

POLICY BRIEF FOR
DECISION MAKERS

Ethiopia: The Climate Change and Energy Debate

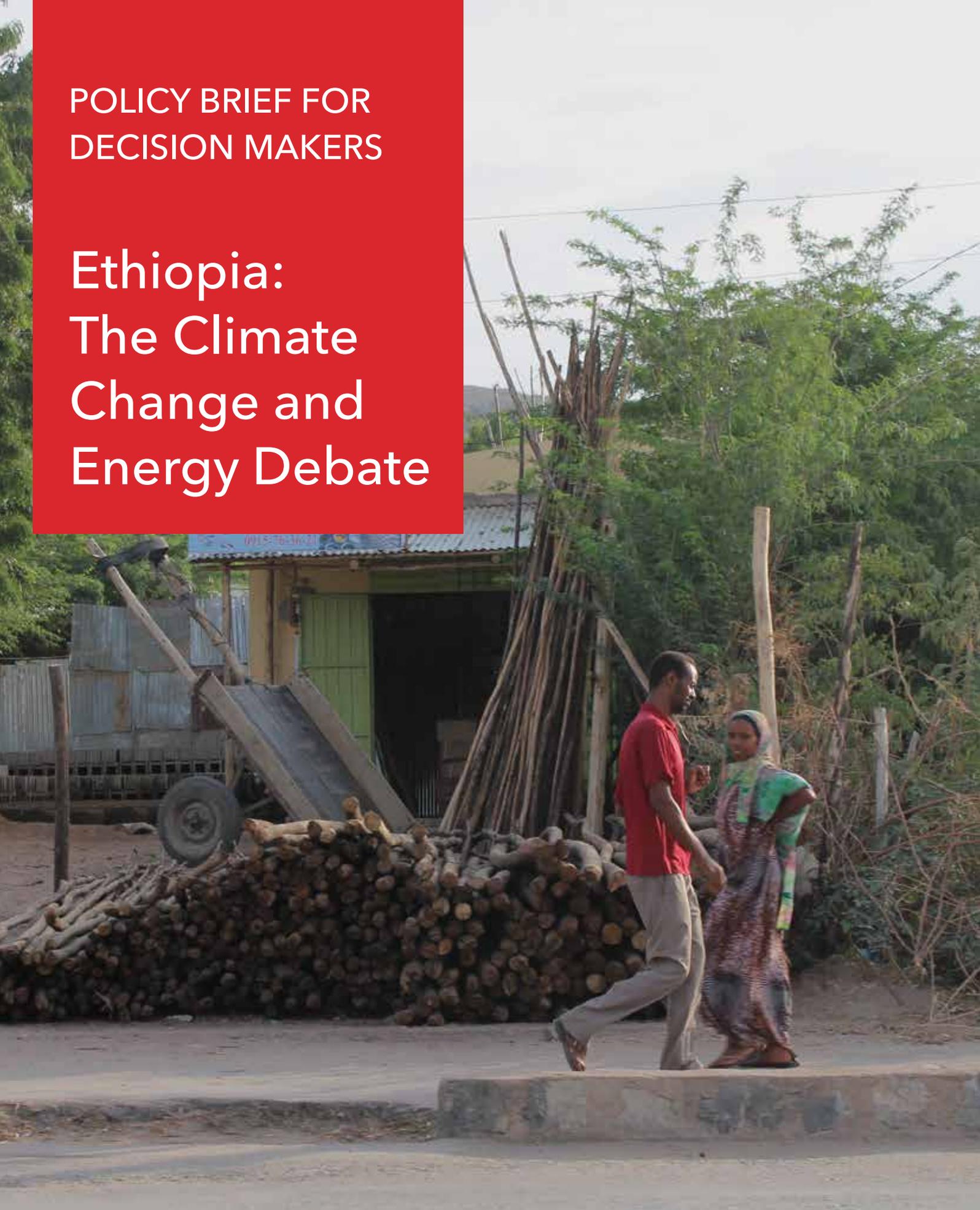




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Binyam Teshome / World Bank

1. THE PURPOSE OF THE POLICY BRIEF

The research project focused on the climate change and energy debate in the context of Ethiopia (with a focus on urban areas including Dire Dawa and Mekelle). The underlying question that the project investigated was:

How can viable alternative energy choices support inclusive growth of secondary cities in Ethiopia, taking into account future climate change and the need for environmentally sustainable, low-carbon, and universally accessible energy sources that also provide socio-economic benefits?

The research demonstrated that there are a number of options available to decision makers which can transform the energy landscape of secondary cities, and create multiple co-benefits in the process. Such a transformation is possible through:

- Opening-up the power sector to wider participation through an enabling regulatory framework;
- Exploring viable alternatives to biomass as a principle source of energy or improving the energy efficiency of biomass use;
- Improving data availability, awareness, and conducting strategic research to inform decision making on climate and energy; and
- Ensuring that urban development takes place in an inclusive and resource-efficient manner, through improved planning.

2. ENERGY CHALLENGES OF ETHIOPIA

Ethiopia's energy systems have not kept pace with the growth of Ethiopia's economy, nor with its accelerating rate of urbanisation and anticipated future energy demand.

a. Electricity in Ethiopia

While electricity access and demand are on the rise in Ethiopia, the growth in consumption is constrained by affordability and poor reliability. Many householders connect via indirect connections to the grid, meaning that they are charged more than the official tariff, limiting the affordability of electricity. In addition, secondary cities in Ethiopia are connected to the national grid, but the poor condition of the grid infrastructure results in losses during transmission, or failure and interruptions of the energy supply.

In Ethiopia's historically vertically integrated single buyer model, the state owned and managed the generation, sale, distribution, and transmission of electricity. While the market has been opened to independent power producers, this is still within a framework of the centralised approach, and the regulatory framework is not yet sufficiently enabling of more innovative options to solving power generation and distribution challenges. Thus, electricity generation facilities and infrastructure are commissioned (and sited) by the central government, while regional and local governments do not currently have influence or decision-making power over local or distributed generation options. There is no regulatory mechanism to

allow potential Independent Power Producers to generate power primarily for their own consumption (such as captive power plants at industrial sites) or to sell to bulk users (such as industrial facilities or even cities). Similarly, there is also no provision to enable individuals or entities to install embedded generation (for example, on-site generation through rooftop solar PV) and then sell the excess back to the grid.

Ethiopia, like many developing countries, does not contribute significant carbon emissions, particularly since hydropower is its dominant source of electricity. Nonetheless as demand for electricity is increasing – and with future hydropower availability subject to increased uncertainty due to climate change – it remains important from a climate resilience and energy security perspective to leap-frog the development path of industrialised countries and avoid a lock-in to carbon-intensive power generation. While there remains significant untapped hydropower potential in Ethiopia and in the region, there is the potential to supplement this with other clean/renewable energy options which would allow Ethiopian cities to benefit from a more climate-resilient, diversified energy supply.



Electricity is currently one of the constraints to economic growth

- Grid connectivity is advanced, but usage is limited and transmission infrastructure is ailing, leading to interruptions in power supply
- The system is based on a historically vertically integrated, single-buyer model, with very recent moves towards opening up for Independent Power Producers (IPPs), still within the single-buyer model
- The energy mix is dominated by hydropower, and needs to diversify to ensure long-term energy security



Biomass dominates household consumption

- Heavy reliance on biomass at the household level leads to adverse health impacts and environmental degradation, even as rising costs of biomass increase household expenditure



Urban expansion, particularly of secondary cities, is taking place at a rapid rate

- The growth of cities is outpacing the installation of the required energy infrastructure
- Urban growth is seeing an expansion of communities living in poverty in these areas

b. Reliance on Biomass

Ethiopia, like many of its African counterparts, is overwhelming reliant on biomass-based energy by households for cooking purposes, primarily charcoal and wood. Burning biomass has public health and environmental consequences, and the social and environmental costs of these energy sources are not reflected in their pricing. While this reliance on biomass is unsurprising in rural areas, what is striking is that even in urban areas (including secondary cities like Dire Dawa and Mekelle), households still use charcoal, firewood, and other biomass for cooking rather than electric stoves. However, recent accurate data on cooking sources is not available, leaving it hard to map the trends over the last five years in this regard.

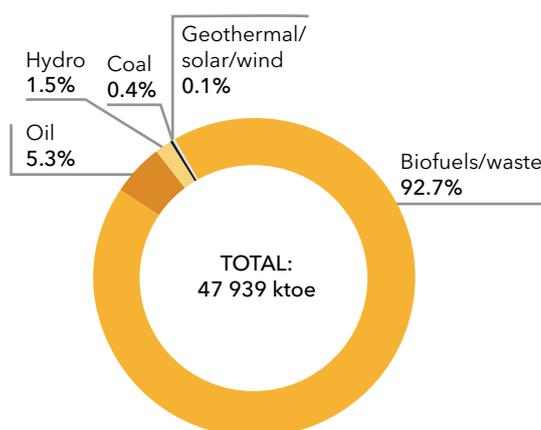
Ethiopia's reliance on indigenous biomass is both an environmental and public health concern, as well as an energy security concern (costs of biomass have already risen to high levels, given the country's diminishing forest cover and ever-decreasing source of supply).

The entrenched use of carbon-based energy in households is exacerbated by the use of carbon-based energy in industrial entities. Coal is a common fuel for thermal energy in industrial processes, such as cement manufacturing. Cement is a growing industry in Ethiopia (tied in part to the country's booming construction sector), and plans to establish several industrial parks around secondary cities suggest industrial fossil fuel use will continue to rise. However, the low level of industrialisation in Ethiopia means that this is still a small percentage of the total energy use.



Altogether, over 90% of Ethiopia's total energy use is biomass-based.

TOTAL PRIMARY ENERGY SUPPLY IN ETHIOPIA IN 2013



3. THE POSSIBILITIES OF A CLEAN ENERGY FUTURE

The challenges in energy provision and use call for a new approach to electricity supply. Fortunately, the opportunities to transform the status quo in Ethiopia are numerous. The potential for hydropower and other low carbon energy options such as solar, wind and geothermal are substantial, and to-date largely under-exploited, and come with the added benefit of mitigating future greenhouse gas emissions. Low-carbon energy sources will ensure long-term sustainable access to safe, modern, reliable energy services in Ethiopian cities. Scaling up a renewable energy industry and driving energy efficiency would also aid the creation of green jobs and generate wealth in urban communities involved, for example through the creation of new value chains (such as trained technicians for installation and maintenance of renewable energy units). Already there are some projects underway to develop waste-to-energy technologies in secondary cities, and programmes for improved cookstoves and alternative fuels for cooking and for industry, and small-scale renewable plants (hydro and biogas).

Developing a renewable energy industry will create new economic opportunities

Scaling up clean energy and allowing for different modes of delivery (that may or may not depend on the national grid) can help ensure that communities in urban areas enjoy a full suite of energy services and leverage these to increase productive activity, accelerating economic growth. Cities in Ethiopia would be well served by better understanding how active measures to grow a renewable energy industry in the area could help income generation and wealth creation in urban communities involved, e.g. through the creation of new value chains (such as trained technicians for installation and maintenance of renewable energy units).

INDIGENOUS ENERGY RESOURCE POTENTIAL AND CURRENT LEVEL OF EXPLOITATION IN ETHIOPIA

Resource	Unit	Exploitable Reserve	Exploited Percent
Hydropower	MW	45,000	< 10%
Solar	kWh/m ² /day (TWh/annum)	Average 5.5 (2.2 million) (Derbew, 2013)	< 1%
Wind: Power (Speed)	GW (m/s)	1,350 (>6.5)	< 1%
Geothermal	MW	7,000	< 1%
Wood	Million tons	1,120	50%
Agricultural waste	Million tons	15 - 20	30%
Natural Gas	Billion m ³	113	0%
Coal	Million tons	> 300	0%
Oil shale	Million tons	253	0%

Securing the future energy needs of Ethiopian cities

Although the likely impacts of climate change on hydrological variability still require a great deal of additional research, a more climate-resilient energy mix can enhance energy supplies even in the short term, and bring a range of socio-economic, gender, and public health co-benefits. Wind energy in particular has significant potential for complementarity with hydropower resources (especially due to seasonal complementarity).

With the population of secondary cities like Dire Dawa and Mekelle expected to double in the next 20 years, and per-capita consumption of energy expected to rise markedly, it is important that households - by far the biggest consumers of energy in these cities - be provided adequate, reliable, affordable, and effective alternatives to carbon-intensive traditional energy sources, or more energy efficient use of biomass. Expanded choice of low-carbon energy sources, coupled with more reliable and uninterrupted power at affordable rates, are important for cities across Ethiopia to move towards a low-carbon, climate-resilient energy future.

Small-scale power supply options

Small-scale, localised, off-grid or mini-grid applications (such as rooftop solar water heaters and municipal waste-to-energy or biogas plants) are also attractive options for cities in Ethiopia to consider adopting. By supplementing their power use from the national grid, cities can provide greater energy services to residents, and help create more economic opportunities through more reliable and consistent power supply. While the grid's broad reach diminishes the argument for large-scale ramp up of off-grid technologies, the lack of reliability and the current intermittency of grid-based power provides an argument for cities, households and enterprises to supplement their power supply where possible, preferably with clean energy.

Resource efficient cities

Whatever energy supply scenario unfolds, it is essential that cities grow in a spatially smart and resource-efficient

HIERARCHY OF SPATIAL PLANS IN ETHIOPIA



manner with buildings that contribute to climate resilience and infrastructure that avoids lock-in to fossil fuels and to energy or transportation inefficiencies. Strategic and integrated spatial planning, with a greater emphasis on low-carbon growth, is a valuable tool in this context.

Globally, cities are responsible for an estimated 75% of global energy use and 60% of greenhouse gas emissions. In a country of rapidly expanding cities, the way in which cities are planned and managed has enormous implications for the long-term viability, resource efficiency and global competitiveness of those cities and the countries they inhabit.

Urban planning in Ethiopia occurs via two main planning processes. Firstly, the creation of the citywide master plan, and secondly, the creation of local development plans at the sub-city level. Both are informed by the national urban development scheme. Local development plans are, in effect, the implementation plans of the master plan. It is critical then, that the consideration of clean and renewable energy options, and improved energy efficiency, are taken into account in all of these plans.

4. KEY ACTIONS FOR SUSTAINABLE URBAN ENERGY

There are a number of interventions that can facilitate the transition to a cleaner energy future in Ethiopia, consistent with steps already being taken in countries with a similar urban growth trajectory, such as Mozambique, Uganda and Kenya. In order to meet growing demand for electricity and reduce biomass dependency, these countries are also capitalising on their endowment with low-carbon energy

sources, and are beginning to make strides towards more decentralised energy systems, diversified energy mixes, and off-grid solutions. Some of the actions that could be considered in Ethiopia at the national level, at the regional/city level, as well as cross-cutting measures, are outlined below.

a. At the National Level

Innovative **regulatory reform** could allow cities and regional governments greater decision making in localised power generation and supply, while also catalysing private sector involvement in the energy sector. This could include structuring a Feed-in-Tariff, market restructuring to allow for Independent Power Producers to sell directly to customers (rather than being obliged to sell to the grid), as well as technical and regulatory provisions for net metering and embedded generation. Alongside any regulatory reform of this nature, local and central governments need to be strongly capacitated to make such change effective. The establishment of cogeneration plants (based, for example, on bagasse as a feedstock) which would allow companies in the agricultural sector, such as sugar estates, to produce power for their own consumption and to sell excess to the national grid, particularly if net metering were introduced, is one option that would support local needs while adding to the national supply of electricity.

Upgrading and enhancement of the existing national power grid will not only help make the current power supply

(largely hydro, and thus low-carbon) more consistent and reliable, it offers an opportunity to modernise the grid to enable the uptake of more intermittent renewables like wind and solar.

Improving operation and maintenance of the national grid is critical in ensuring that the real value of any upgrading and enhancements is realised over time. This requires sufficient investment on an annual basis for maintenance and rehabilitation in particular.

It is important for the Ethiopian government to invest in **ongoing research on low-carbon and/or affordable energy** options for Ethiopia - and particularly its growing secondary cities. International funds are available to support investment by the Ethiopian government in this regard. A stronger knowledge-base will allow for more informed and effective decision making about low-carbon energy growth. Such a knowledge base would by necessity require improvements in data and analysis to understand trends in energy usage.

b. At the Regional Level

Within their existing fiscal powers, regional governments can investigate the design and introduction of economic incentives for locally based industries to invest in captive generation from renewables, as well as improved biomass combustion for industrial thermal energy.

Regional governments and cities could also consider the development of **guidelines for energy efficiency** in buildings. Energy efficiency codes and green building

design guidelines could be developed to ensure that new buildings make the most of currently available technologies and designs to reduce their energy demand. Building smartly at the outset avoids the need for costly retrofits of efficiency measures later. Such efforts should, of course, be harmonised with any national codes and guidelines.

C. At the Municipal Level

While Ethiopian cities do not currently make decisions about **supplementary power supply at the city level**, relying, instead, on the national grid, they could explore the potential for city-level supplementary energy solutions, firstly within the existing regulatory regime as well as through potential future devolution of some energy-sector powers. City-level management of basic service provision, as opposed to regional or national level management, is already in place in the case of water and sanitation services. A similar model where the city could play a greater management role in power generation and supply is one worth investigating.

Several off-grid options are feasible from a regulatory point of view even today, without legal reforms (e.g. solar rooftop water heaters, or a local micro-grid connected to a biogas digester such as one that is already being constructed in Addis Ababa). Municipal government must, however, ensure that adoption of off-grid applications like solar water heaters does not disproportionately benefit the wealthy while perpetuating energy poverty within under-served communities.

A more climate-resilient and environmentally and socially responsible energy profile that cities could promote could include the installation of:

- rooftop solar water heating;

- municipal or industrial waste-to-energy biogas plants to serve specific areas or industries;
- micro-grids running on solar or wind power for designated industrial or domestic areas; and
- Improved cookstoves for wood and charcoal use, and improved charcoal kilns to improve the energy efficiency of biomass use, while supporting the transition to electricity use at household level.

With the appropriate regulatory regime, city-level power generation would allow cities to use such energy to supplement grid electricity to meet local needs, and to generate an additional revenue stream through power sales back to the grid in the case of excess generation.

However, the long-term resource efficiency of cities is also dependent on their **spatial development**, and in the face of rapid expansion, effective spatial planning and control becomes an important tool in improving energy efficiency. More compact settlements with mixed land-use that provide citizens with access to jobs and services without the need for long commutes, can avoid a degree of lock-in to a resource-intensive spatial form. A carefully planned city, through the citywide master plan and local development plans, can reduce long-term energy demand, particularly from transportation, thereby reducing reliance on fossil fuel imports and improving energy security.

d. Cross-cutting Issues

A key priority should be to **improve energy efficiency** and reduce waste (such as transmission losses), even as the government works to facilitate the growth of renewable energy. Energy efficiency is often the least cost option for meeting energy service requirements. The industrial sector in Ethiopia would be well served by investments in process efficiency and more efficient end-use devices (e.g. heat recovery and better kilns in cement factories, improved kilns and stoves in small enterprises, improved cook stoves in commercial establishments like hotels and restaurants). Even in the household sector - where power consumption is extremely low and there is much room for energy services to be scaled up - improved energy efficiency of stoves and charcoal production will be beneficial in reducing the social and environmental costs of these energy sources. Returns on investment in energy efficiency or energy efficient appliances are typically fairly rapid, making this an attractive option.

Introducing new low carbon energy options, on the other hand, can have high up-front costs, despite often being competitive with conventional systems on a life cycle basis. To overcome the barrier of high up-front costs, **access to credit or affordable financing** is an important factor. The

first step towards this is better information availability and actionable data, such as through robust resource assessments. Once Ethiopia opens up its market to IPPs, initial projects may have to be financed on the balance sheets of investors (equity financing). However, as lenders start seeing results and the market matures, there will be greater scope for debt financing from banks and other financial institutions.

Different types and sources of financing are required to address the current market and regulatory barriers. Financing for market readiness and regulatory reform activities can be provided by the government and international development agencies. Such financing is already being used to evaluate renewable energy resources in Ethiopia and to build the regulatory capability in the national energy regulator - the Ethiopian Energy Authority. It is plausible that with the right regulatory framework and financial powers, secondary cities could also finance such market readiness activities with the help of donor agencies.

Financing for small scale decentralised systems (such as improved stoves for households), on the other hand, should address the needs of both small and micro

enterprises (producers and suppliers of the stoves) as well as consumers. Because of the small size of the financing required for such projects, micro finance institutions might be well suited to meeting these needs. There are already examples in Ethiopia of development finance institutions providing low interest finance to enterprises and consumers in the form of small loans, channelled through larger funds.

Commercial banks and multilateral finance institutions are expected to be the main sources of financing for low carbon technologies in the medium to long term. In order to ease their entry into lending for low carbon technologies, development partners have begun providing capacity building support to a few Ethiopian banks (in areas such as market research, and technical capacity) and have also started providing capital with risk-sharing arrangements (so that banks will not seek exceedingly high collateral from investors).

All these developments are at an early stage in Ethiopia, and continued financial as well as technical support - coupled with strong research and market intelligence support - will be needed to assist Ethiopia make a successful transition to a green, low-carbon energy future.

While policy interventions (likely at the central level) are needed to keep low-carbon energy sources competitive in Ethiopia, the role of policy and financial incentives may not be adequate to create a change in personal preferences that are heavily influenced by tradition. Households need to be trained in energy efficiency and green technologies that have been implemented (on how to use them), and should also be involved in the stakeholder engagement process during the development of programmes, to ensure that solutions are relevant for them.

National and local government with the help of community organisations could help **create more awareness** within households of the benefits of cooking with cleaner fuels. More personal education about available alternatives and a better understanding of health impacts of cooking with traditional biomass could help accelerate the shift towards modern cooking methods, and alleviate the burden on women who are often responsible for sourcing biomass and subject to the health impacts from burning it. Government should also conduct research to understand and enhance the impact of efficient cookstove programmes and fuel modernisation (using ethanol, efficient charcoal production, insulated passive cookers such as Wonderbags¹, electricity, and other innovations), as well as trends towards electricity use at the household level.

e. Research Requirements

Improved information is critical to managing the future trajectory of energy use and demand in Ethiopia, and in this regard, research plays a critical role. Key research areas include:

- Improved climate projections based on robust and reliable data
 - Energy demand modelling that factors in impacts of climate change
 - Understanding the needs and challenges for mainstreaming low-carbon, climate-resilient development in an urbanising Ethiopia
 - Research to support the development of a renewable energy policy for Ethiopia
 - Sociological studies, including gender analysis, on household energy use in Ethiopian cities
- Cost-benefit analysis of low-carbon energy solutions in Ethiopian cities
 - Studies on the potential and appropriate mechanisms for the national grid to integrate renewables
 - Investigations into clean energy and energy efficiency options for energy-intensive industries in Ethiopia
 - Studies on the effect of subsidies and other energy policies on pricing of electricity and competitiveness of non-hydro renewables

¹ <http://www.wonderbag.co.za/>



5. CONCLUDING REMARKS

Secondary cities have a vital role in ensuring that Ethiopia develops in a climate-resilient, environmentally sustainable, energy-secure and economically inclusive manner. To ensure that these goals are realised in a mutually enhancing and complementary manner, rather than in a misaligned, mutually exclusive manner (as they are commonly perceived), it is important for decisions to be taken that - at the very least - explore the devolution of energy supply from a centralised system toward more

regional, municipal and private sector autonomy. Such a shift will have a greater likelihood of success if the knowledge base around climate impacts, energy demand and supply options, as well as energy policy and planning, and financing is improved. At the same time, urban areas (new and existing) need to be planned and developed in a manner that ensures long-term resource efficiency (including energy supply and consumption), leap-frogging the industrialised world's development trajectory.





Cities Alliance

Cities Without Slums