D11.3 – Periodic Risk Monitoring Report

Project Information

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PP	Restricted to other programme participants (incl. Commission Services)	
RE	Restricted to a group specified by the consortium (incl. Commission Services)	
CO	Confidential, only for the members of the consortium (incl. Commission Services)	

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Version	Date	Author	Description of Change
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Abbreviations

DoA	:	Description of Action
PC	:	Project Coordinator
RM	:	Risk Manager
SMB	:	Strategic management Board
WP	:	Work Package

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1 Executive Summary

This document corresponds to the deliverable No.76 (D11.3) “Periodic Risk Monitoring Report” concerning the updating of the risks and mitigation actions plan on month 18. This plan describes both: a) risks that have already been included in the Annex 1 of the GA - DoA and b) unforeseen risks which have been identified during the progress of the project. In addition, risk management procedures – in regard to the identification, assessment and monitoring of the risks- as well as the corresponding mitigation measures are also described in the report.

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2 Introduction

Risks are possible events or conditions that, if occur, have a negative impact on project's objectives, scopes, cost, time schedule or quality. Risks can arise from unexpected technical difficulties or scientific findings, poor communication or cooperation between the partners, resource(s) shortage by the partners, objectives not achievable in terms of budget, partners leaving the consortium, human errors (operational and planning errors, poor quality), etc. Therefore, the risk management is an essential and dynamic part of every complex project. In intelWATT, project risks have been primarily managed by breaking the work program into an achievable set of smaller developments. This enables the consortium to monitor the progress and reduce the potential risks' impacts. In addition a risk management procedure (Figure 1) - which includes four elementary steps - has been established to ensure that all the above uncertainties are precautionary diagnosed and addressed in order the project strategy, operations, outcomes and budget remain on track. The basic aspects of this procedure are the following:

- Risk identification – recognition of the events which can compromise timing, costs, quality or scope of the project;
- Risk analysis - estimation of the impacts to the exposure on each risk;
- Response planning and implementation - strategy planned and prepared to mitigate the risk;
- Evaluation of mitigations actions and reporting - tracking the risk status and the progress towards its elimination.

Figure 1. Risk Management Process

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3 Risk Identification

3.1 Risks categories

Throughout the life-cycle of the intelWATT project, emphasis will be given on the early risk identification in order for an effective response planning and subsequent monitoring to be realized. This includes risks that have already been foreseen and are listed in the DoA as well as unforeseen risks which arise during the progress of the project. All the risks that may emerge in the project are classified to the following categories:

- Operational risks: related to barriers in the achievement of project's objectives.
- Time risks: related to schedule changes or delays in the implementation of the expected tasks as well as on the overall progress of the project;
- Competence risks: related to the resources that should be provided or required for the implementation of a task.
- Deliverables' risks: Any risk related to deliverables' production, including risks relating to content, deadlines or quality levels.

3.2 Roles and Responsibilities

Risk identification is done whenever a new risk is identified by a Consortium partner during the project. Once a new risk arises, the involved partner shall notify the Risk Manager in order the risk management procedures to be activated in time. The consortium has a well-defined structure, comprised of the Project Coordinator (PC), the Risk Manager (RM) and the WP leaders, with clear roles and responsibilities assigned to each one as described in the following:

Project Coordinator (PC) Risk management will be performed under the supervision of the Project Coordinator, who will be responsible for the following tasks:

- Coordinating with the consortium to monitor risks and implement risk response strategies.

- Managing quality control procedures on deliverables.

- Reporting regularly to the consortium.

- Making the final decision on risk actions, in co-ordination with the WP Leaders.

- Developing and/or updating the risk response strategy in cooperation with the SMB.

Risk Manager (RM) is responsible for the following tasks:

- Monitoring the project to identify any new or changing risks.

- Updating the initial risks' list with the support of the consortium.

- Contributing to risk mitigation and contingency planning.

- Monitoring the effectiveness of the risk management strategies.

- Monitoring the assigned risks and informing the Project Coordinator of any threats to the project.

- Assessing the probability that a risk will occur and specifying the criteria used to assess the probability.

- Assessing the impact of risks on project cost, time, scope, and quality objectives, and specifying the criteria used to assess the impact.

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Work Package (WP) Leaders are responsible for the following tasks within their work package(s):

- Identifying and describing any risk.
- Assisting in developing the risk response strategies.
- Performing the risk response steps assigned.
- Reporting on the progress of the risk response to the RM & PC.
- Assisting the PC & RM in activities associated with risk monitoring and control.

4 Risk Analysis

The next step concerns the estimation of the risks' consequences to the progress / implementation of the project. This is performed by the assessment of the probability a risk to occur (likelihood)[1] as well as the size of its possible impacts. The exposure to a given risk is estimated using a risk matrix (Figure 2), which assesses each risk according to these two dimensions on a given scale (low - medium - high). The output (represented with the different colors within the matrix) classifies the risk level (i.e. low risk, medium risk or high risk). Risk analysis' outcome could change over time, depending on the specific causes and effects of each risk and for this reason should be frequently re-assessed the risk and confirmed/updated.

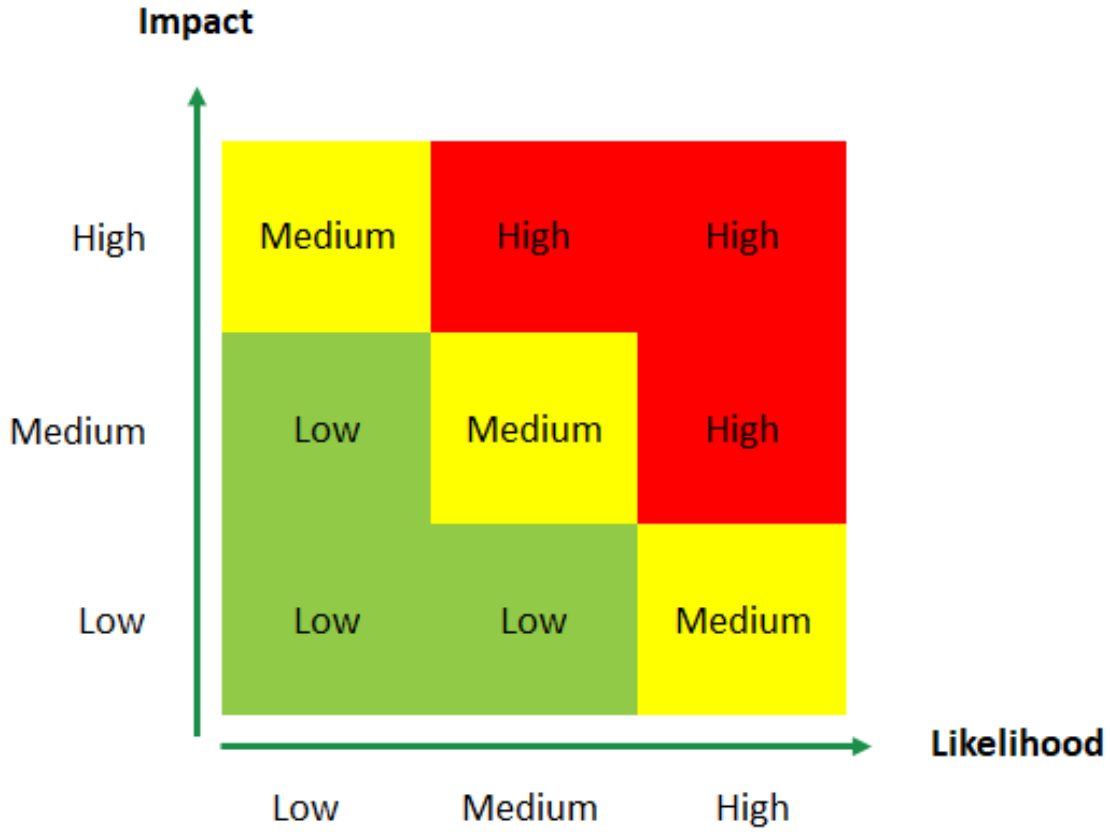

Figure 2. Risk Matrix

[1] Like hood explanation: a) low = very unlikely, but not impossible, b) Medium: Quite possible, c) High: more likely to happen than not

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5 Response Plan

The risk response plan includes the strategies developed to tackle the threats and minimize the effects of the risk to a manageable point. During response planning, higher priority risks should receive more attention than lower priority risks. The following strategies will be taken (depending on the risk category):

- For high and medium - priority risks: Mitigation. Risk mitigation involves reducing the probability and/or the impact of a risk to an acceptable level. Taking early and precautionary actions against a risk is often more effective than attempting to repair the consequences a realized risk has caused. Contingency planning is an example of risk mitigation.
- For low-priority risks: Acceptance. Acceptance is often taken as a risk strategy since it is very difficult to plan responses for every identified risk. Risk acceptance should normally only be applied for low-priority risks. Risk acceptance can be passive, where no action is taken at all, or active. In the passive approach the risk is monitored and reassessed. In the active approach, the most common actions include a revision in costs and/or schedule to addresses known (or unknown) threats.

Every risk will be assigned to the involved WP leader(s) which will be responsible for the management, monitoring and control of all aspects of a risk, including the implementation of the selected responses. The results of response planning will be also included into the Risk Management Register (table 1).

6 Risk Monitoring and Control

Each Work Package Leader is responsible for the Risk Management within their Work Package. Each project partner is highly encouraged to communicate and discuss any (possible) risks and response planning with the Work Package Leader. It is the responsibility of all partners to communicate the RM and PC about the status and effectiveness of each risk and mitigation plan in order to update the Risk Management Register and assess the relevance of the tools. Risk exposure will be continuously re-evaluated and modified accordingly and the results of monitoring and control will be documented.

The Risk Management Register is the tool enabling structured risk monitoring, summarizing all risks (Risk identification), their assessment in terms of likelihood and impact (Risk analysis), the mitigation measure and owner (Response planning) and status (Risk monitoring). It is accessible to all Consortium members through the EMDESK platform.

The Risk management register, therefore, contains:

- The risk number and risk description;
- The WP involved/affected;
- The output of the risk analysis phase, i.e. the indication of the level of likelihood and impact and the consequent Risk level;
- The proposed risk-response measure(s);
- The risk owner; where and if applicable
- The status of the risk (a risk will be considered closed after the adverse situation occurred and it can no longer be considered as a threat to the project).

A first version was prepared at the proposal phase and confirmed during the Grant Agreement signing process. It includes 13 identified project risks and their planned mitigation measures. During the 18 months

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of project activities, the Register has been further developed taking into account new risks that each WP Leader has identified and foreseen for the project implementation.

As explained above, the Risk management register is a living document that is regularly updated. Time-driven revision will occur at the moment of the internal progress reporting and the periodic reporting, but whenever a project partner foresees a new possible risk or whenever a foreseen-risk occurs, it will be updated as well. The current version of the Risk management register is provided below.

7 Conclusions

This deliverable has outlined the risk management procedure to allow effective detection, monitoring and reaction across the project duration and will serve as a reference for all consortium partners during the project implementation. The current version of the Risk Management Register is also provided.

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8 Table I – Risk management Register

Foreseen Risks

Risk No.	Description of risk	WP	Prob.	Impact	Risk Level	Status[1]	Risk mitigation measures that you apply.
1	Failure to membrane upscaling	4,5,6, 7	Low	High	Medium	Foreseen	Upscaling studies will be conducted early on to ensure proper continuation of the project. As an alternative commercially available membranes will be used.
2	Delays in the delivery of the prototypes	3,5,6, 7,8,9	Low	High	Medium	Foreseen	Meticulous compliance with timeframe will be ensured by professional project management. An accurate actions timeline will be determined in month 3.
3	In the innovative valve designs, stagnant fluid areas allow biofilm accumulation and membrane biofouling in prolonged operation	3,7	Medium	Medium	Medium	Foreseen	Fluid stagnant areas are already being investigated and minimized as part of the salt retention study; the design improvements will be extended to minimize biofouling. Newer non-chlorine based biocides, that are compatible with membranes, will be assessed
4	Wear of the piston seal in the batch pressure vessel over time	3,7	Medium	Low	Low	Foreseen	A close fitting, neutrally buoyant piston will be developed to avoid the need for physical seal component, by embedding a sealed metallic float vessel inside the piston and machining the piston to close

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Risk No.	Description of risk	WP	Prob.	Impact	Risk Level	Status[1]	Risk mitigation measures that you apply.
							dimensions to match the vessel internal diameter.
5	The analyte concentration is out of scale	3,5,6, 7,8	Medium	Medium	Medium	Eliminated	If the analyte concentration to be detected will overcome the full scale, or it will be under the Limit of Detection, an improvement to preparation phase will be implemented. For high level of concentration, a dilution of the sample will be performed. For low level of analyte, the sample will be concentrated.
6	Recovery of energy from brine is lower due to changing feed conditions e.g. the influence of multivalent ions and extreme pH (2 > pH > 12) on the membrane properties.	2,3,6	Medium	Medium	Medium	Foreseen	Risk-Mitigation measures: Already from WP2 will follow the requirements and potential of the system & process thus there will be enough time to adjust for the final pilot design.
7	Poor quality data and lack of standardized methodologies lead to a Life Cycle Assessment affected by severe uncertainties.	9	Low	High	Medium	Foreseen	A specific task for the development of the LCSA methodology is foreseen at an early stage of the INTELWATT project. The team will review the most authoritative methods, tools and indicators which combine environmental, social, economic and circularity aspects in a life cycle perspective in order to build up a methodology customized to the case studies. Furthermore, an internal process of validation will be implemented for all

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Risk No.	Description of risk	WP	Prob.	Impact	Risk Level	Status[1]	Risk mitigation measures that you apply.
							project deliverables, based on the critical reviewing approach in LCA and carried out by independent experts not involved in the execution of the tasks. Specific milestone(s) on the validation of methodology and data quality will be foreseen.
8	Surfactants in the respective wastewater irreversibly block the membrane surface.	4,5,6, 7	Medium	Medium	Medium	Eliminated	Exchange or waiver of surfactants in the process
9	Membrane fouling	5,6,7	Medium	Low	Low	Foreseen	Setup and optimization of CIP (cleaning in place) processes
10	Scaling during MD operation in Case study 2 (WP5)	6	Medium	Medium	Medium	Foreseen	Careful selection of MD membranes with antifouling/antiscaling surface. In case of observed relevant salt nucleation and growth due to oversaturation, the crystals will be recovered in MD retentate using a funnel equipped with a filter. These salts if sufficiently pure can be used as valuable crystalline products (e.g. NaCl, MgSO4·7H2O). Alternatively, they can be used to increase the salinity gradient difference between concentrate and soft water.
11	Module type (pretreatment) is not optimal	5,6,7	Low	Medium	Low	Foreseen	Exchange of tubular membrane modules with other membrane module types from the current product portfolio (not

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Risk No.	Description of risk	WP	Prob.	Impact	Risk Level	Status[1]	Risk mitigation measures that you apply.
							especially adapted to the case studies)
12	functionalization/infiltration of GO membranes: chemical stability and mass transport across the membranes	4	Medium	Medium	Medium	Foreseen	Several functional groups will be investigated in order to find out the more stable compromise while IEM will be infiltrated to avoid mass transport across the membranes (additional advantage in terms of membrane thickness since GO acts as scaffold)
13	Large scale membrane fabrication: mechanical stability and ordered flakes control	4	Low	Medium	Medium	Foreseen	Both vacuum and pressure filtration will be investigated and the screen printed will be considered as alternative.

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Unforeseen Risks

Risk No.	Description of risk	WP	Prob.	Impact	Risk Level	Status[1]	Proposed risk-mitigation measures
U1	The output target cannot be met because of excess pressures and/or reduced membrane permeability because of fouling, membrane compaction, or change in membrane properties at the high concentration of electrolyte.	3	High	Medium	High	Foreseen	The pressure relief valve was used to release the system pressure in case of pressure exceed. Reduce flux to lower pressure and increase membrane area accordingly. Variable speed pump and gearing specified in HRRO rig to allow this. The cleaning strategy for membranes will be considered.
U2	Semibatch/batch process does not work according to model	3	Low	Medium	Low	Foreseen	Experiments have been conducted with the existing rig, to show that the model is accurate. The mathematical model was modified and improved to include more non idealities.
U3	Feed pump is not efficient over range of pressures and flows needed resulted in higher than expected SEC	3	Medium	Low	Low	Foreseen	Liaise with pump manufacturers to investigate alternative pumps and motors, such as brushless DC motor, or pump with wider outlet orifice The hydraulic work will be measured independently of electrical work, to separate the assessment of pump efficiency from desalination process efficiency.
U4	Pressure spike at end of batch pressurisation phase	3	Medium	Low	Medium	Foreseen	A proximity sensor will be used to detect the piston position before it reaches the end of travel. Pneumatically actuated bypass valve for fast opening

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							(<1s), in preference to motorised valve. Use pulsation damper to absorb pressure spike Include safety release valve
U5	Air trapped in system prevents recirculation pump from priming	3	Medium	Low	Low	**Foreseen**	Provide vent points at high points in system
U6	The membrane specified is only available from one supplier	3	Medium	Low	Low	**Foreseen**	The membrane has been ordered in advance of completing the design. An alternative supplier was also identified.
U7	The concentration of the feed solution may differ from the standard one assumed in the calculations	3	Medium	Low	Low	**Foreseen**	The control system can cope with different feed concentrations by switching from semibatch to batch phase once a threshold pressure is reached, thus giving variable recovery and concentration factor.
U8	Rapid depressurisation may cause the membrane to delaminate at the start of the purge phase	3	High	Medium	Medium	**Foreseen**	A speed control on the purge valve allows more gradual depressurisation. Spare membranes are being ordered; in case the membrane gets damaged.
U9	Hazard of Boric acid in case of leakage	3	Medium	Low	Low	**Foreseen**	Consideration of a draining system in the lab where HRRO will be installed.
U10	Software needs upgrading, or it might not work	3	Medium	Low	Low	**Foreseen**	Asking the Siemens company to authorize the available update.
U11	Boric acid recovery does not meet the eligible limit for reuse in the rinse bath	3	Medium	Low	Low	**Foreseen**	A post-treatment stage will be considered for this.
U12	Delays in the delivery of ordered items for High-pressure RO rig.	3	High	Medium	High	**Foreseen**	A set of preliminary experiments at lower pressures using the existing rig was done to confirm the feasibility of HRRO concept. Alternative suppliers with shorter delivery times for ordered items were considered.

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							Meticulous compliance with timeframe will be ensured by professional project management.
U13	Suitable perm-selectivity of graphene-based anion exchange membrane and their up scaling	4	High	Medium	High	**Foreseen**	Test of other functional molecules with respect to the ones proposed and further investigation of binder specific for anionic membrane purpose
U14	Delays in delivery times by third party suppliers equipment & materials	3,4,5, 6,7,8	High	High	High	**Pending resolution**	Regular meeting for the supply of items and updates of the availability and delivery from various suppliers.
U15	Cost increases in energy, equipment and materials which might affect budget	3,4,5, 6,7,8	High	High	High	**Pending resolution**	Cost reduction measures
U16	Access restrictions due to COVID situation	All	High	High	High	**Foreseen**	Good planning; many technical online meetings
U17	Solar field deployment available area and building/infrastructure regulators	6	High	High	High	**Foreseen**	Use of high efficiency solar panels / upscaling the capacity of the MD modules
U18	During training from membrane simulators, Reinforcement Learning agents will not have the scope to observe the complete environment.	3,8	Medium	Medium	Medium	**Foreseen**	Further learning with the data from the pilot plants, in a life cycle of continuous improvement of the control systems. Need to incorporate a human supervision in the loop to validate the recommendations of the control system during its continuous learning until it learns enough to be fully autonomous.
U19	Lack of experimental data to validate the performance of the	3.8	Medium	Medium	Medium	**Foreseen**	Continue to maintain fluid communication with the participants of the use cases involved and the need to adjust simulators to the new features according its

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	simulators in near real life conditions.						implementation.

[1] "Status" explanation: a) Foreseen = a risk that it is possible to occur, b) pending – resolution = a risk that it is materialized and mitigation measures are applied, c) eliminated = a risk that is addressed and no longer exists, d) unresolved = a risk that still exists despite the fact that mitigation measures have already been applied (with limited effectiveness).

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