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Modular system based on Molten Carbonate Fuel Cells with tailored composite membranes designed for specific flue gas compositions oriented into CCS integration with an industrial power plant

MOLCAR

„Modular system based on Molten Carbonate Fuel Cells with tailored composite members designed for specific flue gas compositions oriented into CCS integration with an industrial power plant", project contract number NOR/POLNORCCS/MOLCAR/00-17/2020-00

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Work Package 4

Industrial research of CCS installation with MCFC stacks

Warsaw University of Technology & Fuel Cell Poland sp. z o.o.

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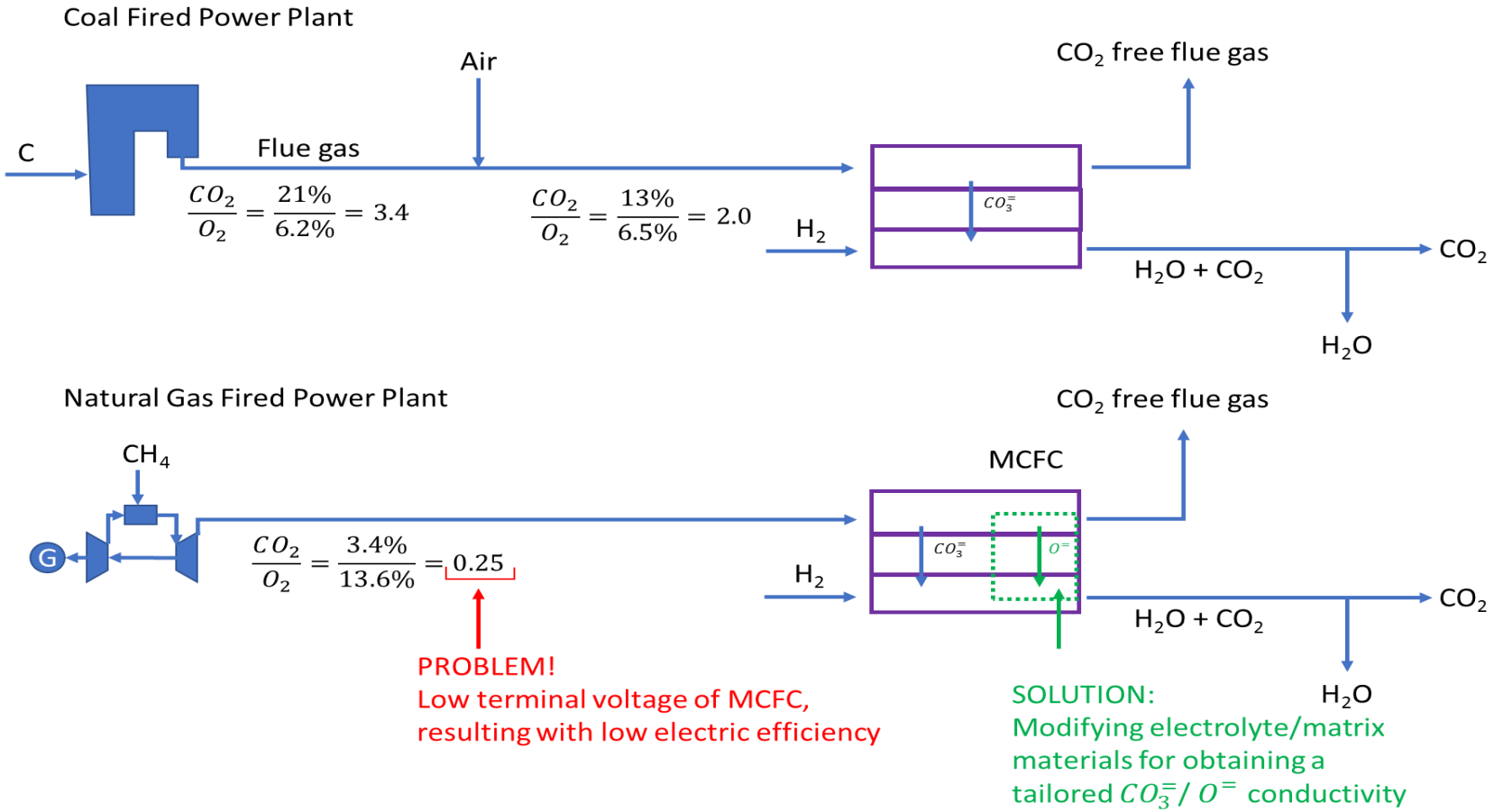
Topic and excellence



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Work Package 4

- **Flue gas composition**

Table Typical composition of flue gas originated from gas turbines

Major species	Typical concentration, % volume
N_2	66..72
O_2	12..18
CO_2	1..5
H_2O	1..5

Table General Electric F-class engine (GE9371FB) exhaust gas and fuel composition

COMPONENT	Fuel, %vol	Flue gas composition, %vol
CH_4	93.1	0
C_2H_6	3.2	0
C_3H_8	0.7	0
C_4H_{10}	0.4	0
N_2	1.6	0
CO_2	1.0	3.9
H_2O	0	8.4
O_2	0	12.4
N_2	0	74.4
Ar	0	0.9

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- **Planned reseach activities**
  - Verification of the MCFC operation with the various composition of flue gases
  - examination of the MCFC operation stability as the component of CCS installation
  - Testing scenarios
    - up to 3 short operating periods
    - up to 3 medium operation periods
    - 1 long operating periods – at least 1000 hours

Oriented into verification of the basic functionalities of the container installation

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Work Package 4

Goal: Long-term tests during operation lasting 120 – 1000 hours

- Task 4.1: Long-term studies of a pilot container installation with a MCFC stack

- Task 4.2: Research on the impact of exhaust gas composition on the efficiency of CO2 capture in the context of increased efficiency

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Work Package 4

- Task 4.1: Long-term studies of a pilot container installation with a MCFC stack

Aim: collect following operational data:

- Temperatures at measured locations inside the stack
- Temperatures of external construction plates of the stack (exposed to large temperature difference)
- Temperatures of gas in inlet and flue gas outlet channels
- Pressure on the inlet and outlet to both anode and cathode
- Absolute fuel pressure
- Pressure drop between inlet and outlet in the anode and cathode channel
- Pressure drop in the main pipelines of the installation

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Work Package 4

- Task 4.1: Long-term studies of a pilot container installation with a MCFC stack

Aim: collect following operational data:

- Fuel and air/flue gases composition controll
- Fuel and air/flue gases flow control
- Detailed control of the value of CO2 capture coefficient and decrease of concentration of CO2 at the cathode outlet
- Fuel and oxidized utilization coefficient

- Data acquisition for ex-post analysis in the resolution of 1 seconds (for steady states) and 0.1-0.2 seconds for transient states.

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Work Package 4

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- Task 4.2: Research on the impact of exhaust gas composition on the efficiency of CO2 capture in the context of increased efficiency

- General analysis of facility cooperation with MCFC, including:
- Various amounts of gas turbine flue gas flow through cathode channel vs. Electricity generation efficiency
- Various amounts of gas turbine/boiler flue gas flow through cathode channel vs. CO2 generation by unit
- Effect of high/low amount of CO2 and O2 in gas turbine flue gas compostion on MCFC effectiveness

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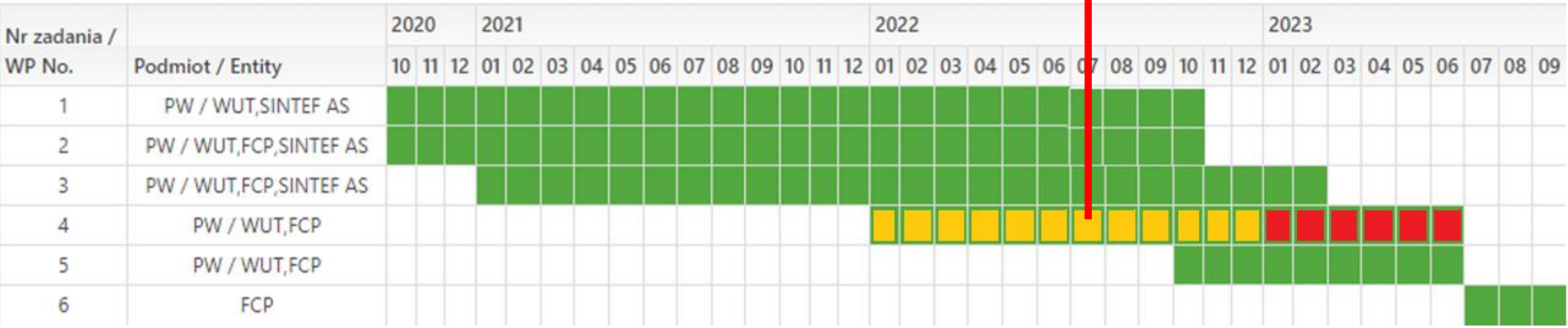
Work Package 4 (01.2022 .. 06.2023)

- **Planned schedule of tasks realisation**



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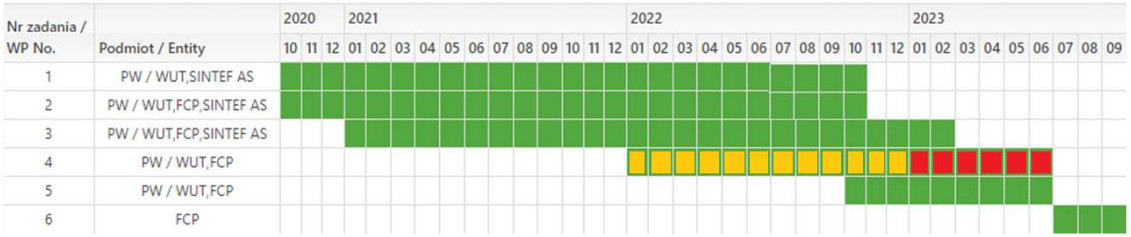
Work Package 4

- **Planned schedule of tasks implementation**



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4	PW / WUT,FCP																																				
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6	FCP																																				

- Preparation of infrastructure for container with MCFC unit for short – mid – long term tests (simultanously), insluding:

- Physical location preparation

- Technical gases (hydrogen, nitrogen, compressed air, flue gas composition) infrastructure organisation

- Test schedule preparation

- Gas delivery scheduling

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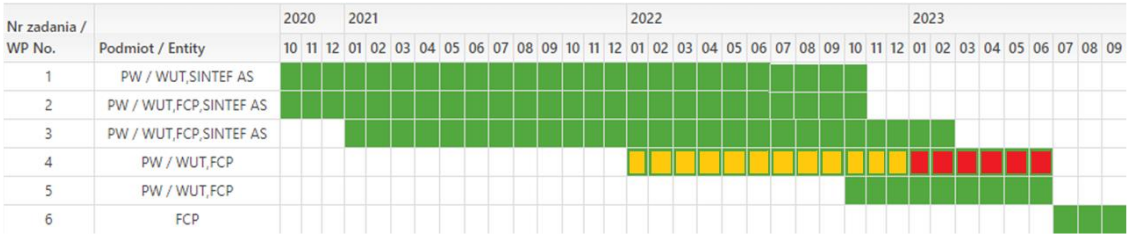
Work Package 4



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6	FCP																																				

- **Planned schedule of tasks implementation**
  - 1st start-up of full installation aimed to formate 10kW MCFC stack

120h - *1st start-up of MCFC stack requires special conditions for removing polymers and reduce the anode electrode*

  - 10kW MCFC stack test under reference conditions

100h – *1st start-up under final procedure, investigation of MCFC stack on reference gases (H2 as fuel; 30%CO2, 15%O2, 55%N2*)

  - Short time investigation of MCFC for CO2 separation from flue gases (starting 20.01.2023)

120..240h - *investigation of MCFC stack with flue gases on cathode side, parameters stabilization and optimization, cool down – analysis of installation parameters during start-up, short time operation and cool down*

  - Mid time investigation of full instalation (starting 06.02.2023)

480h - *investigation of MCFC stack with flue gases on cathode side; feasibility assessment of BoP equipment for long perspective*

  - Long-term investigation of full instalation (starting 03.03.2023)

1000h - *investigation of MCFC stack with flue gases on cathode side aiming to separate CO2 in long perspective; degradation test will be conducted for operating voltage and power; dynamic behavior under changing thermal-flow parameters will be studied; measuring of key performance indicators*

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