[*A MIXED METHOD APPROACH TO MODELLING ELECTRICITY DEMAND PATHWAYS IN ETHIOPIA*]

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Overview

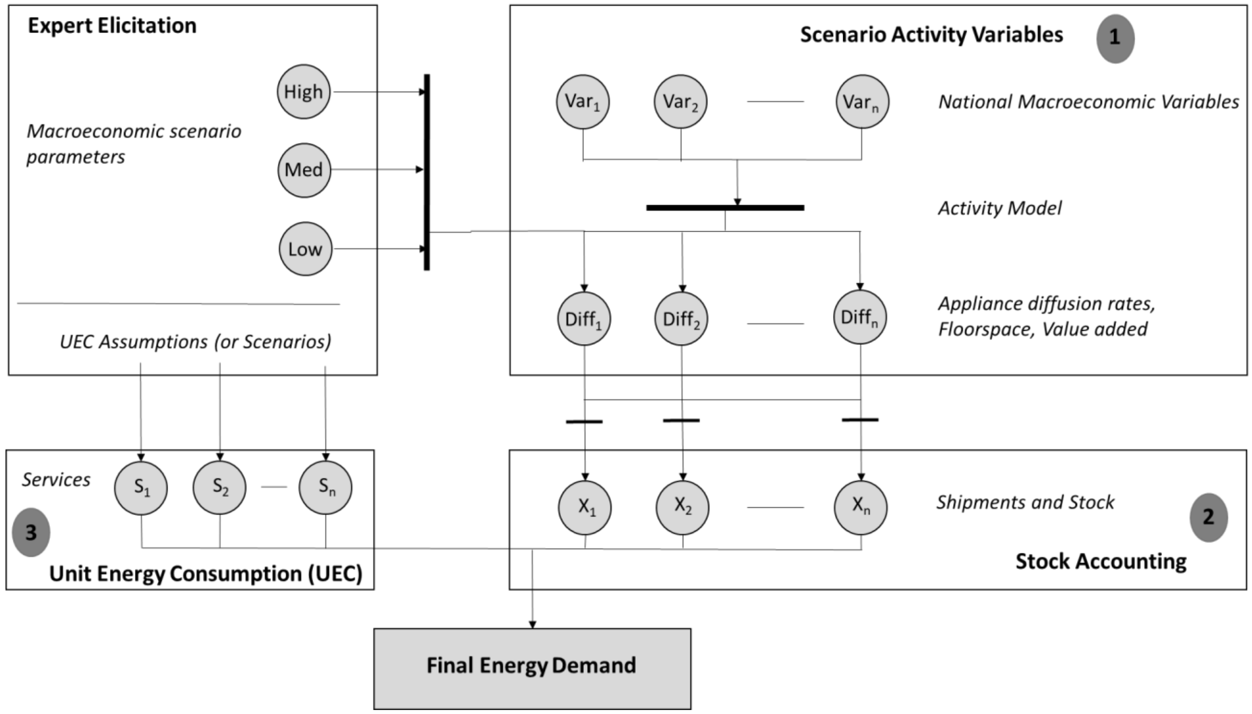
Ethiopia has the goal of reaching lower-middle income country status by 2025 (NPC, 2016), and has also set the goal of achivieng universal energy access by the same year (MOWIE, 2019). Given the country's near term exposure to large hydropower electricity generation, water availability risk, and abundance of other renewable resources (FDRE, 2011), the above goals, and how they are achieved, will have major and long term implications for the energy trilemma of achieving universal energy access, supplied by an energy system that is secure from any shocks or stress, but limits its adverse effects on a changing climate.
A key element of the planning required to manage these issues in an uncertain future is a rigourous exploration of the demand to be met over the long term. Failure in this regard can lead to problems with any one, or all three of the outlined energy priorities.
This paper therefore contributes to existing models for Ethiopia by using a mixed method approach to model pathways of electricity demand in Ethiopia. Both qualitative and quantitative methods of data collection and analysis are used in a complimentary manner to model scenarios of electricity demand in Ethiopia through to 2060.

Methods

The paper makes use of two primary methods to achieve its objective: (1) Expert elicitation on the future of key drivers influencing electricity demand in Ethiopia, used to explore scenarios of electricity demand using (2) a bottom-up electricity demand model for the country.

The expert elicitation process involved the interview of local experts to obtain their judgements about the future quantities of the uncertain drivers in the form of a probability distribution. This interview process also involved discussion on the expert's reasoning behind their judgements that aided scientific rigour and provided qualitative data for the final scenarios to draw from.
A pilot elicitation process was initially undertaken with four experts, to test the process in the context of this work, and to finalise the drivers considered. The following four driver variables for Ethiopia by 2060 were selected: avergage GDP growth, average population growth, percentage urbanization, and average household size.

The Long-range Energy Alternatives Planning tool (LEAP) was used to build a bottome-up model of electricity demand for Ethiopia. The modelling methodology drew from McNeil et al. (2013), with three main analytical steps (see illustrattion on the next page): (1) the use of pooled cross-sectional data and panel data for a range of countries (minimum 20 data points) to estimate appliance diffusion, or other related activity measure in the residential, industry, commercial, and other sectors as a result of changes in the relevant driver variables; (2) an endogenous stock analysis undertaken in LEAP to present the appliance stock in each year using the projected diffusion rates and other relevant drivers (e.g. population growth), and survival profiles and country plans for appliance efficiency; and (3) the estimation of unit energy consumption (UEC) for every appliance in the model, based on appliance power output and annual usage.
The model accounts the product of stock and UEC in each year of the model to determine electricity demand for all appliances for each service operating in every sector of the model. The annual summation of this provides the total projected demand for that year in Ethiopia.



Results

This paper is part of a larger project which, as part of its work, conducted a local epert workshop to develop scenario narratives of five possible social, economic and technical futures in Ethiopia. The scenarios modelled in this paper consider pathways for the selected driver variables in accordance with those narratives; the numerical limits of which are guided by the expert elicitation that was conducted.

The five narrative scenarios account for two demand related-pathways, which can broadly be categorised into a high growth scenario and limited growth. The driver vairables in each scenario will co-evolve till 2060 according to discussion held in the expert elicitation interviews, and economic theory.

Analysis of the completed expert interviews will produce visuals (box plots) on the probability distributions of each expert for each driver considered, and the resulting ranges considered for each scenario. Discussion on the reasonings of the experts as a whole will also be undertaken to showcase the story behind the distributions observed.

Final model outputs will hihglihgt and discuss pathways of electricity demand over the model timeline in across sectors in each scenario. We expect the general divergence across the two scenarios to be as expected – the limits of which though, may prove interesting.

Sensitivities around key model assumptions will also be conducted to explore further, less obvious, insights residing in the model, in the event of alternative occurences in the areas of policy, stochastic events, and behavioural change.

Conclusions

This paper provides long term scenarios of the potential demands placed on Ethiopia's power sector. It has been informed by the judgements of Ethiopian experts, on what are uncertain futures of key drivers of this demand. The outputs provide key inputs for energy system examinations for the country, such as the costs of meeting this demand in a manner that simultaneously works towards the different strands of Ethiopia's energy trilemma, and the policy options for doing so.

References

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