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

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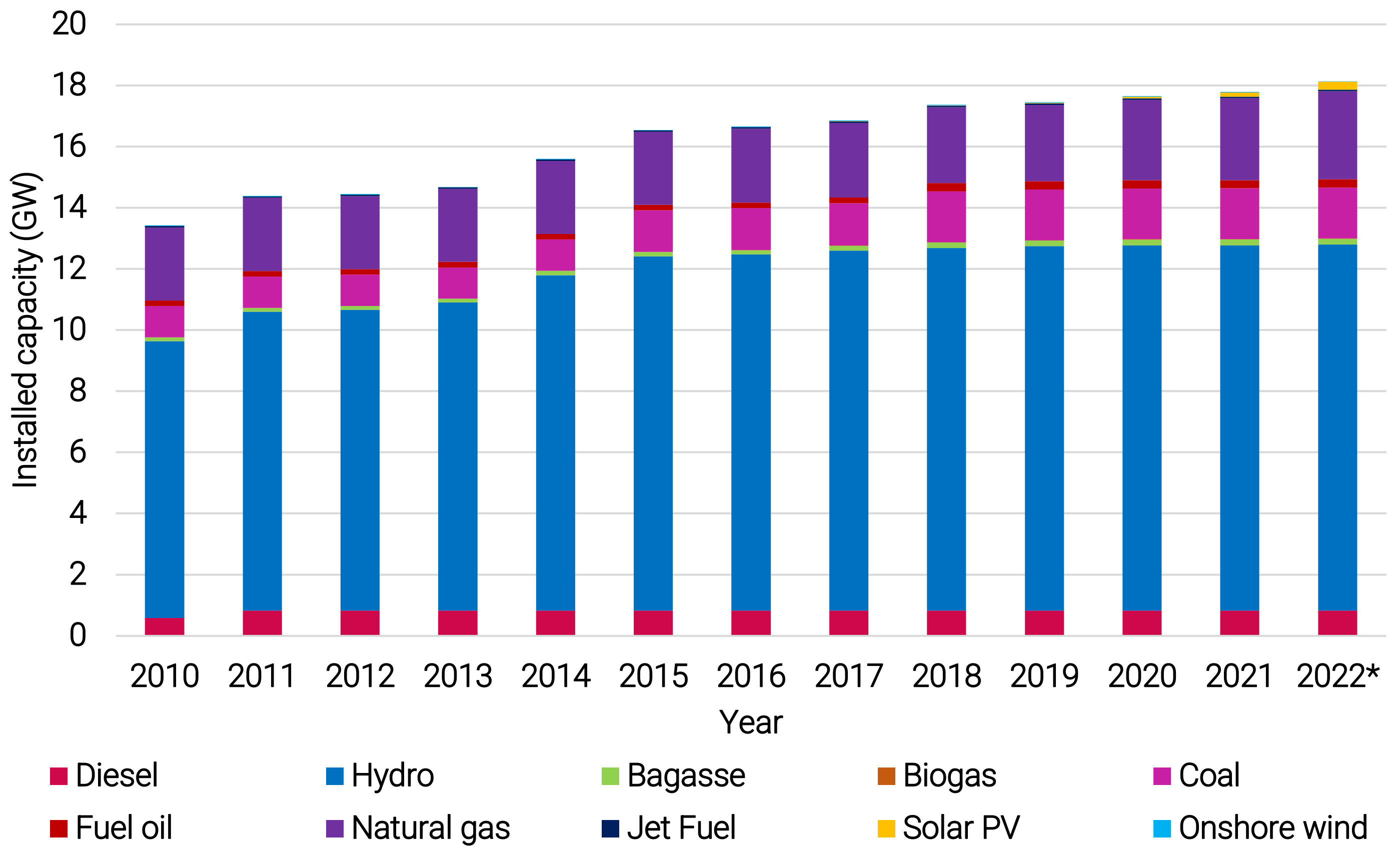
Context

- 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)

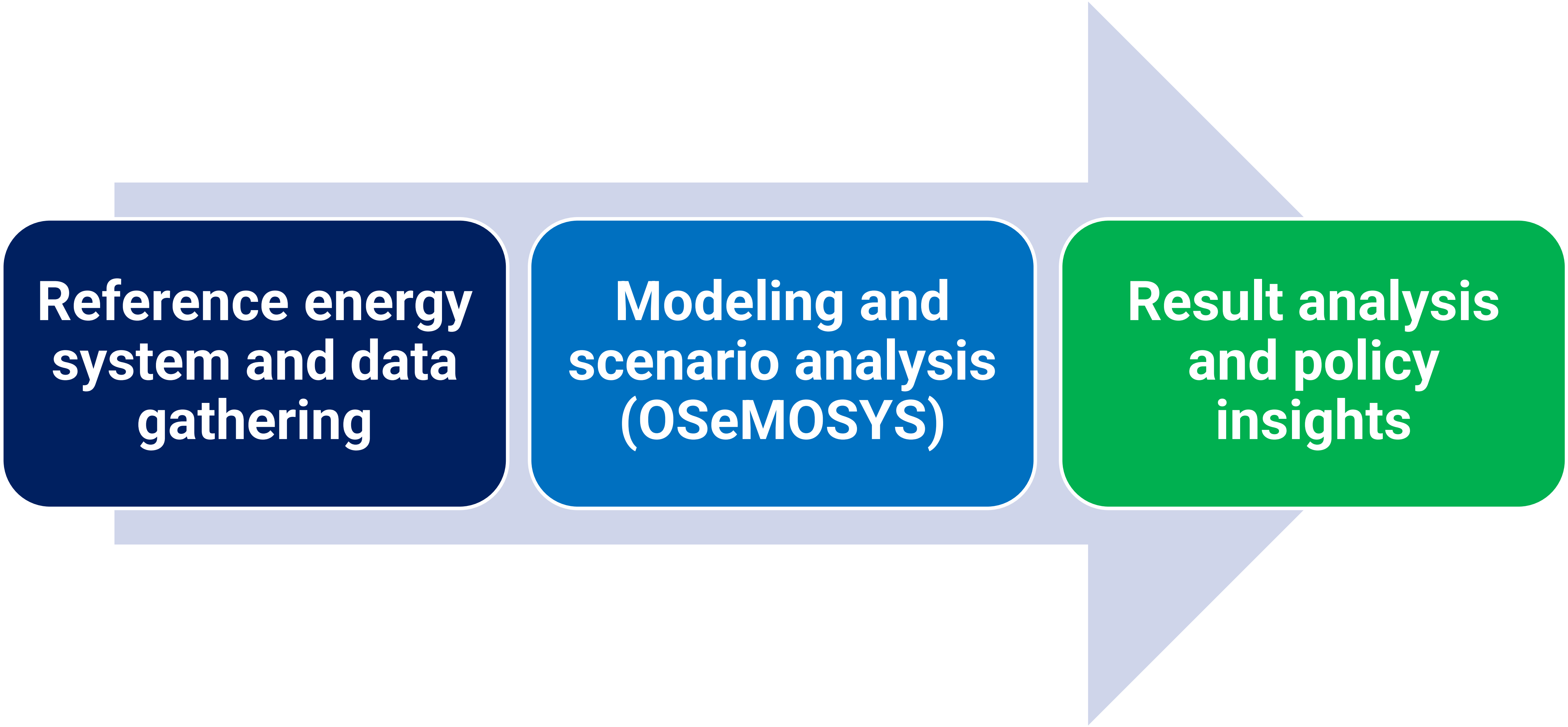


Source: XM, 2022

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?**

Methodology



Scenarios

Business-As-Usual (BAU)

- No carbon target
- Historical trends remain with limited penetration of non-conventional renewable technologies

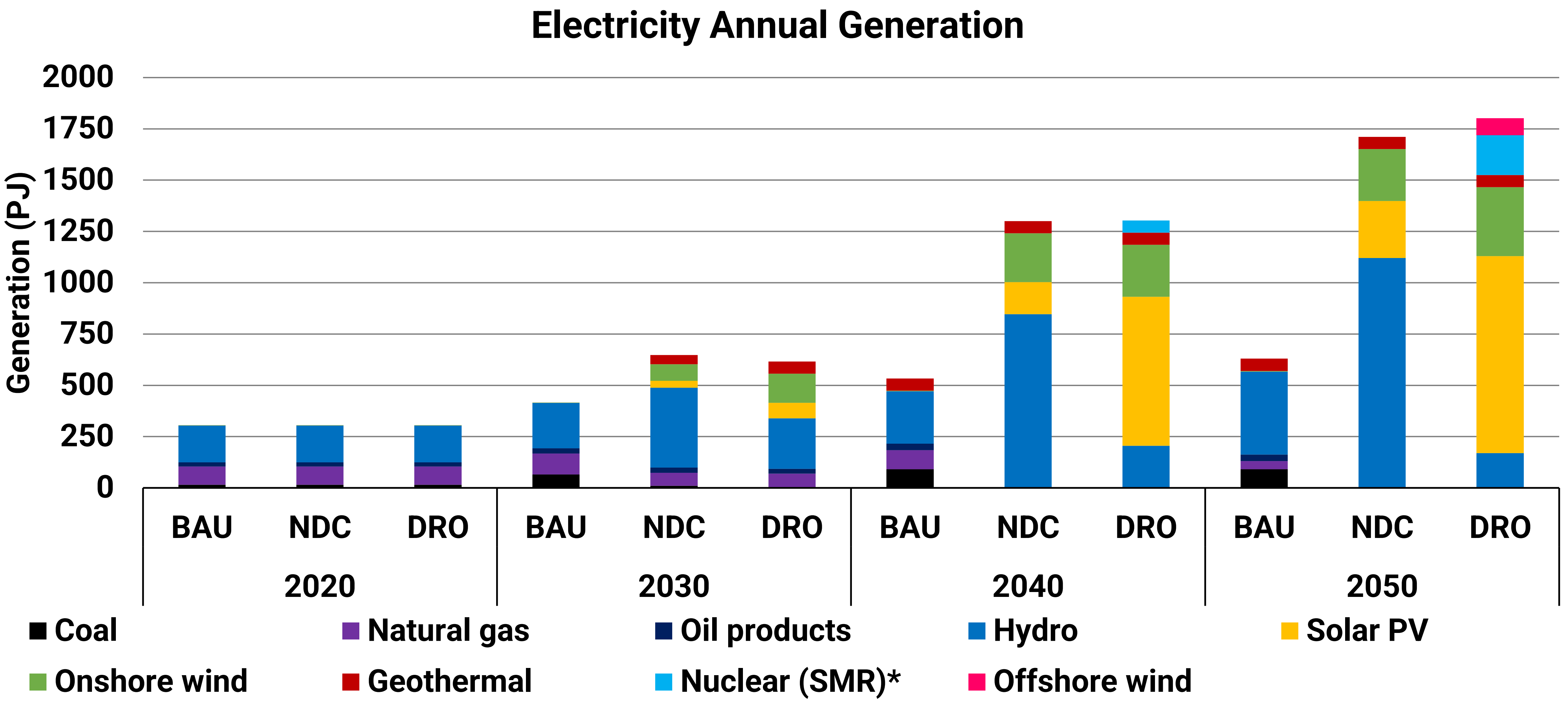
GHG Cap (NDC)

- Full decarbonization by 2050
- Renewable technologies are fully available (PV, wind, CSP, geothermal)

Drought (DRO)

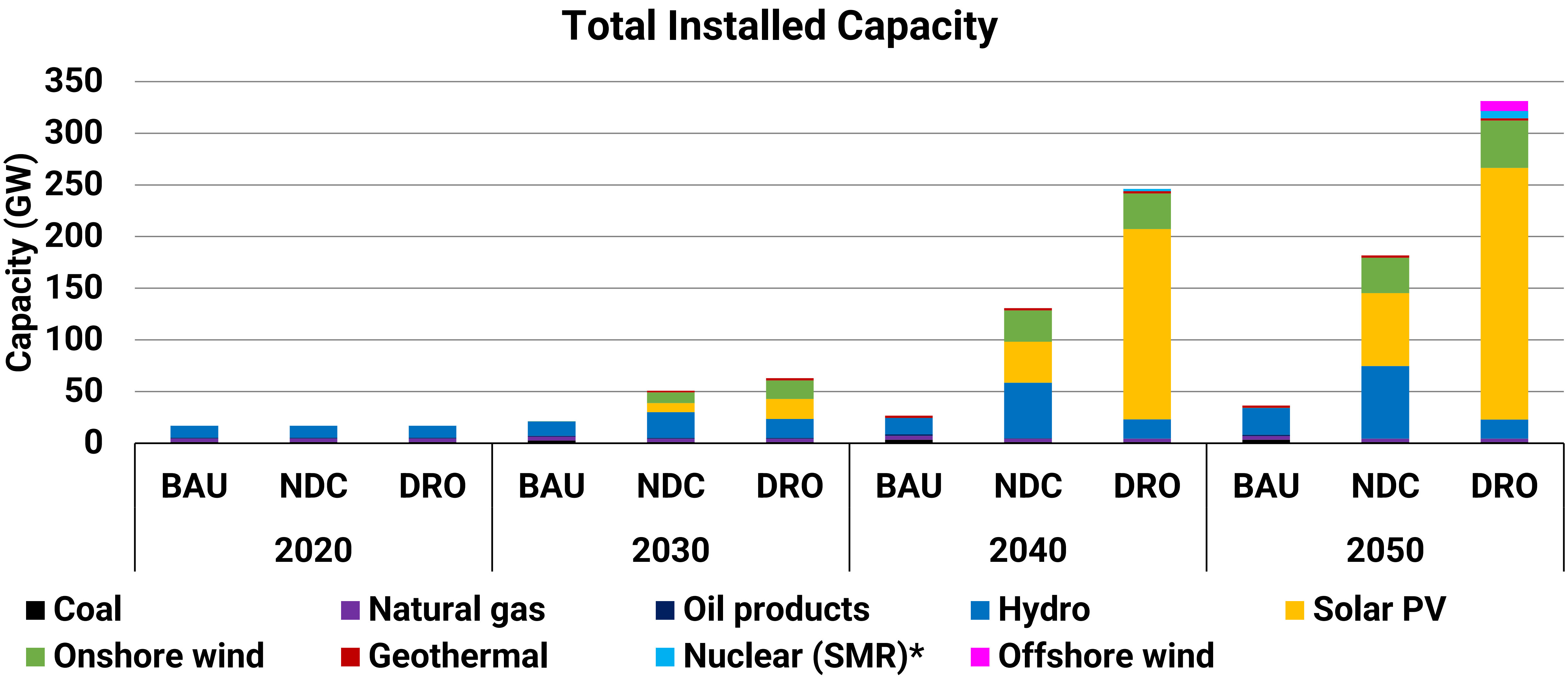
- Full decarbonization by 2050
- Reduction in 50% of capacity factor for hydro-based technologies (Mekonnen et al., 2022)

Results (1/5)



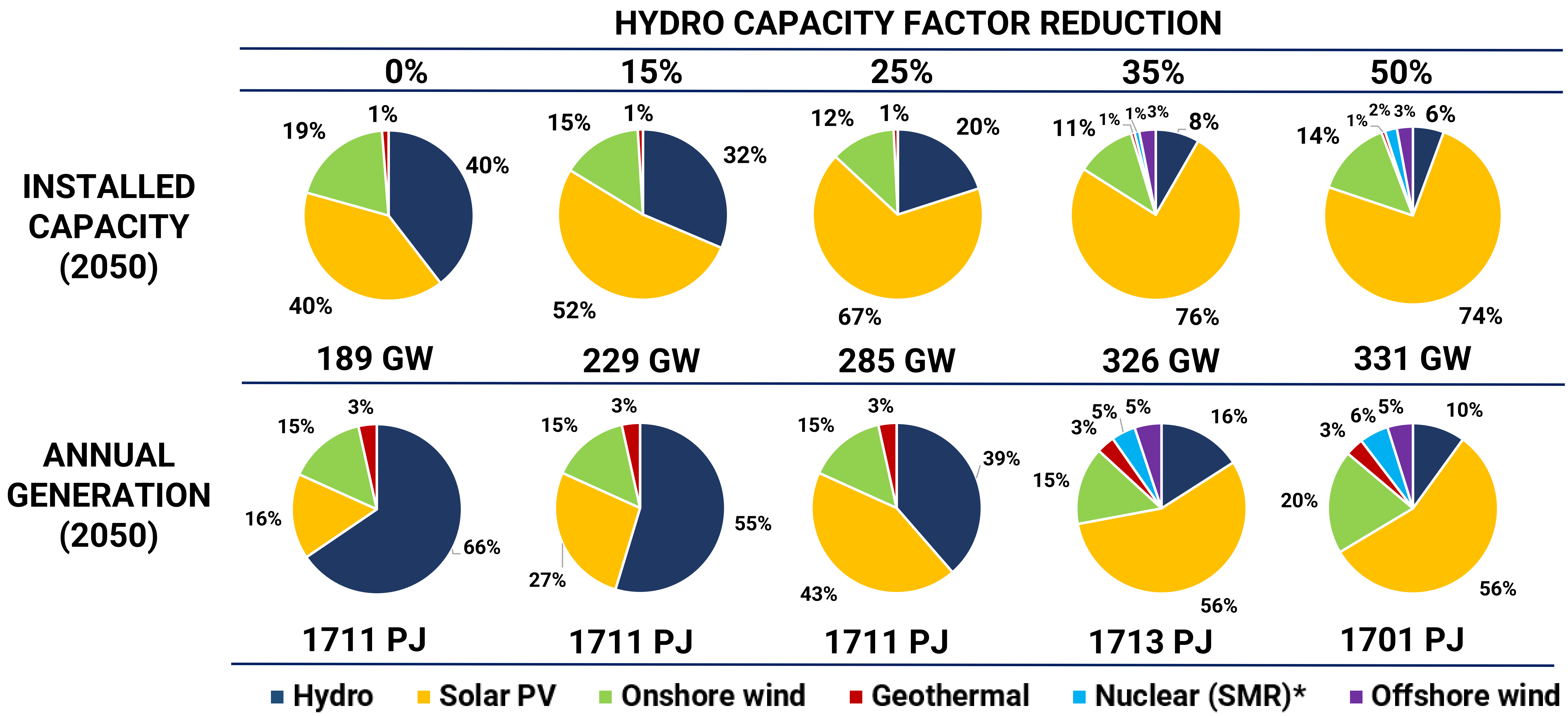
*Small Module Reactor

Results (2/5)



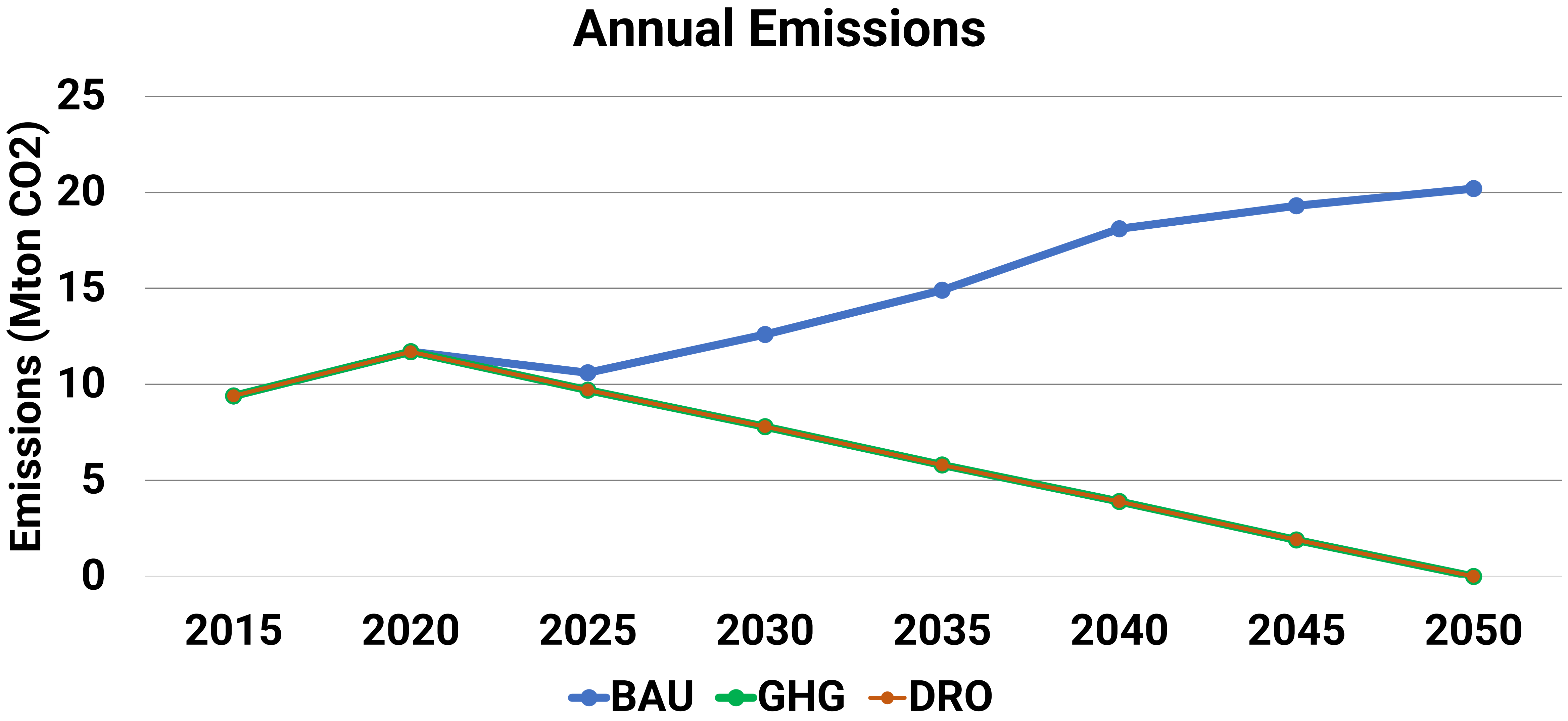
*Small Module Reactor

Results (3/5)



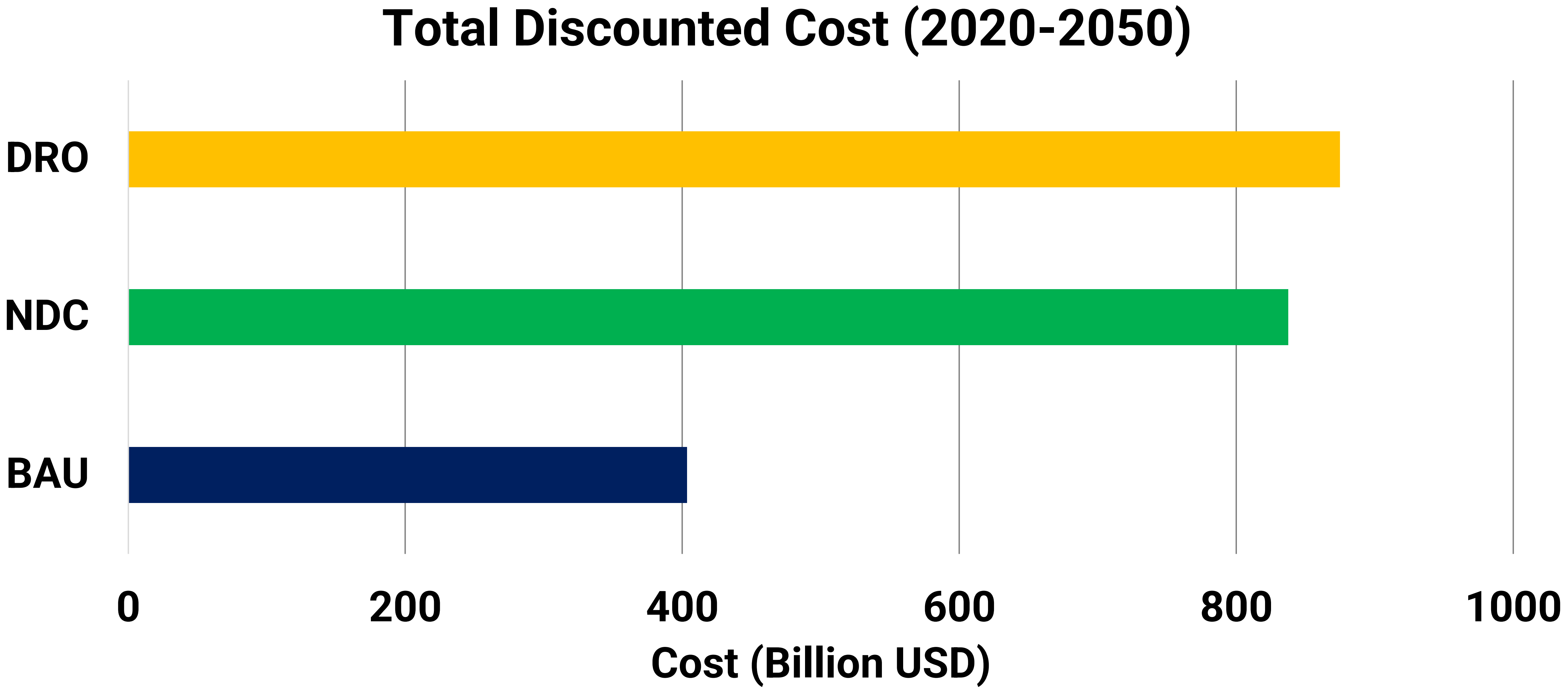
*Small Module Reactor

Results (4/5)



Annual Emissions
Emissions (Mton CO2)
25
20
15
10
5
0
2015
2020
2025
2030
2035
2040
2045
2050
BAU
GHG
DRO

Results (5/5)


Total Discounted Cost (2020-2050)
DRO
NDC
BAU
0
200
400
600
800
1000
Cost (Billion USD)

Conclusion and Policy Insights

Full decarbonization will require six times more electricity, and installed capacity should grow around 10 times. National industry and educational institutions must be prepared to support the power sector transformation

Policy design should promote large-scale investments in hydro, solar PV, onshore wind and geothermal technologies during the next decades (e.g., renewable auctions, public-private agreements, annual targets in capacity expansion)

Under drought conditions, solar PV is required to replace hydro and a more diversified portfolio with the deployment of nuclear (SMR) and offshore wind. Regulatory frameworks for nuclear energy and flexibility measures are critical for this pathway

Future Work

- Data review and update
- Flexibility assessment
- Storage modeling implementation
- Robustness analysis

Acknowledgments

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Thank You!

“The views expressed in this material do not necessarily reflect the UK government’s official policies.”

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