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ELECTRICITY MARKETS & REGULATION

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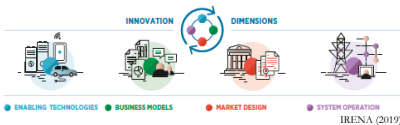
OPPORTUNITIES AND CHALLENGES OF MAINSTREAMING DER TOWARDS THE TRANSITION TO MORE EFFICIENT AND RESILIENT ENERGY MARKETS: EVIDENCE FROM COLOMBIA

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Motivation

- Globally, around 81% of total energy consumption is based on fossil fuels, compared to 19% obtained from renewable sources. Under the Paris Agreement targets, renewables could provide 90% of the reductions in CO2 emissions needed to meet the 2050 target.
- Solar photovoltaic energy in 2020 ranked as the cheapest source of electricity generation globally. This would allow electricity generation from solar energy to increase by 43% by 2040 compared to the levels reached in 2018.
- This article aims to contribute to this growing area of study evidencing the international experience of mainstreaming distributed energy resources (DER). In general, the new approaches have generated more competitive and innovative structures, which for Colombia represents a transcendental opportunity to integrate technologies that complement the generation matrix and pluralize participation towards a more efficient and resilient energy market.



Method/Approach

- Based on a review of literature in some of the most important scientific databases, Science Direct and Scopus, as well as on reports from the Renewable Energy Agency (IRENA) and the International Energy Agency (IEA), this article highlights relevant aspects of the experience in incorporating distributed generation (DG) of four leading countries in the energy transition: Germany, United Kingdom, United States and Australia; and then summarizes the regulatory advances that Colombia has made on its way of the mainstreaming of DER.

Objects of investigation

- Digital transformations in domestic energy markets are beginning to have an impact, with companies using big data to better respond to consumer preferences, and new business models are being promoted that increase competition in line with traditional energy schemes.
- In this context, DERs have emerged, which, as a result of the growing incorporation of non-conventional renewable energy sources (NCRE), have the potential for generating both a lower environmental impact and greater social empowerment.

Experimental setup & test results

- All of the markets studied began with reforms aimed at promoting the incorporation of NCRE, such as renewable generation regulations, which have been accompanied by plans to reduce CO2 emissions in alignment with the millennium Sustainable Development Goals and the decarbonization of the electricity sector.
- Instruments such as Feed-in Tariffs, Feed-in Premiums and Net Energy Metering had been used to diversify the ownership of energy assets. Additionally, as a result of energy policy changes, government support in the form of subsidies, loans and grants has been made available to stimulate the increase of installed solar capacity in most of them.
- Community choice aggregation, green tariff programmes and “deregulation” are part of the innovation through disruptive technologies and diverse local energy initiatives. Distributed generation regulation has generally evolved to allow direct participation of DERAs (aggregate capacity users) as well as VPPs (Virtual Power Plants) in wholesale energy markets.

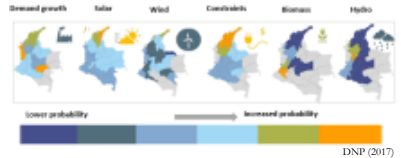
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- Energy transition also brings the establishment of principles and values, which addresses decentralization, decarbonization and digitalization as fundamental components of the development of the electricity sector. Additionally, the entry of new participants as well as the new roles make consumers a key part of the transformation, which promotes social responsibility in the evolution of energy resources.
- In the Guajira region, wind speed and solar radiation are respectively 2 and 1.6 times higher than the world average, which shows the high potential for wind and solar generation in Colombia. Both types of sources could contribute up to 57 GW and, given that they are complementary to hydropower, could lead to more competitive energy costs for consumers, while providing greater resilience to the system, especially in times of drought:
- Germany, United Kingdom, United States and Australia markets has led a series of operational, political, commercial, institutional and regulatory challenges in relation to incorporation of DERs, among which the following stand out:
 - Technical requirements for which the grid was not designed: disaggregated generation, transmission and distribution as well as control of intermittent generation.
 - Coexistence of centralized generation with DG.
 - Death spiral: mass incorporation of DERs usually triggers an increase in charges for grid use, pushing more users to self-generation and self-consumption, which in the long term triggers a significant erosion of the revenues required for the maintenance of the electricity grid.
- The *Ministerio de Minas y Energía* is leading the "*Misión de la transformación Energética*", aim at structuring a proposal for the modernization of the institutional and regulatory framework of the electricity sector, making viable the incorporation of new agents, technologies and transactional schemes in the market.



Regulatory advances of the mainstreaming of DER – Colombia

- In Colombia energy transformation is based on three pillars: competitiveness and efficiency, reliability and accessibility, which includes increasing electricity coverage in non-interconnected areas (ZNI), and sustainability.
- The Colombian electricity system has an installed capacity of 17.5 GW (of which 11 GW are hydro and 5.1 GW are thermal).
- There is a regulatory framework within which the country has based its transition path towards an increasingly cleaner and more diverse energy grid, in which Law 1715 of 2014 is the most important, including for incentivizing smaller-scale renewables.
- It is also relevant the change in the concept of the *Plan de Desarrollo* (Law 1955 of 2019) with respect to Laws 142 and 143 of 1994, in relation to the provision of the residential public electricity service, which is expanded towards the use of new technologies and is not strictly conceived as that offered through distribution networks.

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- Among the principal challenges identified that remain to be addressed in Colombia are the following:
 - Adoption of new technologies: Incorporating AMI and other information technologies into the current energy network is the way to make it more competitive.
 - Definition of the technical requirements necessary to achieve secure integration of distributed resources and microgrids in order to mitigate and monitor their impact on system operation.
 - Institutionalization of new comprehensive remuneration mechanisms.
 - To encourage the interlinking of different actors.
 - To foster a new consumption culture and paradigm shift: users as the key drivers of the energy transformation.
- It is essential to prepare the centralized grid for the imminent transition to increasingly decentralized energy systems. Internationally there has been a general migration towards hybridized structures, where smart grids tend to be an ad-hoc combination of traditional and new technologies, which will coexist as energy development needs evolve.
- The first, underpinned by auctions, where energy is exchanged through long-term contracts, allowing for adequate capacity expansion. The second, where flexible resources for a reliable energy system are affordably procured and delivered through marginal prices.
- The main idea behind this market design is to share appropriate price signals with all actors from the wholesale to the retail market, thus improving their participation in the operation of the system.

Conclusion

- The Colombian energy market needs to become more flexible and enable more active participation by the end user. The incorporation of DERs is relevant to continue guaranteeing energy supply at reasonable prices, with greater service coverage and increased resilience to climatic phenomena.
- The lessons learned from the global energy transition are of great value for countries such as Colombia, which are moving towards the incorporation of DERs and the development and adoption of innovative technologies that enable the digitalization of the energy economy, the strengthening of the generation grid, and the diversification of participants.
- Finding the right balance between competition, regulation and collaboration is the key to fostering the required synergies in the market and unleashing their full transformative potential.

Discussion

- IRENA suggests considering the design of a dual market, under which the traditional wholesale market would be divided into two complementary markets: the energy market and the distribution market: