Optimizing Bio-crude Production: Investigating Butanol as a Co-solvent in Hydrothermal Liquefaction of Oat Hull

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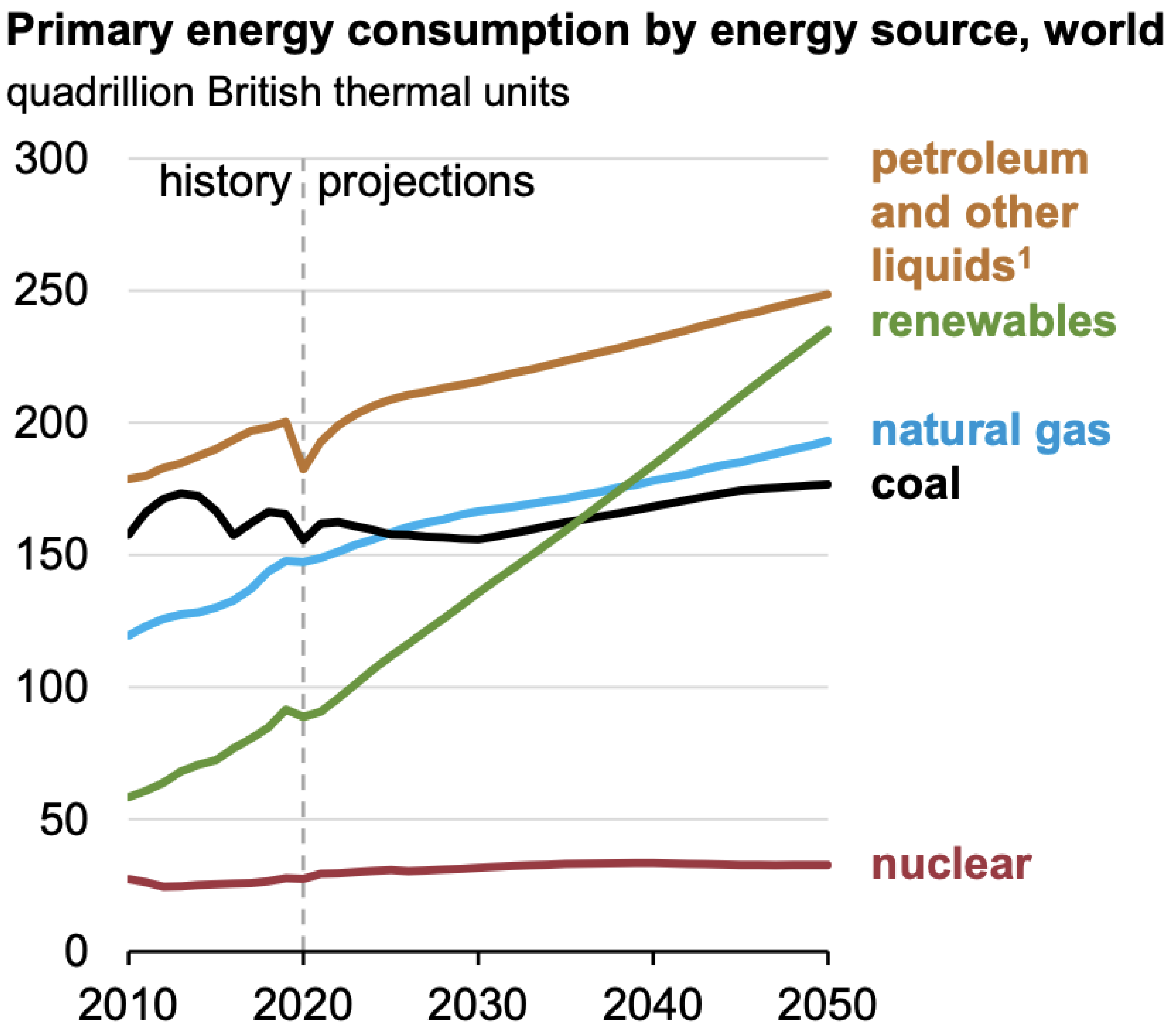
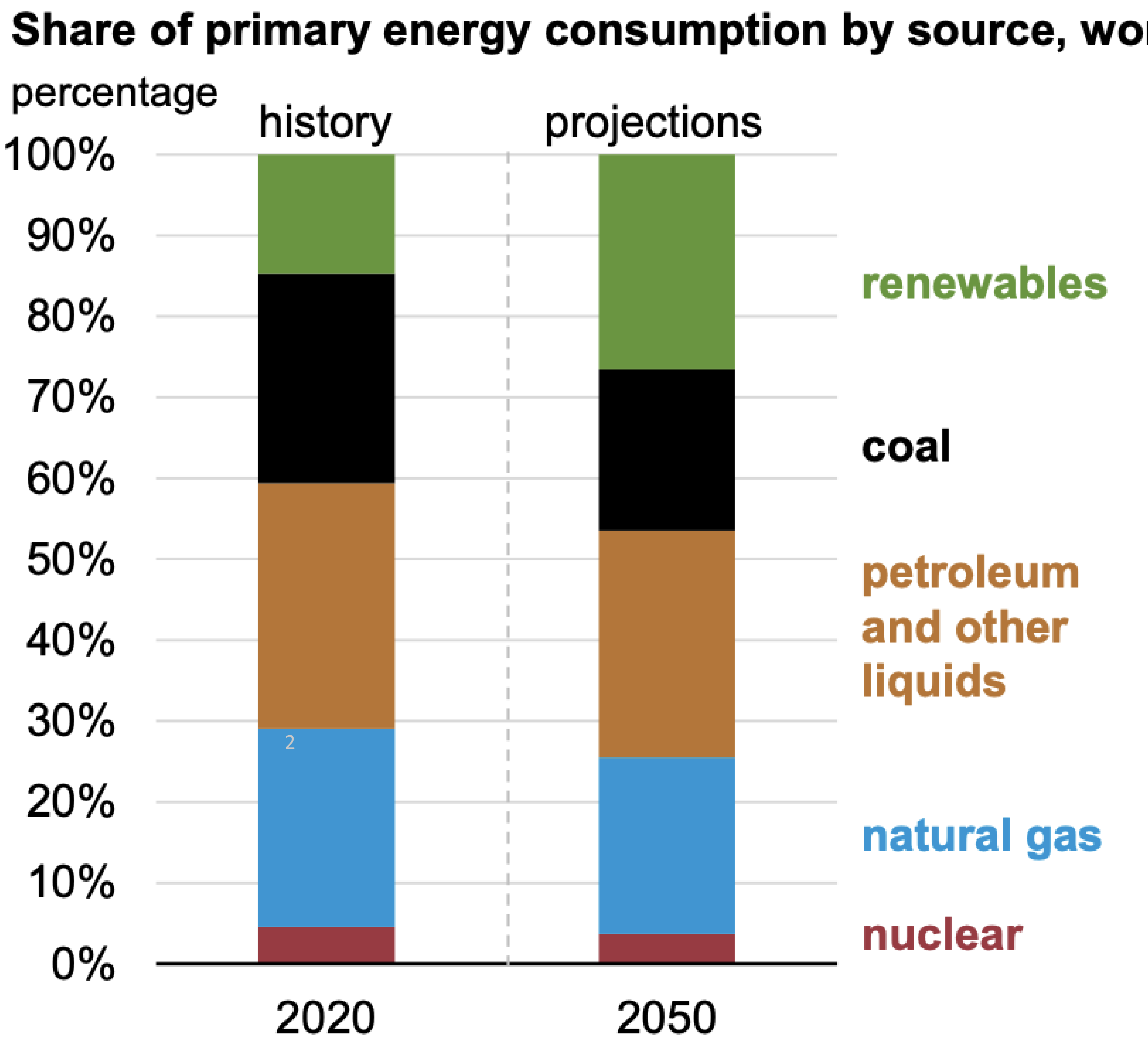
Primary energy consumption by energy source





[1] includes biofuels

Source : https://www.instituteforenergyresearch.org/international-issues/eia-expects-energy-demand-to-increase-almost-50-percent-worldwide-by-2050/

Feedstock: Oat Hulls

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- In 2022, Oats production was **26 million tonnes globally**.
- Oat continues major cereal crop in Saskatchewan, Canada.

  -**annual production of 1.5 million tonnes**.
- Oat hull contributing between 25 and 35 % of the total grains weight **(0.4-0.5 million tonnes per year)**.

Hydrothermal Liquefaction Process

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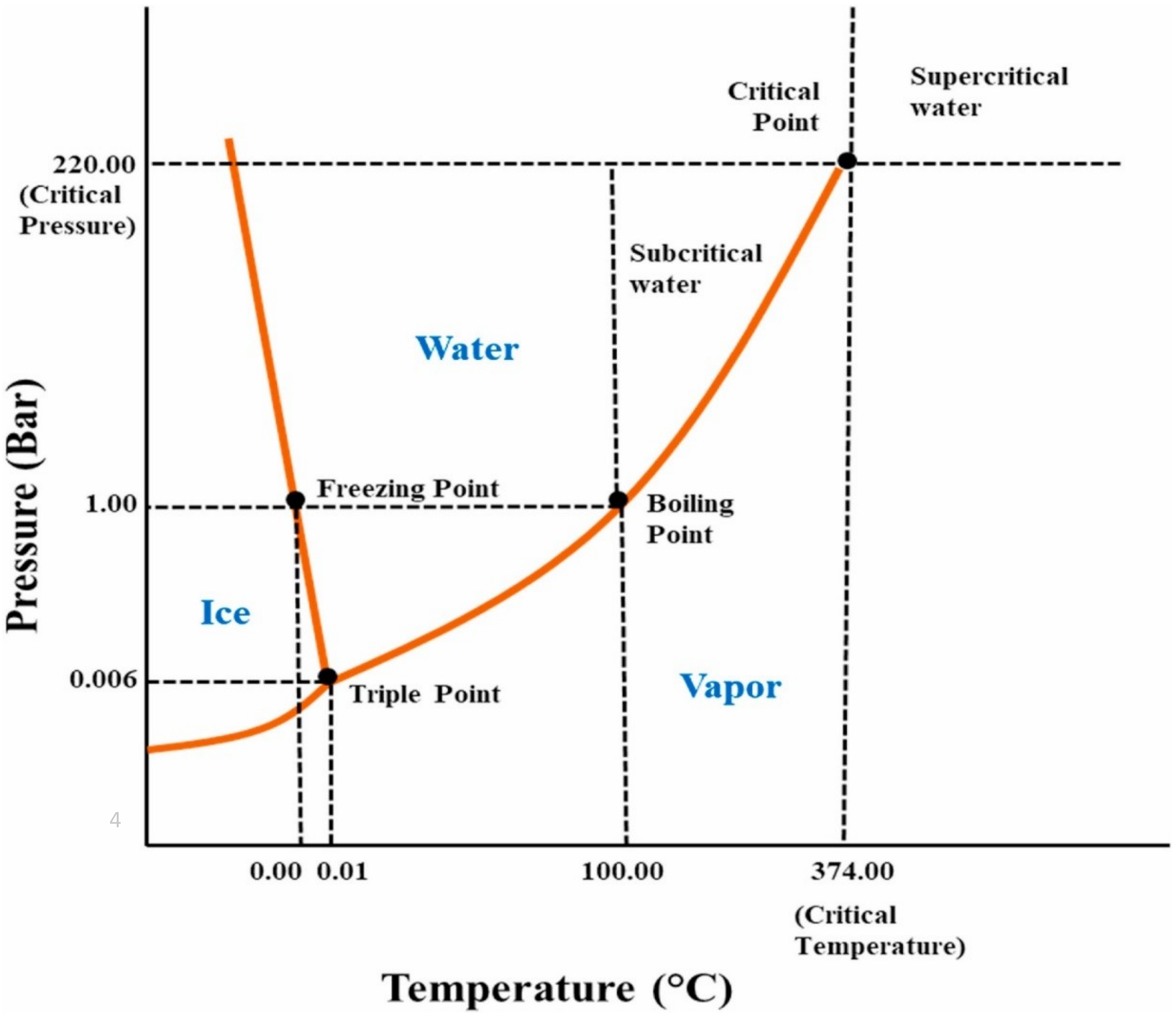
- **Operating Conditions:**
    - **High temperature:** 280–420°C
    - **High pressure:** 10–25 MPa
- Feedstock can be used **directly without drying**.
- **Subcritical Water role:**
    - Acts as a **solvent and catalyst**, breaking down complex organic materials in biomass into smaller molecules.
- **Main Products:** Bio-crude, Hydrochar, Water-soluble fraction, Gases.

Lignocellulose biomass

Hydrothermal Bio oil



Phase diagram of water (Sarker et al., 2021b)

Solvents: Methanol, Ethanol, 1-Butanol

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- **Improved Solubility in HTL:** Dielectric constant of methanol (32.7), ethanol (24.3), 1-butanol (17.8) is less than water(79.7). Low dielectric constant leads to the improvement the solubility of both hydrophobic and hydrophilic components in biomass. It increases bio-crude production.
- **Reduction of Process Severity:** Critical Temperature of methanol (240 ºC), ethanol (240.7 ºC), 1-butanol (289 ºC) is less than that of water (374 ºC). The addition of solvents as co-solvent will reduce temperature and pressure required for the HTL process, making it more energy-efficient.
- ***In-situ* Extraction:** In-situ extraction continuously pulls bio-crude into the solvent phase as it forms, preventing it from undergoing further unwanted reactions.

HTL using solvent and water

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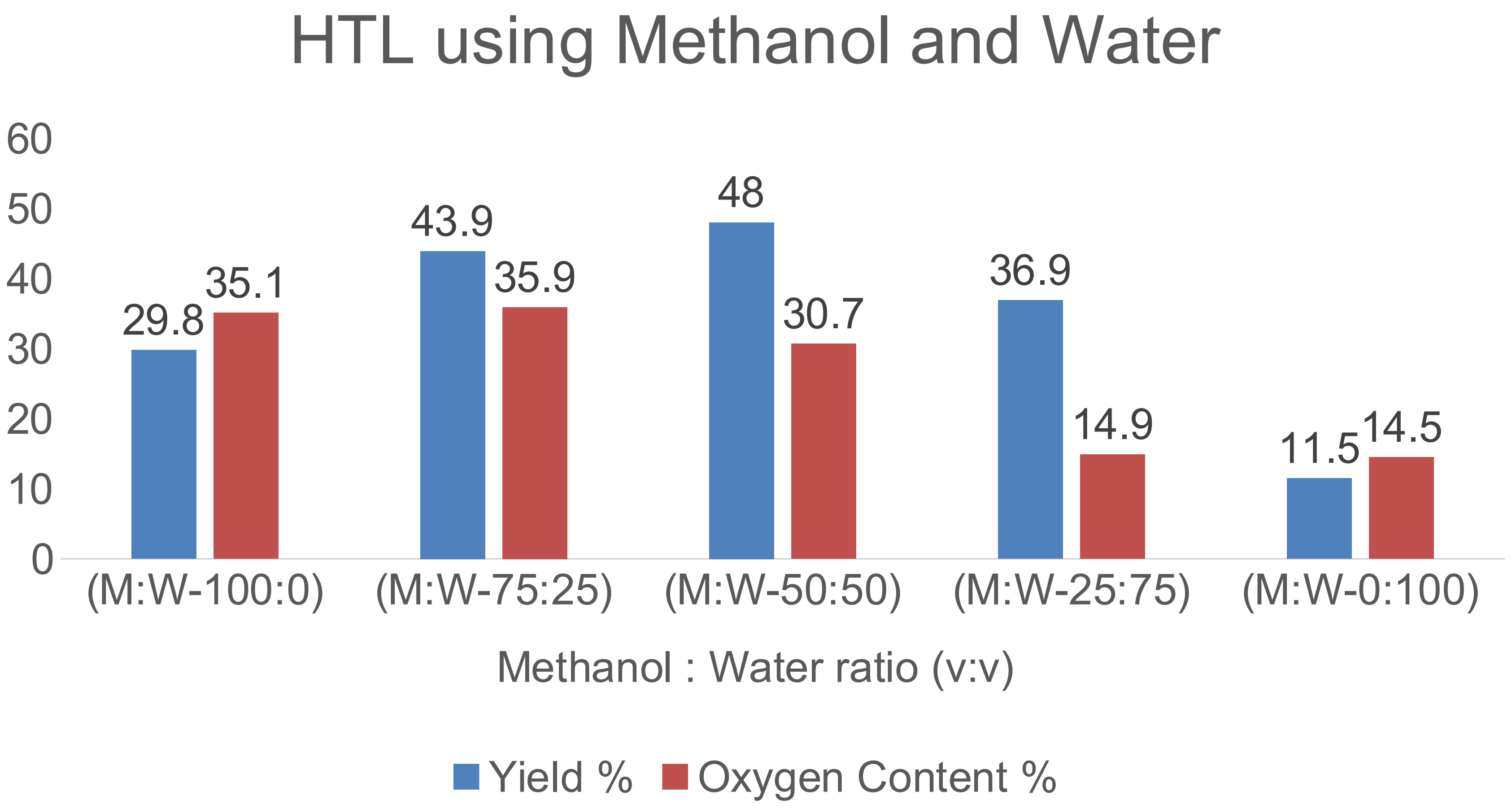

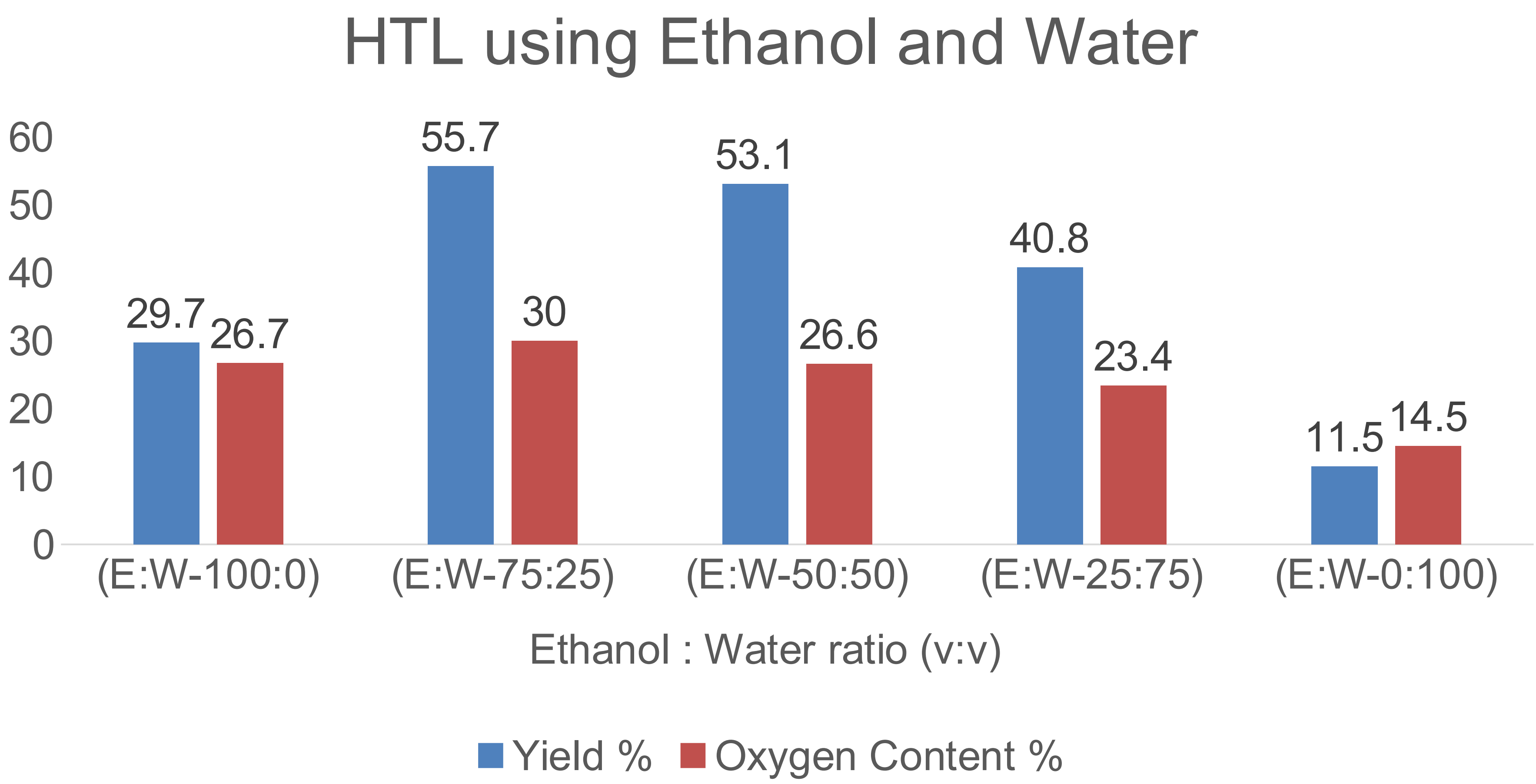

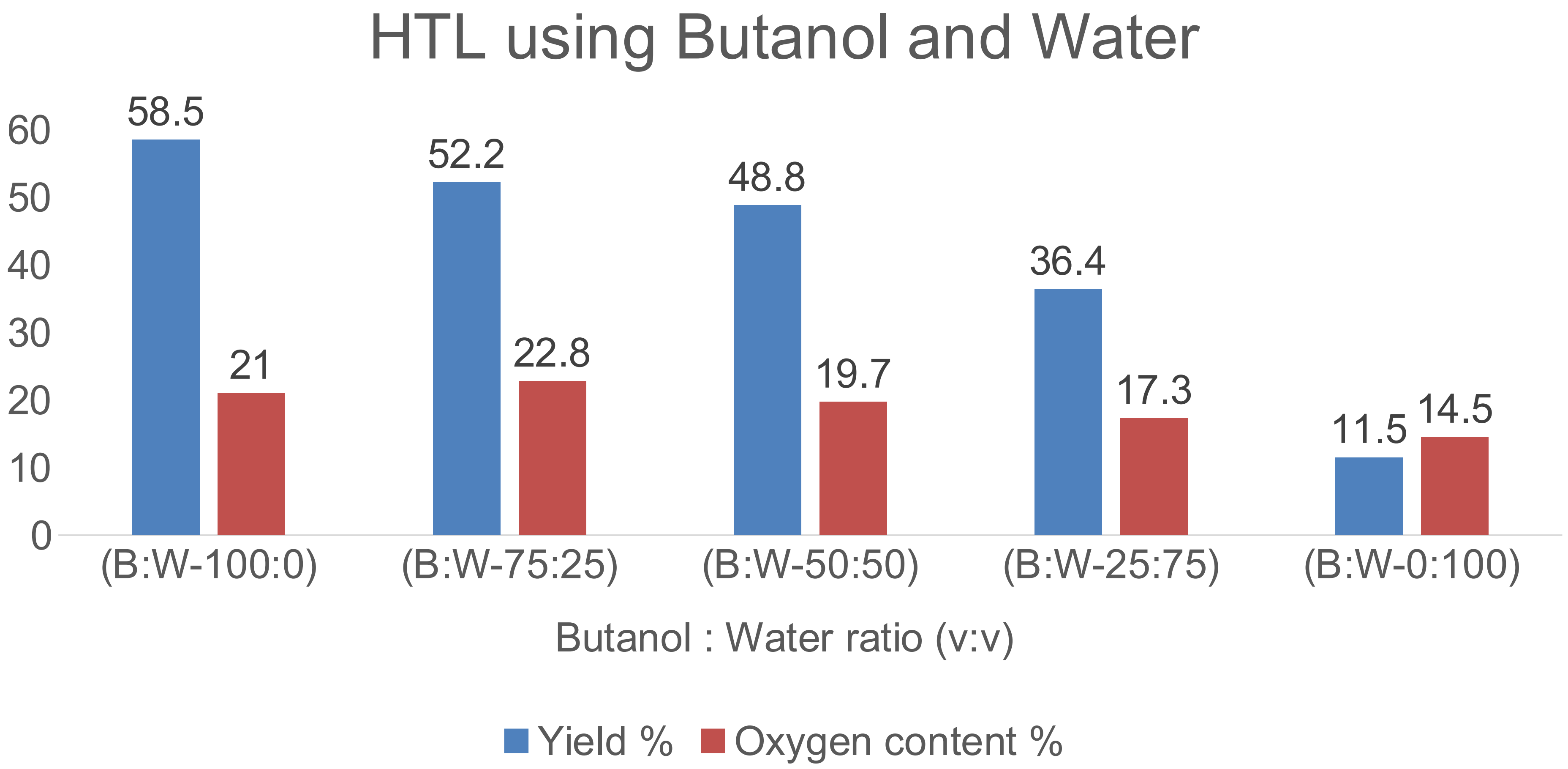

Summary

- The Oat Hull is selected as feedstock for the current research.
- Optimization of HTL parameters and co-solvent system leads to improvement in yield and quality of bio-crude.
- Further research will be conducted using Butanol-water co-solvent system.

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Thank You.