LCA of PEM Fuel Cell Vehicles Powered by Grey and Blue Hydrogen: A Case Study in Saudi Arabia

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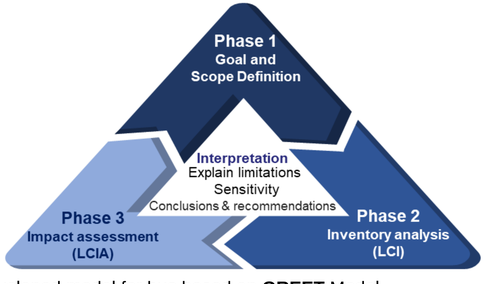
Introduction

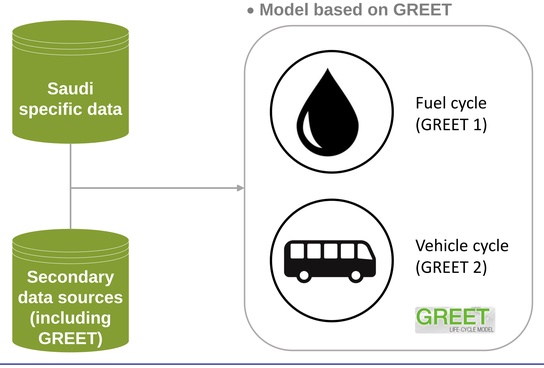
- Increasing concern about climate change globally
- To reduce the transport sector's emissions (accounting for about 25% of total emissions) to reach the KSA's net-zero emissions target for 2060
- Blue and grey hydrogen proton-exchange membrane (PEM) fuel cell vehicles offer a promising alternative solution for decarbonizing the transport sector.

Methodology

- Life cycle assessment (LCA) methodology of the International Standards Organization (ISO 14040 and 14044).

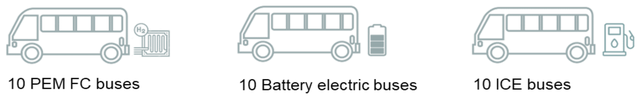


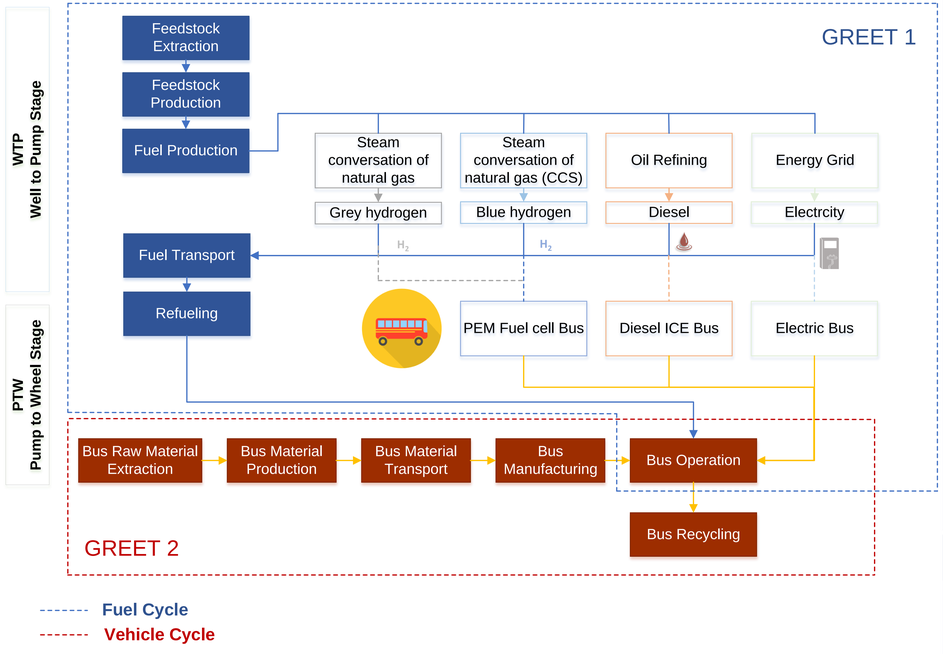
- Developed model for bus based on **GREET** Model



Comparative life cycle assessment

- To conduct LCA of PEM fuel cell buses (**operating in MAKKAH**) and compare that to the internal combustion engine (ICE) buses and the battery electric (BE) buses
- To explore the decarbonization potential of using **grey** and **blue** hydrogen in the PEM fuel cell bus.
- Functional unit: 1km of bus driving
- Cradle-to-grave analysis
- Assessing the impact of global warming potential (**GWP**), abiotic depletion potential (**ADP**), and acidification potential (**AP**)





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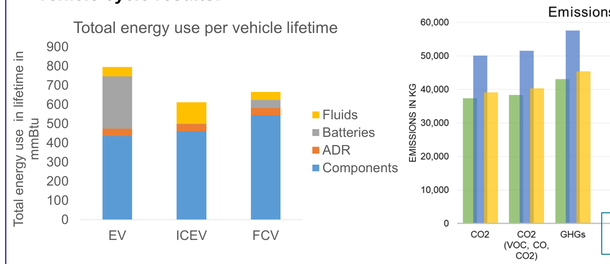
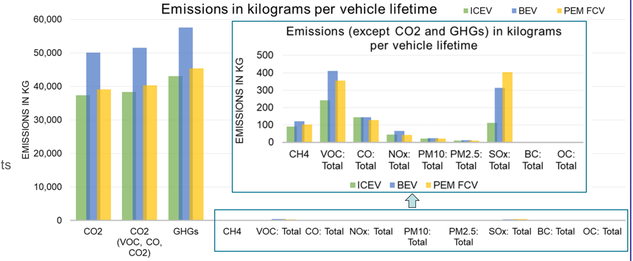
Results

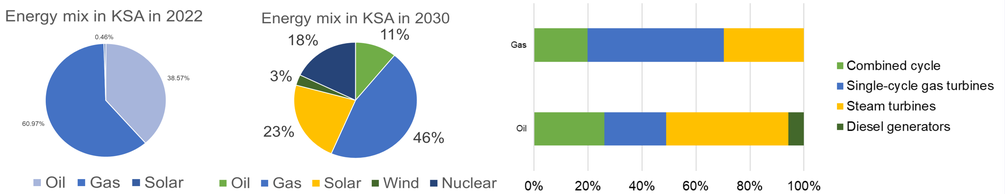
- **Vehicle cycle results:**



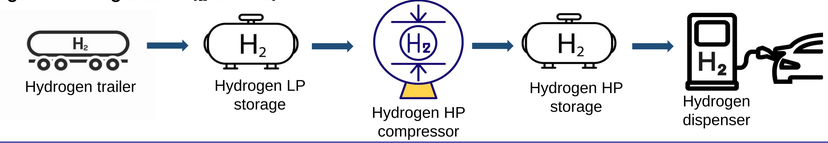


- **Energy use**: BE Bus > PEM FC Bus > ICE Bus; **GHG emissions**: BE Bus > PEM FC Bus > ICE Bus
- Components include PEM FC stack, PEM FC stack BOP, H_2 tank, and Battery management system
- ICE buses - Lead battery, BE buses – Li-ion battery, PEM buses – NiMH battery
- Overall, ICEV buses have **the lowest** energy use and emissions in the vehicle cycle.

- **Part of the input data for the fuel cycle:**



- **Hydrogen refueling station (gaseous):**



Ongoing Work

- Data collection for fuel cycle:
  - The efficiency of **oil/natural gas (NG)/PV** power plants
  - Technology shares for various types of power plants
  - Information collection on **CH_4 leakage** in Saudi Arabia
- Calculation of energy use and emissions for the construction of fuel **refueling** station infrastructure
- To refine the model and assumptions
- To conduct the impact assessment and scenario analysis