Memorandum

Recipient:	Board of Directors of Reykjavík Energy and Sævar Freyr Þráinsson, CEO of Reykjavík Energy
Sender:	Hólmfríður Sigurðardóttir, Lilja Tryggvadóttir, Sædís Ólafsdóttir, Snorri J. Egilsson, Sigrún Tómasdóttir, and Egill M. Þorbergsson from Reykjavík Energy. Magnea Magnúsdóttir and Baldur Hauksson from ON Power. Heimir Tryggvason, Sverrir Guðmundsson, Sunna Mjöll Sverrisdóttir, Jón Trausti Kárason, Svanhildur Jónsdóttir, and Helgi Guðjónsson from Veitur Utilities. Einar Grétarsson from Ljósleiðarinn. Ásdís Nína Magnúsdóttir and Kári Helgason from Carbfix.
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SUBJECT: ADAPTATION OF REYKJAVÍK ENERGY TO CLIMATE CHANGE, 4TH PHASE

Introduction

Scientific consensus confirms that the Earth's ecosystem is undergoing rapid changes due to increased human-induced greenhouse gas emissions. These changes manifest in rising atmospheric temperatures, intensified weather events, shifts in ecosystems, and rising sea levels. As a result, both human and natural living conditions are increasingly under pressure worldwide. Iceland is not exempt from these changes, and many of them already directly impact Reykjavík Energy's operations.

Reykjavík Energy's activities are closely intertwined with natural forces and dependent on them. It is therefore crucial to develop timely adaptation measures and establish monitoring mechanisms for climate adaptation. This adaptation effort is a collaborative project involving government authorities, municipalities, companies, and the public.

The Board of Reykjavík Energy has requested an assessment of potential climate change impacts on the company's operations. The first phase of this initiative resulted in the report *Adaptation of Reykjavík Energy Group to Climate Change – First Phase Towards Enhanced Resilience*, published in early 2021. The report primarily focused on Veitur's operations, given their fundamental role in providing essential services to society.

Findings from Phase 1 were presented to the Board of Directors, at the Scientific Advisory Council meeting in spring 2022, and at Samorkaþing 2022. Since then, annual memorandums have been issued to provide updates, expanding the focus beyond Veitur to include ON Power, Ljósleiðarinn, and Carbfix.

Distinction Between Adaptation and Mitigation Actions:

- Adaptation measures are localized and focus on preparing communities, individuals, systems, and nature for changing conditions, minimizing negative impacts, and leveraging potential opportunities.

- Mitigation measures include reducing greenhouse gas emissions or removing carbon already in the atmosphere. Examples include carbon sequestration from geothermal power plants or energy transition in transportation, while afforestation and direct air capture fall under carbon removal strategies.

Some measures serve both adaptation and mitigation purposes. For instance, installing lightning protection systems is a pure adaptation response to increased lightning frequency, while the Carbfix method for storing CO_2 in rock formations is a pure mitigation measure. However, blue-green surface-water solutions help manage increased precipitation (adaptation) while also enhancing carbon sequestration through vegetation growth (mitigation). Significant synergies exist between adaptation and mitigation efforts. It is vital to avoid mitigation measures that reduce societal adaptation capacity.

Reykjavík Energy's climate risk assessment is based on reports from the Icelandic Committee on Climate Change. The most recent report can be found here. The 2008 and 2018 reports (V2008, V2018) present climate model results predicting weather changes for Iceland and surrounding ocean areas (10–30°W, 60–70°N). The 2018 report (V2018) utilizes four Representative Concentration Pathways (RCPs) for greenhouse gas emissions, measuring changes in Earth's radiative forcing (W/m²) and projecting temperature increases through the 21st century. Reykjavík Energy's analysis incorporates temperature, precipitation, and other climate variables based on RCP-2.6 and RCP-8.5 scenarios.

The Board has requested an updated status report on climate adaptation efforts. This Phase 4 memorandum aims to highlight progress since the last memorandum and to evaluate adaptation options and review the status of the action plan. The contents of this memo are:

Key milestones since the release of Memorandum 3

The table below summarizes climate-related projects across the Reykjavík Energy group, including both ongoing initiatives from previous actions and new projects.

Climate-Related Actions	Responsibility	Adaptation Benefits
A team was established in 2022 to work on simulations and modelling. A system model of the entire operational area has been developed and calibrated.	Sewer System	Current status assessed regarding damage probability and weak system components, based on existing knowledge of Icelandic climate. Most of the setup is complete, data collection and calibration are ongoing.
A model was set up during the year that reads weather forecasts and predicts the likelihood of overflow valve activation.	Sewer System	Increases operator response time and allows stakeholders to be informed earlier.
A pumping station in Naustavogur was commissioned.	Sewer System	Improved flood preparedness due to stormwater in Naustavogur.
Increased monitoring of turbidity levels in the main pipeline of Grábrókarveita to better understand tank performance in sediment precipitation, which significantly increases during precipitation events.	Water Supply	Ensures potable water quality under all weather conditions and improves resource management and utilization.
Installation of variable-speed controllers on extraction wells in Myllulækjar area to better control water quality during weather events.	Water Supply	Ensures potable water quality under all weather conditions and improves resource management and utilization.
Strategic projects on demand and future resource and transport planning in Veitur's water supply on Snæfellsnes and development areas in Esjumelar, Álfsnes, Kjalarnes, and Akranes, incorporating climate impact considerations.	Water Supply	Ensures sufficient resources for the future and access to safe water, considering climate stress.
Installation of a UV disinfection unit in a new water supply pumping station in Hvanneyri.	Water Supply	Ensures safe water quality under all weather conditions.
Preparations for the activation of renewed production wells in Seleyri. Wells expected to be activated with UV disinfection in 2025/2026.	Water Supply	Ensures access to high-quality resources, particularly during extreme weather events when demand increases and water quality declines.
"Hlöðum betur" project started in 2022 and was completed in October 2024.	Electricity Distribution	Results can be used to define actions that balance the distribution grid load, reducing infrastructure expansion needs and associated emissions.
Smart meter installation is well underway, with 64% of meters installed.	Electricity Distribution	Smart metering enables load management, dynamic pricing, and improved utilization. It also enhances

		understanding of grid flow and allows for more targeted infrastructure development. Completion is expected by mid-2026.
Commitment secured for the construction of substation A13 in Sundagarðar. Business agreement signed with Faxaflóahafnir.	Electricity Distribution	Reduces emissions from ships and vehicles.
Revision of Veitur's pricing structure.	All Utilities	Opportunity for demand management, reducing infrastructure expansion needs and related emissions.
Strengthening of structures against weather stress.	ON Power	Reconstruction and reinforcement of cooling tower walls 1-4 and 11 at Hellisheiði due to increased weather stress. Four towers completed, the fifth scheduled for summer 2026.
Strengthening of fan blades against wind load.	ON Power	Fan blades in tower 5-6 have broken due to increased wind load. Replacement completed in tower 5, scheduled for tower 6 in 2026.
Installation of lightning protection in power plants.	ON Power	Lightning protection review and grounding completed at Nesjavellir power plant area. Similar work has started at Hellisheiði power plant.
Landslide protection measures implemented.	ON Power	Soil reinforcement carried out near main pipeline 5 (Skarðsmýrarfjall slopes) above Separation Station 3 to prevent water and landslides from undermining foundations.
Water contamination mitigation.	ON Power	UV disinfection installed in Lindaveita at Nesjavellir to prevent microbial contamination following thawing and precipitation events.
Reykjavík Energy is working on electrification of its vehicle fleet and increasing the use of electric power for work machinery and drilling operations instead of fossil fuels.	Reykjavík Energy	Reduces emissions from employee transport and operational activities.

Climate Risks and Adaptation Options

The table below summarizes the climate risks and adaptation options identified for Reykjavík Energy's subsidiaries. It is based on the group's operational risk database, with additional operational risks identified through discussions with representatives of the subsidiaries. The risk matrices in the table are mirrored from the operational risk database and are defined and explained in LBC-042-9.0. In cases where a risk is present in multiple subsidiaries but varies in severity, the highest risk level is displayed, as this memorandum provides a group-wide assessment. Under adaptation options, projects are categorized as either defined projects or part of routine operations (R). When projects are part of regular operations, they do not have a defined start or end date, nor an estimated cost, but are included in ongoing tasks. As such, these projects are not included in the action plan table.

Responsibility	**Event**	**Cause**	**Knowledge Status**	**Adaptation Options**	**Timeframe**	**Risk Matrix**
Veitur Wastewater	Flooding due to increased stormwater	Increased precipitation intensity, snowmelt	Inefficiency in maintaining combined sewer system	MSc project analysing system and cost assessment of backwater discharge. Alta consultancy developed procedures in collaboration with Veitur and Reykjavík City for blue-green stormwater solutions (BGO). Increased stormwater infiltration implemented in Vogabyggð with rain gardens. Rainwater channel installed along Rafstöðvarvegur instead of stormwater pipeline.	1. Gradual separation of wastewater and stormwater in combined sewer areas (R) 2. Develop and maintain system models (major setup complete, data collection, and calibration ongoing) 3. Utilize system models for targeted network development (R) 4. Capacity increase at pumping stations, Naustavogur pumping station operational 2024 5. Increased stormwater infiltration and percolation, e.g., BGO design in Kvosin, Lönguhlíð, Leirtjörn, and Keldnaland with Reykjavík City. BGO tools used in most road construction projects with Akraneskaupstaður, Borgarbyggð, and Reykjavík City. 6. More structured collaboration and responsibility allocation between municipalities and Veitur in BGO	Short-term (ongoing)

					investment, execution, and monitoring. KPMG initiated work in Nov 2024 (R)	
Veitur Wastewater	Flooding due to rising sea levels	Warming, glacier melt, changed storm patterns affecting storm surges, increased precipitation intensity	Analysis and recommendations from the Icelandic Meteorological Office and the Icelandic Road Administration on planning for low-lying areas (e.g., recent reports and proposed Icelandic Climate Atlas)	7. More structured collaboration and responsibility allocation between municipalities, utilities, and other stakeholders (R) 8. Review infrastructure design parameters, e.g., incorporating sea flood risk in low-lying sewer designs (R) 9. Proactive involvement in cooperative projects and urban planning (R)	Long-term (5+ years)	3C (High)
Veitur & ON Power's Water Supply	Decline in groundwater levels	Droughts, changing precipitation patterns	Load testing completed in Vatnsendakriki, water balance and RoN assessed increased water extraction impact in Engidalskvísl	10. Develop strategy for water resources considering climate load (R) 11. Renew and activate wells in Seleyri 12. Increase reserves for Akranes water supply 13. Improve water quality in Grábrókarhraun wellfield 14. Drilling in Bláfjöll to assess water balance and increase monitoring 15. Municipal cooperation on future water extraction from Hengill to Ölfus (R) 16. Shared water use in geothermal park (R)	Long-term (5+ years)	3D (Moderate)

Veitur & ON Power's Water Supply	Fluctuations in cold water demand	More frequent and extreme temperature fluctuations	Increased monitoring of groundwater level fluctuations due to climate changes, expansion of district and smart meters, improved tracking of extraction data	17. Reduce unnecessary waste, e.g., educate the public on responsible water use, such as not watering at night (R) 18. Improve leakage detection through smart monitoring of distri-bution networks and better leak detection technologies	Long-term (5+ years)	3D (Moderate)
Veitur, ON Power & Carbfix	Microbial and chemical contamination in water sources	Increased precipitation intensity, extreme flooding, snowmelt	Comprehensive microbial and chemical monitoring, continuous groundwater model updates by Vatnaskil, simulations for planned urban expansion	19. Pollution prevention and filtration 20. Improved speed regulation for water extraction wells 21. Preparatory studies to increase high-quality reserves (R) 22. Manage extraction considering water quality and reserves (R) 23. Monitor water quality used in Carbfix process (R)	Short-term (ongoing)	3D/2C (Moderate)
Veitur Water Supply	Algal growth in Berjadalsá reservoir	Prolonged high solar radiation and stagnant water	Thickening of the bottom algae layer may lead to breakdown, causing foul taste and odor. Foreign engineering firm assessed reservoir operations. Increased water quality and temperature monitoring.	24. Increase flow-through in the reservoir, more frequent sand filter cleaning in summer, increased visual inspection, and cleaning as needed (R)	Short-term (ongoing)	3C (High)
Veitur Water Supply	Chemical pollution in wells & infrastructure damage	Wildfires near water extraction areas	Real-time chemical monitoring of key	25. Active consultation group of stakeholders	Short-term (ongoing)	3C (High)

			drinking water parameters, established emergency sampling protocols after wildfires, mapping groundwater flow and vegetation coverage	and emergency responders in water protection zones (R) 26. Update fracture mapping in Heiðmörk		
Veitur Electricity	Flooding	Increased precipitation intensity, snowmelt, rising sea levels	Substations exposed due to basement locations, need for risk mapping in GIS	27. Location requirements for substations in design guidelines (R) 28. Information sharing and dialogue with planning authorities (R)	Short-term (ongoing)	3D (Moderate)
Veitur Electricity	Power grid disruptions	Extreme weather, icing, cold spells	Vulnerable power grid, lack of knowledge on return period of extreme events	29. Burying power lines, planned completion by 2028 (R)	Short-term (ongoing)	3D (Moderate)
Veitur Electricity	Decreased distribution capacity & reduced lifespan of power lines	More frequent and extreme temperature fluctuations, droughts	Underground cables overheat, dry soil reduces thermal conductivity	30. Use thermally conductive soil around cables in new projects (R) 31. Specify thermal conductivity requirements in tenders (R) 32. Implement temperature monitoring on cables (R) 33. Monitor load on cables in system council and act if overload occurs (R)	Short-term (ongoing)	2C (Moderate)

Next Steps Forward

The action plan for climate change adaptation is a living document and will be updated annually. Furthermore, the action plan will be developed with consideration of the EU Taxonomy, where operations can be classified as green based on climate change adaptation.

Item		**Veitur Utilities**				**ON Power**	**Ljósleiðarinn**	**Carbfix**
		Wastewater	Cold water	District heating	Electricity distribution			
Operational risk framework in place and updated (2024)		Yes	Yes	Partially	Partially	Partially	Yes	Partially
Number of adaptation options	Total	12	17	11	11	15	7	5
	Of which projects*	4	9	2	2	6	2	1
Definition (elaboration) of relevant adaptation options*	In place	3	4	0	1	2	0	0
	In progress	1	5	2	1	4	2	1
Status of cost assessment and benefit analysis of options*	In place	1	3	0	1	2	0	0
	In progress	3	6	0	1	0	0	0
Prioritization of defined options available		Partially	No	No	No	No	No	No
External stakeholder analysis for adaptation option(s) available		No	No	No	No	No	No	No
Plan to address uncertainties in place		Partially	Partially	No	No	No	No	No
Adaptation action plan available		Partially	Partially	No	No	No	No	No
Indicators for monitoring and evaluation available		*Will be defined once the action plan is in place.*						
***Only adaptation options classified as projects in progress are included here, not those that fall under routine operations.**								

Action Plan

The action plan presents the adaptation options that have been defined in the aforementioned tables (Table: CLIMATE RISKS AND ADAPTATION OPTIONS and NEXT STEPS FORWARD). The options are not limiting, and projects can be added at any time during the process. The aim is to manage the projects within Orkuveitan's project management systems.

Responsibility and Option	**Description**	**Storage (e.g., link to Vitinn / Asana)**	**Cost Estimate**	**Uncertainty Factors**	**Indicators for Monitoring and Evaluation**	**Priority (1,2,3)**
Wastewater Treatment:						
Wastewater System Model	Hydraulic and hydrodynamic model of the entire wastewater service area that can calculate the response of the wastewater system to climate-related events. The model is needed to assess the current system considering climate change.	Link to the project in Vitann	ISK 210-330 million excl. VAT	Increased capacity with experience (positive uncertainty factor). Scope of calibration plans in uncalibrated areas (preliminary estimate available, further assessment likely to positively impact the timeline).	Proportion of service area at the first development stage. Proportion of service area with a second-stage system model.	High (1) (The system model is essential for assessing climate risk now and in the future).
Capacity Increase in Pump Stations	Increased resilience of the system and improved flood preparedness due to surface water in Naustavogur.	Link to the project in Vitann	ISK 2.1 billion	Uncertainty regarding potential future precipitation intensity trends.	Percentage of completed pump stations.	High (1) (System resilience is crucial due to the risk of increased precipitation intensity).
Design and Implementation of BGO	Increased surface water retention and infiltration into the soil.	Link to the projects in Vitann: Kvosin, Langahlíð, Leirtjörn, and Keldnaland.	Not yet determined	Uncertainty regarding cost and work division between Reykjavik City and Veitur. Ensuring solution effectiveness in	Percentage of impervious surface directed into BGO with infiltration. Overall	High (1) (One of the most important tools to reduce the load on the wastewater system. Clearly required in

				implementation and operation is critical for achieving results.	runoff coefficient of the planning area.	Reykjavik's master plan and the detailed planning of new neighborhoods and sites).
Water Supply:						
Activation of New Water Extraction Wells in Seleyri	Strengthening the high-quality water reserve for Borgarnes and improving water extraction capacity in drought conditions.	Link to the project in Vitann	~ISK 150 million	Uncertainty about potential climate change effects on groundwater levels.	All samples must always meet drinking water quality standards.	High (1) (Seleyri has become the most important water source for Borgarnes, making it crucial to ensure the condition of water extraction infrastructure).
Drilling of Research Wells in Bláfjöll	Enhancing understanding of water divide locations and, thus, the catchment areas of water sources in the capital region.	Link to the project in Vitann	~ISK 200 million (under review due to drilling difficulties)	Progress in drilling and cost.	Percentage of drilled wells.	High (1) (Significant development in Bláfjöll; this project is crucial for better assessing associated risks).
Improved Flow Control	Installation of variable speed drives in boreholes in Jaðar, Heiðmörk, to improve water quality.	Link to the project in Vitann	ISK 170 million	How different boreholes respond to activation.	All samples of high quality.	High (1) (Using variable speed drives instead of on/off pumping is better for stable water quality).
Update of Fracture Map of Heiðmörk	Using LiDAR data to update fracture coverage.	Link to the project in Asana	ISK 2 million	The extent to which LiDAR data can improve coverage in vegetated areas.	Final product: fracture map of the area.	High (1) (Fracture location significantly affects groundwater flow in Heiðmörk. This work is crucial for Heiðmörk's detailed planning).
Electricity Distribution:						
Electricity Grid Model	Creating a model of the electricity distribution	Link to the project in Vitann	~ISK 170 million	Conductor current capacity, soil, and	Proportion of the service area included in the	High (1) (The system model is the foundation

	network (utility network). Useful for analyses, including bottleneck identification and climate impact assessment.			uncertainty about future use.	model and model development stage.	for all analyses of the electricity distribution network).
ON Power:						
Renewal of Panels and Electrical Equipment	Fan blades have broken in the cooling tower due to increased wind load.	Link to the project in Vitann	Not yet determined	Not yet determined	Percentage of completed blades/panels.	Not yet determined.
Improvements to the Andakílsá Hydropower Dam	Infrastructure renewal.	Link to the project in Vitann	~ISK 910 million	Not yet determined	Project progress.	High (1) (The infrastructure is aging, and sediment accumulation in the reservoir is increasing).
Reykjavík Energy:						
Screening of Hydropower Potential	Assessing potential hydropower projects.	Project being set up in Vitann	Not yet determined	Not yet determined	Not yet determined	Not yet determined.

Stakeholder Collaboration Status

Wastewater Treatment:

- Representative from Veitur's wastewater team is on Samorka's professional council, serving as a channel for communication and advocacy with public administration.
- Collaboration with the Scientific Committee on Climate Change and its impact on Iceland; the wastewater division is open to further cooperation.
- Veitur's management team actively works on improvements in partnership with the municipalities it serves.
- Engagement with academic and research institutions through formal and informal interactions, such as participation in research projects, conferences, seminars, professional associations, and teaching.
- Cooperation with the Environment Agency of Iceland, contributing to the implementation of the Water Framework Directive and shaping regulatory frameworks.
- Outreach to customers and municipalities, educating on the benefits of blue-green infrastructure (BGO) for private and municipal land outside Veitur's direct influence. Potential improvements through stronger public awareness efforts in collaboration with Veitur, municipalities, and other stakeholders.
- Knowledge-sharing with other wastewater utilities.
- Coordination with health authorities to incorporate lessons learned into operating permit conditions.
- Enhancing procurement processes to support continuous learning, holistic thinking, and creative climate solutions.
- Collaboration with partners on joint investment projects (e.g., municipalities, the Icelandic Road and Coastal Administration), improving holistic planning and cross-sector teamwork.

Water Utility:

- Veitur and Orkuveitan have representatives in the consultation group of the Association of Municipalities in the Capital Area regarding water conservation and utilization.
- Active working group on wildfire mitigation measures involving fire departments, Civil Protection, Reykjavik Forestry Association, and municipalities.
- Strong collaboration between Veitur, Hafnarfjörður Water Utility, and Kópavogur Water Utility, particularly in assessing the impact of increased extraction in Vatnsendakrikar, including additional groundwater level monitoring stations.
- Need to initiate discussions with all entities utilizing groundwater in Reykjavik, Ölfus, and the Hengill region.

District heating:

- Veitur's heating team representative sits on Samorka's professional council, acting as the primary channel for communication and advocacy regarding heating systems with public administration.
- Due to heating infrastructure expansions, Veitur collaborates closely with all municipalities in its service area and the Association of Municipalities in the Capital Area.
- Pipeline placement is a planning issue, and their location along coastlines or under landslide-prone areas depends on collaboration with planning authorities and/or Reykjavik City.
- Needs assessment in partnership with the Icelandic Meteorological Office to determine the expected frequency of extreme weather events and/or extended cold spells, with potential updates to building regulations and indoor heating guidelines.

Electricity distribution:

- Representative from Veitur's electricity division is part of Samorka's energy transition working group, a collaboration platform for utilities on energy transition issues.
- Representative from Veitur is also in Samorka's load management working group, analyzing the impact of energy transition on utility companies.
- Direct communication with HS Veitur, RARIK, and other utilities for knowledge-sharing.
- A representative of distribution utilities sits on Landsnet's stakeholder advisory council, with regular meetings to discuss Landsnet's policies and future planning. Veitur maintains ongoing communication with Landsnet regarding connections to its distribution network. A significant portion of fees that Veitur collects from customers consists of transmission charges from Landsnet, and collaboration between financial departments is being strengthened to improve predictability in tariff changes.
- Intermittent but constructive dialogue with the Reykjavik Fire Department regarding fire protection and flood risks for distribution infrastructure.
- Regular discussions with municipalities in Veitur's service area to refine mutual requirements, review planning strategies, and propose amendments. Opportunities remain for further improvement on both sides.
- Ongoing discussions with suppliers and manufacturers about environmentally friendly equipment. For example, Veitur ceased purchasing SF6-insulated switchgear in 2022, as SF6 is a potent greenhouse gas.

ON Power

- Representative from ON and Orkuveitan participates in Samorka's energy policy group, a collaboration platform for energy and utility companies.
- Collaboration with municipalities on reforestation and land restoration projects.
- Generally strong cooperation with stakeholders and municipalities.
- Challenging interactions with stakeholders in Skorradalur, a concern for the future of the Andakílsá hydropower plant.
- Good collaboration with new and existing industrial park customers to enhance efficiency, environmental performance, and climate measures.

Carbfix:

- Carbfix representative is on the Icelandic Standards Council's environmental standards committee.
- Engagement with academic and research institutions through formal and informal channels, including participation in research projects, conferences, seminars, professional associations, and teaching.