Development of functional activated carbon based on Corn Distiller Soluble to for enhanced CO_2 capture

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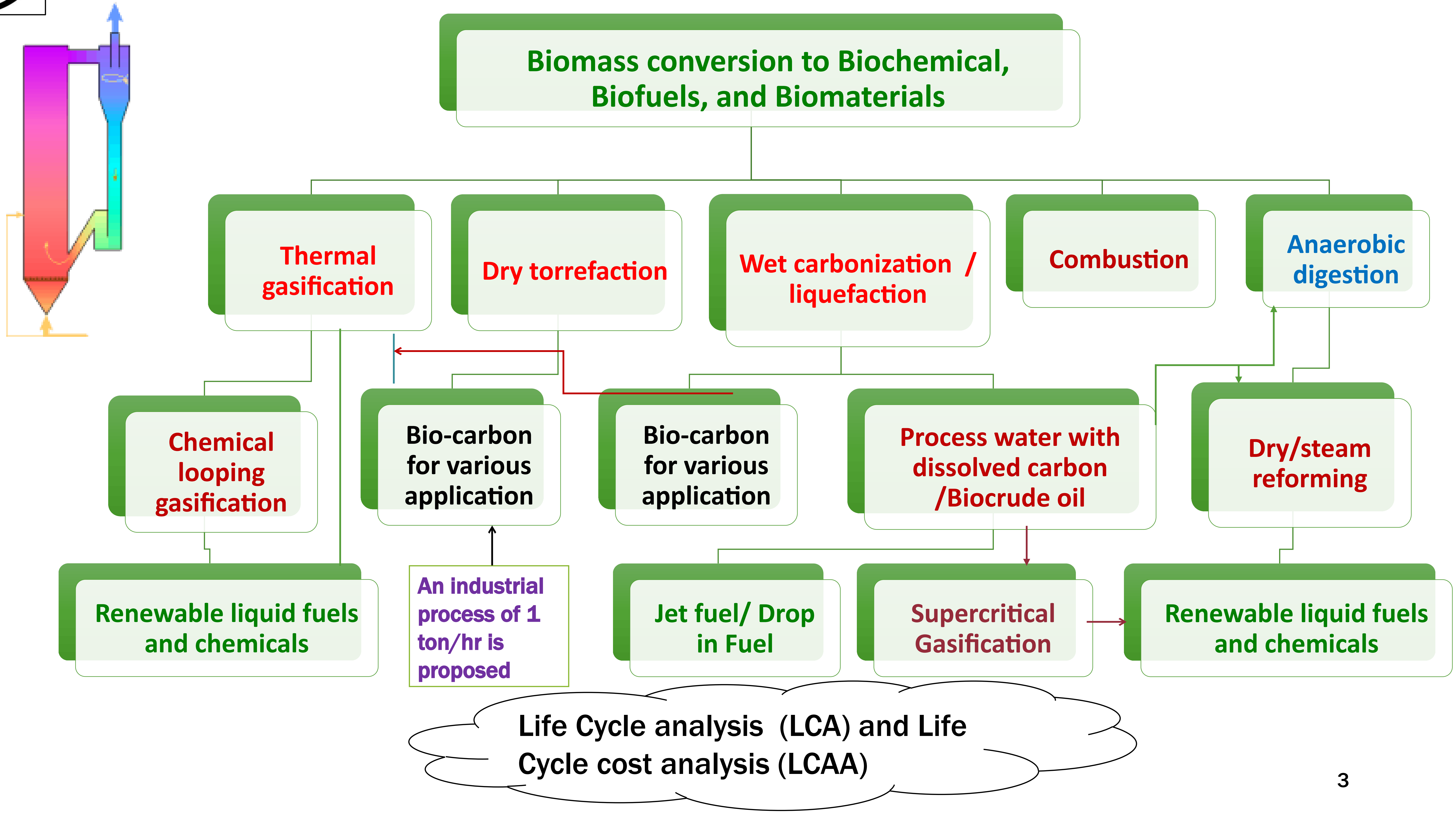
BIO AND PLASTIC WASTE CONVERSION RESEARCH PROGRAM AT BRIL

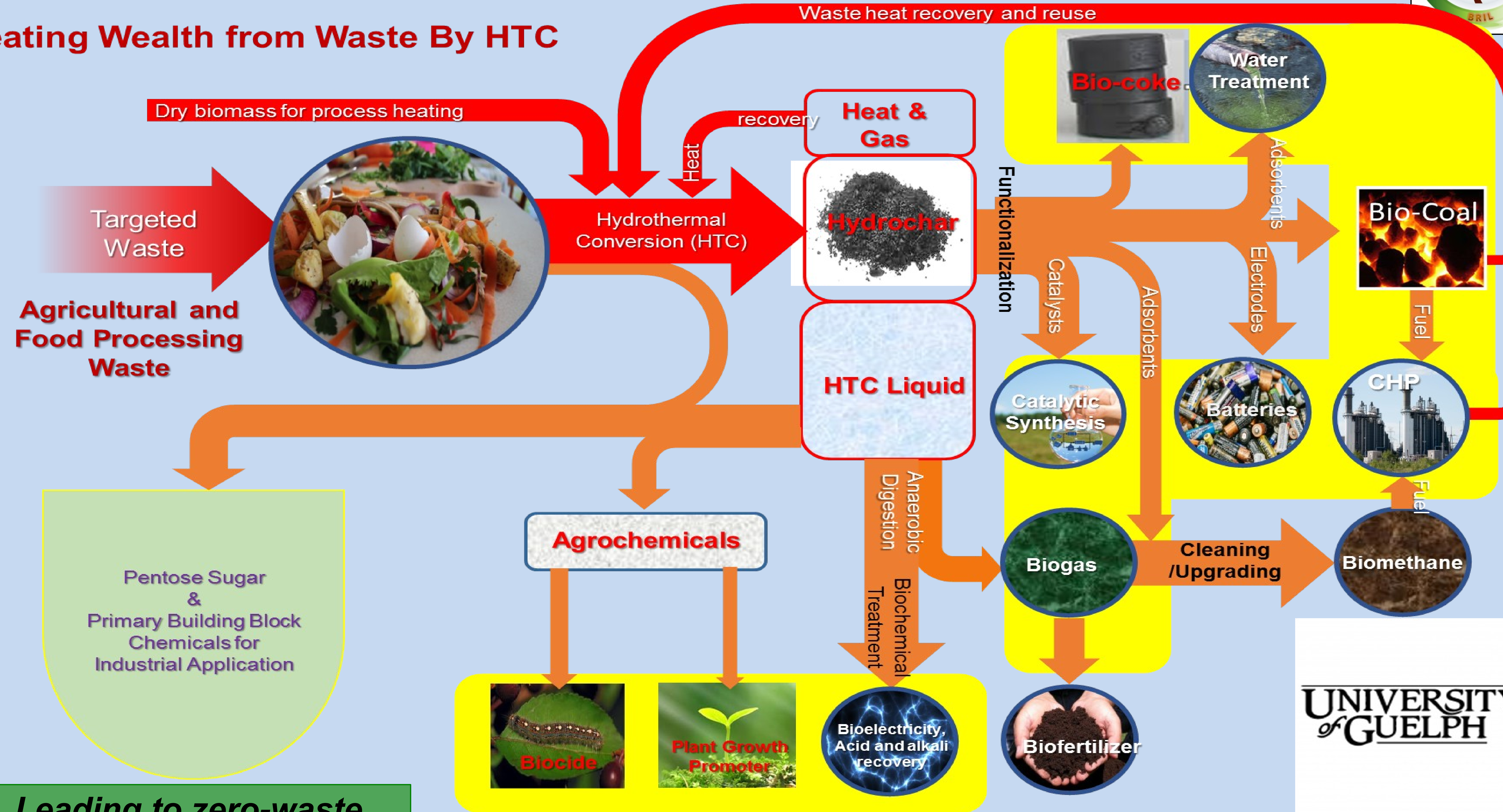
"WASTE IS A RESOURCE-WAITING FOR AN OPPORTUNITY"



Approach: Preprocess greenhouse residues, energy crops, crop residues, municipal green bin fruit processing wastes through HTC processing.

Approach Under Evaluation

Creating Wealth from Waste By HTC

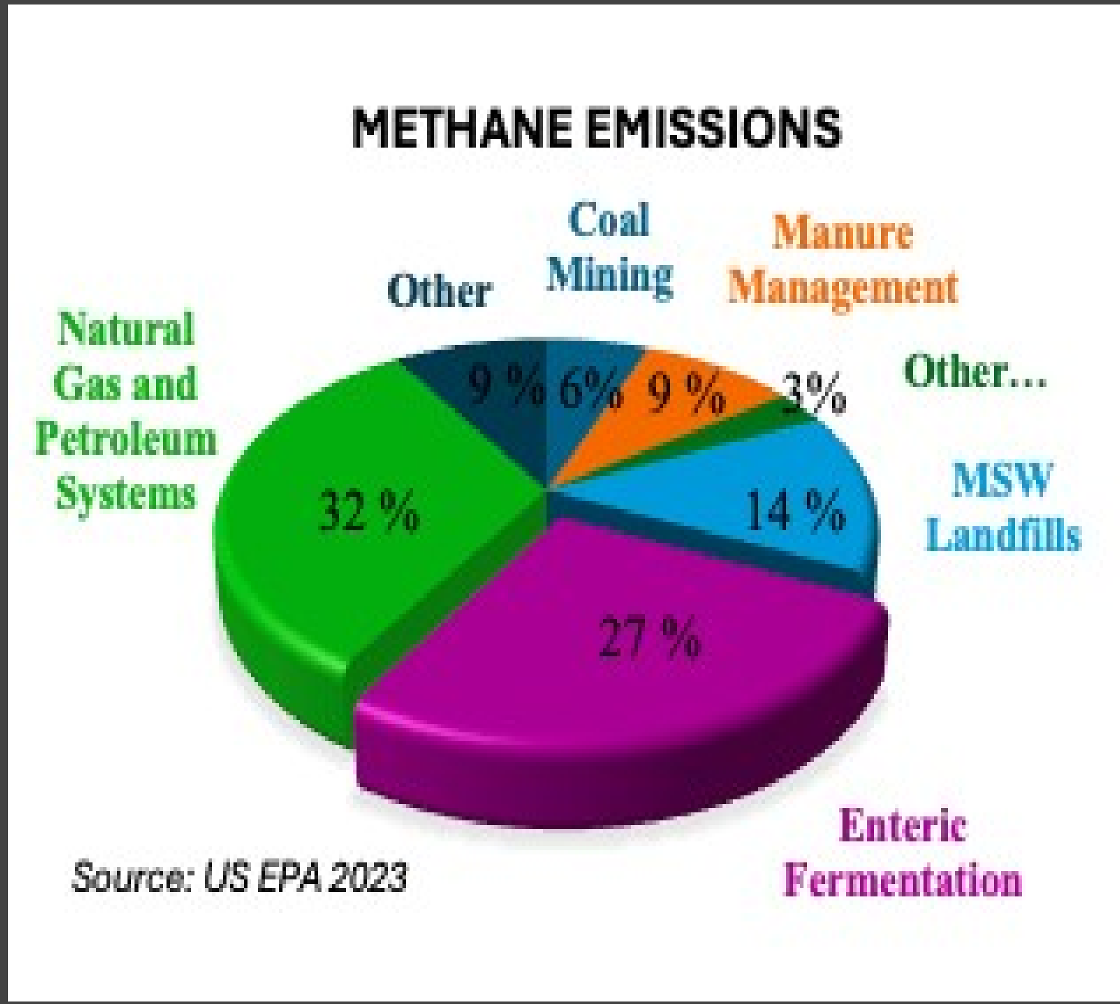


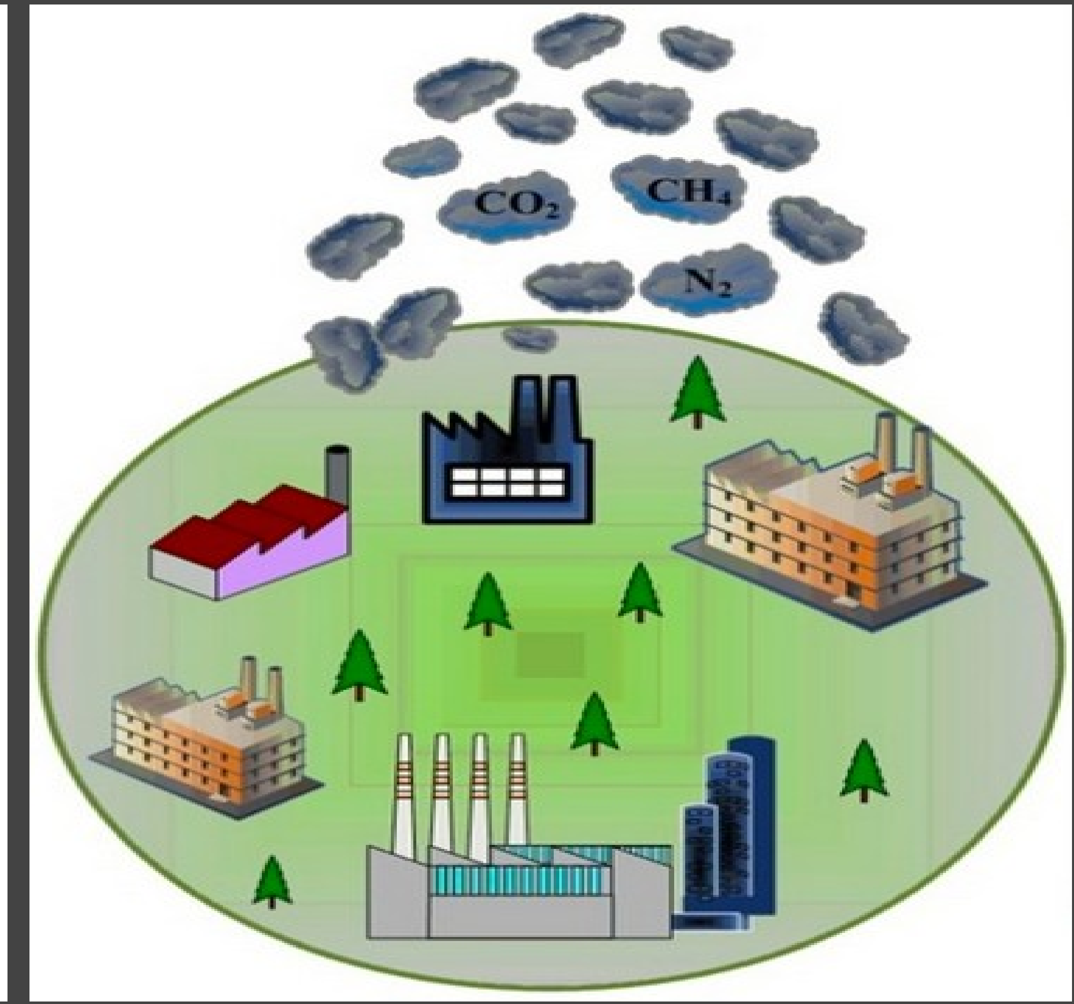
Leading to zero-waste solutions

HTC products from low quality agri-food residue can be a potential newer value chain

INTRODUCTION

- CO_2 is recognized as the primary greenhouse gas.
- Human activities such as fossil fuel combustion, industrial and agricultural processes are the main sources of CO_2 emissions.
- Developing and applying a novel and sustainable technology or products to capture CO_2 is essential yet remains challenging.





In our study, activated carbon with a high surface area has been produced via the Hydrothermal carbonization technique (HTC) combined with the KOH activation synthesis route to capture CO_2.

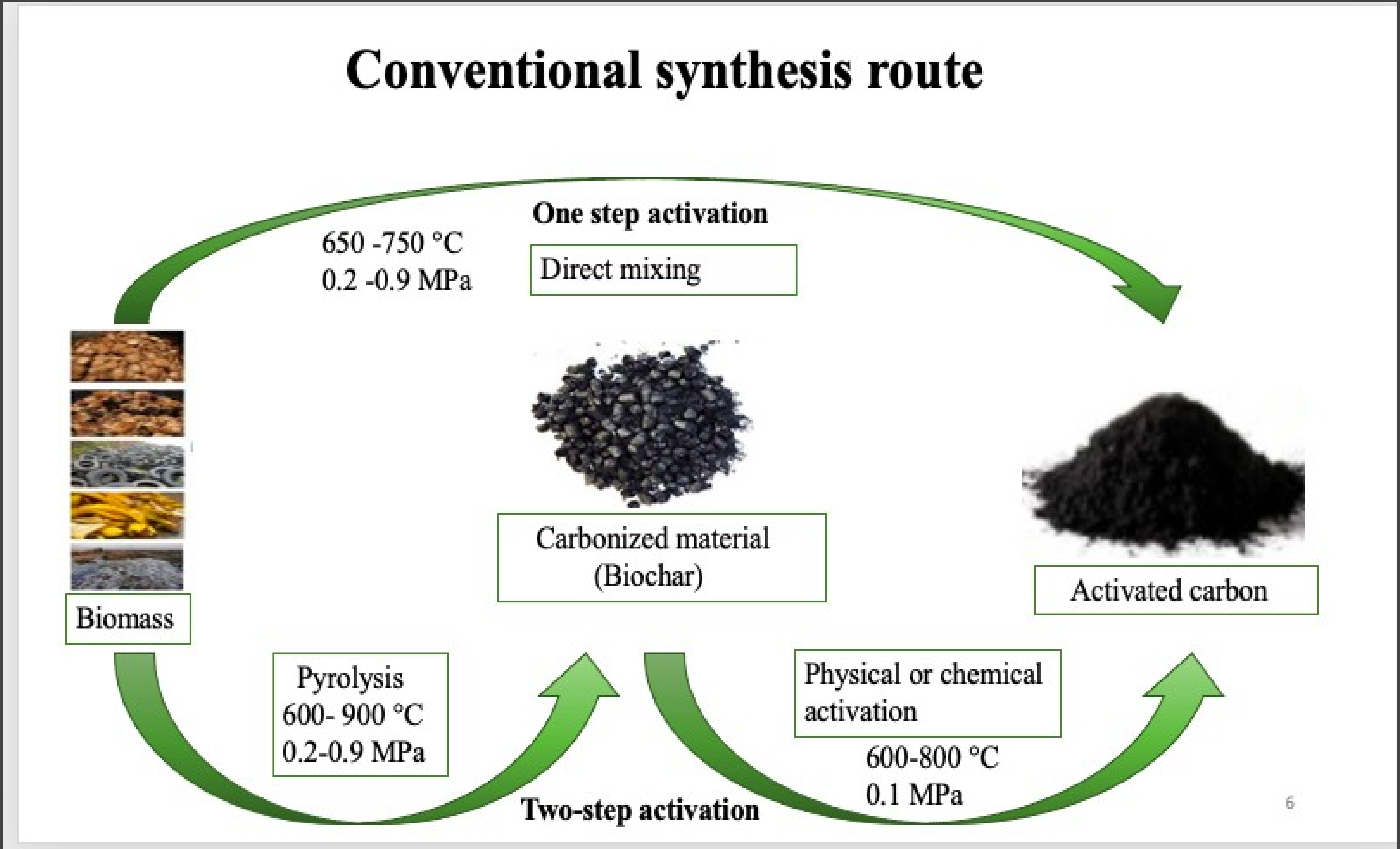


Fig 1. Conventional synthesis route to produce activated carbon.

Our synthesis route

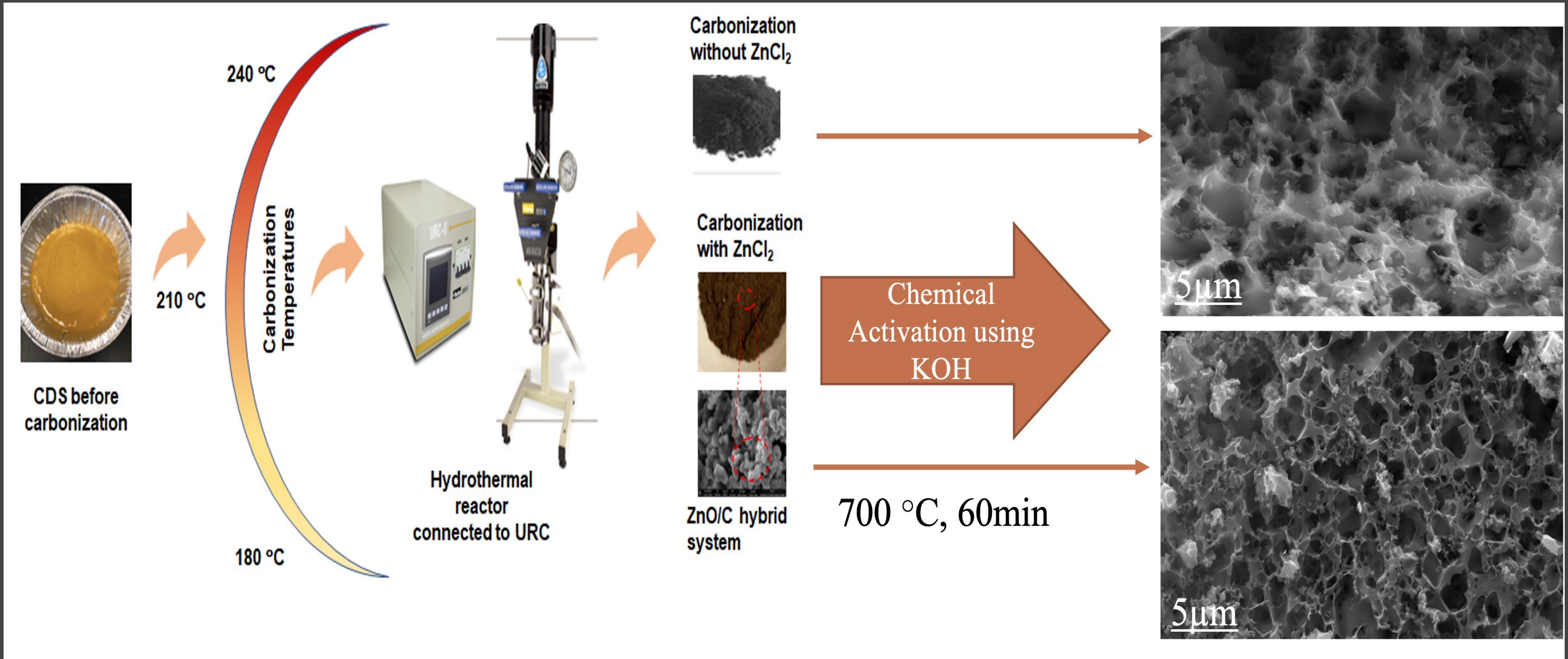


Fig 2. Schematic representation of proposed synthesis route to produce activated carbon.

Acronyms

- Optimized conditions were used to perform catalytic HTC using various ratios of $ZnCl_2$ (1:10, 1:5, 1:7, 1:3, 1:2 and 1:1 biomass to $ZnCl_2$)
- ZnO/C-1:7 and ZnO/C-1:3 hybrid systems were selected for further analysis, as exceeding the concentration of $ZnCl_2$ in biomass beyond 1:3, led to surface agglomeration and lower mass yield.
- The raw CDS (R-CDS) and Opt-HC (hydrochar at optimal conditions) were chosen for baseline comparison.

Results and Accomplishments

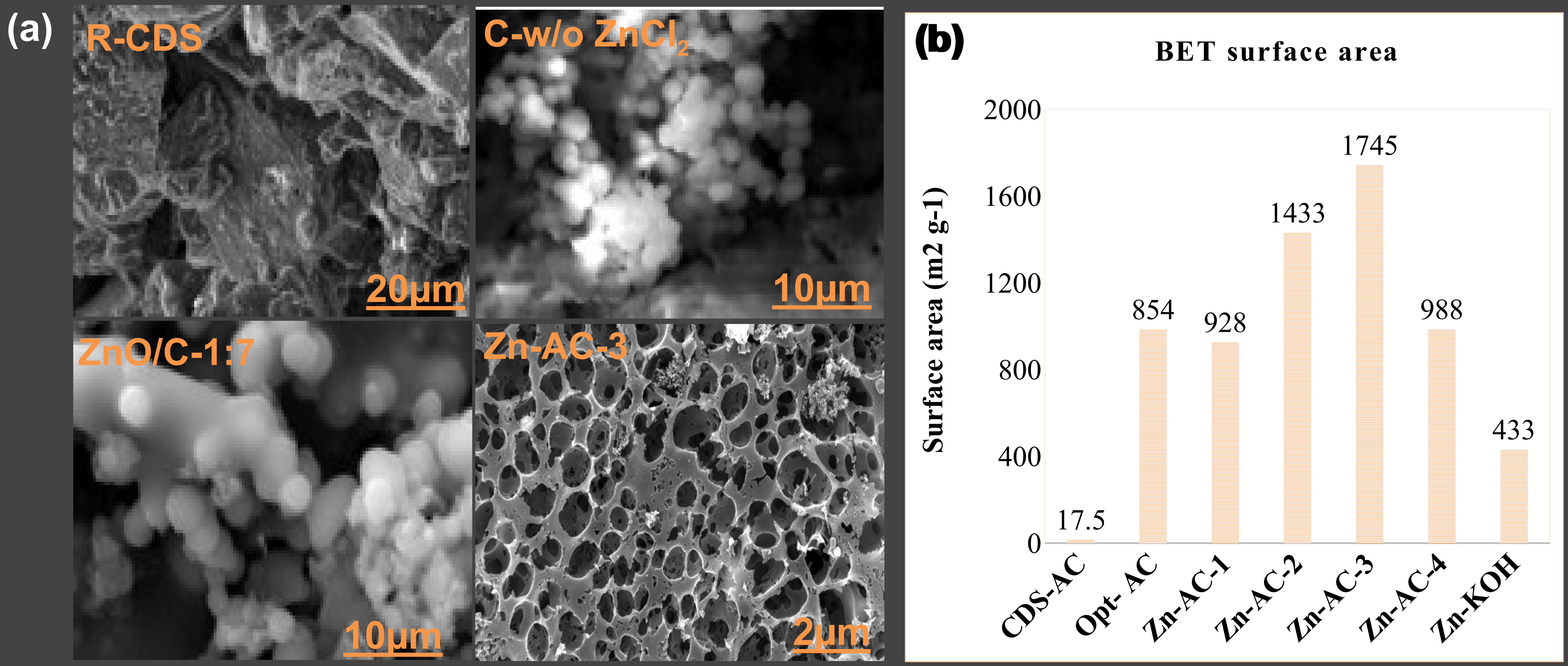


Fig 3. (a) SEM images and (b) BET surface area of synthesized activated carbon.

Results and Accomplishments

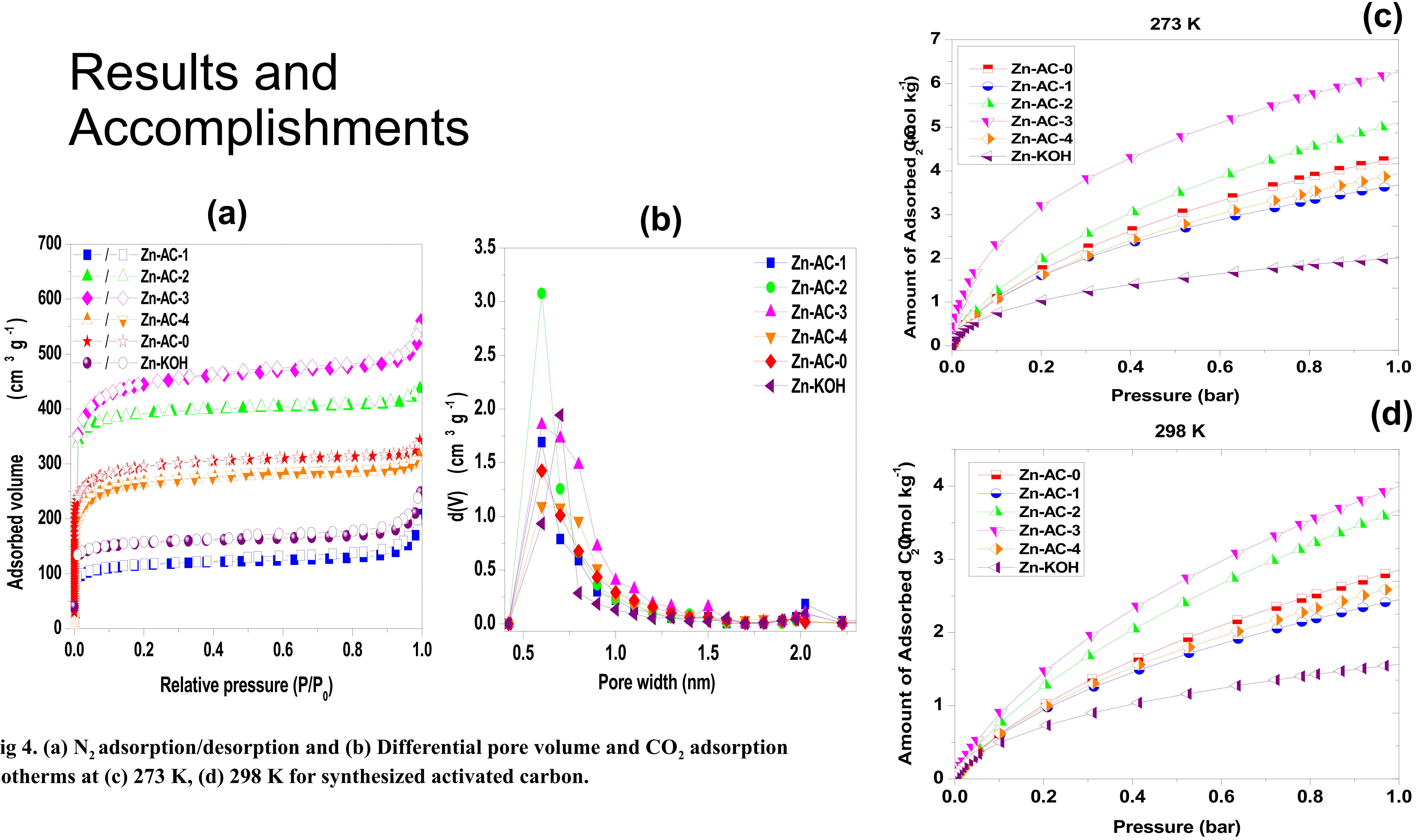


Fig 4. (a) N_2 adsorption/desorption and (b) Differential pore volume and CO_2 adsorption isotherms at (c) 273 K, (d) 298 K for synthesized activated carbon.

Challenges

- Scaling up the activation process is still a challenge.
- The market success of activated carbon depends on consistent quality and properties tailored for specific applications (e.g. water treatments and gas adsorption).
- High operational and capital costs for large-scale systems, including energy, activating agents, and reactor infrastructure.
- However, these challenges can be overcome by process optimization, scaling economies, and diversifying end-product applications.
- Achieving high yield, energy efficiency, and throughput.
- A successful activated carbon project will not only push the boundaries of technology but also create tangible benefits for AAFC and the farming community by increasing the value of agriculture residues, providing economic opportunities, and driving sustainability in Canada's biomass sector.

Next steps and Bring Home Messages

- Cyclic stability and ease of regeneration are as crucial as adsorption capacities for CO_2 adsorbents as an important characteristic.
- CO_2 adsorption isotherm of activated biocarbon should be investigated for cyclic stability and regeneration to analyze its applicability for practical applications such as post-combustion CO_2 capture, where adsorption occurs between (25-70 ◦C).

This study provides insightful guidance for designing the multifunctional carbon material based on low value biomass as a CO_2 adsorbent as well as for environmentally sustainable applications.

This study directly contributes to circular bioeconomy by emphasizing resource efficiency, waste valorization, and environmental sustainability.

Acknowledgements

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UNIVERSITY of GUELPH ENGINEERING

BRIL Team

Bio-renewable Innovation Lab BRIL

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