POLICY BRIEF

Low carbon options for energy demand

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Abstract

Low carbon growth seeks to promote economic development while keeping GHG emissions low. This policy brief presents five concrete actions to reduce household energy demand. This can lead to direct economic benefits and reduced emissions, and several options also have development co-benefits such as health improvement. In addition, pursuing energy efficient technologies reduces the stress on natural forests for wood fuel production, and it reduces the need for building new power plants over the next 10 years.

INTRODUCTION

This policy brief presents low carbon growth options for household energy use. Generally speaking, low carbon growth seeks to promote economic development while keeping GHG emissions low, or lower than without interventions (Würtenberger *et al.*, 2010). Low carbon growth typically focuses on reducing emissions (e.g. in energy, industry and agriculture) and increasing carbon sequestration (e.g. through improved forest management). Energy use is an important component of development (as an enabler), but also contributes to emissions (various types of energy conversion emit greenhouse gases (GHG)). The demand for energy typically grows with development, but GHG emissions need not grow at the same pace, as conversion and use of energy can be made more efficient. This policy brief describes energy demand in Ghana now and in the future, and identifies a number of concrete options related to energy demand that are consistent with a low carbon growth pathway. The options described are already being implemented in Ghana to varying degrees. This policy brief puts them into perspective regarding development benefits, costs and barriers, and shows GHG abatement costs and potential by constructing a Marginal Abatement Cost (MAC) curve.

ENERGY DEMAND IN GHANA TODAY

In Ghana, the total annual energy consumption is around 450 PJ. Of total demand, 72% comes from the residential sector. Energy demand in the residential sector consists of the use of wood fuel[1] for cooking (76%) petroleum products for transport and cooking/lighting (17%), and electricity use for lighting and appliances (7%) and (2008 figures; Energy Commission, 2010a,b).

Box 1: Labeling for energy efficient appliances in Ghana

Ongoing efforts to create a regulatory framework for the use of efficient appliances could be used to facilitate their choice as a low carbon abatement option in Ghana. For example, the legislative instrument (LI) 1932 of 2008 on energy efficiency will prohibit the import and sale of used refrigerators in Ghana. Energy Efficiency Standard and Labeling under Regulations, 2005 (LI1815) has already being implemented for air-conditioners.

[1] Although woodfuel products are in itself renewable and thus CO_2 neutral, woodfuel combustion can lead to net emissions when there is no reforestation, and due non-CO_2 GHG emissions from the combustion process and charcoal production. In Ghana, 90% of the fuelwood is obtained directly from natural forests and the annual deforestation rate is 3% (Energy Commission, 2009)

There are several opportunities for improving the efficiency of residential energy use. Charcoal production and the use of wood and charcoal in stoves can greatly be improved by a relatively simple redesign of the technologies used. Lighting can be made more efficient by using energy-efficient lamps such as compact fluorescent lamps (CFLs), and electricity demand for appliances can be reduced by the introduction of newer, more efficient models.

ENERGY DEMAND IN GHANA IN 2020

The use of wood fuel (charcoal and firewood) is expected to more than double between 2010 and 2020 (Energy Commission, 2009). With increasing household income and urbanization, it is expected that a larger number of households will switch to using charcoal instead of firewood. Residential electricity demand is also expected to increase as electrification rates increase and as households acquire more electric appliances (e.g. air conditioners, refrigerators) with rising income levels.

Assuming an economic growth rate of 5%, a similar growth rate for electricity consumption will lead to an increase in demand of 60% by 2020. GHG emissions related to electricity consumption are expected to increase even more, as the CO_2 intensity of electricity production in Ghana is likely to increase by 2020 due to the growth of electricity generated by thermal power plants using diesel, light-crude-oil and natural gas as fuel.

Projected increases in energy demand will further put pressure on natural forests (for wood fuel) and requires a large expansion of the electricity generating capacity. Therefore low carbon alternatives for energy demand can not only deliver economic and development benefits, they can also contribute to lowering the stress on forests and the rate at which power plants will need to be built.

LOW CARBON OPTIONS

Low carbon options for energy demand comprise alternatives to existing technologies, but with lower emissions. Adopting low carbon alternatives may also be economically beneficial and have 'development co-benefits'. Below, five concrete alternatives for household energy demand are listed. Each option is described in terms of technology, barriers to implementation and development benefits.

Improved charcoal production: currently, charcoal is produced mostly by earth mound kilns in Ghana (NCRC, 2008). This production method has efficiencies of 10-20%, i.e. the amount of wood that needs to be burnt to create charcoal is high. Using a more efficient kiln, which can be based on a relatively simple technology, can double the production efficiency (Global Climate Adaptation Partnership, 2010). Improving efficiency in charcoal production reduces the pressure on forested land, and thereby contributes to the long term sustainability of the sector. Improved production methods also limit exposure to smoke and pollution from fires. Moreover, using efficient production methods can pose opportunities for entrepreneurs. The main bottleneck for small scale producers is that the technology requires an initial capital investment, while the traditional method doesn't. In addition, charcoal production is a highly fragmented and informal sector, thus changes are difficult to initiate. In spite of ongoing pilot projects, improved charcoal production methods have not yet reached widespread application.

Improved cook stoves (ICS): The burning and heat transfer of traditional charcoal/fuelwood cook stoves can be considerably improved by introduction of simple design elements (ClimateTechWiki, 2010), which may almost double the stoves' efficiency. The use of an ICS can reduce the amount of smoke and indoor pollution, which leads to health improvement. Moreover, households that rely on collecting firewood, can spend more time for other productive activities. If wood fuel is purchased, ICS reduces the costs for purchasing fuel. Improved cook stoves require an upfront capital investment, which can be a barrier for poor households, but the payback time may be as short as a couple of months. In Ghana, pilot activities on improved cookstoves have been undertaken for years, but due to a lack of local technical capacity to supply sufficient and high-quality improved cook stoves and a lack of awareness and distribution channels, uptake of the technology has been slow. Recent successful programs include a voluntary carbon market program which receives funding from the sale of carbon credits.

Efficient air conditioners: The energy efficiency of air conditioners (ACs) varies widely, and newer models generally are more efficient. While efficient ACs generally have a higher purchasing price, the lower expenses on energy make the operating costs lower over the lifetime of the appliance. Further development co-benefits of applying efficient AC technology are limited to the corresponding reduction in electricity demand. Currently, the Government of Ghana supports the use of efficient ACs through awareness campaigns (Energy Foundation) and setting efficiency standards (Energy Commission). Consumer awareness and information sharing on the benefits can increase the sales of efficient ACs. It is expected that further standardization and technological advances will continue to improve the efficiency of new models – in an international market for appliances, Ghana cannot assume to influence this by national policies.

Efficient refrigerators are similar to efficient ACs, with the notable addition that a program to replace old and inefficient refrigerators may have additional climate effects, as old refrigerators may still use CFCs as cooling agent which have a high global warming potential and can be harmful if the old appliance is not disposed in a controlled manner.

Compact Fluorescent Lightbulbs (CFLs): Until 2 years ago, traditional, incandescent lamps were commonly used in Ghana. The purchase costs are lower than for energy efficient CFLs. However, over the lifetime of a CFL, there are significant net cost savings for households, due to lower electricity costs. Payback times for purchasing a CFL instead of an incandescent light bulb are less than half a year. In 2007, the Government of Ghana implemented the free replacement of 6 million traditional light bulbs by CFLs and banned the import of incandescent light bulbs. As a consequence, in 2009, only 3% of all lightbulbs in the country were still incandescent (Energy Commission, 2010). The program led to significant electricity savings, leaving more electricity to be used for other purposes.

MARGINAL ABATEMENT COST (MAC) CURVE

Figure 1 shows the Marginal Abatement Cost (MAC) curve for the five low carbon options described above. A MAC curve may help to identify the most cost-efficient options to lower GHG emissions (see van Tilburg et al. (2010) for a discussion on a MAC curve for Ghana). The graph depicts on the y-axis the extra (or 'marginal') annual costs of the options per tCO_2-eq reduced over the lifetime of the

technology. The x-axis shows the annual carbon reduction potential that can be achieved by implementing the low carbon option. This potential is given for the year 2020.

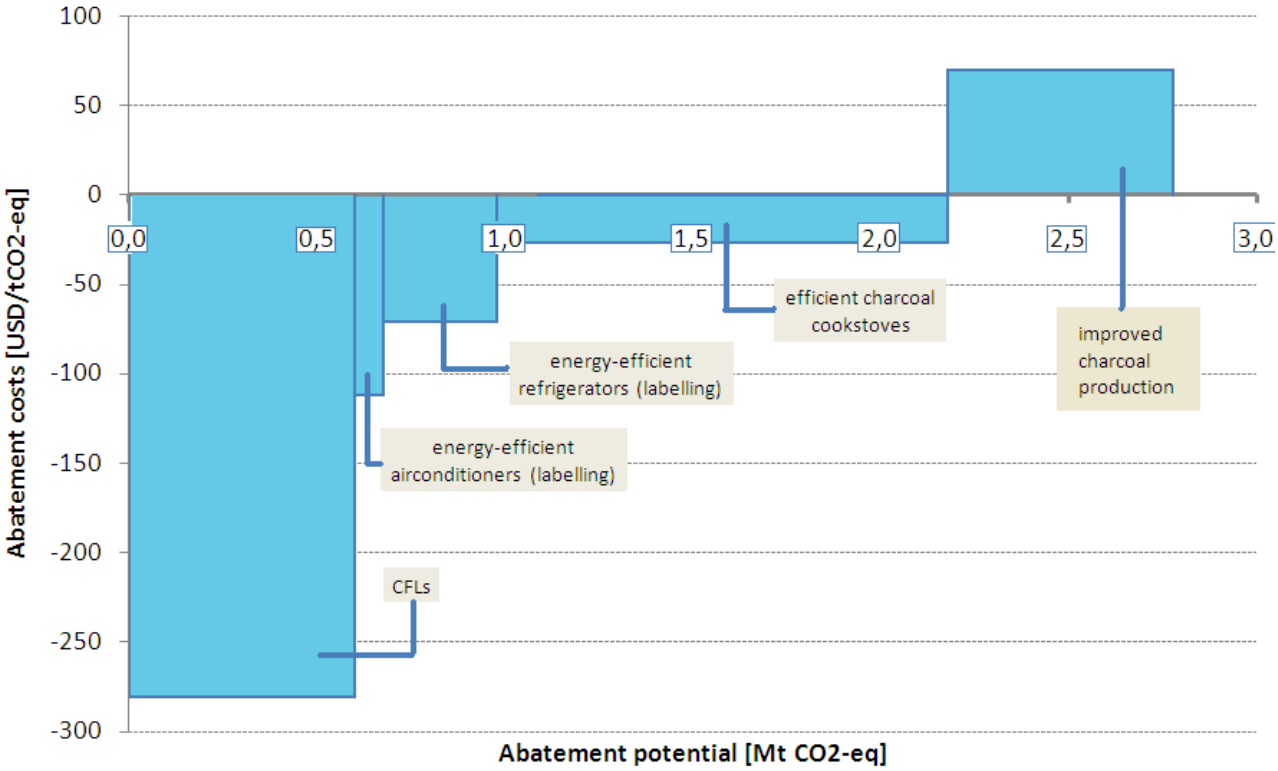

Figure 1: Marginal Abatement Cost (MAC) curve for household energy demand in Ghana in 2020[2]

The figure shows that with one exception the low carbon options discussed here have negative costs, i.e. they have net economic benefits while avoiding GHG emissions. According to this analysis, the replacement of incandescent lightbulbs with CFLs is the most cost-efficient option to reduce CO_2 emissions. This option has already been fully implemented by the Government of Ghana. However, other options to reduce household electricity use which are currently under implementation are also economically beneficial over the lifetime of the technology. The use of efficient charcoal stoves has the largest potential for avoiding GHG emissions. As discussed above, it also has significant

[2] **Assumptions:** 10% discount rate. Abatement potential for 2020, but due to high uncertainties about future inflation and price developments of the technologies analyzed, cost estimates are based on 2010 data.
Replacement of CFLs: assuming full replacement of incandescent light bulbs at costs to the consumer (not assuming the government subsidy of 6mio CFLs).
Efficient refrigerators: assuming energy efficiency labeling of refrigerators and consequently purchase decision for an energy-efficient model during standard replacement cycle (7% annual replacement + 5% market growth), not assuming an additional government-led replacement program. Assumes 2mil refrigerators in Ghana today. The calculation of GHG abatement potential only assumes CO_2 emissions from reduced electricity use, it does not assume the effect of proper disposal of CFCs when old refrigerators are replaced.
Efficient air conditioners. Assuming energy efficiency labeling of refrigerators and consequently purchase decision for an energy-efficient model Assuming annual replacement rates of 11% and 8% growth in the market. Assumes 400'000 air conditioners in Ghana today. The calculation of GHG abatement potential only assumes CO_2 emissions from reduced electricity use
Efficient cook stoves: Data mostly based on Voluntary Carbon Market projects for Gyapa cook stoves in Ghana.
Efficient charcoal production: Indicative abatement costs from Global Climate Adaptation Partnership (2010) due to lack of Ghana specific information. Abatement potential assumes full conversion to more efficient technologies.
A full overview of data and assumptions is available from the authors. Please contact Xander van Tilburg (vantilburg@ecn.nl).

development co-benefits. The cost for improving the efficiency of charcoal production is only indicative, as due to the informal nature of the sector no Ghana specific data could be found.

CONCLUSION

The discussion of GHG abatement potential, development benefits, costs, and barriers to implementation of low carbon options for household energy use shows that there are a number of options which save costs to consumers and the economy, avoid GHG emissions and have additional development benefits. Although the MACC curve suggests that there most of the options presented here have a lower emissions impact than the 'business as usual' situation, and that these options have 'negative costs', caution is warranted as a MAC curve only reveals one side of the story.

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