Prospective analysis of energy resilience to Climate Change at community level

Avila-Nuñez, Alberto, Posgrado en Ciencias de la Sostenibilidad de la UNAM, +527222062459, aavnu@ier.unam.mx
Castro-Domínguez, Juan-Carlos, Instituto de Energías Renovables UNAM, +527773003482, jccad@ier.unam.mx
León-Rodríguez, Nario-Ruperto, Instituto de Energías Renovables UNAM, +527773433481, nleo@ier.unam.mx
Cedano-Villavicencio, Karla G. ,Instituto de Energías Renovables UNAM, +527771358071, kcedano@ier.unam.mx

Overview

Climate Change (CC) is a well-known topic in Energy research, due to the role of energy systems (ES) in the GHG emissions and the mitigation efforts to prevent higher temperature increases. CC impacts the whole ES dynamics, changing the consumption patterns due to temperature increases, affecting critical infrastructures such as grid networks or power facilities, and also generating an increase in energy resources variability and scarcity (e.g. hydropower).

In recent years, the concept of climate resilience has been adopted, including both mitigation and adaptation strategies in order to maintain, improve and transform infrastructures. Regarding ES, the concept of energy resilience (ER) is used and it includes other impacts beyond CC, such as societal, cultural, political or economical ones. In that sense, the ER concept is explored in this study at community level, where the national level dynamics, the community's material conditions and the household needs are closely related and determine its ER.

Methods

To model this approach, the community of Emiliano Zapata, Morelos in Mexico was selected. First, potential CC impacts in the local ES were identified; then possible climate resilience scenarios were explored, as well as strategies to increase ER. Different combinations of strategies for Energy Efficiency, technology substitution and spread of Renewables in the local energy mix were used to develop four scenarios: Business as Usual (BAU), Technical Resilience focused in adopting only Energy Efficiency solutions (RET), Sustainable Resilience (RES) with the aim to decarbonize and adopt new social measures to fight climate change, and finally Desirable Decarbonization (DDE) that explores a deeper transformational change of the community both in technological and societal ways. Finally, these scenarios were modeled using LEAP software in order to identify the future ES dynamics (offer, demand and resources availability) as well as the potential mitigation outcomes at community level for the period between 2021-2050, using historical data from 2010-2020 to calibrate the model.

Results

Preliminar results show that the BAU scenario reaches the biggest emission scenario as expected, while RET and RES scenarios achieve significant savings, the first one considering expected technological changes driven by the market, and the second one, by adopting renewable energy and electrification. The DDE scenario explores a nearly net-zero future in 2050 consuming less energy than the 2020 levels, even considering the demographic expected growth and expected temperature increase of nearly 2°C. Also only in the DDE scenario a 2°C warming condition was expected, and the other scenarios experiment with impacts of 2°C< global warming increase.

Conclusions

Solar PV spread and electrification of household energy needs were the game changers to enable this transition in RET, RES and DDE scenarios, as society organization and strengthening of local governance were crucial to also enable the technological substitution. Demonstrating that most ambitious net-zero plans must be reinforced at community level taking into account their context (demography, cultural, geography) and propose beyond technological solutions in order to prepare the population to fight against climate change and promote local ER.