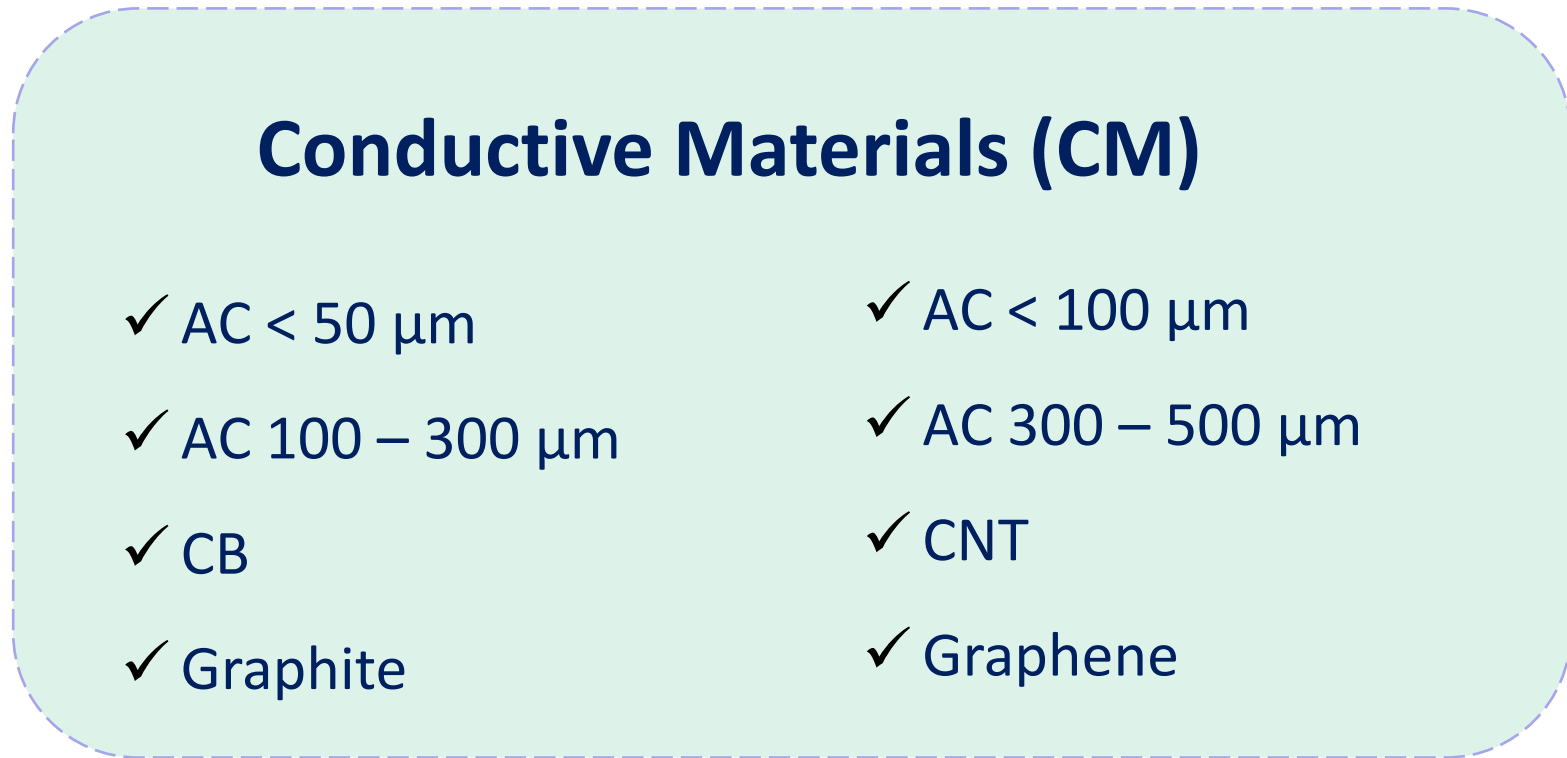
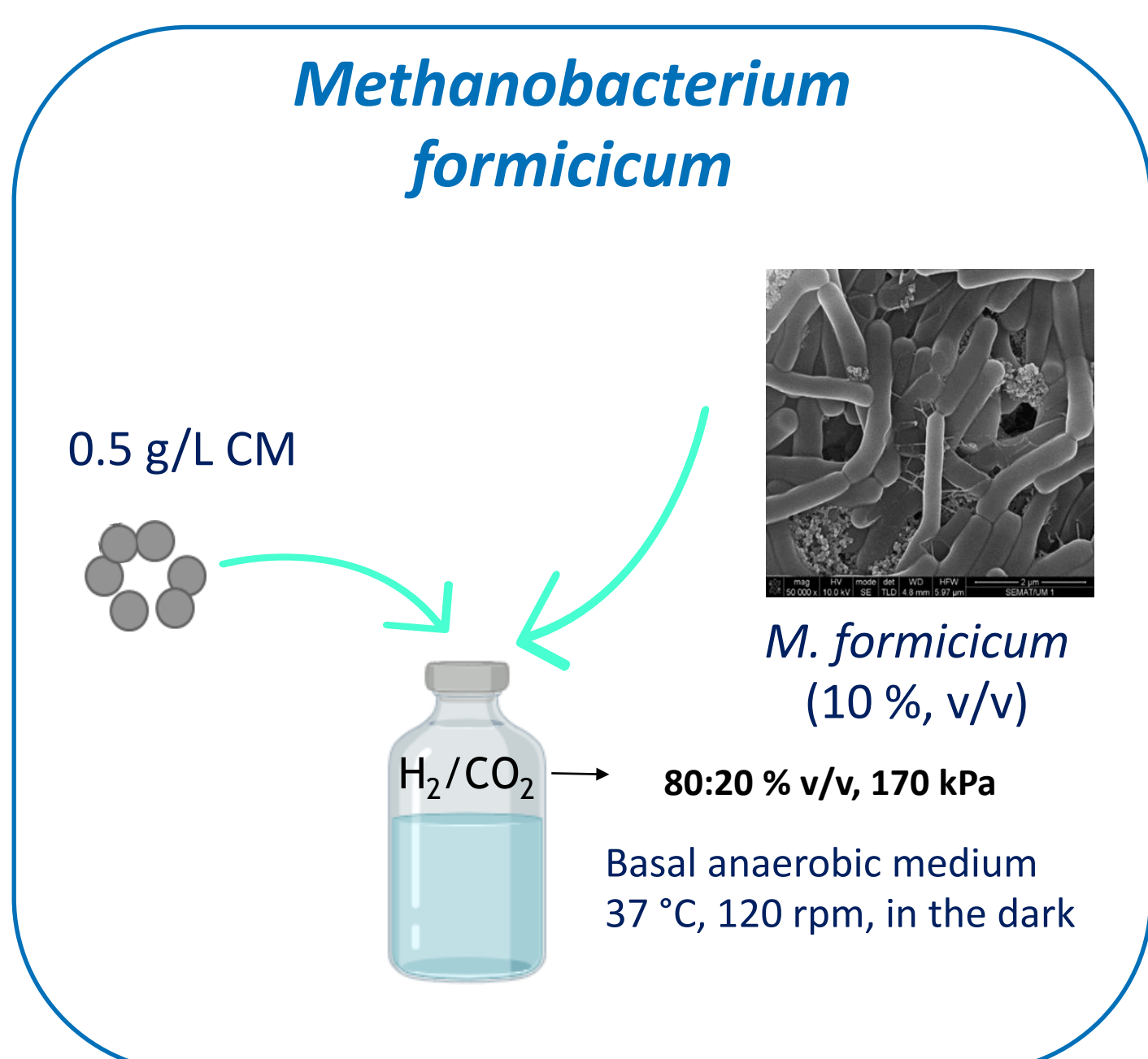
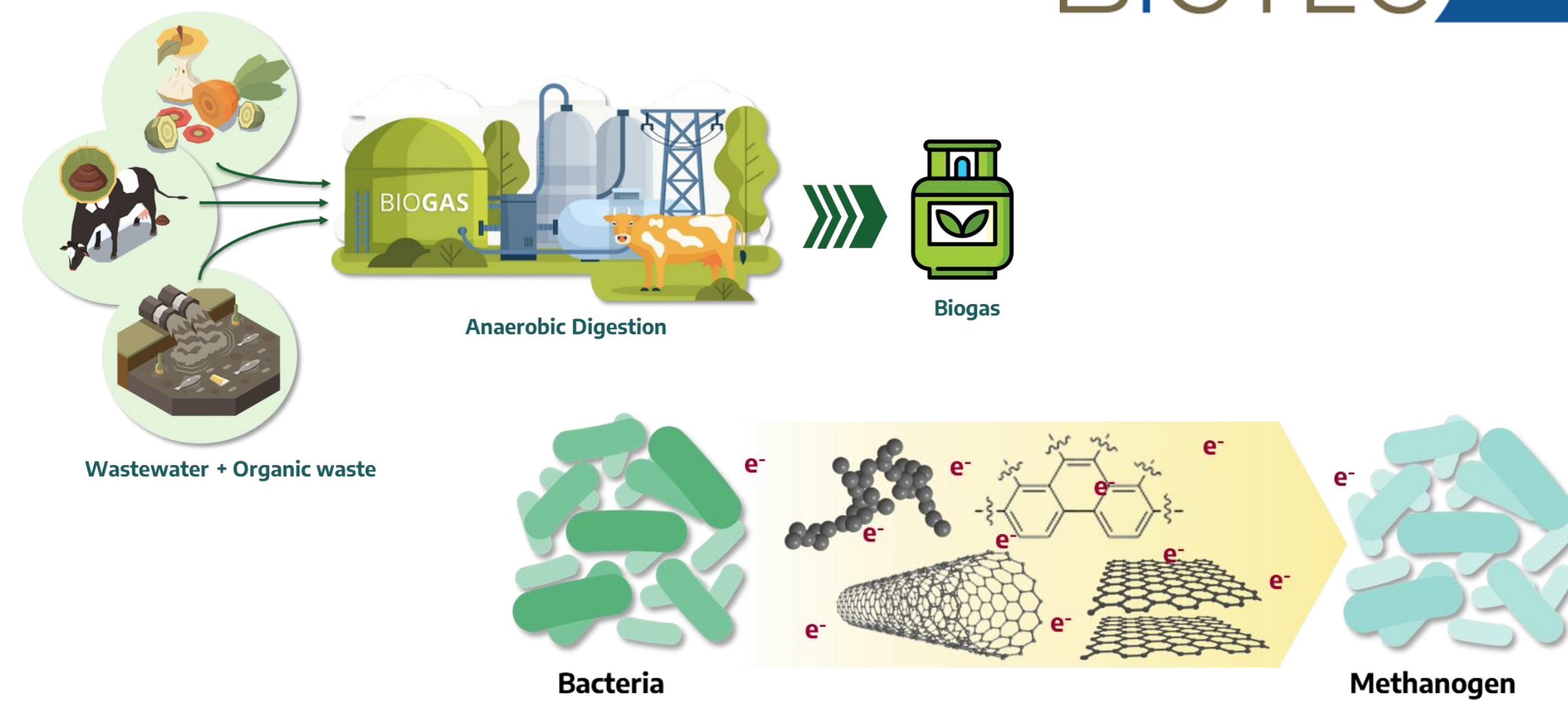


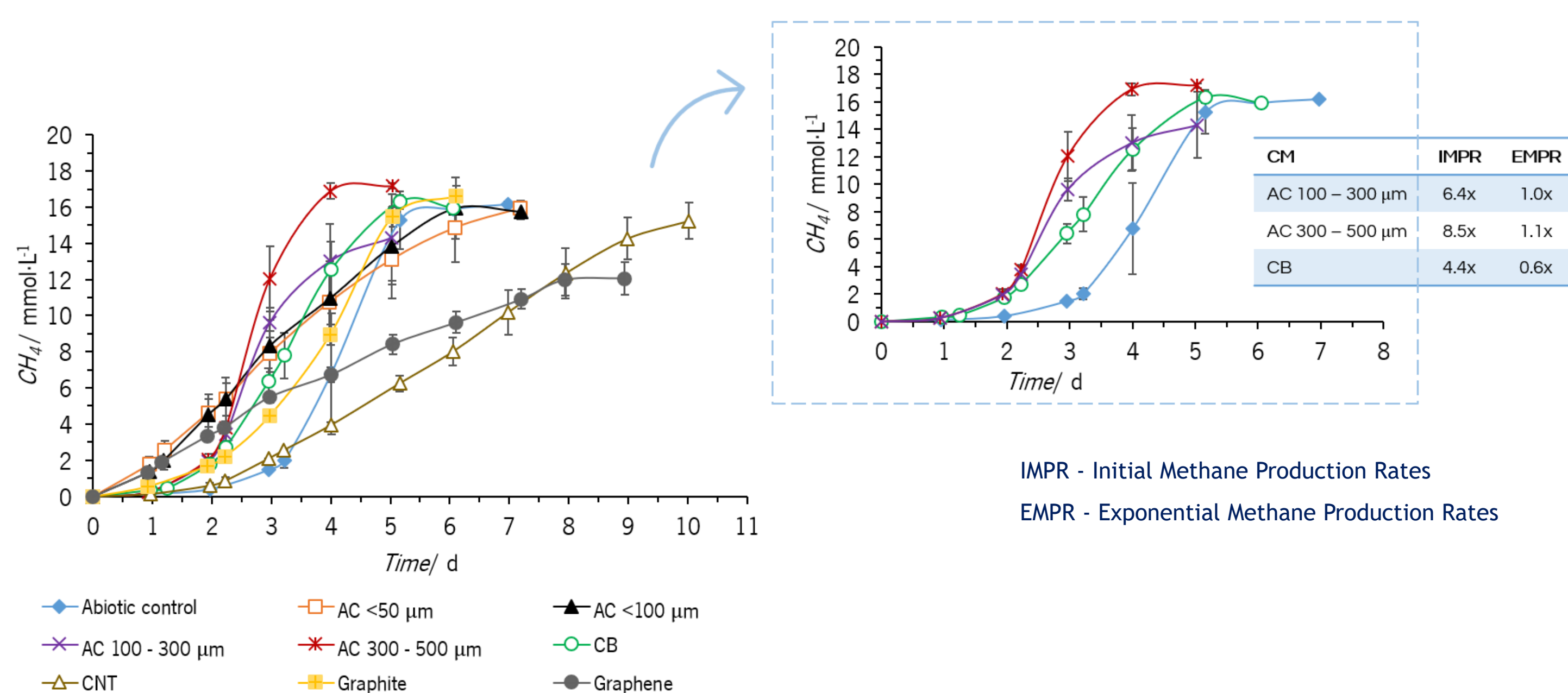
Biomethane production through anaerobic digestion (AD) can help to reduce the dependence on fossil energy. The addition of conductive nanomaterials (CM) to AD systems results in the acceleration of methane production (MP) and the improvement of the resilience of these systems. However, the mechanisms underlying this phenomenon are still unclear, particularly regarding the effects of different materials on the activity of methanogens.

The present work aimed to evaluate the effect of the structure, roughness, and shape of different carbon-based CM, such as activated carbon (AC), black carbon (CB), carbon nanotubes (CNT), graphite, and graphene, on a hydrogenotrophic and an acetoclastic methanogenic pure culture.



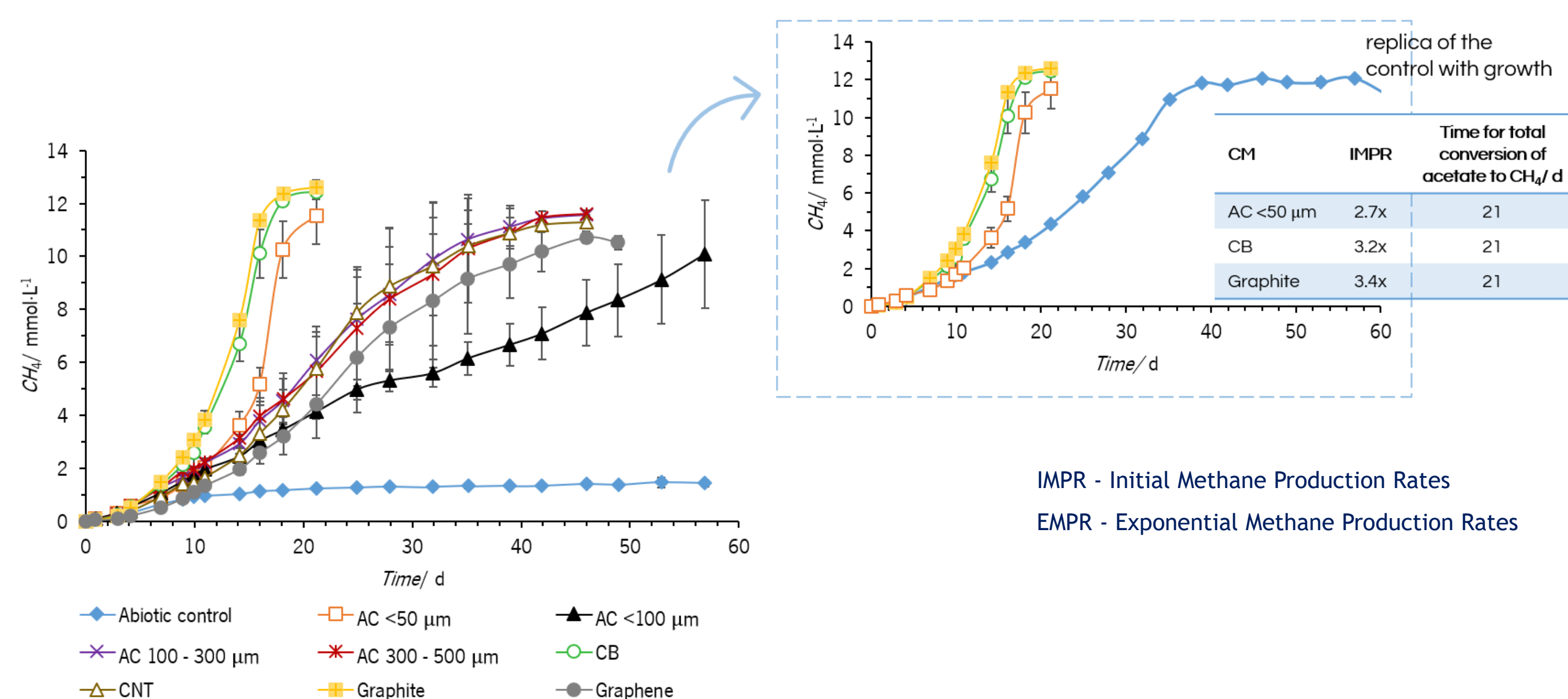
Methane production was monitored over time by gas chromatography

### Effect of adding different carbon nanomaterials on methane production with *M. formicum*



- ✓ Decrease in lag phases in the presence of all CM;
- ✓ For AC 300-500 µm, and AC 100-300 µm, IMPR values were 8.5x and 6.4x higher than the condition without CM;
- ✓ Complete conversion of hydrogen to methane occurred in 5 days with AC 100–300 µm and AC 300–500 µm;
- ✓ AC 300-500 µm proved to be the most promising;
- ✓ CB also presented good results both on IMPR and EMPR improvement.

### Effect of adding different carbon nanomaterials on methane production with *M. harundinacea*



- ✓ Reduction of lag phases with the addition of CM;
- ✓ Graphite and CB exhibited 3.4x and 3.2x higher IMPR than condition without CM;
- ✓ Graphite, CB, and AC <50 µm converted acetate to methane in 21 days;
- ✓ The control replica (condition without CM) that showed growth took 39 days to complete the exponential phase, which reveals a positive effect of CM.

- ✓ The presence of CM had a positive influence on both methane production rates, in the decrease of lag phase duration (55% decrease for *M. formicum*), and in the time of incubation (total conversion of acetate to methane in 21 days for *M. harundinacea*).
- ✓ Different CM had different effects on the MP and lag phase of each pure culture. Thus, the textural characteristics of CM and physical-chemical conditions imposed on the environment did not explain alone the improvements observed in MP.
- ✓ Further studies are needed to assess the mechanisms that explain those differences.