



# MaxH2DR

## Project risk matrix

Version 1.0

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# MaxH2DR

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## Introduction

During the consultation with the project partners and considering current pandemics situation and delivery delays due to the Russian attack on Ukraine the initial Risk Matrix as included in the proposal was extended. Added risks as well as adjustments of the initial risk evaluation are marked by yellow color (Tables 1-3). The initial Risk Matrix is presented in Table 4. The extended Risk Matrix will be continuously updated and used for risk management in the project.

## Technical Risks

Table 1: Critical technical risks for implementation

Description of risk	WP	Proposed risk mitigation measures
<b>Kinetic experiments give conflicting results</b> <u>Likelihood: medium; Severity: medium</u>	1	Repeated experiment, better controlled conditions, assure homogeneity of the samples
<b>Kinetic modelling fails to reproduce experimental results</b> <u>Likelihood: medium; Severity: medium</u>	1	Revise model structure based on experience, literature and systematic evaluation of discrepancies
<b>Safety limits are exceeded due to H<sub>2</sub> enrichment in the gas exhaust of the metallurgical laboratory set up</b> <u>Likelihood: medium; Severity: medium</u>	1	Inert gas (N <sub>2</sub> ) will be injected to the exhaust gas pipeline prior to any O <sub>2</sub> contact (e.g. air) and CO monitoring will be added to the gas outlet of the set up.
<b>Design and construction of shear cell might be delayed which affects DEM cohesion model development</b> <u>Likelihood: low; Severity: low</u>	1	The structural coupling of cohesion model with the DR model can and will be carried without measurements data. This allows for a fast adjustment as soon as data are available.
<b>Design and construction of special stand for testing sinter reduction in hydrogen atmosphere might be delayed</b> due to e.g. equipment supply delays due to electronics shortage, inflation, covid, etc. <u>Likelihood: medium, Severity: medium</u>	1	Delay will be immediately reported to the WP coordinator who can modify the following tasks to reduce the reliance and adjust WP schedule to complete the tasks in time.
<b>Problem with hydrogen gas seal along piston in stresses experimental set up</b> <u>Likelihood: medium; Severity: medium</u>	1	Double seal with nitrogen flow in the intermediate region
<b>Insufficient normal stress in stresses experimental set up</b> <u>Likelihood: medium, Severity: medium</u>	1	Use a reduced volume of the set up. If still insufficient, the experience will be limited to shear stress results, which can still be sufficient for a proper calibration procedure.
<b>Difficulties in launching a research installation</b> <u>Likelihood: low; Severity: medium</u>	1, 2	Contingency plan will be developed, contacts of experiences staff, partners and service companies will be prepared.
<b>Breakdown of key laboratory device or instrument</b> <u>Likelihood: low; Severity: high</u>	1, 2	Plan for backup facilities. Temporary rescheduling of tasks to guarantee the progress of the project.

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Description of risk	WP	Proposed risk mitigation measures
<b>Reproducibility of particle orientation in experiments is low</b> <u>Likelihood: high; Severity: medium</u>	2	Required number of experiments to ensure reproducibility will be defined with statistical methods prior to experiment start
<b>Insufficient pellet crushing during experiments</b> <u>Likelihood: low; Severity: medium</u>	2	Controlling particle distribution and changing/repurchasing material
<b>High dust content in experimental set up</b> <u>Likelihood: high; Severity: high</u>	2	Implementation of new suction and filter system
<b>Severe numerical problems encountered in flowsheet models</b> <u>Likelihood: low; Severity: medium</u>	3	Incremental development of software with regular checkpoints. Backup by experienced researchers in the consortium.
<b>Flowsheet models produce infeasible states of the studied plants</b> <u>Likelihood: medium; Severity: low</u>	3	Revise formulation of unit process models and impose appropriate constraints
<b>Excessive computational burden or low accuracy of developed models in case for instance of complex units/processes</b> <u>Likelihood: low; Severity: medium</u>	3	The analyses of the unit/process will be deepened. The possibility of simplification of the related model and combination of different modelling approaches will be considered.
<b>The simulation of large scale DR reactor might lead to too exhaustive computing times endangering project schedule</b> <u>Likelihood: medium; Severity: low</u>	3	Coarse graining, replacement of complex DR single particle models by less complex models, reduced gas phase kinetics, periodic boundary conditions
<b>Lack of validation data</b> <u>Likelihood: medium; Severity: medium</u>	3	Literature data will be used as first validation step in case of lack of data. In addition, stakeholder consultations will be intensified.
<b>High amount of outliers/anomalies in collected data</b> <u>Likelihood: medium; Severity: medium</u>	3	Early outliers detection with statistical methods and substitution approaches/experiment or model modification.

## Financial risks

Table 2: Critical financial risks for implementation

Description of risk	WP	Proposed risk mitigation measures
<b>Budget deviations in adjustment and operation of H<sub>2</sub> reduction test trials</b> <u>Likelihood: low; Severity: medium</u>	1	Continuous costs monitoring. Contingency actions such as a) re-defining experiment matrix, b) alternative experimental design
<b>Costs increase for experimental activities</b> due to strong increase of the price of energy, fuel and materials as a consequence of the Ukraine war. <u>Likelihood: high; Severity: low</u>	1,2	Continuous costs monitoring. Contingency actions such as a) re-defining experiments matrix, b) limit other costs to gain margins for covering the increased costs of experiments.
<b>Currency risk - change in the exchange rate (Zloty/Euro)</b> <u>Likelihood: low; Severity: low</u>	All WPs	Currency exchange rate monitoring. Any additional costs will be covered from own funds.

## Administrative risks

Table 3: Critical administrative risks for implementation

Description of risk	WP	Proposed risk mitigation measures
<b>Key milestones and deliverables are delayed</b> Likelihood: medium; Severity: medium	All WPs	Delay will be immediately flagged to the WP coordinator who can modify the following tasks to reduce the reliance and adjust WP schedule to complete the tasks in time.
<b>Key persons leave the teams during the project</b> Likelihood: medium; Severity: medium	All WPs	Plan for backup personnel and expertise. Regular documentation and exchange of progress and results.
<b>Cyber-attack of project partner PCs/ experimental plants and data loss</b> Likelihood: medium; Severity: high	All WPs	Regular data backup, especially of relevant experimental data; Regular virus scan; Blocking of USB ports and online connections of relevant experimental equipment
<b>Delaying project implementation due to global pandemic</b> Likelihood: medium; Severity: medium	All WPs	Close monitoring of possible delays, rapid communication to WP leader to analyse the implications and reschedule tasks and actions
<b>Delay in deliveries of auxiliary materials (e.g. process gases, spare parts).</b> Likelihood: high; Severity: medium	1, 2	Avoiding the threat by working with alternative suppliers - based on many years of cooperation
<b>Failure to obtain permits for the construction of the installation</b> Likelihood: low; Severity: medium	2	Avoiding the threat by applying to administrative bodies and correction of documentation when a risk occurs
<b>Safety of the developed installation</b> Likelihood: low; Severity: medium	2	Thorough safety evaluation of the installation with possible risks and mitigation plan
<b>Delays in the preparation of technical and tender documentation</b> Likelihood: medium; Severity: high	2	Early preparation start, monitoring, timely correction actions. The tender will be in line with the Awarding Regulations Orders.
<b>Insufficient communication among the partners</b> Likelihood: low; Severity: high	3	Roles and responsibilities between participants will be clearly defined in project meetings. Up-to-date communication is ensured by regular meetings.

## Initial Risk Matrix from the proposal

Table 4: Critical risks for implementation

Description of risk	WP	Proposed risk mitigation measures
<b>Technical risks</b>		
<b>Kinetic experiments give conflicting results</b> <u>Likelihood</u> : medium; <u>Severity</u> : medium	1	Repeated experiment, better controlled conditions, assure homogeneity of the samples
<b>Kinetic modelling fails to reproduce experimental results</b> <u>Likelihood</u> : medium; <u>Severity</u> : medium	1	Revise model structure based on experience, literature and systematic evaluation of discrepancies
<b>Safety limits are exceeded due to H<sub>2</sub> enrichment in the gas exhaust of the metallurgical laboratory set up</b> <u>Likelihood</u> : medium; <u>Severity</u> : medium	1	Inert gas (N <sub>2</sub> ) will be injected to the exhaust gas pipeline prior to any O <sub>2</sub> contact (e.g. air) and CO monitoring will be added to the gas outlet of the set up.
<b>Reproducibility of particle orientation in experiments is low</b> <u>Likelihood</u> : high; <u>Severity</u> : medium	2	Required number of experiments to ensure reproducibility will be defined with statistical methods prior to experiment start
<b>Flowsheet models produce infeasible states of the studied plants</b> <u>Likelihood</u> : medium; <u>Severity</u> : low	3	Revise formulation of unit process models and impose appropriate constraints. Backup by experienced researchers in the consortium.
<b>Breakdown of key laboratory device</b> <u>Likelihood</u> : low; <u>Severity</u> : high	3	Plan for backup facilities. Temporary rescheduling of tasks to guarantee the progress of the project.
<b>Excessive computational burden or low accuracy of models</b> <u>Likelihood</u> : low; <u>Severity</u> : medium	3	Deepen the analyses of the unit/process. If possible, simplify the related model and combine different modelling approaches.
<b>Financial risks</b>		
<b>Budget deviations in adjustment and operation of H<sub>2</sub> reduction test trials</b> <u>Likelihood</u> : low; <u>Severity</u> : ,edium	1	Continuous costs monitoring. Contingency actions such as a) re-defining experiment matrix b) alternative experimental design
<b>Currency risk - change in the exchange rate</b> <u>Likelihood</u> : medium; <u>Severity</u> : low	All WPs	Currency exchange rate monitoring (Zloty/Euro). Any additional costs will be covered from own funds.
<b>Administrative risks</b>		
<b>Key milestones and deliverables are delayed (also due to pandemics)</b> <u>Likelihood</u> : medium; <u>Severity</u> : medium	1, 3	Delay will be immediately flagged to the WP coordinator who will modify the following tasks to reduce the reliance and adjust WP schedule to complete the tasks in time

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Description of risk	WP	Proposed risk mitigation measures
<b>Key persons leave the teams</b> <u>Likelihood</u> : medium; <u>Severity</u> : medium	All WPs	Plan for backup personnel and expertise. Regular documentation of progress and results.
<b>Insufficient communication among partners</b> <u>Likelihood</u> : low; <u>Severity</u> : high	3	Roles and responsibilities between participants clearly defined in meetings. Communication is ensured by regular meetings.