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

H2020 Research and Innovation action
Grant Agreement no 817841

Deliverable D6.3:

Risks related to society

Version No.: 1
Dissemination level: Public

Due date of deliverable: 2022-04-30
Submission date to coordinator: 2022-04-26
Actual submission date: 2022-05-19

Start date of project: 2018-11-01
End date of project: 2022-10-31

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817841.

Table of contents

1 Introduction

BEST - Bioenergy and Sustainable Technologies GmbH is a K1 Competence Centre in the Austrian COMET programme and closes the gap between academic research and industrial technology development by undertaking industry-driven applied research and development in the fields of bioenergy, the sustainable bio-based economy, and future-proof energy systems. The company carries out research on the joint use of bioenergy and other renewable energy supply technologies as a means of providing efficient, sustainable and economic solutions for the energy system of the future. The area "Sustainable Supply and Value Chains" focuses on socio-economic and environmental aspects involving the entire bioenergy value chain, from the resource to the final product, and its market. The in-house expertise in the field of thermal gasification and chemical looping additionally helped to identify potential social risks

As subcontractor hired by the Technical University of Vienna (TU Wien) for the *Task 6.3: Risks related to society*, BEST GmbH conducted the social risk assessment in the Horizon2020 CLARA project. The qualitative risk assessment covered social risks related to national economy (e.g. additional jobs created), political and legal framework as well as to social acceptance. Besides the identification and categorization of potential risks using a risk assessment matrix, first ideas on potential mitigation strategies were derived.

The whole report on the *Risks related to society* can be found in the Annex.

2 Annex: Report on the risks related to society

report

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Monika Enigl

CLARA – Chemical looping gasification for sustainable production of biofuels

Risks related to society

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Project number	N 51-232-0
Project duration	July 2021- April 30th 2022
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Table of Content

1 Introduction and Methodology

The aim of CLARA is to develop a concept for the production of biofuels based on chemical looping gasification of biogenic residues. Through cutting-edge research and interdisciplinary cooperation, the CLARA consortium aims to investigate the complete biomass-to-fuel chain and bring the suggested process to market maturity. The CLARA approach is shown in Figure 1.

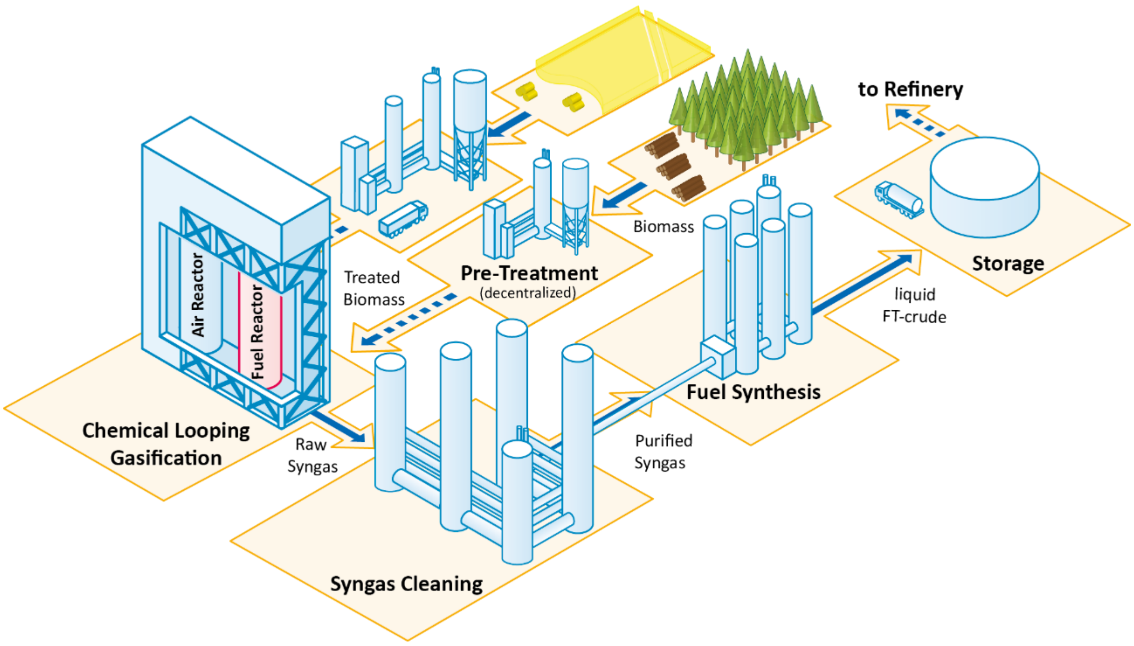

Figure 1 Schematic diagram of the CLARA approach

The overall **objectives** of Task 6.3 were to analyse potential risks related to society concerning the CLARA approach and to elaborate first mitigation strategies. Particular attention was drawn to socio-economic risks with regard to investments in biomass production, (pre)processing, logistics and trade as well as social acceptance/participation and the involvement of regional stakeholders.

This risk assessment considered the whole biomass supply chain (production, (pre)processing, logistics and trade) as well as the installation and operation of a commercial chemical looping gasification plant including the production of biofuels. The risk assessment was conducted for a 200 MW plant which uses wheat straw and pine residues as feedstock.

The qualitative risk assessment covered social risks related to national economy (e.g. jobs created, increased regional), political and legal framework as well as to social acceptance. Besides the identification and categorization of potential risks using a risk assessment matrix (see Table 1), their impacts were evaluated and mitigation strategies were derived (see Figure 2 - Principles, framework and process of a risk analysis. According to ISO 31000:2018(en)).

Table 1: Template Risk assessment matrix

		Severity		
Likelihood		1	2	3
	1	LOW -1-	LOW -2-	MEDIUM -3-
	2	LOW -2-	MEDIUM -4-	HIGH -6-
	3	MEDIUM -3-	HIGH -6-	HIGH -9-

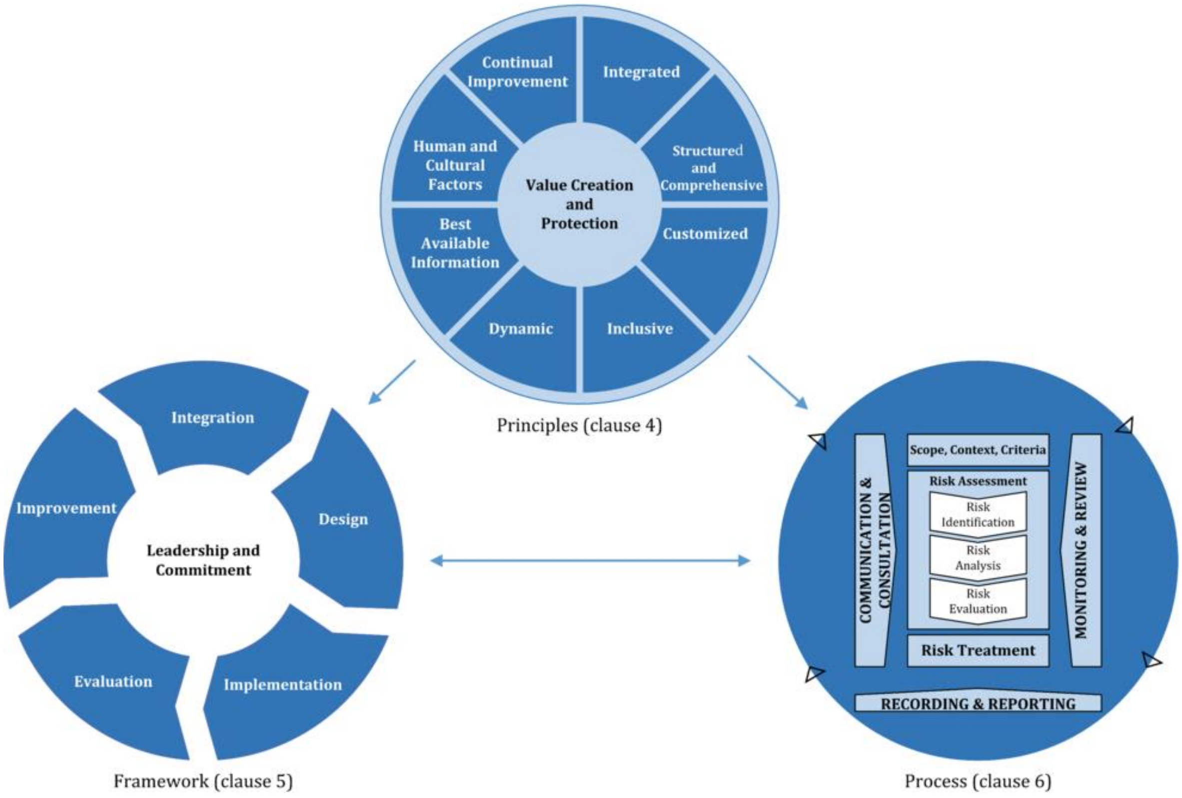

Figure 2: Principles, framework and process of a risk analysis. Source: ISO 31000:2018(en) Risk management — Guidelines

Considering the novelty of the investigated technology the approach within this study is a qualitative one. Out of numerous parameters to assess risks related to society (see chapter 2 Risk identification and analysis) first the most meaningful were identified. An in-depth literature search and qualitative interviews with distinguished stakeholders were the methods of choice. Five guided interviews with stakeholders from academia and industry were carried out. The underlying questionnaire can be found in the Annex.

Subsequently, a qualitative risk analysis was used to prioritize the identified project risks using a pre-defined rating scale and it also included the appropriate categorization of the risks. In the qualitative assessment the following steps were conducted:

- Identification of the risks;
- Identification of the possible consequences (risk analysis);
- Evaluation of risks
- Recording of the findings.

A qualitative risk assessment doesn't require a numerical basis, instead risks are represented by the severity of harm x likelihood of harm. Qualitative risk assessment involves making a formal judgement on the consequence (severity) and probability (likelihood). In contrast, quantitative risk assessment would be used to measure risk by assigning a numerical value. This type of risk assessment is more commonly applied for health and safety risks during a detailed engineering phase.

The results of the risk assessment are visualized in a risk assessment matrix. A risk assessment matrix is an analytical tool used to define the level of risk by plotting the likelihood of the risk against the severity of the consequence. It assists in decision-making when determining how to manage risk and will help increase the visibility of the risk. Advantages of the risk assessment matrix are:

- Adequate categorization of risk
- Prioritizing the process of risk management
- Avoid allotting resources to managing risk indiscriminately
- Guide in tackling risk effectively based on the severity

In January 2022 the first results of the interviews and literature search (e.g. Fytili and Zabaniotou, 2017[1]; Terrapon-Pfaff et al. 2019[2]; Hansen et al. 2021[3]) were presented to the consortium and feedback was collected and incorporated in the further steps of the risk assessment. The CLARA project partners as well as relevant stakeholders were asked for extended feedback regarding the identified risks, impacts and mitigation strategies. Therefore, a stakeholder workshop was organised by TU Wien. BEST actively participated in the workshop and contributed to the workshop invitation list and content planning. Based on the results of the workshop the risk analysis and the risk assessment matrix were updated and adapted.

The risks described in chapter 2 were aggregated in 15 risk clusters, which were the basis for a workshop with the project consortium in March 2022. A short description of each risk cluster can be found in chapter 3. The results presented there are the compilation of the workshop, where the 15 risk clusters were evaluated along the matrix below. 10 – 11 participants actively contributed with their opinions. Each risk was evaluated separately and the results are summarized in a matrix at the end of chapter 3.

The 2 questions for each risk were:

1. How do you rate the likelihood of this risk to occur?
2. How do you rate the severity of this risk in case it occurs?

The reply options for each question were: low – medium – high.

[1] Fytili, D., Zabaniotou, A. Social acceptance of bioenergy in the context of climate change and sustainability – A review, Current Opinion in Green and Sustainable Chemistry, Volume 8 (2017). https://doi.org/10.1016/j.cogsc.2017.07.006

[2] Terrapon-Pfaff, J. , Fink, T., Viebahn, P., Jamea, E.M. Social impacts of large-scale solar thermal power plants: Assessment results for the NOORO I power plant in Morocco,Renewable and Sustainable Energy Reviews, Volume 113 (2019). https://doi.org/10.1016/j.rser.2019.109259.

[3] Hansen, A.C., Clarke, N., Hegnes, A.W. Managing sustainability risks of bioenergy in four Nordic countries. Energ Sustain Soc 11, 20 (2021). https://doi.org/10.1186/s13705-021-00290-9

2 Risk identification and analysis

In the following, the risks identified in the literature research and interviews are clustered and presented.

2.1 Risks related to Socioeconomic Factors

Dependencies in supply chains and new competitions for industries

Biomass cultivation and use for new purposes can lead to societal impacts on traditional cultures and sustainable agricultural practices.

The risk of affecting demand in ways that distort markets and compete for resources with food and feed production and with the new circular bioeconomy solutions. The increased feedstock demand can lead to an unsustainable production and use of biomass, which is already the case in some parts of the world. Unsustainable use affects society in several and severe ways, i.e. climate crisis, loss of jobs, etc. – eventually loss of our basis of existence. A sustainable forestry and agriculture are therefore essential for the society.

Biomass feedstock supply and the increasing competition for its utilisation as a limiting factor have also been mentioned in the literature and the interviews several times. The size of a 200 MW plant is considered as technologically and economically reasonable but might be limited by feedstock supply – both the needed quantities as well as effort for logistics due to decentral sources can be challenging. The estimated huge quantities of ca. 400,000 t/y can cause market distortion within the concerned industries – one example from the past mentioned was the protests by the pulp and paper industry against biomass CHPs in Carinthia, Austria (based on the argument that woody biomass should be used for material purposes instead for energy production).

A further risk mentioned is that subsidies can lead to unintended steering effects for biomass utilization and enlarged competition for that feedstock. In addition, subsidies for this technology which should be competitive can lead to economic bias. Related to this is the risk of developing a suboptimal renewable energy economy and delaying the deployment of the best performing solutions. The market should decide which biomass technologies will prevail – this is unpredictable, which is good because the market should not be “*over regulated*”[4].

[4] All citations from the interviews are indicated in italic and in quotation marks

A further risk stated is that in a project proposal costs might be presented higher than they actually are in order to finance the planned project (“*society pays grants*”).

Social sustainability risks & Socially undesirable distribution between income groups and region

Bioenergy has only indirect links to social imbalances. Any transformation to climate neutral energy solutions involves innovation costs. There is a risk that these are borne disproportionally by some particular groups such as district heating consumers paying high heating bills or low-income households paying high energy taxes.

On the other hand, if regional resources are utilized (feedstock, labour etc.) there is a major potential for regional development and added value through a CLARA plant. This is especially true for rural communities. CLARA plants can also provide new perspectives for young people in rural areas with few incentives for them to stay. They may be less likely to leave or may be more likely to return upon completion of higher studies in order to pursue local employment (e.g. related to plant operation, engineering, farm/feedstock management) In that regard, risks related to working conditions, such as but not limited to unequal employment benefits and contract periods, working conditions and lack of commuting infrastructure, as well as safety issues (e.g., employees have to be provided with personal protective equipment) in the supply chain and in the plant have to be minimized. The technology has a significant potential to replace oil imports. Inversely the negative effects on society would be tremendous if e.g. feedstock is imported from overseas.

Regarding the implementation and the operation of a large-scale industry plant there is also the risk of economic exclusion of micro-scale SMEs. They may have reduced chances for business opportunities due to their lack of capacities compared to foreign or more highly-skilled external firms and labour force. In addition, there could be a mismatch between educational qualifications and labour based on the training currently offered locally.

Other risks related to large-scale industry plants are the risk of deterioration in socio-economic situation and standards of living in adjacent communities as well as the erosion of local purchasing power and decreased standards of living among local low-income groups. Concerns of local stakeholders that regional economic growth and demand for products from migrant and local workers, students and business visitors could inflate prices for local consumers, including those not benefitting from the project need to be taken seriously. Further concerns could be related to the potential for increased crime rates related to drug and alcohol abuse due to the influx of external and/or foreign workers and students, as well as concerns that increased traffic to the project site could cause an increase in fatal road accidents.

2.2 Risks related to the Political and Legal Framework

Uncertain political framework in regards to e.g. CO_2 pricing bears a considerable risk that the CLARA technology will not succeed for economic reasons ("*it is cheaper to extract fuel from the soil than to produce it via gasification*"). A major revision of tax systems still lacks in most European countries. CO_2 taxes have to be considerable to guarantee incentive effects and it is uncertain if policy makers will take courageous decisions.

Subsidies are gratifying – especially for pilot plants - but for a long-term establishment the CLARA technology has to be profitable without them. Fossil fuels have to become "*too expensive*". In some countries there is a fear to "*hurt commuters*" and loose potential votes[5]. Other open questions are if CLARA fuels are considered "CO_2 neutral" and accepted in blends (analogous to E5, E10).

One interviewee is not optimistic that the CLARA approach can reach market penetration "*on time*" (referring to the climate crisis).

Flawed approval procedures can lead to a lack of security regulations which will endanger society.

If a plant gets public subsidies it should be ensured that the experiences of other technology providers are provided to the applicants. Otherwise there is a risk of repeating slipups that cost society.

Another unresolved issue is the carbon capture and utilisation of the separated CO_2.

Framework conditions like national recovery plans (as a consequence of the COVID 19 pandemic) or RED II are considered in favour of the CLARA approach.

Conflicts and differing interests between political parties and their consequences can never be predicted and cause uncertainty.

2.3 Risks related to Social Acceptance

The three dimensions of social acceptance:

[5] This relates to the essential question how the costs of greening the economy could and should be distributed.

Socio-political acceptance	Socio-political acceptance is referring to how policies and technologies are seen by political stakeholders and the broad public.
Community acceptance	Community acceptance is relevant when trying to build a power plant in a community, where local stakeholders and especially residents are asked not to oppose a certain project.
Market acceptance	Market acceptance builds on the economy, where new technologies should be introduced by market players on the supply side, and used on the demand side

Socio-political acceptance

The most common risk factors related to political stakeholders and the broad public are:

- Concerns about emission (including char, tar, particulates etc.) and waste generation
- Concerns about food safety and biodiversity
- Knowledge gap: Biased information and basic knowledge of various industrial processes
- Reduced social standing and political influence:
    - Concerns that increased migration and inequitable benefit sharing could lead to adverse changes in the social structure and power dynamics within communities

Community acceptance

Risks regarding the social acceptance of local stakeholders are often connected to the following factors:

- Unequal distribution of costs and profits
- Accelerated changes to community atmosphere and cultural identity
- Increased migration of external and foreign workers and students could affect the region's cultural traditions, values, behaviours and lifestyles

- Social conflict, rivalry and feelings of envy: Social tension among community factions and villages, driven by unmet expectations and envy towards communities benefitting from projects
- Uncertainty, unrealistic expectations and frustration: Lack of understanding and uncertainty regarding the activities and outcomes among local stakeholder groups leading to unrealistic expectations and frustration.
- Social exclusion and powerlessness in decision-making: Local stakeholders feel that their possibilities to participate meaningfully in the consultation and decision-making process were limited.
- Suspicion towards the project and its developers, as well as community protest: Despite job creation and community development projects, local stakeholders feel that they were not sufficiently informed and engaged, leading to discontent and opposition to the project and suspicion towards the developers and implementing organizations.
- Strain on regional infrastructure and services: Fears of local stakeholders that the population increase due to (construction) jobs and students for training purposes will put a strain on public infrastructure and services like sanitation, healthcare and education.

The so-called NIMBY (not in my backyard) effect can also be observed for the CLARA approach. The use of renewable feedstock is good for the acceptance but many people may not want those plants in their neighbourhood ("*see wind parks*"). An increase of traffic density, emissions and noise is to be expected and can lead to reservations by neighbouring residents.

For one interviewee it is clear that a CLARA plant can only be built within industrial areas and does not see the risk of social acceptance if the location is accurately selected.

Market acceptance

The **most crucial risk identified** through the guided interviews was the social acceptance of **end-users, being** the first answer and emphasized in several interviews. Interview partners mentioned the emotionally charged atmosphere concerning biomass utilization for energetic use. Community members may expect answers to questions like

- Which feedstock is used?
- Where does it come from?
- How can sustainability of feedstock and its conversion be assured?
- How reasonable are subsidies for green electricity?

- Is land use change an issue?

It also seems that there is the perception that gasification is a more dangerous technology than others and that accidents could occur. Hence, poor management of the development of CLARA technology could lead to a consumer backlash that reduces demand.

If there are mining activities for the production of the oxygen carrier social acceptance can be negatively influenced.

The higher fuel prices were judged differently: one person thinks that end-users are willing to pay more for sustainable products, another thinks that higher prices could negatively influence social acceptance.

Chemical looping plants also bear a certain technical risk of emission leaks (e.g. methane) which can be unfavourable to social acceptance as well.

A further risk is a low level of investor awareness. However, based on the interview results it seems like there are sufficient potential **investors** who do have enough trust in technologies like the CLARA approach if they are economically feasible.

Regarding the plant operation, following risk factors should be taken into consideration:

- The assurance of a constant feedstock supply could become a risk. The radius within which the feedstock can be acquired is limited due to the enormous logistics.
- Although CLARA uses residues, feedstock (e.g. wheat straw) supply can also be threatened by seasonal availability or calamities like e.g. drought.
- In one interview the concern on pre-treatment was mentioned. The pelletization could be a bottleneck. It has to be assured that there are enough capacities (maybe more plants) plus stocks to provide the quantities needed.

3 Risk evaluation

In this chapter the results of the evaluation of the 15 risk clusters are presented.

3.1 Dependencies in supply chains

- Effects on demand/supply in ways that distort markets
- Competition for resources with food and feed production, as well as with new circular bio-economy solutions
- Subsidies leading to unintended steering effects for biomass utilization and enlarged competition for the respective feedstock

3.1.1 Likelihood

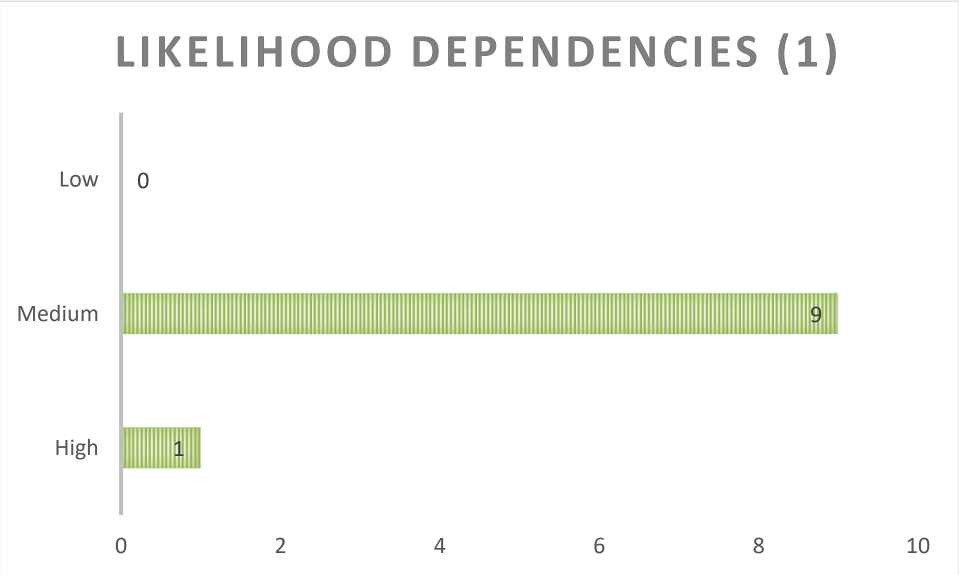

Figure 3 Likelihood to occur for the risk “Dependencies in supply chains”

3.1.2 Severity

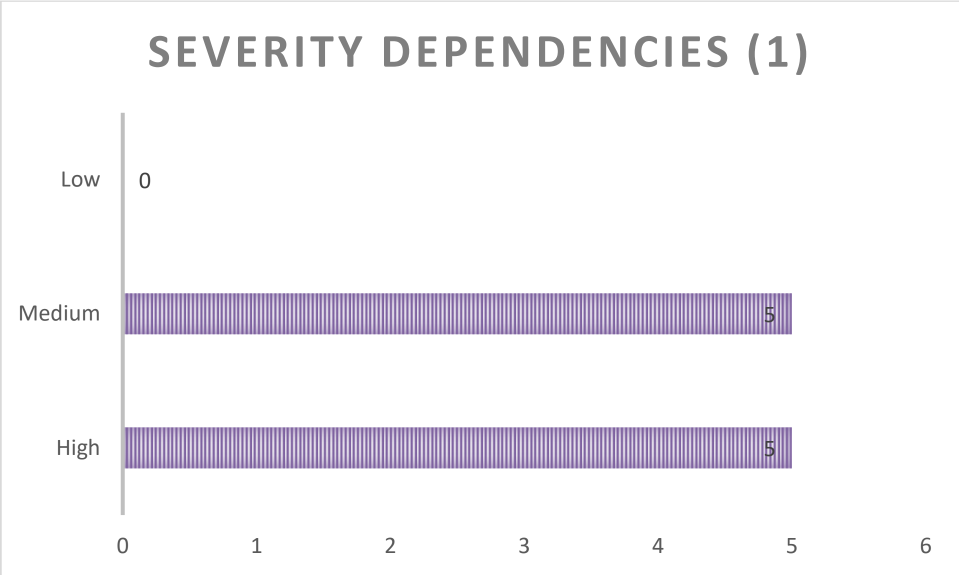

Figure 4 Severity if the risk “Dependencies in supply chains” occurs

3.2 Social sustainability risks

- Bioenergy has only indirect links to social imbalances. Any transformation to climate neutral energy solutions involves innovation costs. There is a risk that these are borne disproportionally by some particular groups such as district heating consumers paying high heating bills or low-income households paying high energy taxes.

3.2.1 Likelihood

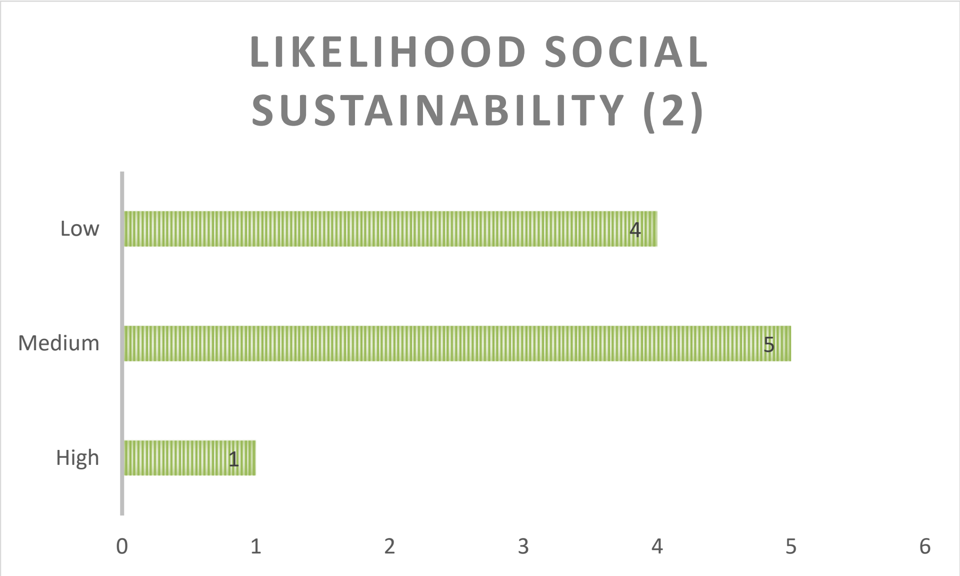

Figure 5 Likelihood to occur for the risks related to “Social sustainability”

3.2.2 Severity

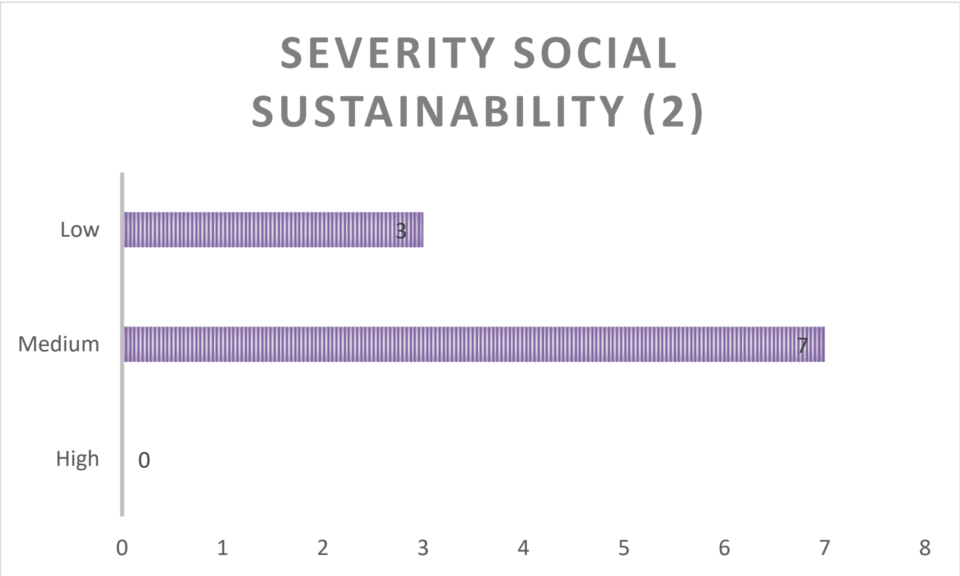

Figure 6 Severity if risks related to “Social sustainability” occur

3.3 Socially undesirable distribution

- Risk of economic exclusion of micro-scale SMEs

- Deterioration in socio-economic situation and standards of living in adjacent communities as well as the erosion of local purchasing power and decreased standards of living among low-income groups

3.3.1 Likelihood

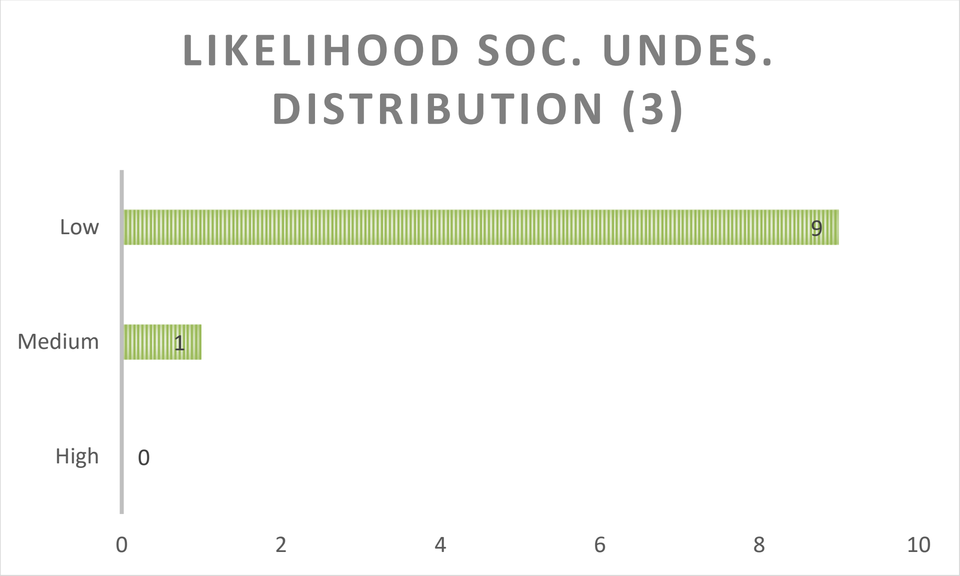

Figure 7 Likelihood to occur for the risk "Socially undesirable distribution"

3.3.2 Severity

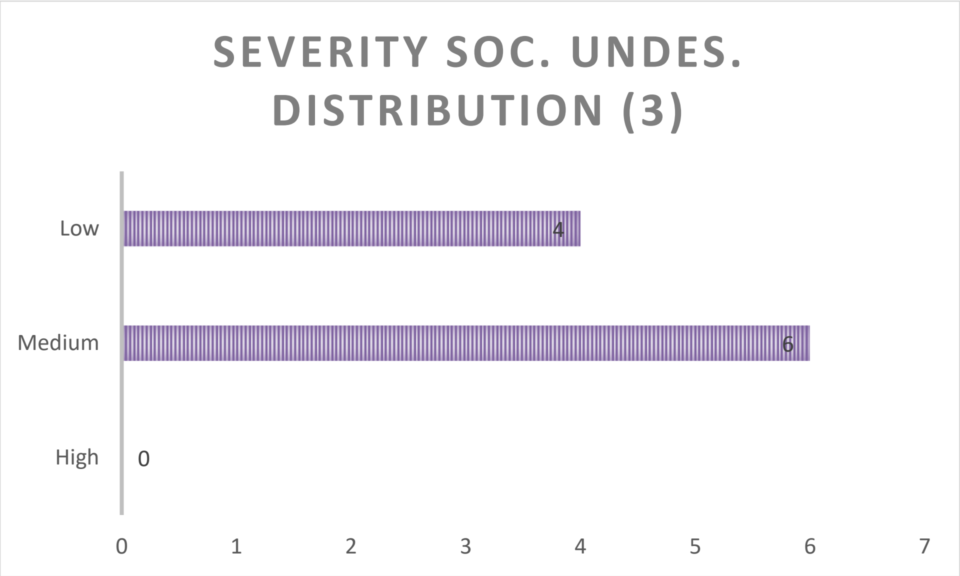

Figure 8 Severity if the risk "Socially undesirable distribution" occurs

3.4 Political and legal framework – uncertainties

- Uncertain political framework as regards to e.g. CO_2 pricing of fossil fuels - considerable risk that the CLARA technology will not succeed for economic reasons

3.4.1 Likelihood

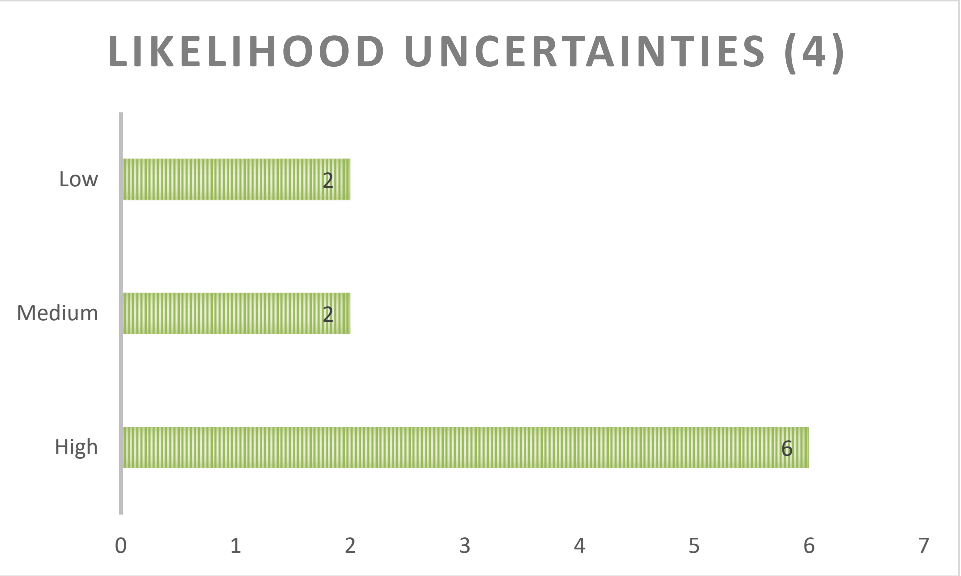

Figure 9 Likelihood to occur for the risk “Uncertainties in the political and legal framework”

3.4.2 Severity

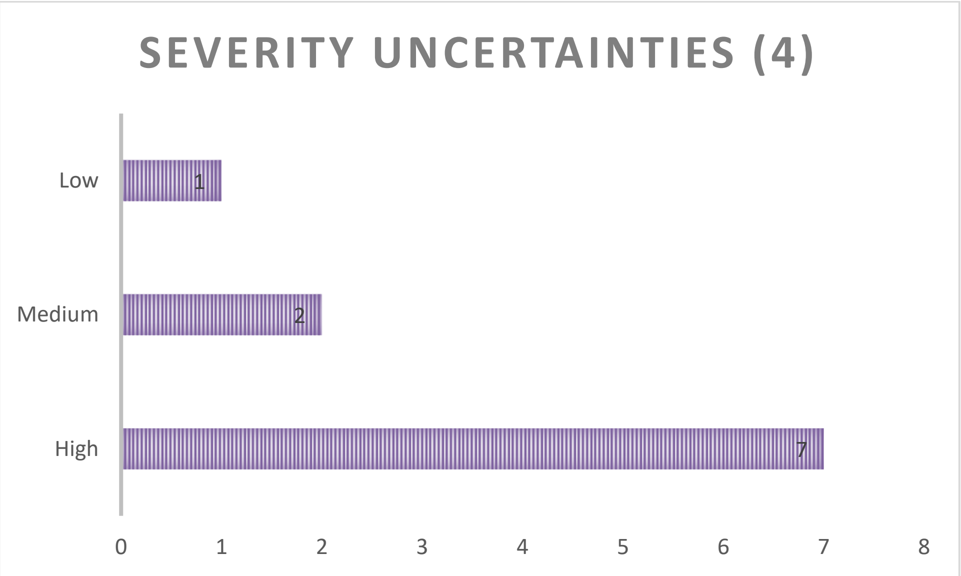

Figure 10 Severity if the risk “Uncertainties in the political and legal framework” occurs

3.5 Political and legal framework – subsidies

- Subsidies are gratifying – especially for pilot plants - but for a long-term establishment the CLARA technology has to be profitable without them

3.5.1 Likelihood

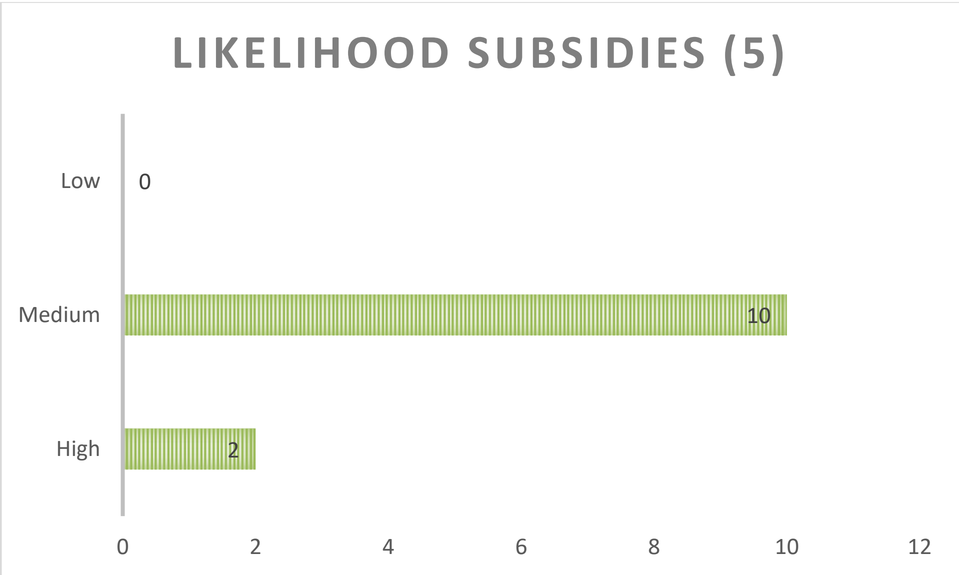

Figure 11 Likelihood to occur for the risk “Not profitable without subsidies”

3.5.2 Severity

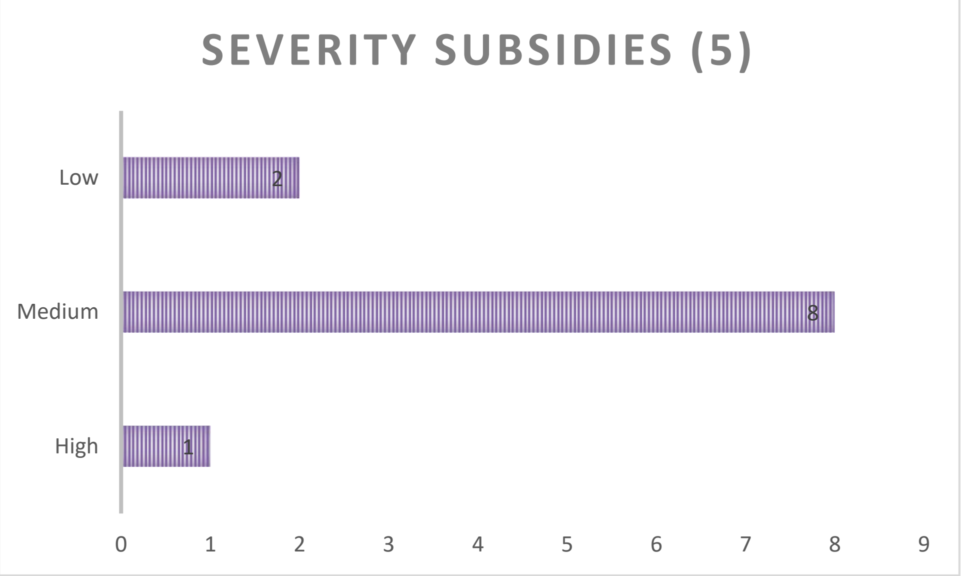

Figure 12 Severity if the risk “Not profitable without subsidies” occurs

3.6 Political and legal framework – approval procedures

- Flawed approval procedures regarding the implementation of the plant can lead to a lack of security regulations which will endanger society

3.6.1 Likelihood

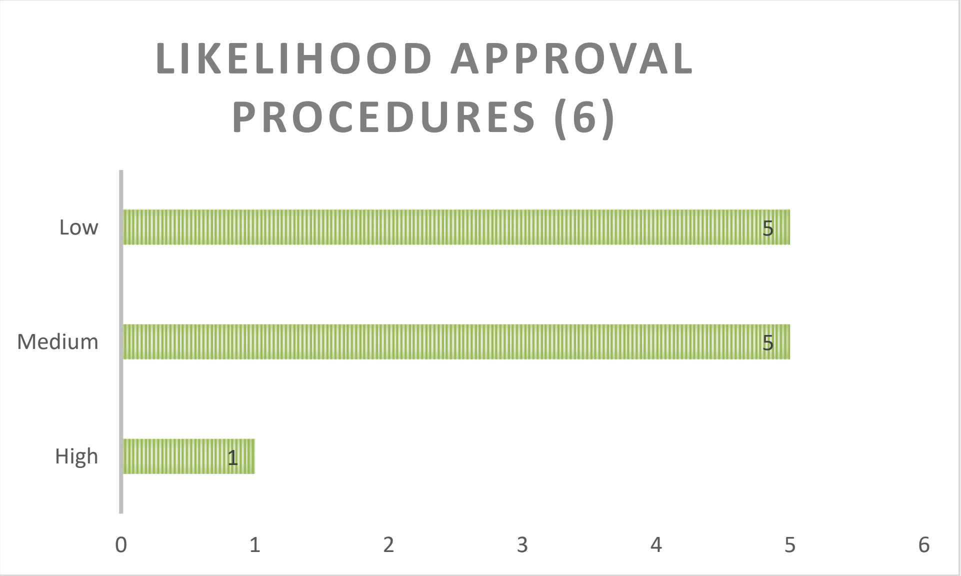

Figure 13 Likelihood to occur for the risk “Flawed approval procedures”

3.6.2 Severity

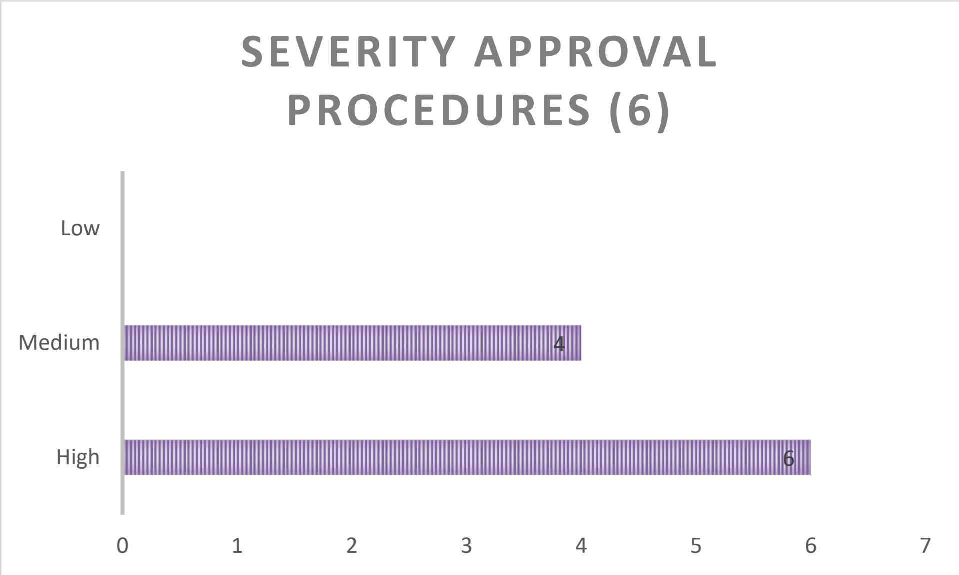

Figure 14 Severity if the risk "Flawed approval procedures" occurs

3.7 Social Acceptance – Environment

- Concerns about emission and waste generation
- Concerns about food safety and biodiversity

3.7.1 Likelihood

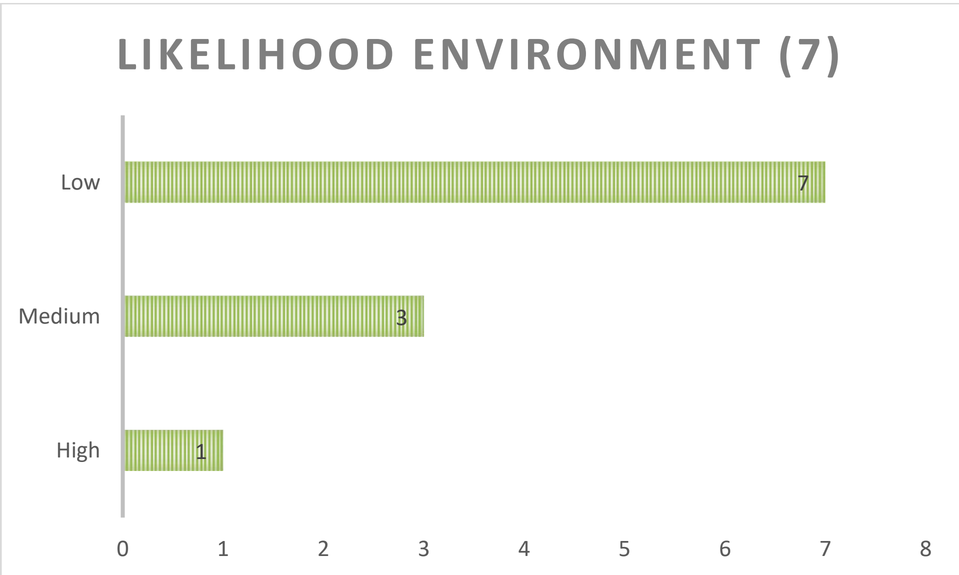

Figure 15 Likelihood to occur for the risk “Lack of acceptance due to environmental concerns”

3.7.2 Severity

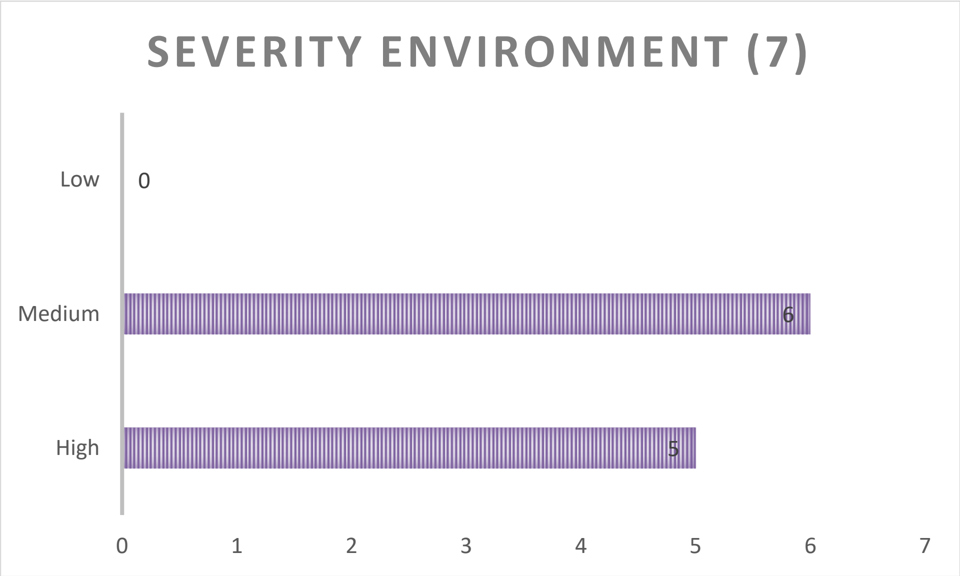

Figure 16 Severity if the risk “Lack of acceptance due to environmental concerns” occurs

3.8 Social Acceptance – Knowledge gap

- Biased information and basic knowledge of various industrial processes

3.8.1 Likelihood

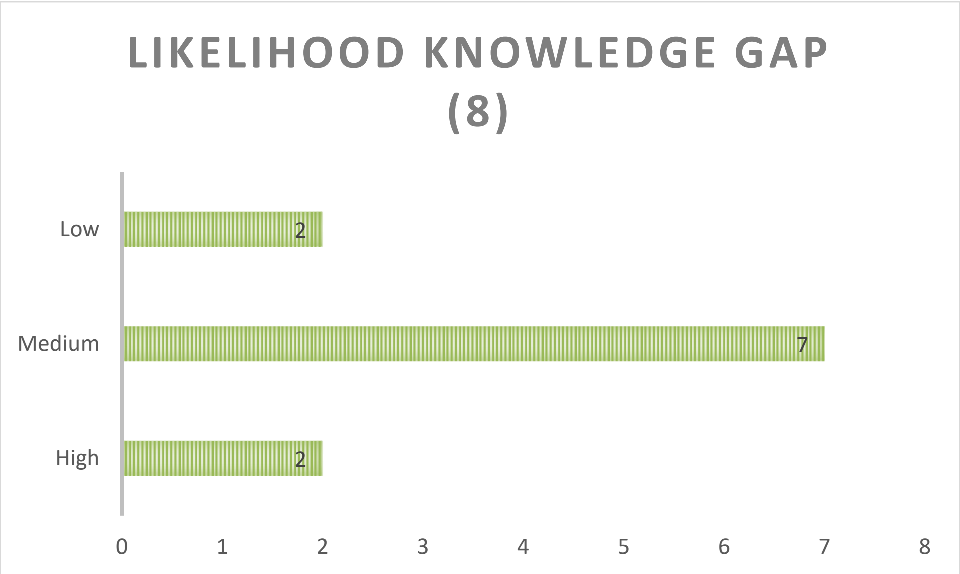

Figure 17 Likelihood to occur for the risk “Lack of acceptance due to knowledge gap”

3.8.2 Severity

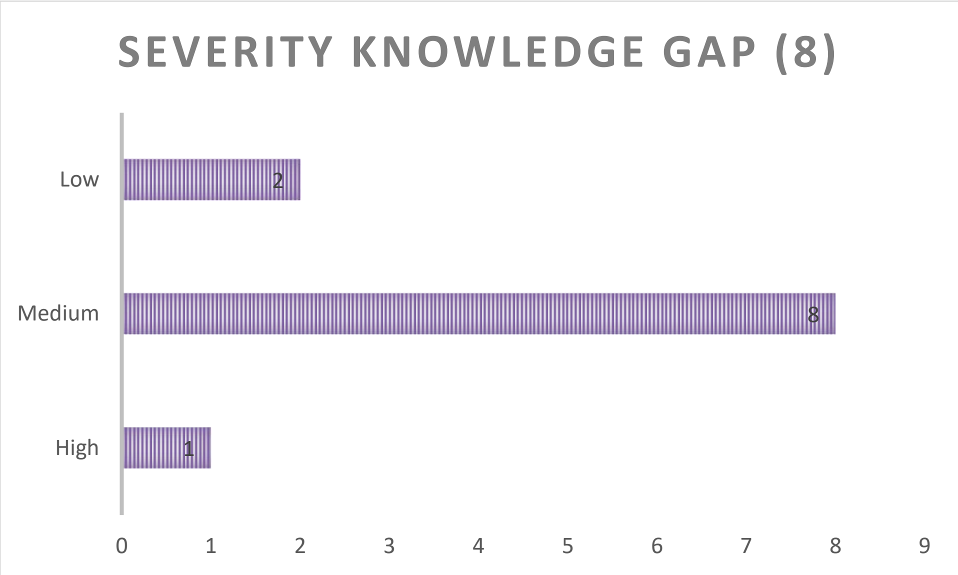

Figure 18 Severity if the risk “Lack of acceptance due to knowledge gap” occurs

3.9 Social standing and political influence

- Concerns that increased migration and inequitable benefit sharing could lead to adverse changes in the social structure and power dynamics within communities (Reduced social standing and political influence)

3.9.1 Likelihood

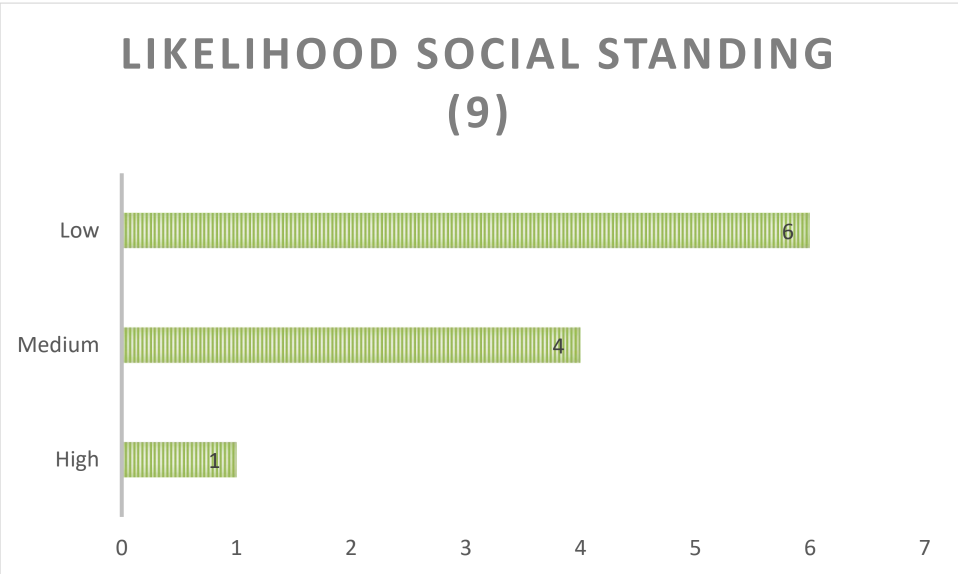

Figure 19 Likelihood to occur for the risk “Lack of acceptance due to changes in social standing”

3.9.2 Severity

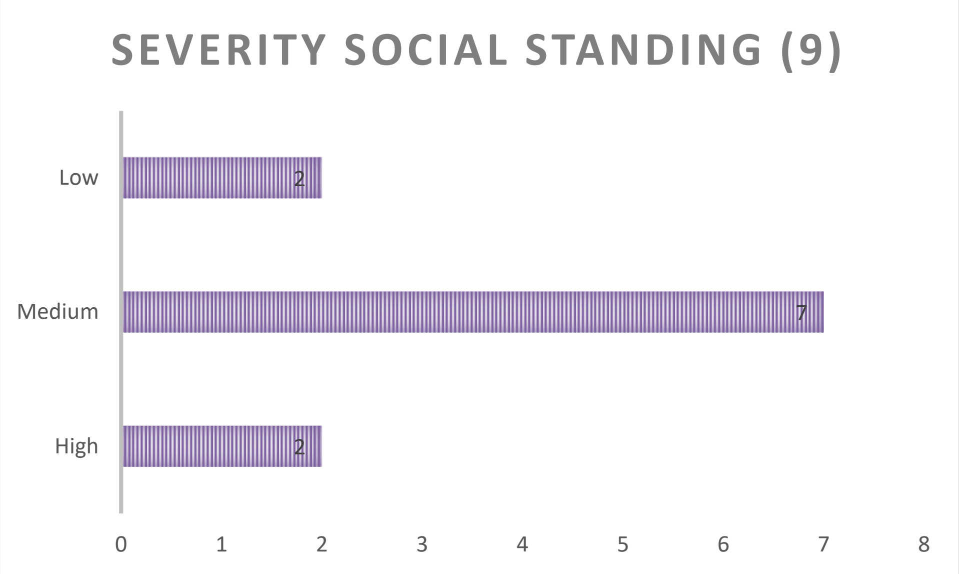

Figure 20 Severity if risk “Lack of acceptance due to changes in social standing” occurs

3.10 Community acceptance – changes in regional/local structures

- Fears that the population increase due to (construction) jobs and students etc., will put a strain on public infrastructure and services like sanitation, healthcare and education
- Unequal distribution of costs and profits
- Accelerated changes to community atmosphere and cultural identity
- Increased migration of external and foreign workers and students could affect the region's cultural traditions, values, behaviors and lifestyles

3.10.1 Likelihood

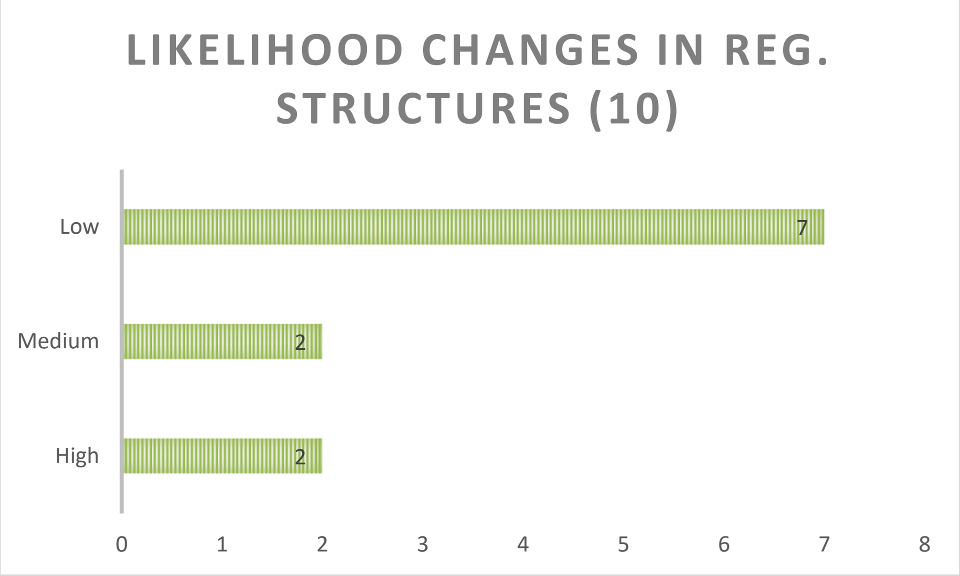

Figure 21 Likelihood to occur for the risk “Lack of acceptance due to changes in regional/local structures”

3.10.2 Severity

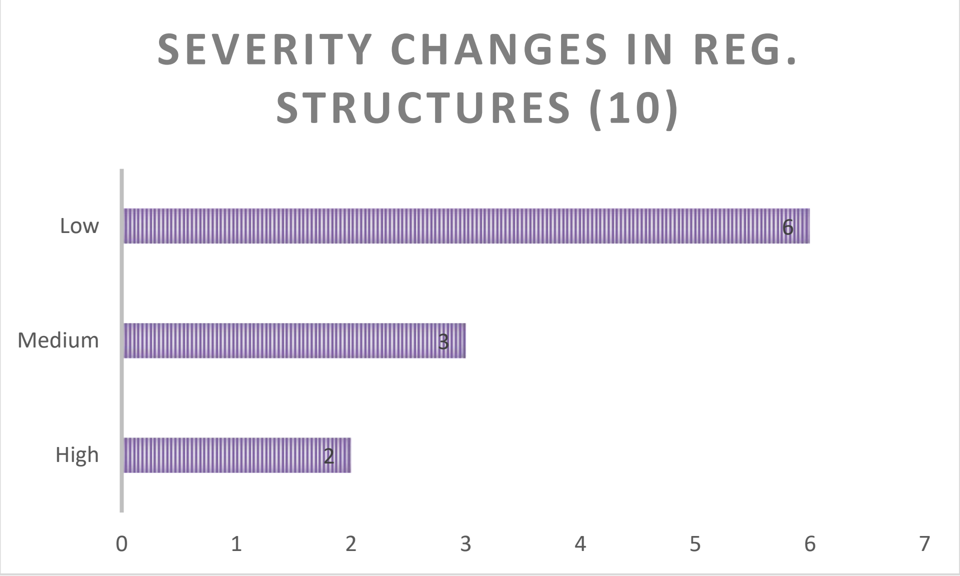

Figure 22 Severity if risk “Lack of acceptance due to changes in regional/local structures” occurs

3.11 Lack of participation in the decision process

- Suspicion towards the project and its developers, as well as community protest: Despite job creation and community development projects, local stakeholders feel that they were not sufficiently informed and engaged

- Lack of understanding and uncertainty regarding the activities and outcomes among local stakeholder groups leading to unrealistic expectations and frustration
- Local stakeholders feel that their possibilities to participate meaningfully in the consultation and decision-making process are limited

3.11.1 Likelihood

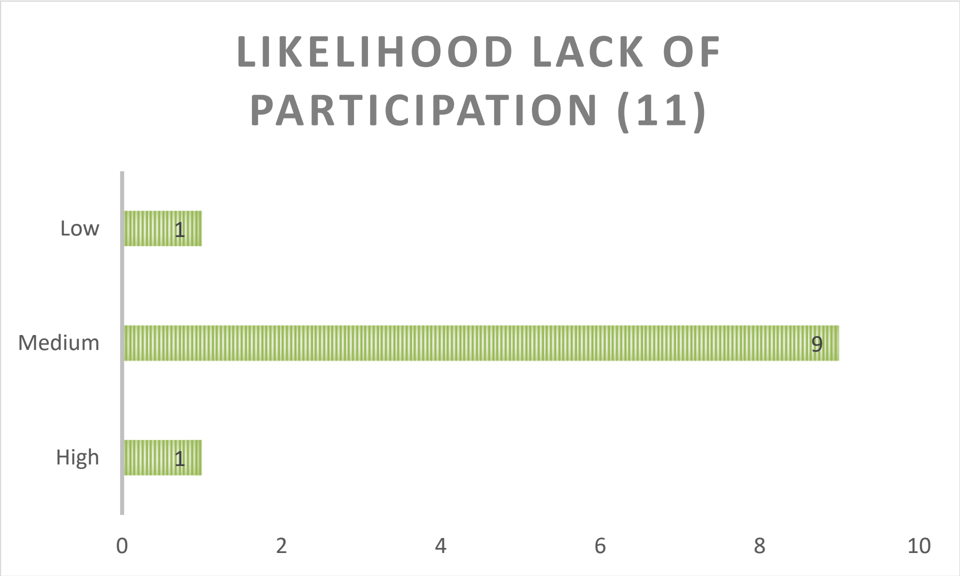

Figure 23 Likelihood to occur for the risk “Lack of participation in the decision process”

3.11.2 Severity

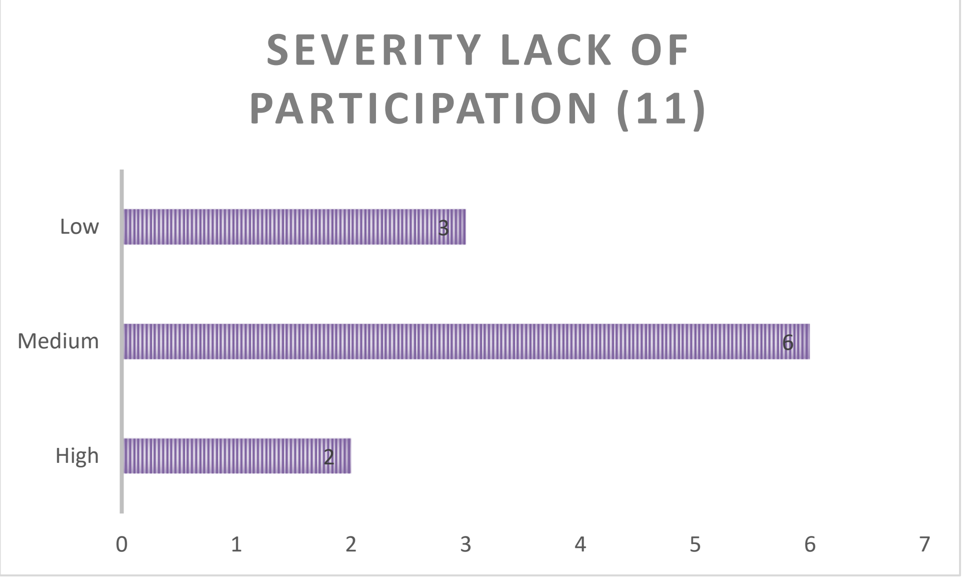

Figure 24 Severity if risk "Lack of participation in the decision process" occurs

3.12 NIMBY (not in my backyard) effect

- The so-called NIMBY (not in my backyard) effect may also be observed for the CLARA approach. The use of renewable feedstock is good for the acceptance but many people may be reluctant to accepting those plants in their neighbourhood.

3.12.1 Likelihood

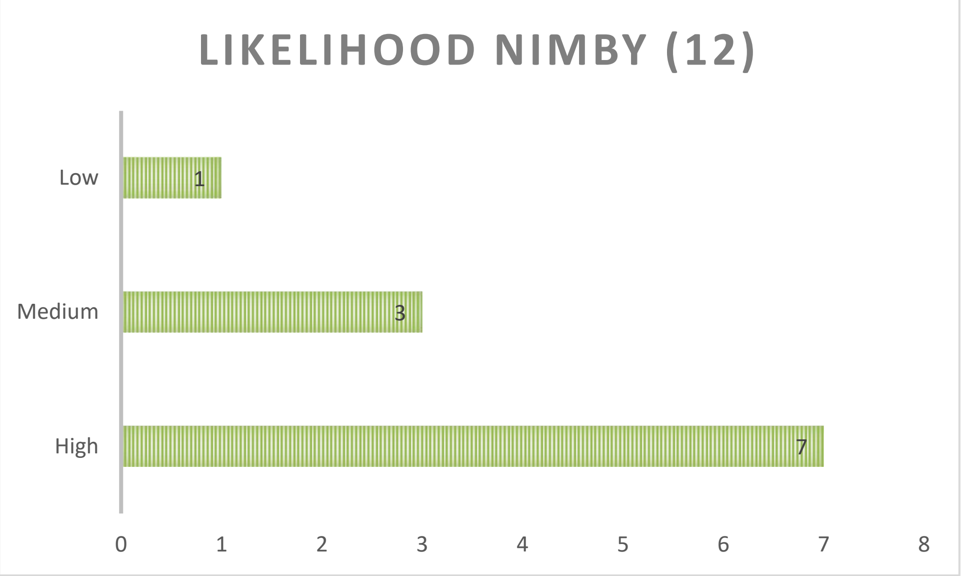

Figure 25 Likelihood to occur for the risk “NIMBY effect”

3.12.2 Severity

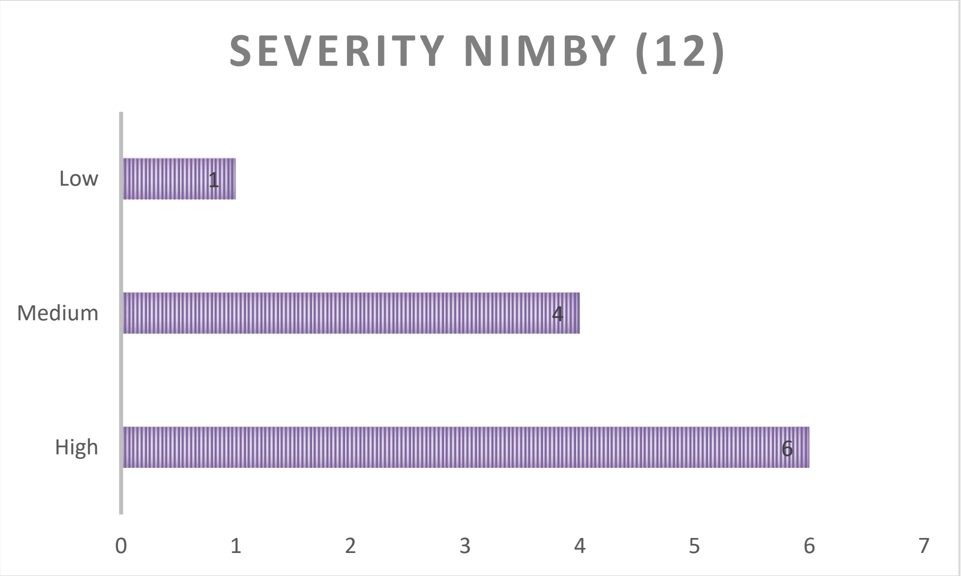

Figure 26 Severity if risk “NIMBY effect” occurs

3.13 End user acceptance

- Emotionally charged atmosphere concerning biomass utilization for energetic use
- Society wants answers to questions like

- Which feedstock is used?
- Where does it come from?
- How can sustainability of feedstock and its conversion be assured?
- How reasonable are subsidies for green electricity?
- It also seems that there is the perception that gasification is a more dangerous technology than others

- Chemical looping plants bear a certain technical risk of emission leaks (e.g. methane) which can be unfavorable to social acceptance as well

3.13.1 Likelihood

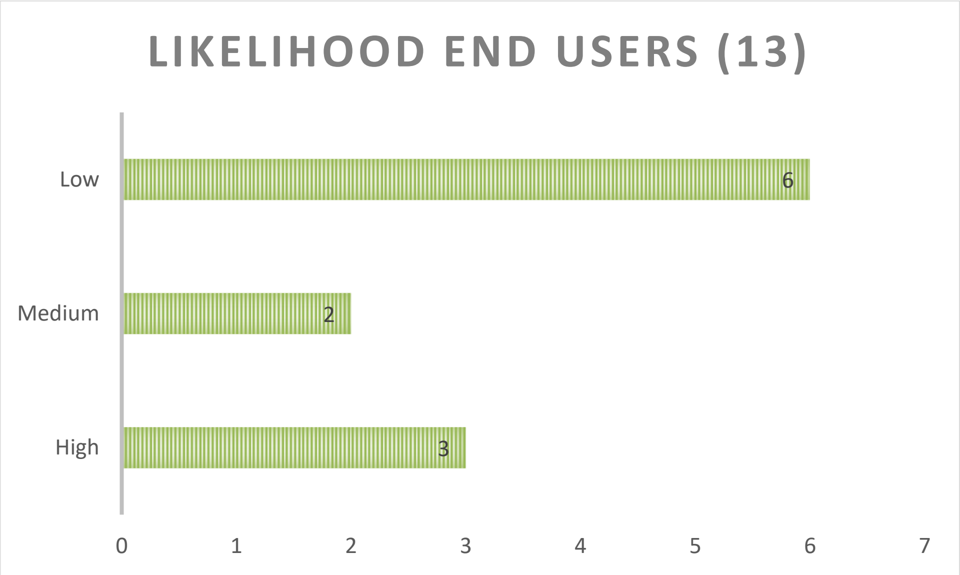

Figure 27 Likelihood to occur for the risk “Lack of end user acceptance”

3.13.2 Severity

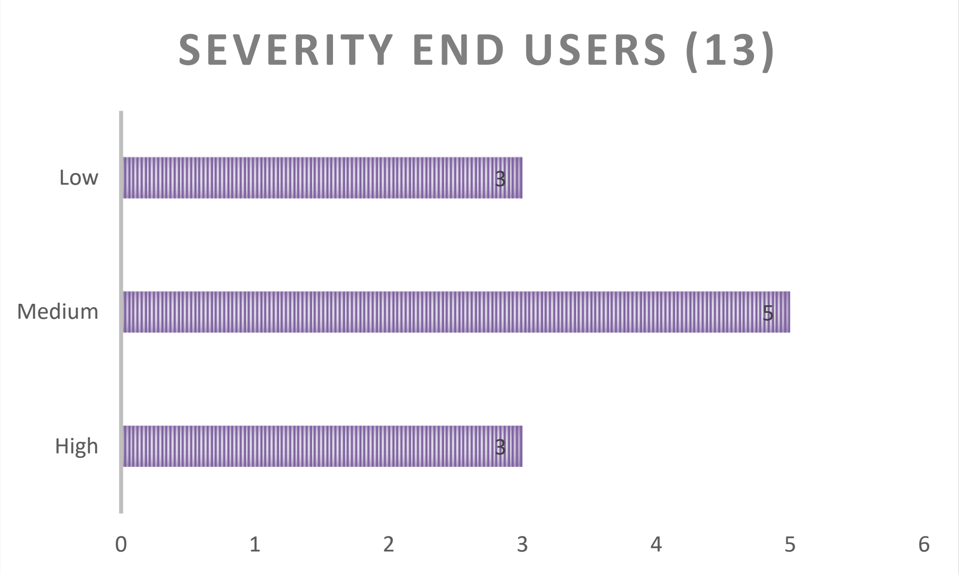

Figure 28 Severity if risk "Lack of end user acceptance" occurs

3.14 Investors' acceptance – feedstock supply

- The assurance of a constant feedstock supply could become a risk. The radius within which the feedstock can be acquired is limited due to the enormous logistics
- Although CLARA uses residues, feedstock (e.g. wheat straw) supply can also be threatened by calamities like e.g. drought

3.14.1 Likelihood

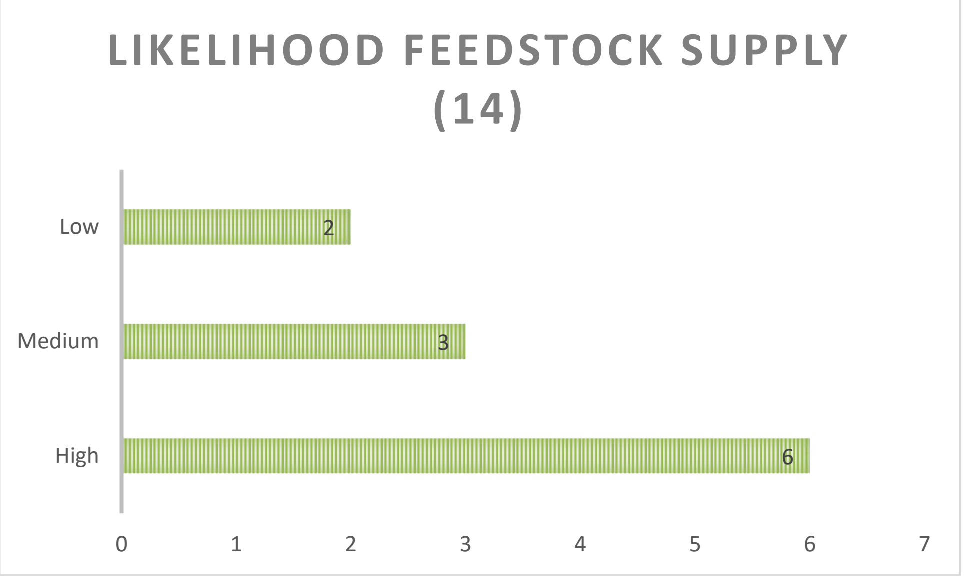

Figure 29 Likelihood to occur for the risk “Lack of investors’ acceptance due to feedstock supply issues”

3.14.2 Severity

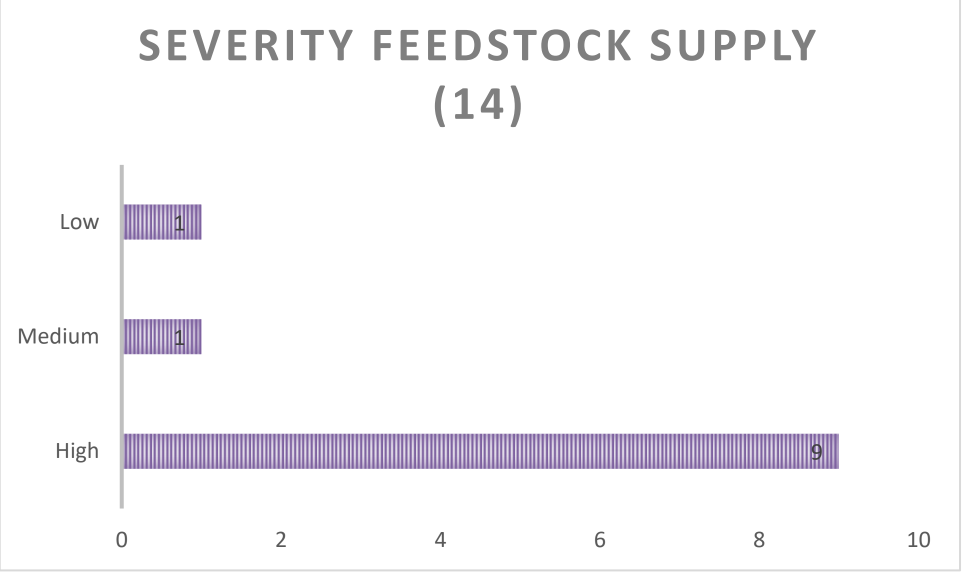

Figure 30 Severity if risk “Lack of investors’ acceptance due to feedstock supply issues” occurs

3.15 Investors' acceptance – plant operation

- E.g. pelletization could be a bottleneck - it has to be assured that there are enough capacities (maybe more plants) plus stocks to provide the quantities needed

3.15.1 Likelihood

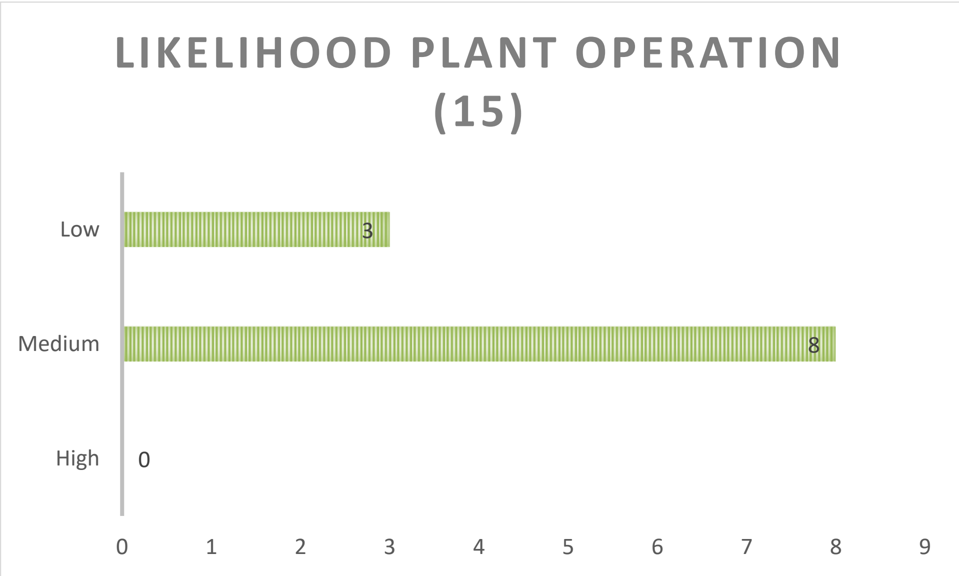

Figure 31 Likelihood to occur for the risk "Lack of investors' acceptance due to plant operation issues"

3.15.2 Severity

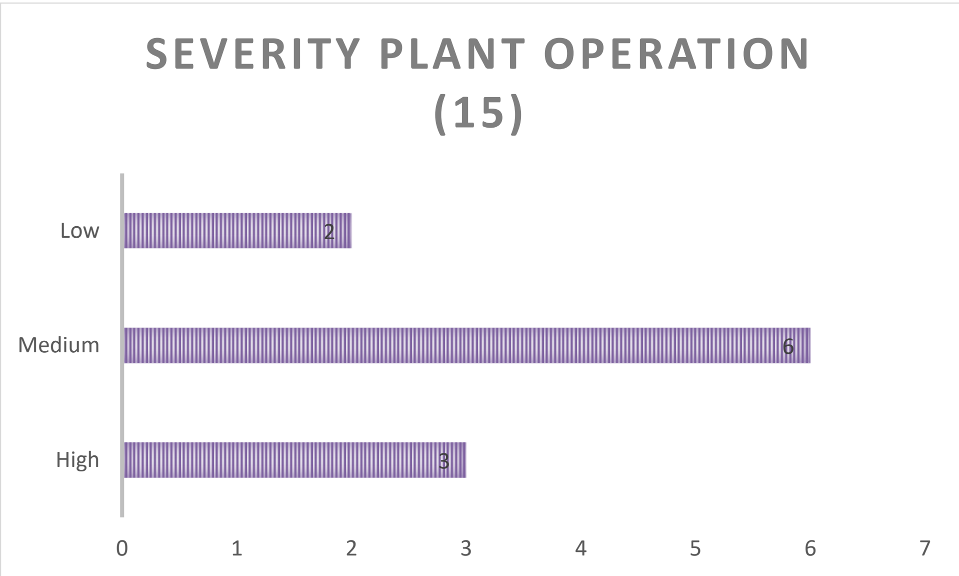

Figure 32 Severity if risk "Lack of investors' acceptance due to plant operation issues" occurs

3.16 Risk matrix

Table 2 summarizes the evaluation results in a risk matrix. A risk matrix is a tool that is used to assess the risk and its visibility by taking into consideration the probability against the consequence severity. The risk matrix is a simple matrix that is used in order to increase the knowledge and visibility of the risks which will help in making better decisions. It shows the likelihood of certain risks to occur and the severity of certain risks in case they occur.

Concerning the risks related to society, for two of the identified risks the likelihood was rated low (1), for eleven it was medium (2) and for two it was high (3). Concerning the severity, it was rated low (1) for no risk, medium (2) for seven and high (3) for eight risks in case they appear. The risks “NIMBY (not in my backyard) effect” and “Investors’ acceptance – feedstock supply” are rated high for likelihood as well as severity. This means that the likelihood of occurrence is high and the impact would be major on the implementation and operation of the plant. Hence, these risks have to be prioritized. Nevertheless, mitigation strategies should be developed for all the identified risks (see also chapter “Risk mitigation strategies”).

Table 2: Risk matrix – evaluation of risks related to society

Likelihood \ Severity	1	2	3
1	-	Socially undesirable distribution Social standing and political influence	-
2	-	Social sustainability risk Political and legal framework – subsidies Social acceptance - knowledge gap Community acceptance – changes in regional/local structures Lack of participation in the decision process	Dependencies in supply chains Political and legal framework – uncertainties Political and legal framework - approval procedures Social acceptance- environment End user acceptance Investors acceptance - ´plant operation
3	-	-	NIMBY effect Investors acceptance - feedstock supply

4 Risk mitigation strategies

4.1 Results from interviews - suggestions to increase social acceptance

In the qualitative interviews (see questionnaire Annex) one question was on how to increase social acceptance. A clear communication of the background motivation, benefits and data gained in these assessments is seen crucial to enhance social acceptance. The facts and figures distributed should be on

- Goals of the project/plant
- Job creation
- Products
- Regional development
- Use of residues as feedstock and their conversion to products of value
- Relative danger of gasification, which shows that gasification is not more dangerous than other technologies.
- Emissions
- Traffic
- Noise

Various channels should be used for communication

- Social media
- Open visits for schools etc.
- Regional media
- A vehicle (bus, scooter etc.) that is (partly) filled with CLARA fuel and promote accordingly

It should also be well communicated that the CLARA approach is fully in line with RED II and that a fuel versus fuel debate is obsolete. An adequate implementation is self-evident for a long-term social acceptance. Transparency ("*open and honest*") throughout the whole implementation process is another one; gasification is less known and thus scares people more. Neighbouring residents and their concerns have to be taken seriously and mitigation measures towards augmented traffic, noise or emissions have to be clarified in advance and binding.

Another recommendation is to be in good contact and exchange with the local authorities to get support from them.

The plants should be built close to communities which can provide feedstock and are likely to derive great benefits from such a plant.

The assured and exclusive use of residues, i.e. feedstock that is fully accepted through RED II, to avoid feedstock competition and assure credibility towards society are proposed.

4.2 Results from workshop – risk mitigation

The results of this chapter are the compilation of the above-mentioned workshop in March 2022, where a brainstorming session on risk mitigation strategies was done. Eight participants actively contributed their ideas.

The mitigation strategies are listed along the identified 15 risks clusters.

4.2.1 Dependencies in supply chains

- Long-term supply contracts
- Build on written official long-term contracts, with penalty in case of failing the supply
- Feedstock flexibility for operation
- Define priorities for biomass utilization
- Make use of different feedstock types
- Diversify sources/logistic chains
- Design plant for different sources/gas qualities
- Build big storage site
- Buy from multiple suppliers
- Involve suppliers in the project (e.g. include them in the operating company, pay a fair price)
- Give enough information to media, about the need of feedstock
- Predefined quotas for feedstock that can be used for biofuel production
- Exclusion of certain feedstock for biofuel production (especially plants that are predominantly used for food production)

4.2.2 Social sustainability risks

- Support low-income households/groups with political framework (subsidies, tax breaks etc.)
- Redistribute income from CO_2 taxes to all citizens

- Provide information via e.g. social media, internet

4.2.3 Socially undesirable distribution

- Try to involve all stakeholders as early as possible, to consider their thoughts and needs
- Inform to the legal entities to distribute the product well
- Market regulations to ensure a fair competition and opportunities for local SMEs to participate actively (e.g. quotas for projects carried out by local SMEs)

4.2.4 Political and legal framework – uncertainties

- Include Industrial sector in the EUTS market
- Ensure reliability on the political framework and make clear boundaries for the usage of different fuels for their proposed sector of utilization
- Discussion with political parties regarding impact of legal framework
- Try to establish a lobbying team for your project stay in contact with authorities concerned
- Contract with legal advice company, lawyers
- Active dialogue with international and domestic entities that shape incentives such as e.g. CO_2 tax mandates
- Cooperation with consultant(s) that may provide foresight and tailored solutions/mitigation strategies

4.2.5 Political and legal framework – subsidies

- Involve local administrations to push the technology
- Subsidies might be replaced by other mechanism for example the CO_2 tax or low carbon fuel standards
- Push innovations for chemical looping technology?
- Push for fixed minimum quotas for biofuels in the transport sector
- Do good lobbying
- Try to create a financing concept with private investors
- Try to simplify the technology to lower investment
- Give all the information possible to entities for this type of subsidies and the needs for our system

4.2.6 Political and legal framework – approval procedures

- Define a work/technology risk assessment plan
- Transparent and detailed technical information to authorities at an early stage of the project
- Consider the authorities' concerns
- Communicate and publish about your technology
- If possible use the European standards for the approvals
- Independent verification of approval procedures and review of approval mechanisms by a third party

4.2.7 Social Acceptance – Environment

- Align technology with RED II sustainability requirements
- Inform stakeholders/provide outreach to society & provide information
- Open and proactive communication with local population, dialogue in form of workshops, in which potential concerns about food safety, emission etc. are addressed
- Use social media
- Use residues and waste biomass for fuel production as in the case of CLARA
- Transparent information to authorities and public
- Stick to non-food materials
- Minimize technical risks - train the operators

4.2.8 Social Acceptance – Knowledge gap

- Awareness campaigns to stakeholders, final consumers, local communities and general public
- Transparent information
- Publish at different levels and have an information centre at site
- Offer to teach, courses, workshops, documentals

4.2.9 Social standing and political influence

- Give local population the possibility to be involved in some decisions
- Offer forms of (financial) participation to local communities & individuals from those communities
- Align goals of plant owners with community goals (shareholder agreement)
- Lobby for the technology

- Involve local players (companies) in the supply and erection
- Mechanisms and policy frameworks that guarantee benefit sharing and participation (e.g. quota of employment that needs to be satisfied with local community or a mandate that FIRST a certain employment opportunity is to be awarded to someone qualified from the local community)

4.2.10 Community acceptance – changes in regional/local structures

- Try to give many jobs to the local community
- Use biomass from local suppliers if possible
- Discuss with/inform/involve local stakeholders – including schools (impact depends on plant site and existing infrastructure)
- Offer benefits to the regional/local to balance the other negative effects. New jobs, taxes to regional entity, etc.
- Organize events together with community in regular intervals with the aim of bringing people together that normally may be less likely to interact (local population & people that moved in because of employment)

4.2.11 Lack of participation in the decision process

- Involve stakeholders and communities from the beginning of the project
  Transparent information and discussion with local stakeholders in e. g. Infodays, workshops, round-tables, social media etc.
- Provide other forms of outreach (newsletters to postbox, etc.)
- Provide in-depth information material
- Offer forms of (financial) participation of local shareholders
- Preparing, mentoring, consulting
- Giving benefits to participants

4.2.12 NIMBY effect

- Highlight social, economic and environmental benefits of the plant/technology
- Open communication policy/information campaigns/transparent information
- Have an information centre at site
- Raise awareness in local population that this technology is a contribution towards a sustainable society
- Highlight & communicate positive impacts on community
- Understand whether concerns are justified and clarify misunderstandings
- Keep discussion channels to opposed parties open

- Offer forms of (financial) participation
- Involve local players in the operating company
- Build plants in areas with few other job perspectives if it is a suitable area concerning feedstock

4.2.13 End user acceptance

- Highlight social, economic and environmental benefits of CLG drop-in fuel – also compared to ordinary gasification
- Open information policy/transparency campaigns focus on technology/transparent information at different levels
- Informing the end-user about the final product to use according to EN standards
- Creating a platform (website?) that is publicly accessible with a frequently asked questions (FAQs) section in which all pressing questions are answered in a straightforward manner
- Allow for open access studies on life-cycle assessment
- Establish quality label for biofuels

4.2.14 Investors acceptance – feedstock supply

- Long term supply contracts
- Feedstock flexibility for operation
- Sufficient storage facilities
- In case of calamities import pellets from neighboring countries
- Involve feedstock suppliers in the operating company
- Marketing, publicity
- Give information
- Create a worst case, ideal, and best-case scenario for feedstock supply by a qualified subcontractor (independent, scientific opinion) to ensure investors acceptance

4.2.15 Investors acceptance – plant operation

- Establish a feasible supply net
- Partnership with local feedstock suppliers
- Use storage on site
- Sufficient scaling of capacities
- Contracts with different suppliers of biomass

- Demonstrate robustness of concept
- Locate bottlenecks and present work-arounds (e.g. storage for pellets)
- Set up an operating company with a high level of experience and sufficient financial background
- Long-term contracts with suppliers
- Use different feedstock types (flexibility)
- Import pellets from neighboring countries

5 Conclusions and Outlook

In total 15 risk clusters related to society could be identified for the CLARA approach. These risk clusters were related to the areas (I) socio-economic factors, (II) political and legal framework and (III) social acceptance (including market acceptance). The risk evaluation showed that risks related to the political and legal framework as well as to the social acceptance are the major concerns regarding a successful implementation of the CLARA approach. From the concerns mentioned above it can be concluded that sustainability and feasibility assessments are key - also for social acceptance. In particular, the different aspects of social acceptance pose risks with high likelihood of occurrence and severity: The so-called NIMBY (not in my backyard) effect is also observed for the CLARA approach. The use of renewable feedstock is beneficial for increased acceptance but many people may still be opposed to those plants in their neighbourhood. Furthermore, the assurance of a constant feedstock supply is a high risk. The radius within which the feedstock can be acquired is limited due to the enormous logistics and although CLARA uses residues, feedstock (e.g. wheat straw) supply can also be threatened by calamities like e.g. drought. Hence, these risks should be prioritized when determining on the appropriate risk mitigation strategy. First ideas on potential risk mitigation strategies such as long-term supply contracts and fuel flexibility are listed in chapter 4.2.14. This prioritization will benefit the implementation of the CLARA approach. While it's impossible to fully plan for uncertainty, acknowledging and understanding what risks could occur provides an opportunity to create action plans for those unexpected events. Appropriate planning for risks increases the likelihood of project completion and success.

For all identified risks detailed mitigation strategies should be developed based on the approaches presented in chapter 4. Having an awareness of the potential impact can reduce or neutralize the effect of a project risk before it occurs. It seems that informing and involving the local community and various stakeholders in versatile ways is a risk mitigation strategy that can be applied for many potential threats.

Table of Figures

6 Annex

6.1 QUESTIONNAIRE FOR GUIDED INTERVIEWS

1. Are there any risks related to society that you see resulting from the CLARA approach?
2. How do think social acceptance will be? Do you have any suggestions how to increase social acceptance?
3. Which risks do you see arising from political or legal framework? Are any further legal regulations/clarifications or policies necessary in your opinion?
4. Which risks do you think can result from or for national economy?
5. Do you see feedstock-specific risks

6.2 OVERVIEW RESULTS OF THE LITERATURE RESEARCH

Source	Risk addressed	Risk category	Project stage
Fytili and Zabaniotou, 2017	Emission and waste generation	social acceptance-socio political acceptance	all
Fytili and Zabaniotou, 2017	Concern about food safety and biodiversity	social acceptance-socio political acceptance	operation/maintenance
Fytili and Zabaniotou, 2017	Bias	social acceptance-socio political acceptance	construction/implementation
Fytili and Zabaniotou, 2017	Knowledge gap-Information and basic knowledge of various industrial activities	social acceptance-socio political acceptance	construction/implementation
Fytili and Zabaniotou, 2017	Unequal distribution of costs and profits	social acceptance-acceptance by local communities	all
Fytili and Zabaniotou, 2017	Confidence in the implementation of programs	social acceptance-acceptance by local communities	construction/implementation
Fytili and Zabaniotou, 2017	long-term viability of advanced bioenergy systems	social acceptance-market acceptance	all
Fytili and Zabaniotou, 2017	Low level of customer awareness	social acceptance-market acceptance	all
Fytili and Zabaniotou, 2017	Low level of investor awareness	social acceptance-market acceptance	construction/implementation
Alasti, 2011	Political uncertainties	political/legal framework	all
Alasti, 2011	Dependencies in supply chains	socio-economic	operation/maintenance
Alasti, 2011	Competition for new industries	socio-economic	construction/implementation

International Risk Governance Council, Geneva, August 2007	Working conditions in the supply chain	socio-economic	operation/maintenance
International Risk Governance Council, Geneva, August 2007	*Working conditions at the plant*	*socio-economic*	*operation/maintenance*
International Risk Governance Council, Geneva, August 2007	Dependence on biofuel production can lead to societal impacts on traditional cultures and sustainable agricultural practices.	socio-economic	operation/maintenance
International Risk Governance Council, Geneva, August 2007	poor management of the development of biofuels could lead to a consumer backlash that reduces demand	social acceptance-market acceptance	operation/maintenance
International Risk Governance Council, Geneva, August 2007	Competition for food products, wood fibre and products in the forestry sector is expected to drive prices upwards, with impacts on the food as well as the paper and wood industries.	socio-economic	operation/maintenance
International Risk Governance Council, Geneva, August 2007	effects of subsidies for a source of energy that should be competitive to avoid economic bias	socio-economic	all
Hansen et al. 2021	Governance sustainability risks - Community trust and acceptance	social acceptance-acceptance by local communities	construction/implementation
Hansen et al. 2021	Social sustainability risks Socially undesirable distribution between income groups and region	socio-economic	all

Hansen et al. 2021	Economic sustainability risks- Excessive use of wood as fuel rather than as material	socio-economic	operation/maintenance
Hansen et al. 2021	Economic sustainability risks- Excessive development of bioenergy rather than other renewable energy technologies	socio-economic	construction/implementation
Terrapon-Pfaff et al., 2019	Reduced social standing and political influence	social acceptance-socio political acceptance	all
Terrapon-Pfaff et al., 2019	Accelerated changes to community atmosphere and cultural identity	social acceptance-acceptance by local communities	all
Terrapon-Pfaff et al., 2019	Social conflict, rivalry and feelings of envy	social acceptance-acceptance by local communities	all
Terrapon-Pfaff et al., 2019	Uncertainty, unrealistic expectations and frustration	social acceptance-acceptance by local communities	all
Terrapon-Pfaff et al., 2019	Social exclusion and powerlessness in decision-making	social acceptance-acceptance by local communities	construction/implementation
Terrapon-Pfaff et al., 2019	Suspicion towards the project and its developers, as well as community protest	social acceptance-acceptance by local communities	construction/implementation
Terrapon-Pfaff et al., 2019	Strain on regional infrastructure and services	social acceptance-acceptance by local communities	all

Terrapon-Pfaff et al., 2019	Economic exclusion of micro-scale SMEs	socio-economic	all
Terrapon-Pfaff et al., 2019	Deterioration in socio-economic situation and standards of living in adjacent communities	socio-economic	operation/maintenance
Terrapon-Pfaff et al., 2019	Erosion of local purchasing power and decreased standards of living among low-income groups	socio-economic	operation/maintenance
Terrapon-Pfaff et al., 2019	Mismatch between educational qualifications and labour market requirements	socio-economic	all
Terrapon-Pfaff et al., 2019	Poor and unequal labour conditions	socio-economic	all
Terrapon-Pfaff et al., 2019	Increased crime and fatal road accidents	socio-economic	all