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Modeling Decarbonization Pathways in the Power Sector in Developing Countries: The case of Colombia



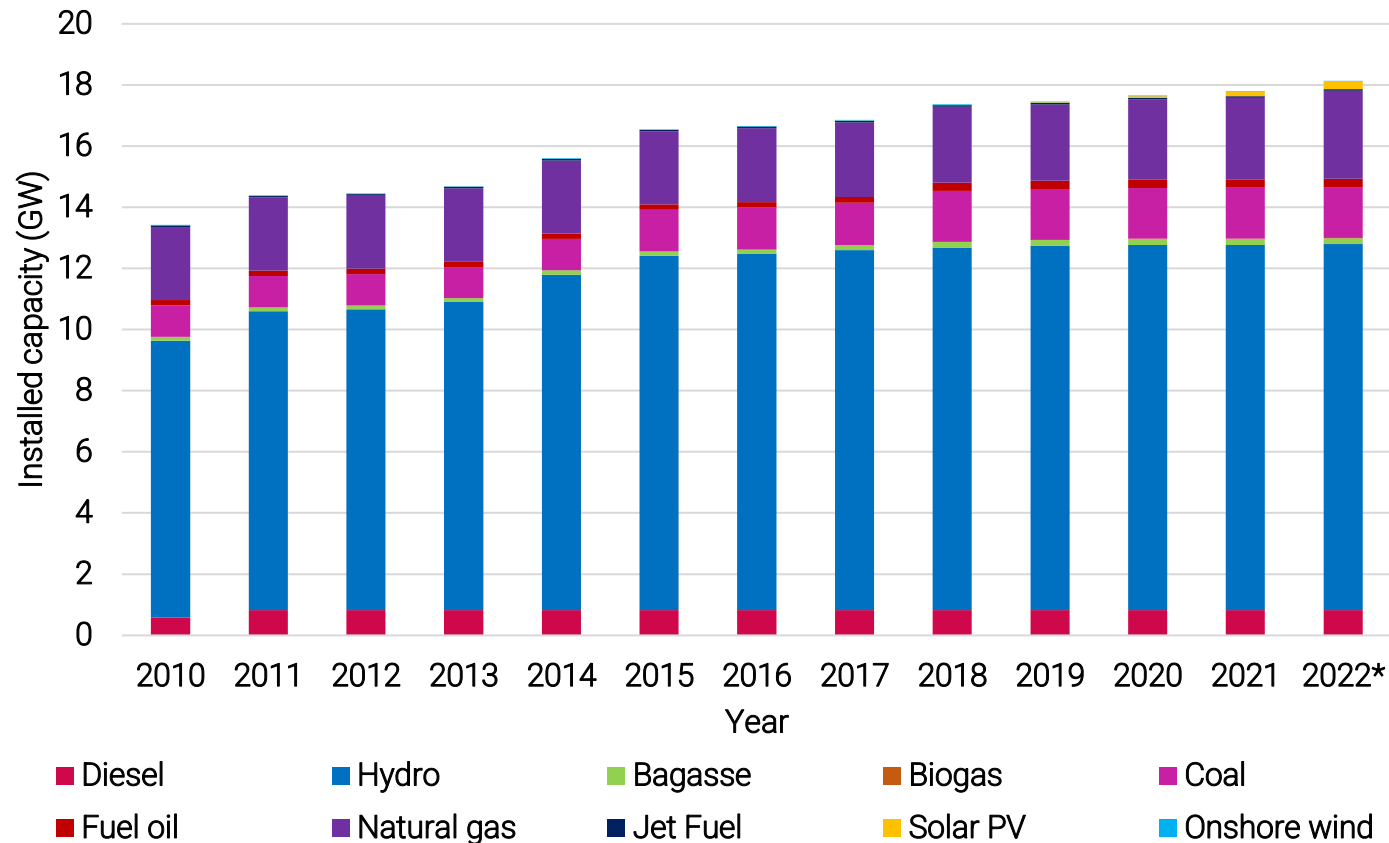
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Energy Modelling Platform Latin America and The Caribbean (EMP-LAC)

2023

Context

- National Determined Contribution (Gobierno de Colombia, 2020): 51% GHG reduction by 2030 and carbon neutrality by 2050
- Electricity consumption should grow five times at the same time that the power system is decarbonized fully by 2050 (Plazas, 2022)
- Colombia is highly vulnerable to the effects of global warming and climate change (Gobierno de Colombia, 2021a; Portafolio, 2021; UNODC, 2008)

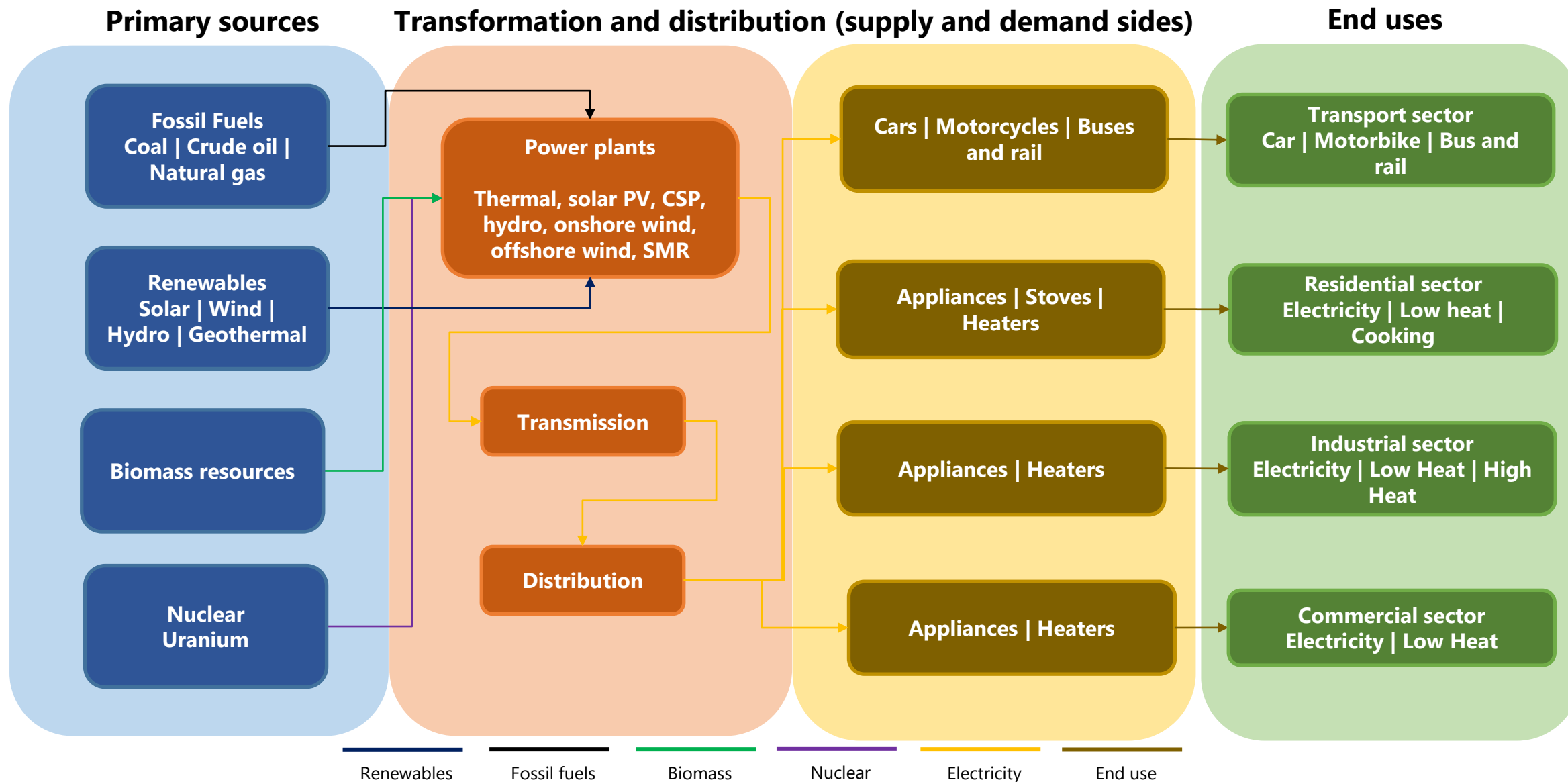


Source: XM, 2022

Research questions:

- **How will the Colombian power mix evolve under a full decarbonization target by 2050?**
- **What is the effect of a progressive drought regime in the performance of a decarbonized power system in Colombia?**

Energy Reference System



Scenarios

Baseline (BAU)

No carbon target

Historical trends remain with limited penetration of non-conventional renewable technologies

GHG Cap (NDC)

Full decarbonization by 2050

Renewable technologies are fully available (PV, wind, CSP, geothermal)

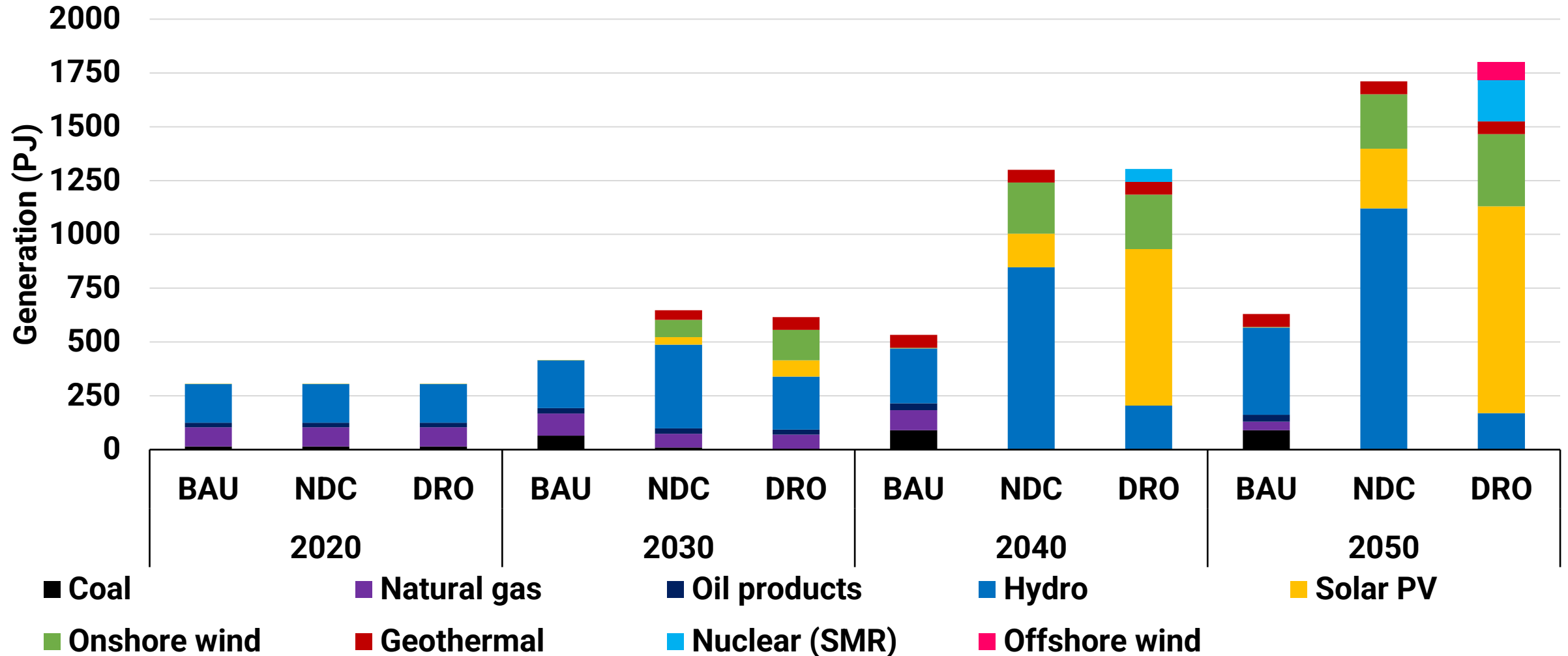
Drought (DRO)

Full decarbonization by 2050

Reduction in 50% of capacity factor for hydro-based technologies (Mekonnen et al., 2022)

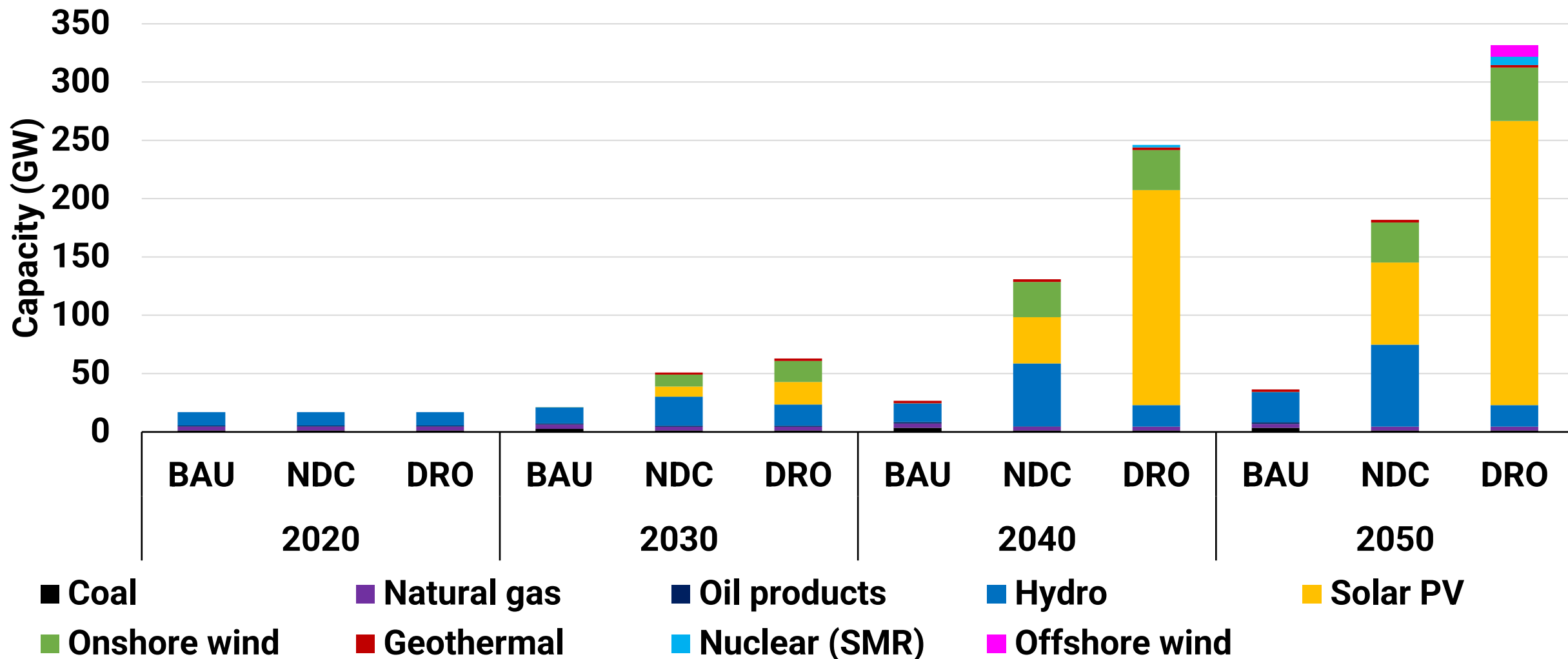
Results (1/4)

Electricity Annual Generation



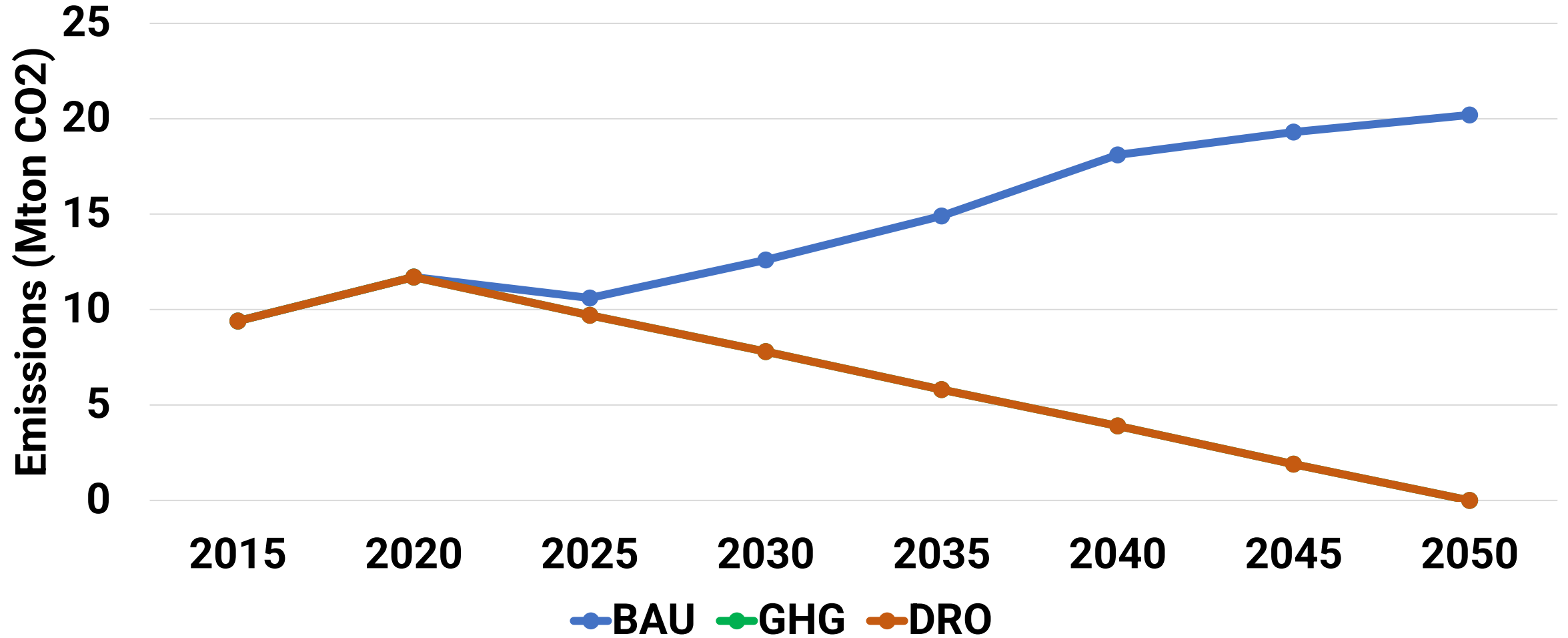
Results (2/4)

Total Installed Capacity



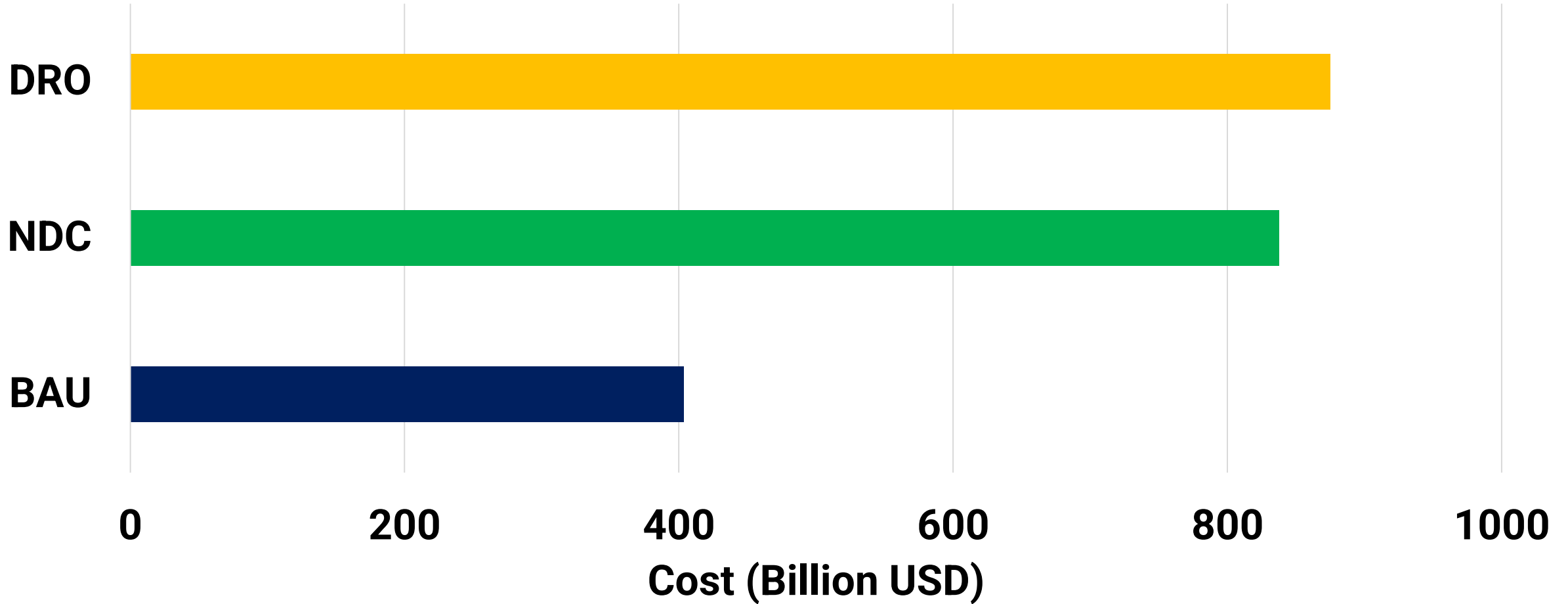
Results (3/4)

Annual emissions



Results (4/4)

Total discounted cost



Conclusion and Policy Insights



The current energy mix will not enable the accomplishment of the NDC and GHG emissions could double by 2050



Carbon neutrality requires the electrification of end-uses demanding between three and six more electricity, essentially hydro, solar PV and onshore wind



Under drought conditions, solar PV is required to replace hydro and a more diversified portfolio could work with the deployment of nuclear (SMR) and offshore wind

Future Work

Flexibility assessment

Data review and update

Storage modeling implementation

Robustness analysis

Acknowledgments

References

- ❖ Cannone, Carla, Allington, Lucy, Pappis, Ioannis, Cervantes Barron, Karla, Usher, Will, Pye, Steve, Howells, Mark, Zachau Walker, Miriam, Ahsan, Aniq, Charbonnier, Flora, Halloran, Claire, Hirmer, Stephanie, Taliotis, Constantinos, Sundin, Caroline, Sridharan, Vignesh, Ramos, Eunice, Brinkerink, Maarten, Deane, Paul, Gritsevskiy, Andrii, ... Nikolaus Pinto De Moura, Gustavo. (2023). CCG Starter Data Kit: Colombia (v2.0) [Data set]. Zenodo. <https://doi.org/10.5281/zenodo.7526335>
- ❖ Gobierno de Colombia. (2020). ACTUALIZACIÓN NDC COLOMBIA-2020 Actualización de la Contribución Determinada a Nivel Nacional de Colombia (NDC). [https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Colombia First/NDC actualizada de Colombia.pdf](https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Colombia%20First/NDC%20actualizada%20de%20Colombia.pdf)
- ❖ Howells, M., Rogner, H., Strachan, N., Heaps, C., Huntington, H., Kypreos, S., Hughes, A., Silveira, S., Decarolis, J., Bazillian, M., & Roehrl, A. (2011). OSeMOSYS : The Open Source Energy Modeling System An introduction to its ethos , structure and development. Energy Policy, 39(10), 5850–5870. <https://doi.org/10.1016/j.enpol.2011.06.033>
- ❖ Plazas, F. (2022). Modelo de Optimización del Sistema de Energía Colombiano para la Configuración de una Canasta Energética Sostenible. Trabajo de Maestría en Ingeniería Industrial. Universidad Industrial de Santander.
- ❖ Portafolio. (2021). Colombia, entre los 11 países con más riesgos “graves” por el clima. <https://www.portafolio.co/economia/finanzas/colombia-es-uno-de-los-paises-con-mas-riesgos-graves-por-el-clima-segun-estados-unidos-557637>
- ❖ UNODC. (2008). Preparándose para el futuro: amenazas, riesgos, vulnerabilidad y adaptación frente al cambio climático. UNODC. <https://www.unodc.org/documents/colombia/2013/Agosto/DA2013/MATERIAL-DIFUSION-No.3-ADAPTACION.pdf>

Thank You!

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