TRADE-OFF ANALYSIS OF ENERGY SCENARIOS OF INTENDED NATIONALLY DETERMINED CONTRIBUTIONS (INDC) FOR A DEVELOPMENT COUNTRY - PERUVIAN CASE

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Overview

The current international context, where the fight against climate change and the mitigation of greenhouse gas (GHG) emissions have been consolidated in the Paris agreement, it is of great need that energy planning includes strategic analysis and evaluates the implications that imply the commitments assumed in these fields, especially in the developing countries like Peru [1].

The challenge for Peru is synthesized in improving its energy planning system in order to identify a methodology for strategic long-term energy planning that enables the country's sustainable energy development, also designed for developing countries, since many times the results or attributes that are intended to be achieved are clearly opposed, for example, it seeks to provide cheap energy but generate the least amount of GHG emissions possible.

Other aspects to analyze is the level of standardization of the planning methodology currently used in Peru; the impact that energy planning has on the national economy; as well as, the contribution of the energy commitments assumed by Peru in the goals of sustainable development.

Methods

An evaluation horizon has been considered until the year 2040. The variables used can be defined as:

Variables under uncertainty (futures):
They are those that can not be controlled, and are subject to market uncertainties, also called futures; which are: the evolution of the gross domestic product (GDP), the reserves of natural gas and the prices of liquid fuels.

Controllable variables (plans):
They correspond to those variables on which they can interfere, they can be structured according to the requirements of the sector; called Plans, which are: composition of the supply in electricity generation, availability of gas pipelines and percentage of domestic natural gas supplies.

The combination of 36 plans and 18 futures leads to the formulation of 648 energy policy scenarios.

The attributes:
They are characteristic of the plans against the evaluated future ones, those that seek to satisfy conflicting interests. The attributes considered are the following nine: 1) Percentage of natural gas supplies at the residential level, 2) Natural gas imports, 3) Participation of unconventional renewable energy resources (URER), 4) Energy self-sufficiency, 5) Commercial balance, 6) Consumption of natural gas, 7) Investment costs, 8) Market concentration using the variable of measurement Herfindahl-Hirschman Index (HHI), 9) GHG emissions.

Energy Model:
An integral energy model has been structured using a hybrid or mixed methodology that uses an econometric component, an end-use component and an optimization component. Finally, the LEAP [2] model is used to consolidate the national energy balance.

Trade-Off Analysis Model:
The Trade-Off methodology [3] allows us to compare plans whose results are very different in attributes that have conflicting interests. It starts from the evaluation of plans for a certain future using the results matrix, the plans are compared two by two in all futures. If there is a plan that is the best behavior in all future, it is considered that this plan is a robust plan; On the contrary, if there were different plans that are those with the best behavior in a certain future, we would be in a dilemma where there are competing interests, in these cases a comparison of plans is made using the criteria of dominance or conditional significant domain. Once we determine the plan that dominates

significantly better in the attributes in conflict in the determined future, we elaborate a summary table where we reflect all the plans chosen for a certain future, it should be noted that sometimes you can choose several plans in the same future .

Results

In the business as usual (BAU) scenario, the total energy demand towards the end of the analysis period, ie, the year 2040, would be 1.9 PJ, and will have an average annual growth rate of 3.99%. In the case of electric power, the final demand will be 0.5 PJ and its growth rate will be 5.23%.

In terms of the structure of final energy demand, the transport sector will continue to be the one with the highest participation with 42.5%, followed by the residential and commercial sectors would be 23%, the public sector 1.6%, the fishing sector 0.6 %, the agricultural and agribusiness sectors of 0.6%, the mining-metallurgical sector of 14.1%, the industrial sector of 15.1% and the petrochemical industry 2.5%.

The structure of the final demand by products, indicates that the predominant share that will continue to have petroleum derivatives with 53.1% (especially diesel), followed by natural gas that will represent 11.8% of total demand, coal and coke with 2.9%, electric power with 27.8%, and biomass (composed of bagasse, firewood, dung and yareta) with 4.2%.

From the analysis of this structure, it is observed the great participation that the derivatives of the hydrocarbons will continue to have, followed by the electric energy. In the case of firewood, dung and yareta their contribution will be significantly reduced compared to the current situation.

From the comparison of the results of the projection of the energy demand for the three GDP futures, it is observed that at the end of the analysis period the global energy demand for the scenario with optimistic GDP will have an increase of 35.2% and for the future with pessimistic GDP will present a reduction of 20.1%, both with respect to the projection of the future with GDP base.

Of the 648 scenarios evaluated, which are the result of the combination of 36 plans and 18 futures, a third of such scenarios are not considered robust plans; given that they have a low participation of non-conventional renewable resources (URER), being dominated by plans that consider higher levels of participation (between 10% and 15%), they present greater robustness. This implies that a high URER component within the energy matrix gives value to future plans, also improves the attributes of self-sufficiency and reduces the concentration of energy sources.

Conclusions

It is concluded that the most robust energy plans correspond to those in which the Southern Andean gas pipeline is implemented (plans 14 and 26), the natural gas home supply is high; and the composition of the electric supply is balanced, since in both plans the hydroelectric and thermal supply composition are equal. Plan 14 (45% of hydraulic supply, 45% of thermal supply and 10% of URER supply) and Plan 26 (42.5% of hydraulic supply, 42.5% of thermal supply and 15% URER).

On the other hand, the mitigation options proposed within the document that sustains the national contributions of Peru (iNDC for its acronym in English) within the energy sector only represent a reduction of 9% of GHG emissions and constitute a little robust plan against to plans with greater URER participation and more ambitious mitigation options.

References

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