

Natural Hydrogen: Its Potential Role in Canada’s Low-Carbon Energy Transition

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INTRODUCTION

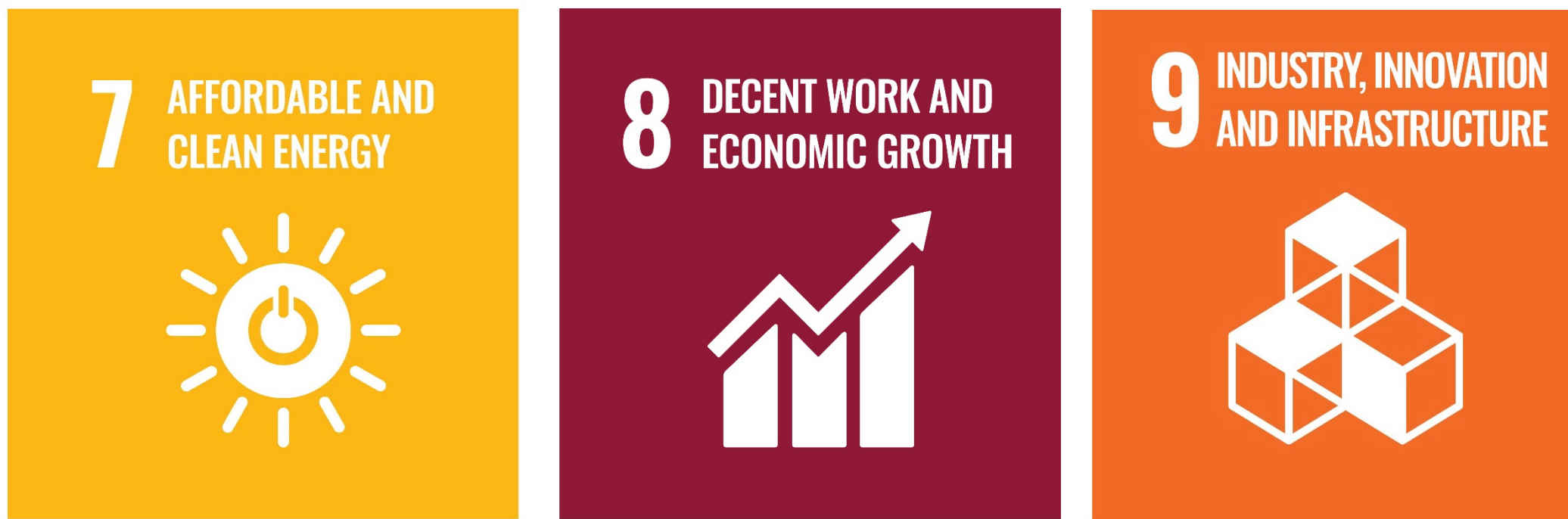
Natural hydrogen, often referred to as “gold hydrogen” or “geologic hydrogen,” has gained significant attention as a potential source of clean and affordable energy. It occurs naturally within the Earth’s crust through geological processes. Unlike conventional hydrogen production methods that rely on fossil fuels or energy-intensive electrolysis, natural hydrogen has the potential to provide a low-emission and cost-effective source of clean energy. Given Canada’s vast geological diversity and abundant natural resources, the country may be well positioned to explore and develop natural hydrogen as part of its broader energy transition strategy.

RESEARCH QUESTION

To what extent can natural hydrogen contribute to Canada's low-carbon energy transition?

OBJECTIVES

- Examine the geological prospectivity, techno-economic viability, environmental implications and policy readiness of natural hydrogen within Canada’s low-carbon transition.
- The project used an interdisciplinary approach aligned with the following UN SDG Goals.



METHODOLOGY

- Research Method, structure literature review and techno-economic screening analysis.
- Data Source: secondary sources, peer-reviewed, government and industry reports.
- Techno-economic boundary: production, purification and transportation.
- Analysis tools; Python, Excel and Power BI.
- Assumption used for transportation (tube trailer and pipeline).

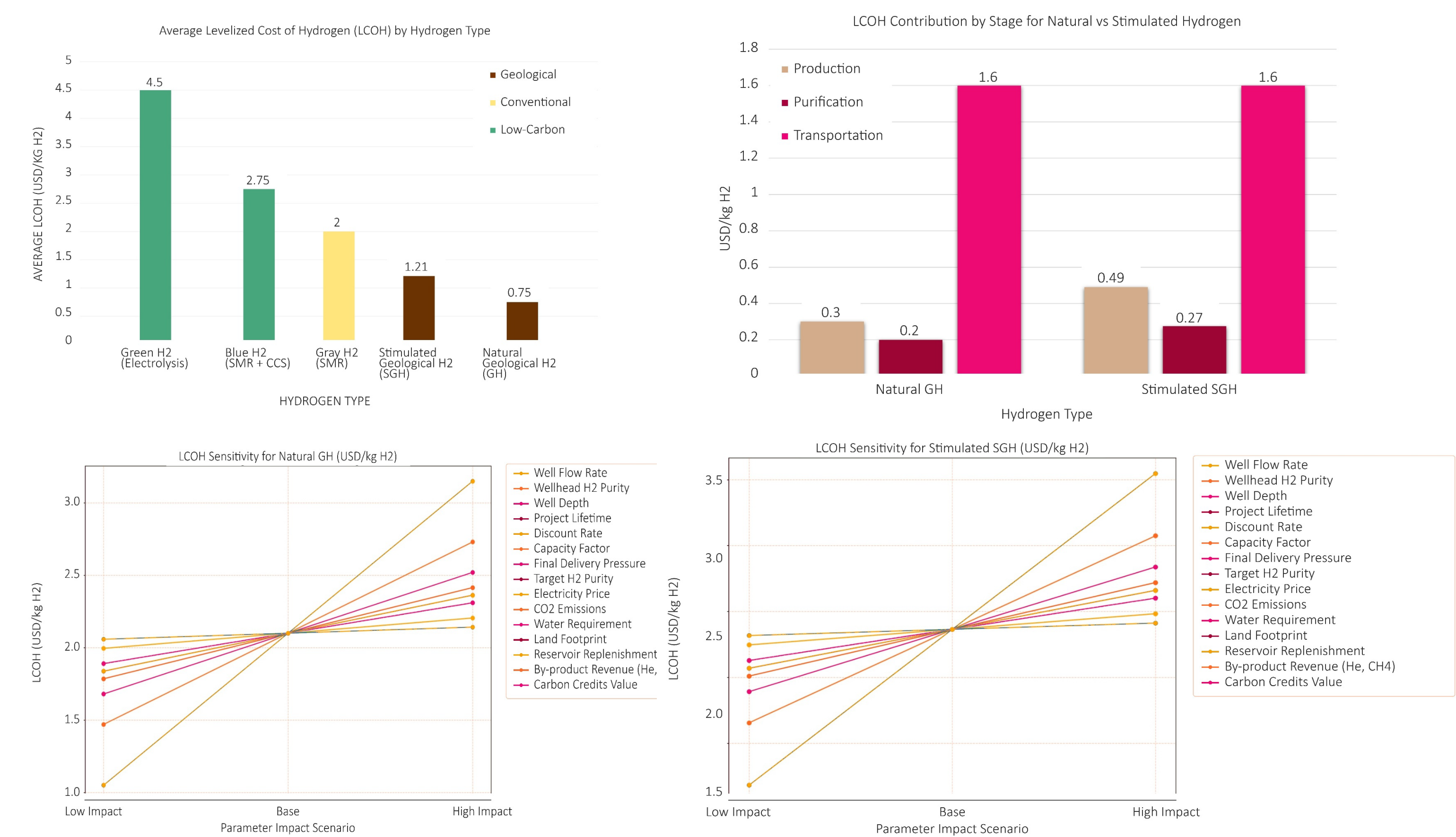
RESULTS

TECHNO-ECONOMIC ANALYSIS

- The techno-economic analysis evaluated the economic viability of natural geological hydrogen (GH) and stimulated geological hydrogen (SGH)
- The analysis covers financial performance from upstream (production and extraction) to midstream (purification and transportation) stages.
- It examines capital expenditure (CAPEX), operating expenditure (OPEX), and levelized cost of hydrogen (LCOH), and sensitivity results to identify the dominant economic drivers across the geological hydrogen value chain.
- The base case value use for Natural hydrogen is 0.54USD/kg H2 and 0.92 USD/kg H2 for stimulated hydrogen

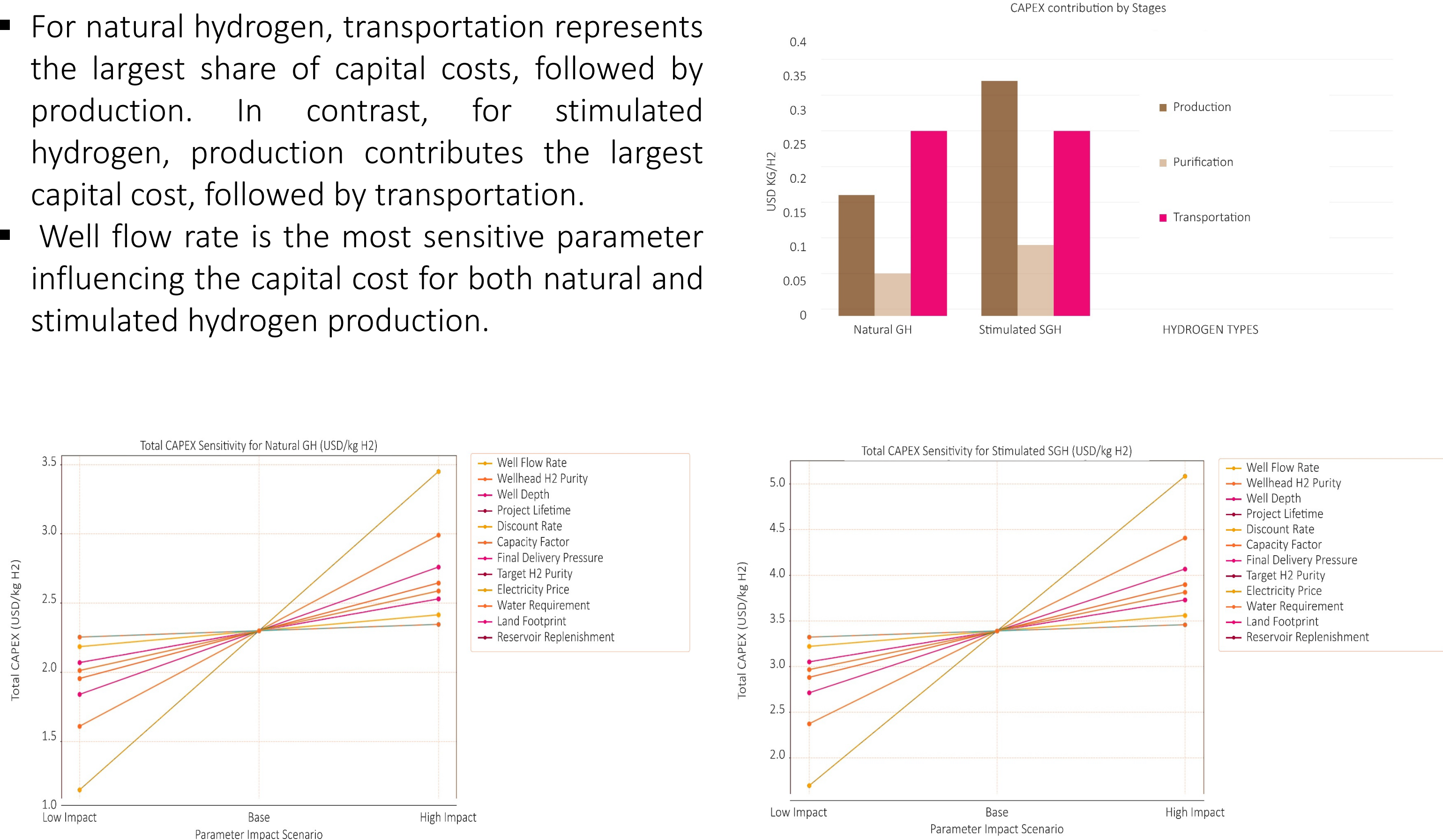
RESULTS CONTINUE

LCOH ASSESSMENT



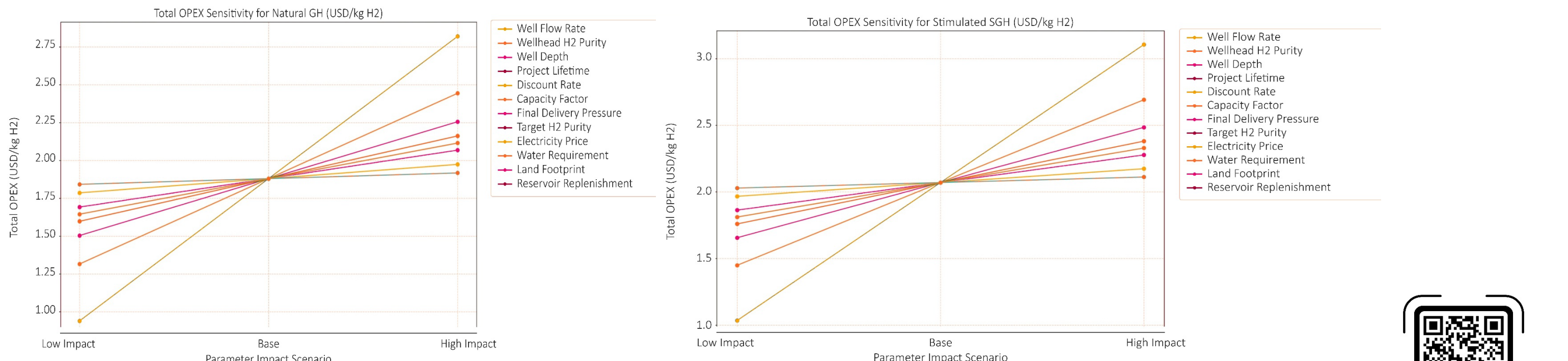
- Transportation represents the largest contributor to the levelized cost of Hydrogen (LCOH) across the entire value chain.
- Well flow rate, with an LCOH of 3.0USD/kgH2 for geologic hydrogen and 3.5 USD/kgH2 of stimulated hydrogen, is the most sensitive parameter affecting the levelized cost of hydrogen for both natural and stimulated hydrogen.
- These cost differences demonstrate that geological hydrogen could be a highly competitive and economically attractive option for supporting Canada’s low-carbon energy transition.

CAPEX ASSESSMENT



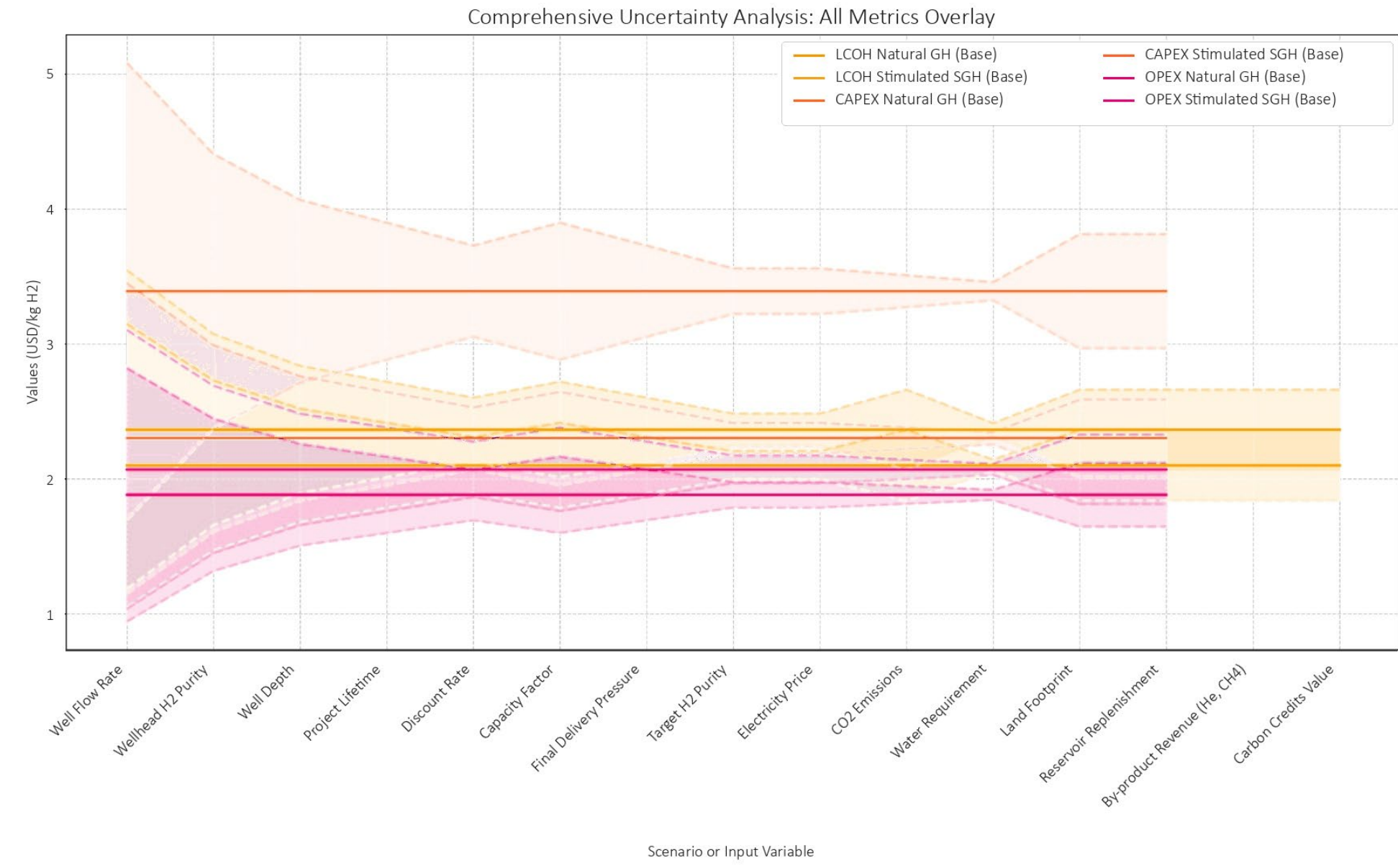
OPEX ANALYSIS

- For geologic hydrogen, well flow rate represents the influencing driver for the OPEX with 2.75USD/kgH2 while it is 3.3USD/kg of stimulated hydrogen



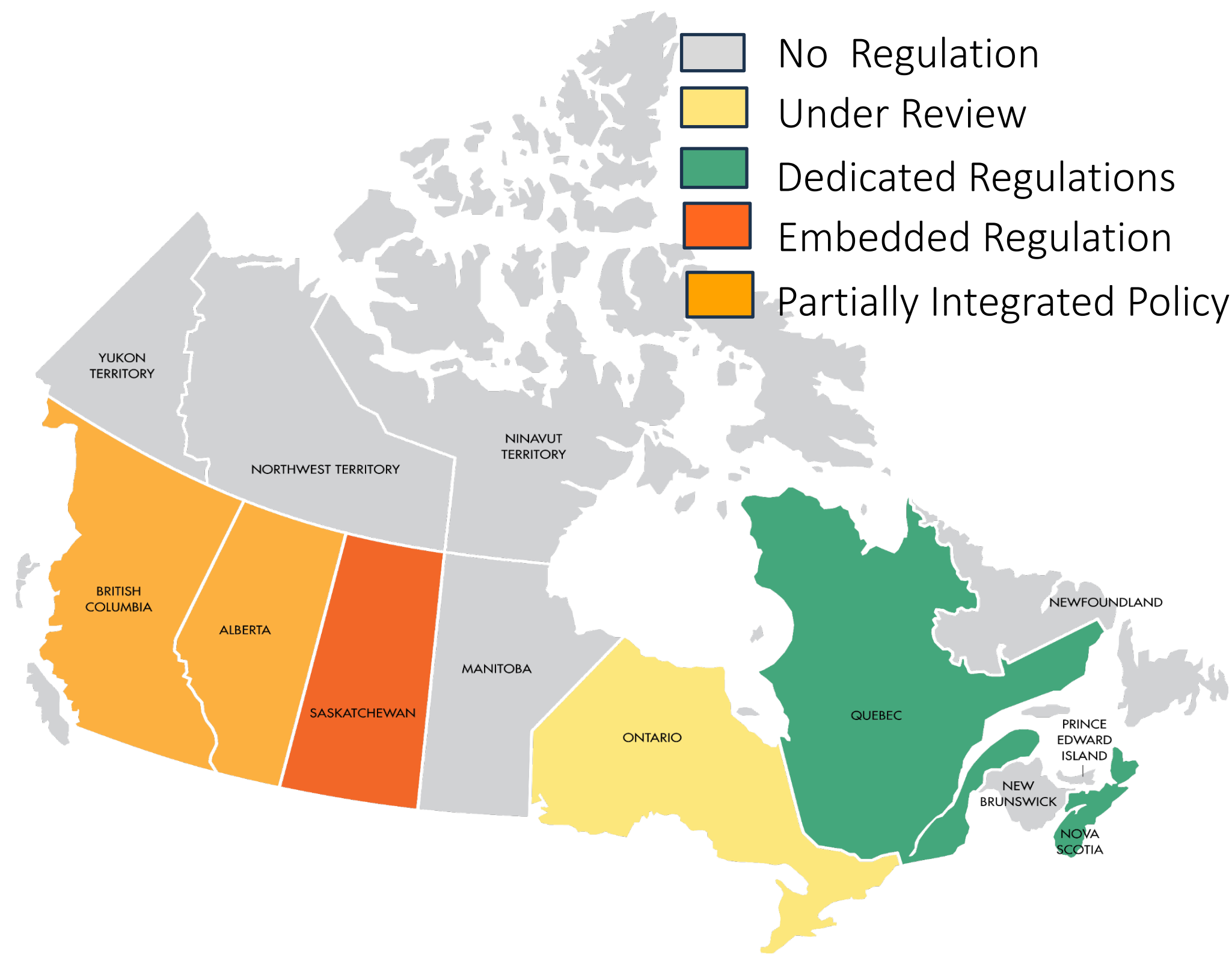
UNCERTAINTY ANALYSIS

- The uncertainty overlay chart displays all three metrics, LCOH (blue), CAPEX (green), and OPEX (red), each separated into natural GH (solid baseline) and stimulated SGH (dashed baseline with shaded uncertainty bands).
- The high level of uncertainty for well flow rate, wellhead H2 purity, and well depth results from the high degree of variability that results from subsurface geological uncertainty, technical extraction challenges, and non-linear economic leverage.



POLICY ASSESSMENT

- Regulatory frameworks remain uneven: only a few provinces have dedicated natural hydrogen legislation, while others incorporate it into broader mining or subsurface resource acts.



CONCLUSION

- Natural hydrogen contribution to Canada’s low-carbon and net-zero ambitions depends on confirmed commercial viability and proven subsurface accumulations. Natural hydrogen has a lower footprint than conventional hydrogen production, with regulatory clarity continuing to evolve.
- Canada’s geological setting provides favorable conditions for natural hydrogen generation and accumulation.
- Techno-economic assessment indicates that natural hydrogen can be commercially favorable under the right conditions. The estimated levelized cost of hydrogen (LCOH) is USD 2.10/kg.
- Key cost drivers include well flow rate, wellhead hydrogen purity, and drilling depth.

REFERENCES

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