SMR role in achieving NDC goals in Isolated systems

INPRO

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The energy sector is the main source of greenhouse gas emissions. Therefore, measures aimed at reducing them, such as increased penetration of renewable energies, improved energy efficiency, expansion of the nuclear generation capacity, carbon capture and storage, among others, significantly contribute to achieving Mexico’s reduction goals.

Mexico target is to reduce **35% by 2030 of GHG relative to its baseline**, with at least 30% coming from domestic resources and 5% through international cooperation and financing dedicated to clean energy. (Mexico NDC, Update 2022)
For administrative purposes, the National Electric System (SEN) is divided into 10 control divisions. The National Interconnected System (SIN), which constitutes the country’s large electrical grid, covers seven control regions of the SEN that are interconnected, along with the isolated systems of: Baja California (BC), Baja California Sur (BCS), and Mulegé (SEM).

**BCS Isolated System**

- Cities that rely on tourism as their most important income
- Two nodes, (La Paz and Los Cabos)
- More than 1,000 km of empty desert
- No natural gas pipelines, thus there’s a restriction regarding the use of more NG for power generation.
- Electricity Generation mainly through fossil fuels (Fuel oil and diesel)
Model & Inputs

Balmorel is a detailed techno-economical partial-equilibrium model suited for analyses of power systems. The model optimizes societal welfare across time and regions by minimizing the total cost of a given energy system.

01 Demand
The electricity demand relied on official data published for the period 2018 to 2035, after that year it was estimated with ESTAP Times. A disaggregation of the demand was conducted based on the 10 Control Regions (RC) considering their hourly consumption patterns.

02 Costs
The baseline fuel prices for the planning horizon were obtained from the Annual Energy Outlook 2022 (AEO). For the costs associated with different generation technologies: the Energy Information Administration (EIA) and the National Renewable Energy Laboratory (NREL). Learning curves were also applied to technologies in order to show costs reductions over time. For nuclear power plants the costs were taken from the national power company, and the fuel costs were calculated using the AP1000 as a reference.

03 Renewable potential
The country benefits from a high potential for renewable resources. It enjoys abundant solar resources, particularly in the northern regions. Additionally, it has significant wind resources, especially in coastal areas and the Isthmus of Tehuanotepec.
Renewable energy potential
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Storage technologies
For storing electricity all regions can invest in batteries, Pump Hydro Energy Storage can only be considered in 5 regions (BCS is not one of them)

Transmission lines
BCS System has the option to interconnect the rest of the country by an underwater transmission line after 2037

Nuclear
Among the assumptions that were applied regarding the possibility of allowing the installation of new nuclear energy capacity in the country, there was a restriction in the amount of nuclear energy expansion that the model could take, in BCS the following restriction was in place:

In the La Paz region, feasibility studies for the installation of a medium or small nuclear reactor have been conducted and were reported in the Electric Sector Outlook published by Mexico’s Energy Secretariat.
Scenarios

01 Reference
The reference scenario depicts the development of the electrical system without any further climate policies in place. The scenario does not encompass the existing clean energy policy or any nationally determined contributions. There is a CO₂ restriction of up to 170 MtCO₂ from 2030 onwards.

02 NDC
This scenario is the same as the reference scenario except for the fact that it includes a constraint on CO₂ emissions to meet the Nationally Determined Contributions (NDC) by 2030. The NDC scenario implements a CO₂ limit of 77 MtCO₂ by 2030 and 39.3 MtCO₂ in 2050.

03 NDC without nuclear restriction
Among the assumptions there was a restriction regarding the amount of nuclear energy expansion that the model could take. In BCS, in La Paz Node, the option was for the model to choose medium or small nuclear reactor, in accordance with some feasibility studies that have been conducted and were published in the Electric Sector Outlook published by Mexico’s Energy Secretariat.
• For the reference scenario nuclear accounts for almost half of the generation in 2050, thus being the largest generator. Followed by solar PV.

• With 584 MW Nuclear capacity is the fourth largest technology by installed capacity in the region, far below Solar PV (2,268), Battery (1,000) and internal combustion (777)

• There is a steep reduction in GHG from 2020 to 2025 onwards since the model stops using fuel oil in the power generation.

• After 2035 the GHG start to rise again due to a more intense use of Natural Gas.
• For the NDC scenario, again nuclear accounts for almost half of the generation

• Nuclear capacity reaches 696 MW, becoming the third largest technology by installed capacity in the region, but far below Solar PV (2,796), and Battery (2,138)

• The reduction in GHG from 2035 onwards is a result of a change in the dispatch from Internal Combustion and thermoelectric to solar and nuclear
• This scenario shows the highest share of nuclear generation accounting for almost 65% of the BCS total generation.

• Nuclear capacity reaches 934 MW, becoming the second largest technology by installed capacity below Solar PV (1,064).

• The reduction in GHG is less compared to the other scenarios due to this region still using Internal combustion technology for power generation. This can be partially explained when looking at the country's generation profile, where Nuclear energy accounts for just above 50% of the total generation.
Nuclear energy
As a result, from modelling the Electricity generation system, it shows the need of increasing the Nuclear capacity in order to accomplish the NDC goals, even in a country like Mexico where there’s a considerable wind and solar resource.

Isolated systems
The above mentioned is more relevant in systems that are not connected to the rest of the country and thus are unable to share resources. Then, Nuclear energy, specially SMR, becomes greatly important.

Nuclear limitations
For all NDC scenarios that were tested, the model took the maximum limit of nuclear energy capacity available. The restriction mainly comes as a result of economic restraints and time to build a power plant.

Further studies
Further studies can be carried out to study the sensitivity analysis for nuclear energy costs against other technologies.
Thank You