30pm before decreasing overnight. Between 2am and 5am, the average load is around 60W.

Behavioural data

In addition to collecting data on lighting use to enable lighting load profile to be determined, the self-completion survey also explored behaviour with regards to lighting choices. Key findings included:

- A lack of consumer knowledge and understanding and numerous misconceptions with regards to light bulb types and information on light bulbs (e.g. fewer respondents stating they had a certain bulb type than was, in fact, the case)
- The prevalence of building related issues as a barrier to energy efficient behaviour in this area (e.g. lack of access to light fittings)
- The considerations that consumers make when purchasing light bulbs (e.g. the importance of warm-up time) and their impact on making energy efficient choices
- Idiosyncrasies in consumer purchasing behaviour (e.g. purchasing of incorrect bulbs).

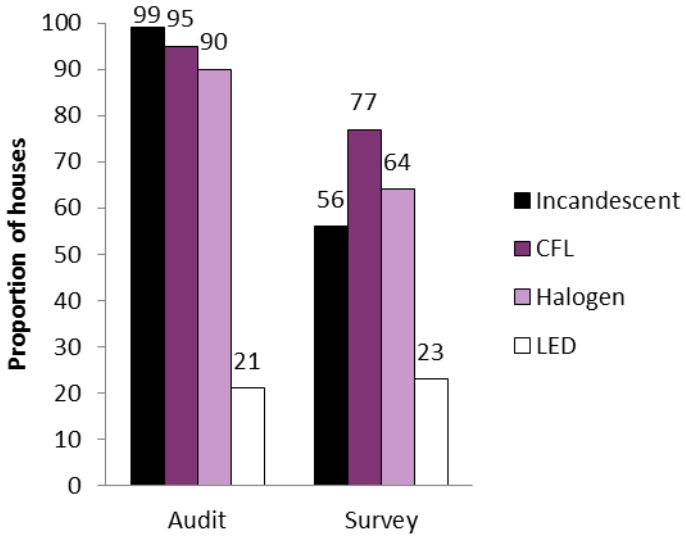
[3] Where lamp technology could not be identified and wattages were not defined, a 60W incandescent lamp was assumed. Where lamp technology was identified but the wattage was not able to be ascertained, there was an assignment of a default wattage for that particular lamp type. Results relating to load profile relate only to the rooms nominated as most frequent used and not for the entire house.

Taking each of these in turn:

Consumer knowledge and understanding

Survey respondents were asked whether or not they had incandescent, CFL, Halogen or LED lamps in their home. The audit contained data on actual lamp type. Analysis was then conducted to compare the proportion of houses which contained different lamp technologies in the survey and the audit. The results of this analysis are shown in the chart below:

Figure 2: Lamp comparison between audit and survey [n=149]



The audit data illustrates that most households surveyed had incandescent[4], CFL and Halogen bulbs in their home. However, with the exception of LED lamps, fewer respondents recognised they had these lamp types in their home than was, in fact, the case. The contrast for incandescent bulbs is quite stark; 56% of households said they had one or more incandescent bulbs, when in fact 99% of households actually owned one or more. There are a number of possible explanations of why respondents did not always recognise the different lamp types present in their home including:

- Respondents did not recognise the lamp type by name. An average of 15% of respondents for each lamp type were uncertain whether or not they had one in their own home. This suggests that the name of the lamp type alone is not sufficient for some respondents to recognise the lamp type. Pictures may have been effective at jogging people's memories and have been used in other studies to prompt recognition.
- Respondents only focus on the most used lights when they consider the bulb types within their home. This ties in with data on behaviour. Even in the most frequently used rooms, respondents only used a proportion of the installed lights.

Barriers to energy efficient behaviour in this area

Particularly evident from the pilot survey of the self-completion survey were the design and building related barriers to energy efficient lighting behaviour. Anecdotal evidence from cross referencing the data from the lighting audit with the data from the self-

[4] Production of 100-watt bulbs has stopped in the US and Europe, while production of 60-watt bulbs has been stopped in Europe and is being phased out in the US

completion surveys identified that some respondents had more lights installed in their home than they in fact used. Anecdotal evidence from the pilot of the self-reported survey identified some of the reasons for this, with respondents discussing how they were adding lighting and lamps to the room, without taking any away. Reasons for this included:

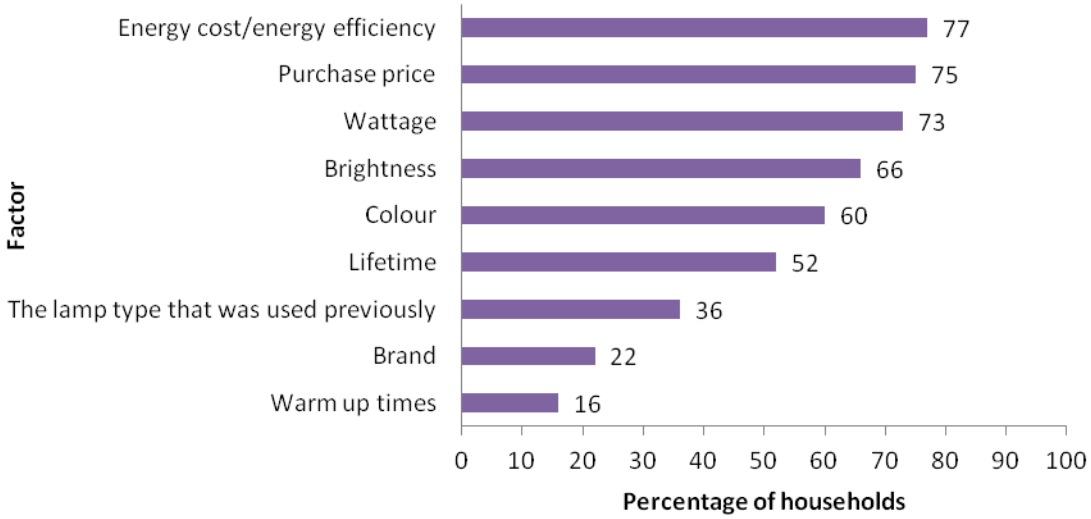
- Purchasing more plug in lights to compensate for lamps that were no longer working / needed to be changed. Due to issues of accessibility, some respondents had found it difficult (often following numerous attempts) to change lamps
- Purchasing more plug in lamps to create a brighter light rather than changing the lamp type
- Purchasing more plug in lamps to create a softer light rather than changing the lamp type

The latter two points suggest the need for more dimmers. This was also identified in the survey, 15% of respondents said they would like to have more dimmers when asked how they would change the way their light switches are set up. However, anecdotally, it did seem the number of respondents who would benefit from dimmers was in fact greater than the 15% who cited this.

Influences on purchasing decisions

The chart below shows the percentage of households who cited each factor as an influence in their purchasing decisions. Respondents were permitted to select more than one factor if they wanted to:

Figure 3: Factors influencing purchasing decisions [n=149 houses]



Although not a statistically significant result, the general findings result in some interesting challenges for encouraging the purchase of energy efficiency lamp types. Although energy cost / energy efficiency was cited most frequently as the factor that influences the purchasing decision for different lamp types / brands, purchase price and wattage were also frequently cited. The requirement for a low purchase price does not always complement the most energy efficient choice as energy efficient lamps tend to be more expensive to purchase than the less efficient choices as they are more complex to produce.

Anecdotal evidence from the survey also indicated that the desire for particular wattage types does not always complement energy efficient choices as some respondents were confused about the indications of wattage on energy efficient lamps. For example, one

respondent reported buying two energy efficient lamps for her bedroom lights. She purchased the wrong wattage and therefore did not think the lights were bright enough. When recalling this incident, she did not recognise that the wattage on the brand she had purchased was indicated differently on energy efficient as opposed to non energy efficient lamp types.

Other confusions discussed by respondents highlighted a lack of awareness about the options available to them:

- "*I would like to change halogens and dimmers for LEDs, but I'm unsure about performance and price options as I want bright lights in the kitchen*."
- *"I might get LED lights one day when prices and brightness improves"*

Idiosyncrasies in consumer purchasing behaviour

Of the 149 homes that took part in the self-completion questionnaire, 82% said they purchased new lamps when required, 17% said they bulk bought lamps in advance of needing them and 11% said they bought them when they are discounted in some way[5]. Particularly when purchasing in advance (either because they are discounted in some way or not), this behaviour could lead to respondents effectively stock piling lamps that may or may not get used.

Even when purchased as required, respondents anecdotally reported mistakes in the purchase (particularly by lamp fitting) which meant that the lamp they had purchased could not be used for the intended light fitting. 79 out of 147 respondents said that they had spare light bulbs in a drawer of cupboard that they could no longer use because they have changed light fittings and the bulbs no longer fit. This observation has been made in other studies as well. Lighting audits that have taken account of both installed and non-installed lamps have noted the volume of lamps that are not installed. This study additionally points to the fact that many of the installed lamps may not subsequently be installed due to purchasing error.

Implications and considerations

Market transformation programmes are based on a market theory and a hypothesis of how the market will be changed through a specific intervention. To tell the story of market transformation an evaluation needs to measure a variety of indicators as markets are complex and involve a wide array of market actors in the supply chain as well as on the customer side.

From the lighting behaviour study, there are a number of behavioural indicators that should be considered when evaluating the effect of market transformation efforts. The results showed potential weaknesses in using some data in isolation and in the importance of behavioural indicators to help mitigate against overclaim of market transformation. It was also essential in this study that data were cross-compared to get a true picture of market effects.

The lighting behaviour survey suggested:

- A potential weakness in survey based approaches to establishing uptake of technologies and new technologies – as respondents did not recognise technologies by name
- A potential weakness in measuring number of installations as a measure of uptake – as respondents were not always using, and sometimes actively not using, installations

[5] Respondents could cite multiple options

- A potential weakness in using indicators of purchasing behaviour in isolation – as respondents were not always coherent in their attitudes and behaviour e.g. demonstrating conflicting opinions
- A potential weakness in using sales data to get a full picture of uptake of measures – as respondents had not always installed the lamps they had purchased and, in some cases, it seemed unlikely they would install.

The implications for the indicators used to evaluate the progress of policies designed to bring about market transformation in the residential energy market are that:

- Focusing on non behavioural evaluation indicators of market transformation could lead to misleading conclusions about the market including potentially higher estimates of market transformation
- Evaluation indicators of market transformation need to be used in an integrated way
- An evaluation that considers behavioural indicators could also uncover interesting implications for market transformation policy.

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