MAPS

Mitigation Action Plans & Scenarios

ENERGY MODELLING FOR THE AGRICULTURAL SECTOR

A summary of the SATIM Model Methodology

TECHNICAL // Agriculture

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Introduction

Although relatively small in monetary and energy terms, the agricultural sector plays an important role in the South African economy. Primary agriculture was estimated by the Department of Energy (DOE) to account for 2.6% of Total Final Consumption (TFC) of Energy in 2006 (DOE, 2009). This closely mirrors the 2.4% contribution of the sector to gross domestic product (GDP) in that year (Stats SA, 2012). Energy emissions from the sector were estimated to contribute less than 1% to total greenhouse gas emissions in 2000 (Mwakasonda, 2009), but when other agricultural sources of GHG emissions like enteric fermentation, biomass burning and N_2O emissions from managed soils are considered, this share of total emissions approaches a more significant 6%. Given the disparities between different sector emissions, not all sectors in SATIM have enjoyed the same level of investment. Research funding has tended to concentrate on sectors having a high environmental impact and profile like the transport sector and electricity supply sector. Given the relatively small contribution to TFC and GHGs of the agriculture sector in South Africa, this module of the SATIM model has been kept quite simple.

Agriculture and GHG emissions in SATIM

The national energy balance indicates that the dominant carriers of energy to the agricultural sector in South Africa are diesel (55%), electricity (30%) and gasoline (7%) and thus the GHG emissions impact of direct energy services is a very modest portion of the national combustion of coal and petroleum products. Agriculture can however also be a significant contributor to GHG emissions through land-use change, enteric fermentation or direct emissions from cultivation, particularly rice. SATIM has not been used to investigate these emissions and no attempt has been made to link them to energy services in the model. In studies where such calculations have been required they have been done in parallel models. The detailed SATIM methodology will therefore be of little use to researchers modelling emissions from agriculture not directly linked to energy use. It is however useful to emphasise that a decision needs to be made at an early

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 overview of the SATIM agricultural sector methodology and may be of interest to researchers from countries where the sector is also a relatively small GHG emitter, as is the case in South Africa, and a compact modelling approach is appropriate.

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

TABLE 1:

SATIM ASSUMED ENERGY SERVICE SHARES OF AGRICULTURE TFC BY ENERGY SUPPLY

ENERGY SERVICE	COAL	OIL DIESEL	ELECTRICITY	OIL GASOLINE	OIL HFO	OIL PARAFFIN	OIL LPG
Heating	100.0%				100.0%	100.0%	100.0%
Processing			26.1%				
Traction		99.2%		98.4%			
Irrigation		0.8%	36.1%	1.6%			
Other			37.8%				
SUM	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

stage in a national mitigation study whether to include land-use and enteric emissions, possibly as indirect outputs of energy services, or whether to keep this modelling effort separate and synthesise the results at the end.

Model structure and energy service shares

Five energy services have been identified in agriculture for analysis purposes (Winkler, H et al, 2006) and along with the five major sources of energy in the national energy balance, form the basic structure of the SATIM agriculture sector model as shown in Table 1. The share of energy services presented will be of interest as a point of reference for researchers from other countries but it must be emphasised that there is a lack of studies on agricultural energy use in South Africa and the estimates are uncertain.

Future demand for energy from the agricultural sector

Although the balance has steadily swung in favour of imports over the last 50 years, South Africa is still a net food exporter (SAIRR, 2012) (FAO, 2011), exporting 30 – 47% more food than it imported in 2006/2007 (FAO, 2011). Given that not all production is consumed locally, Value Added (GDP) is used as the driver for energy demand in the agricultural sector.

In the South African Long Term Mitigation Scenarios (LTMS) , assumptions were made as to the future change in energy intensity of services in the agricultural sector as shown in Table 2.

TABLE 2:

ASSUMPTIONS OF CHANGE IN AGRICULTURAL ENERGY INTENSITY FOR THE LTMS

ENERGY SERVICE	REDUCTION FACTOR	INTENSITY [GJ/2003 RANDS]		
		2001	2020	2030
Irrigation	0.5%	0.201	0.220	0.232
Traction	-0.5%	0.453	0.412	0.392
Processing	-0.5%	0.172	0.156	0.149
Heat	-1.0%	0.117	0.096	0.087
Other	0.5%	0.298	0.328	0.344

In SATIM however, until such time as better data can be acquired on which to base these assumptions, energy intensity has been assumed constant over the projection period and the elasticity of energy demand with respect to value added has been set to 1. In SATIM currently therefore, agricultural energy demand is assumed to grow directly proportional to GDP. In South Africa's case where the agriculture sector accounts for less than 3% of total final energy consumption, this is unlikely to be a major source of error. In other economies, especially those where agriculture is a dominant contributor to the economy, energy intensity and elasticity would have to be more precisely determined.

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.

Conclusion

The SATIM agricultural sector methodology will not be very relevant to some countries because it has been kept quite simple, given that the sector is a marginal consumer of energy and its energy services make a small contribution to GHG emissions. In heavily forested countries with a large agriculture sector, the land use change impacts of agricultural expansion on climate change are very severe and the treatment of the sector in mitigation studies will be far more rigorous than has been the case in South Africa. In cases where the study focus will be on other sectors and a similarly simplified approach is appropriate, the SATIM methodology may however prove to be a useful reference

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

FAO. (2011). Why has Africa Become a Net Food Importer? Explaining Africa Agricultural and Food Trade Deficits. Rome: Trade and Markets Division, Food and Agriculture Division of the United Nations.

Mwakasonda, S. (2009). Greenhouse Gas Inventory South Africa 1990 to 2000. Pretoria: Department of Environment & Tourism, Republic of South Africa.

SAIRR. (2012, February 1). South Africa remains a net food exporter. Retrieved from South African Institute of Race Relations: http://www.sairr.org.za/media/media-releases/SA%20remains%20a%20net%20food%20exporter.pdf

Stats SA. (2012). Gross domestic product annual estimates 2002 – 2010 Regional estimates 2002 – 2010 Third quarter 2011. Pretoria: Statistics South Africa.

Winkler, H et al. (2006). Energy Policies for sustainable Development in South Africa - Options for the Future. Energy Research Centre. University of Cape Town.

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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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