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Coaches	**Supervisors**	**Funding**
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Intensifying pyrolysis of biomass and solid waste by chemical looping

Aim

Establish the symbiotic link, comprising **pyrolysis gas, N_2 and heat**, between pyrolysis plants and chemical looping by experimental proof, stability tests, reaction kinetics, process calculations, and techno-economic assessment.

Justification

Faced with the challenge of increased waste from a growing population and of climate change due to anthropogenic emissions, pyrolysis, an established low carbon impact process, offers circularity in our carbon consumption by breaking down complex molecules and polymers to yield chemicals that are valuable for sustaining our modern standards of life.

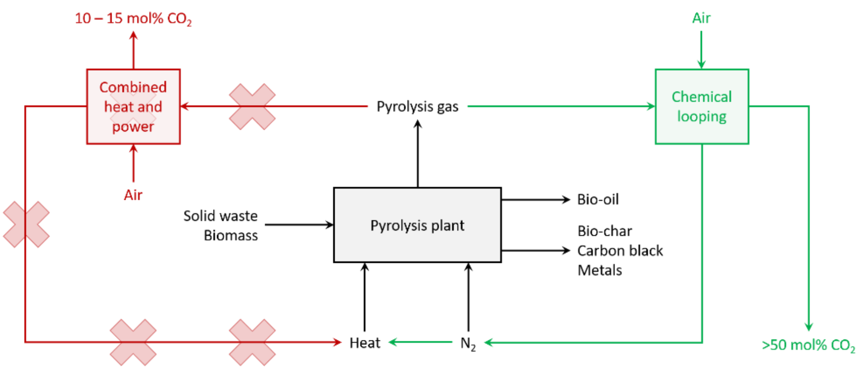

Figure 1: Envisioned symbiosis between a pyrolysis plant and chemical looping.

Pyrolysis requires **heat** and **near absence of O_2** to produce value-added bio-oil, solids residue, and pyrolysis gas. Near absence of O_2 is provided in the process typically by an inert gas such as **N_2**, produced either by cryogenic distillation on-site or transported to the plant. The **pyrolysis gas**, rich in calorific fuels, is typically combusted in a combined heat and power unit (engine or turbine) to generate **heat** for the pyrolysis process and electricity for on-site purposes. Although efficient, the use of an engine or turbine inevitably leads to additional **CO_2 emissions** from the overall process unless a cost-intensive CO_2 scrubber is deployed to separate the emitted CO_2 (see Figure 1).

To address the limitations of the current state-of-the art, we propose the use of an emerging cyclic process called "chemical looping" (displayed in Figure 2) which applies abundant metal oxides as solid intermediates to split the exothermic combustion reaction yielding **CO_2**/H_2O in one step and **N_2/Ar** in the other step. Thus, the application of chemical looping will result in 3 distinct advantages:

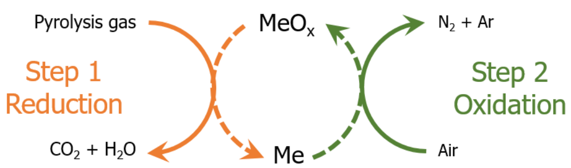

Figure 2: Schematic representation of chemical looping.

1. **N_2** and **heat** can be generated on-site using the chemical energy of the pyrolysis gas.
2. A **CO_2-rich stream** can be produced on-site that eases CO_2 separation for further storage or utilisation.
3. Avoidance of moving parts (as in engines/turbines), high **tolerance to changes** in gas composition (and impurities) caused by changes in feed to the pyrolysis plant.

Program

Literature review	**Experimentation**	**Process development**	**Process assessment**
N_2 requirements	Synthesis and characterisation	Mass/energy balances	Scenario development
Py-gas composition(s)	Long-term testing	Reactor sizing	Monetary expenses
Which metal oxide?	Kinetic data acquisition	Heat integration	Technical feasibility

The ideal candidate should be enthusiastic about experimental work and investigation. He/she should be interested in collecting experimental evidence and arranging the findings in the larger framework of a technically and economically feasible commercial process.