Chemical **L**ooping G**a**sification fo**r** Sustain**a**ble Production of Biofuels

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Deliverable D6.4:

Technology Risk Assessment

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1. Introduction

The overall objective of WP6 is the assessment of risks related to health, safety, environment, society, technology and economics for the full biomass-to-end-use process chain using technologies developed in the CLARA project and to propose actions for risk mitigation. Task 6.4 is dealing with technology risks.

2. Methods

Regarding technology risks AE set up a draft risk table covering the whole technology chain from the biomass preparation to the product separation as a starting point.

Each section of the plant was introduced. Possible technology risks were discussed and classified regarding their severeness and probability. Finally, mitigation measures were proposed.

The risk table was presented and discussed at the General Assembly Meeting in Thessaloniki in November 2022. After the Meeting the draft was sent out to all partners to comment and complete the draft. As result, the final risk table was fixed and is the central content of the D6.4.

The assessment of the full-chain process has been done for the following sections, leading partner in brackets:
P Feedstock Pre-Treatment (CENER)
G Chemical Looping Gasification (AE, TUDA)
C Syngas Cleaning (TUDA, RWE)
S Fischer-Tropsch Synthesis (AE, RWE)

3. Risk Table

no	Description	likelihood	severity	likelihood x severity	Mitigation
P1	Presence of undesirable (stones, metalic elements…)	3	1	3	Passive elements: sieves and magnets before mixer
P2	Constant water content not reached	1	1	1	Mixing of feedstock after preparation
P3	Blockage of feeding lines and/or tend to bridging	2	2	4	Spin reverser (feeding screws), vibrating elements and intermediate silos
P4	Pelletizer blockage	2	2	4	Stock milled biomass mixed with grease
G1	Insufficient bed material circulation	2	2	4	Increase velocity in the air reactor, optimize geometry/layout of J-Valve
G2	Blockage in feeding system	1	2	2	Redundant feeding system; Quality control of pellets
G3	Insufficient Oxygen transport	1	2	2	Change Oxygen carrier
G4	Incomplete gasification	2	2	4	Change Oxygen carrier; additives; increase temperature
G5	Bed material agglomeration	2	1	2	Additives; change feedstock; decrease temperature
G6	Blocking of syngas cooler	2	2	4	Change feedstock; additives; change cooler design
G7	Large material losses --> high required make-up rates	1	2	2	Optimize cyclone(s), material recycle from filters/gas coolers
C1	Blocking of syngas filter	3	1	3	Increase filtration temperature; use pre-coating material
C2	Blocking of syngas srubber	2	2	4	Change scrubber design; change scrubbing liquid
C3	Sulphur-poisoning of shift catalyst	3	2	6	Change feedstock; Additives; increase temperature; use sour shift catalyst
C4	Carbon deposites on shift catalyst	2	1	2	Increase steam injection
C5	COS hydrolysis insufficient	2	2	4	Change catalyst; increase temperature
C5	Tar removal insufficient	2	2	4	Add additional tar removal step
C6	H_2S removal insufficient	1	2	2	Improve NaOH scrubber efficiency; add CuO-adsorber
C7	(Light) Tar condensation in compression unit	2	2	4	Add additional tar removal step
S1	Insufficient CO conversion rate	2	1	2	Increase tail gas recycling; change catalyst
S2	Catalyst poisonning	1	2	2	Improve syngas cleaning
S3	Insufficient cooling	2	2	4	Improve reactor design
S4	Blocking of FT-product condensors	2	1	2	Raise condensation temperature; use multi stage condensation
S5	Carbon deposites on Steam Methane Reformer	2	2	4	Add pre-reformer stage; increase steam content

Likelihood:	1 = very unlikely
	2 = could occur
	3 = very likely
Severity:	1 = plant can be operated at lower efficiency or lower availability
	2 = process step has to be modified or equipment redesigned
	3 = total process does not work and has to be changed

4. Conclusions

Technology risks were identified for each section of the technology chain. These risks were classified regarding likelihood and severity and a product of both was calculated to get an overall risk factor.

Out of a maximum of risk factor 9, one risk with the risk factor of 6 occurred. All other risks had a factor of 4 or less. Overall risks are not higher than in other 2nd generation biofuel production routes.

Suitable mitigation actions were proposed for each risk.

Some process steps have a lower TRL (5 or 6). Here additional research actions can reduce the technology risks in future plants.

For other process steps with higher TRL suitable specification of equipment and a good quality control during delivery and erection can reduce the risks.

5. Disclaimer