ENERGY MODELLING FOR THE RESIDENTIAL SECTOR A summary of the SATIM methodology

MAPS
Mitigation Action Plans & Scenarios

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Introduction

Although the residential sector is relatively small in terms of energy consumed, it is the most important sector in any economy. It is interesting because it is the supplier of labour, a direct consumer of products made by all the other sectors in the economy, and the subject of social development. According to the Department of Energy's energy balance of 2006 (DOE, 2009), 21% of energy used in South Africa was consumed by the residential sector. The dominant carriers of energy are coal (29%), electricity (27%) and wood (36%) meeting approximately 93% of sectoral energy needs. Liquefied Petroleum Gas (LPG) and kerosene merely meet 3% and 4% of energy demand respectively. The fact that 65% of energy needs in this sector are met by coal and wood reflects South Africa's reliance on fuels with high pollution levels.

Structural assumptions and modelling decisions

The modelling process in the residential sector is faced with both energy consumption data and classification challenges. There are numerous and structurally diverse households, which have differing energy needs. To simplify energy modelling, energy analysts usually group households with similar energy consumption patterns and characteristics together and therefore household diversity creates a classification challenge. The modeller therefore has to trade off model detail, computational effort and data

Purpose

Energy economy environment models such as TIMES are often used to look at opportunities and costs of reducing greenhouse gases (GHGs). The South African TIMES model (SATIM) has been developed for this purpose and its methodology is documented online. This document presents a brief overview of the SATIM residential sector methodology. This document will be of great interest to researchers dealing with social conscious mitigation actions and who are faced with sparse data for modelling the residential sector.

The full SATIM methodology is available on the Energy Research Centre website http://www.erc.uct.ac.za/

availability. Household classification must enable analysts to build a model which can incorporate and react to the following:

➤ Energy use profiles and consumption levels across differing classifications
➤ The movement of households between differing groups
➤ Policy interventions which target certain households (i.e. an increase in residential electricity tariff for high energy consumers)
➤ Mitigation actions relevant to a specific household group (i.e. a solar water heating programme on low income households)

In SATIM, the compromise that was reached was to group household by income and electrification status. That resulted in three income groups (low, middle and

high) which were further classified into electrified and non-electrified households as shown in Figure 1. SATIM is an evolving model and each iteration of SATIM provides a possibility for sectoral improvement, although problems with data have in certain cases required devolution. The Long Term Mitigation Scenarios' (LTMS) disaggregation of households by income, electrification status and rural/urban divide has, for instance, generally been considered the most comprehensive grouping as it was informed by a stakeholder engagement process. The current model however groups households by income and electrification status since Statistics South Africa no longer provides household data by urban or rural classification as this classification is argued to be unhelpful for development purposes. The decision to group households into income levels was motivated by the rich socio-economic datasets that exists in South Africa and the fact that income determines how much and what commercial fuels are consumed. In an instance where free fuels (such as wood and shrubs) are used, income may not necessarily be the determinant of fuel use (wood) and fuel availability serves as the only determinant.

Model structure and energy service shares

Four and five energy services have been identified for electrified and non-electrified households respectively and are shown in Figure 1. Appliances used to meet these end uses are shown in the main model documentation (accessible at www.erc.uct.ac.za). Figure 1 shows that 46% of households are classified as low-income households. The amount of energy used by the five household groups to meet their respective end uses is shown in Table 1.

FIGURE 1:

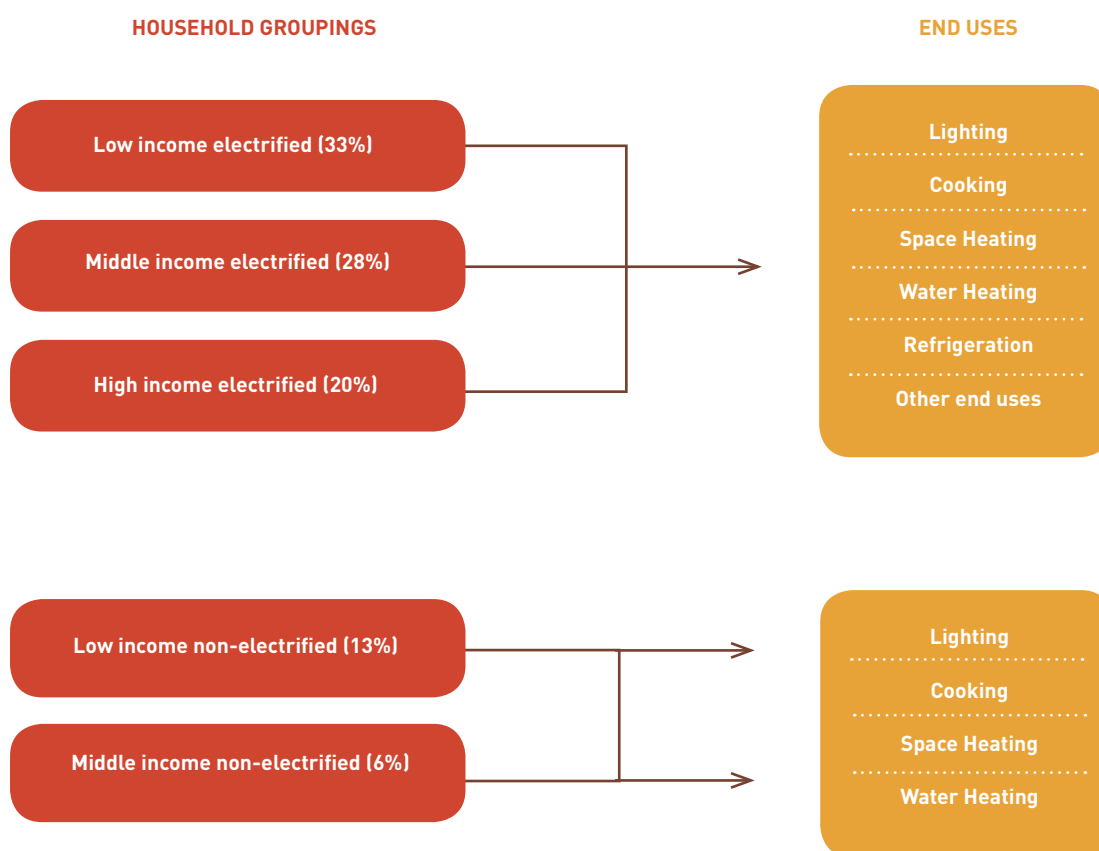**HOUSEHOLDS CLASSIFICATION AND ACCOMPANYING END USES**

HOUSEHOLD GROUPINGS

Low income electrified (33%)

Middle income electrified (28%)

High income electrified (20%)

END USES

Lighting

Cooking

Space Heating

Water Heating

Refrigeration

Other end uses

Low income non-electrified (13%)

Middle income non-electrified (6%)

Lighting

Cooking

Space Heating

Water Heating

TABLE 1:
FUEL USE BY END USE

ENERGY SERVICE (PJ)	ELECTRICITY	OIL PARAFFIN	COAL	BIOMASS WOOD	OIL LPG
Lighting	27.30	1.14			
Cooking	26.86	8.58	5.50	84.88	1.06
Space Heating	18.28	5.33	21.32	16.27	0.16
Water Heating	54.17	6.43		24.61	0.63
Refrigeration	17.10				
Other	15.21				
Non Energy		1.08			
Total	158.92	22.56	26.82	125.76	1.85

Conclusion

The SATIM residential sector methodology will be useful for developing countries where income serves as a significant determinant of energy consumption and one of the factors influencing fuel choice. In countries where natural resources are freely collected, such as heavily forested countries, disaggregating households by income may not be so useful. The decision to disaggregate households also depends on what type of data is available.

References

DOE. (2009). Energy Balances 2006 V1 - Microsoft Excel File. Retrieved from Department of Energy: http://www.energy.gov.za/files/media/media_energy_balances.html

South Africa's LTMS

The Long Term Mitigation Scenarios (LTMS) was a cabinet-mandated process from 2005-2008, led by the then South African Department of Environmental Affairs and Tourism, to establish the evidence base for a national low carbon development path. Key to the process was its unique blend of facilitated stakeholder engagement and rigorous research.

The LTMS arose out of the realisation that South Africa would need to contribute its fair share to greenhouse gas mitigation. Greenhouse gas emissions in South Africa come mainly from energy use and supply. Moving to a low carbon development path would require a major shift in thinking and in action. Hence a blend of process and research was critical when assessing mitigation potential within the country. Having accurate numbers would build confidence, but equally important was that a wide range of key stakeholders within South Africa agreed that the numbers were credible.

The LTMS research was peer-reviewed and found to be of best practice. Reviewers recommended sharing the experience with other developing countries. From this recommendation the MAPS Programme was born. For more information see http://www.erc.uct.ac.za/Research/LTMS/LTMS_project_report.pdf.

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MORE ABOUT MAPS

Mitigation Action Plans and Scenarios (MAPS) is a collaboration amongst developing countries to establish the evidence base for long term transition to robust economies that are both carbon efficient and climate resilient. In this way MAPS contributes to ambitious climate change mitigation that aligns economic development with poverty alleviation.

Central to MAPS is the way it combines research and stakeholder interest with policy and planning. Our participative process engages stakeholders from all sectors within participating countries and partners them with the best indigenous and international research.

MAPS grew out of the experience of the Government mandated Long Term Mitigation Scenarios (LTMS) process that took place in South Africa between 2005 and 2008. The LTMS, with its home-grown stakeholder-driven approach, its reliance on scenarios and the rigour of its research and modelling were key to its approach. The LTMS informed South Africa's position for Copenhagen and is the base of much of the country's domestic policy.

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