Comprehensive and Integrate Impact Assessment Framework for Development Policy Intervention

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Introduction

In the current frame where climate change, over-exploitation of natural resources and sustainable development are becoming day by day more relevant, it is no more possible to ignore the pace at which developing countries are growing and earning a pivotal role in the global context. Additionally, recent intense migration flows together with the projection of the population growth, especially in the African continent, are putting lights on the need of taking action. Nowadays, still the major amount of rural population in Africa does not have access to electricity; this, in turn, implies the lack of access to basic services, like education, health services, the use of potable water for drinking and cooking, and consequent efficient exploitation of lands for agriculture and breeding. An urgent action is required, that combines development strategies with local and global needs. Moreover, due to their socio-economic dimension, African countries have the full potential to implement a growing path able to match the social and economic development with sustainability issues, especially in the energy sector.

Aim of the project

Thanks to the scientific expertise acquired in years of research activity devoted to African context, climate change, energy and economy nexus and their linkage with policies, Fondazione Eni Enrico Mattei (FEEM) can contribute to fostering African development with a multidisciplinary, comprehensive and integrated research approach called *ComprehensIVe and Integrated Country Study (CIVICS)*. The aim of this project is to sustain national policies drawing a sort of guidelines acting as "sustainability compass", thanks to the integration of different tools for impact evaluation of various implementing strategies at the national level. All these tools combined create a framework that African decision-makers can use to support their choices, thanks to the possibility of assessing impact of national strategies at both economic and environmental level. Additionally, having a strong focus on the energy sector that is considered crucial for the above-mentioned reasons, this framework also gives forecast on future energy scenarios and provide solutions based on the conscious exploitation of renewable resources with low environmental impact. Furthermore, it has a double advantage: not just drawing development pathways that are in line with local needs and strategies, but also matching local policies with the sustainable development framework of SDGs, and thus promoting a development which is also sustainable and aligned with the present global challenges.

Methodology: the integrated modelling framework

The tools used are:

i. Supply chain analysis (SCA) of local products;

ii. Input-output analysis (IOA) tool;

iii. Energy modelling tools.

From the SCA it is possible to derive information about bottlenecks in the supply chain of local products that are strategic for the national economy. Indeed, by analysing step by step all the processes involved in the production of a good or a service, the supply chain criticisms are highlighted, and possible ad-hoc implementing strategies can be formulated for the improvement of the process. These improvement strategies can affect the energy, social and economic sector of the country; thus, they need to be assessed so that they can fit in the sustainable frame. This can be done by integrating SCA results with shock analysis performed by IOA tool. In such a way, impacts at a social, environmental and economic level of these strategies can be evaluated. Additionally, with energy modelling tools, it is possible to formulate an energy strategy ad-hoc for these interventions, addressing also the sustainable framework (CO_2 reduction, etc.).

The impact assessment tool of the integrated framework of CIVICS is based on the theory of input-output analysis and serves as an instrument for assessing the impact of a specific solution in the context of the entire economy under analysis. For this reason, in order to have a survey width that is as extended as possible, it is necessary to take into

account all the production systems that characterize the economy with the maximum available sectoral characterization and all the relevant impact categories.

The integration between the various tools of the system allows to face the problem with a multidisciplinary approach. In this context, the adoption of an input-output model acts as a bridge between supply chain analysis and energy modelling. In this sense, after a specific study of a given supply chain in the country being researched, it will be possible to identify the problems, evaluate the possible solutions and the consequent impact, in terms also of variation in energy demand. This variation of energy demand will be provided to the energy model. In particular, the energy system modelling of a country consists in the description of the power generation technologies, transmission lines and energy demand of the country, with the main constraint of ensuring the energy balance of the system between hourly energy demand and energy supply. The selected modelling framework is capable of optimizing the hourly dispatch of energy and the eventually necessary asset stranding minimizing the total actualized cost function.

All the tools used for the analysis are open-source in order to guarantee the future ownership of the local stakeholders. In such a way, through a process of empowerment, they can be aware of the co-developed activity and unleash a sustainable development. Also, relying on open-source tools and open-access data ensures the possibility for the stakeholders to depend on their own capacities after the conclusion of the project, besides of guaranteeing a sound scientific reliability to the entire process.

Results: the pilot case of Kenya

The case study on the basis of which the CIVICS approach was tested concerned the Kenyan coffee sector. Thanks to strong partnerships developed at local level, it was possible to organize field missions, visiting all the stakeholders of coffee supply chain and studying the organization of the several production steps (from bean to exporters / local consumers). This activity allowed to integrate field-observations and interviews with literature on coffee and get evidence of bottlenecks in the chain. Also, thanks to active collaborations, it was possible to collect energy data in order to model the Kenya energy system with more details and spatial resolution (i.e. multiple node approach).

In particular, the impact of the construction of two new coffee grinding sites (mills) in strategic locations to minimise transport costs was assessed, as all the coffee supply chain stakeholders identify the scarcity of mills and the high transport costs as two of the main criticisms. In addition, the presence of unused coffee waste was observed, during the primary process. For this reason, an impact category was introduced, modelling the production of biomass from coffee waste. In this way, in integration with the energy model, it was possible to simulate and evaluate the possibility of the installation of a plant for the production of electricity from the combustion of biomass from coffee waste or the installation of an anaerobic digester for the production of bio-methane to be used as fuel for power production.

With the help of the input-output model, it was possible to evaluate the indirect impacts linked to the saving of transport for farmers, in bringing coffee to the mill and the introduction of new machinery. Subsequently, a scenario of increased demand for coffee was simulated in conjunction with the above interventions.

Through the energy model it was possible to assess the potential impact of the proposed strategy on two different levels. The baseline work conducted for the study was the realization of a model of the national electricity system of Kenya, composed of four geographical nodes, characterized by their hourly electrical demand through a year and the power plants installed in each of the defined nodes; this permits a detailed characterization of the functioning of the national energy system in the reference year of 2015. From this baseline scenario is possible to assess the impact of the proposed shocks by means of comparative analysis.

The first level of shock assessed is the effect on the energy system of the change of national electrical demand, provided by the IOA tool, to understand how the system would react to the new load, and the identification of possible criticalities.

The second level of analysis that is conducted by means of the built energy model is the evaluation of the possibility of connection of two different kinds of technologies to the national grid, namely a biomass power plant and a biomass gasifier for the production of methane to exploit the waste biomass produced by the supply chain of coffee. An optimization can be performed to assess which option is more cost effective between the two above-mentioned technologies, or if the construction of one single technology per each milling facility, where the waste biomass is produced, is more efficient for reasons linked to logistic costs.

Finally, the results yielded by the energy model can ultimately be fed again to the input output model to assess the impact on the entire socio-economic structure and the environmental implication of the solution identified through the energy model, guaranteeing in this way a holistic nature to the process.