Reykjavik Energy Climate account

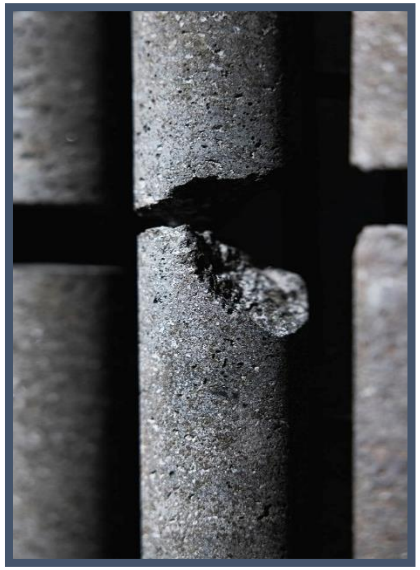
Orkuveitan

VEITUR

LJÓSLEIÐARINN
REYKJAVIK FIBRE NETWORK

ON POWER

Carbfix



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Front Page: Snorri Jökull Egilsson

About the climate account

The GHG emissions are compiled annually, where the total emissions are calculated based on operations (activity data) from January 1st to December 31st each year. The greenhouse gas accounting is conducted according to the methodology of the corporate standard Greenhouse Gas Protocol (GHGP) and in accordance with the international standard ISO 14064-1. An overview of the direct and indirect emissions across Reykjavik Energy's (RE) value chain is shown in Figure 2.

Purpose and Objectives of the RE group's Greenhouse Gas Accounting:

The purpose of RE's greenhouse gas accounting is to transparently communicate the RE's impact on climate change and its efforts to reduce those impacts. This includes informing about the company's greenhouse gas emissions (GHG), specifying the types and amounts of emissions due to its operations, reporting plans and actions taken by the company to reduce emissions, improve energy efficiency, and transition to more sustainable practices.

Overall, the greenhouse gas accounting of RE is a means to communicate RE's commitment to increased sustainability, present its environmental impact, and provide stakeholders with a better understanding of the company's climate-related initiatives and performance.

Intended Use and Users of the GHG Inventory

RE's greenhouse gas accounting is used by its owners, Reykjavik City, Akranes Town, and Borgarbyggd municipality, along with politicians, government agencies, licensing authorities, scientists, environmental organizations, and the public. Environmental authorities rely on the data to assess the effectiveness of adaptation and mitigation actions in climate issues and to monitor progress towards climate goals. Scientists use the data for climate analysis, and licensing authorities, environmental authorities, the public, and RE's employees use the information to advocate for sustainable practices and clarify responsibility for emissions from RE. Overall, RE's greenhouse gas accounting contributes to transparency, accountability, and informed decision-making in addressing the climate crisis.

Responsibility for the Greenhouse Gas Accounting

The CEO of RE is responsible for and validates the results of RE's greenhouse gas accounting and carbon footprint with their signature.

Frequency and Accessibility of the Greenhouse Gas Accounting:

Annually, RE compiles information about greenhouse gas emissions, mitigation actions for those emissions, carbon sequestration in land reclamation and afforestation, along with the net emissions from RE and publishes it publicly on its website. This includes an overview of the status of climate actions in relation to the company's climate goals.

Monitoring of the Greenhouse Gas Accounting and Climate Goals

RE's climate group consists of representatives from RE's Environmental Affairs, Research and Innovation, and all subsidiary companies. The group's role is to update the greenhouse gas accounting and climate goals of RE as appropriate and before the climate section of the RE Annual Report is published publicly. Furthermore, the group ensures that RE's dashboards on the carbon footprint are updated regularly and accessible to managers and other staff. The group initiates projects that contribute to RE achieving its climate goals and improve the greenhouse gas accounting. Representatives of the climate group meet on average once a month.

Reykjavik Energy

Reykjavík Energy (RE) is an energy- and utility company, jointly owned by the Reykjavík City, Akranes Town, and Borgarbyggd municipality.

RE produces energy and water, and develops utility infrastructure for the majority of the Icelandic population.

RE consists of four subsidiaries, Veitur Utilities, Reykjavik Fibre Network, ON Power, and Carbfix. Veitur Utilities operates electricity distribution-, district heating-, water supply-, and sewage utilities for up to 70% of households in the country and has been crucial for the development and urbanization of the capital region, significantly improving the living conditions of its residents. This also applies to ON Power, which operates two geothermal power plants and a small hydropower plant. Together, the power plants produce hot water for over half of the capital region, as well as electricity for the public, businesses, and heavy industry. ON Power has also developed Iceland's most extensive network of electric vehicle (EV) charging stations, in response to the rapid growth of EVs in the country, ensuring they meet the rising demand. Reykjavik Fibre Network (IS. Ljósleiðarinn) is at the forefront of developing and managing a nationwide fibre optics network, serving as a fundamental component in facilitating the shift of communities towards a more sustainable future.. RE's newest subsidiary, Carbfix, is a global leader in developing and implementing solutions to tackle global warming through Carbon Capture and Storage (CCS). This aligns well with RE's previous steps towards improving living conditions and quality of life through innovation.The company name Reykjavik Energy RE is used when referring to all the companies within the organisation and organisational boundary.

Organizational boundary

The organisational boundary of the climate account is defined by the operational control approach. RE has operational control over its subsidiaries, namely ON Power, Veitur Utilities, Reykjavik Fibre Network, and Carbfix. Associated companies in which RE holds a minority stake are not considered within the operational control approach. These are Orkuskólinn REYST, Netorka hf., Íslensk Nýorka, and Aflvaki. Associated companies are those where the group has limited influence over the financial and operational policy but does not have operational control. Figure 2 shows the main emissions sources that fall within scope 1, 2 and 3 of RE's climate account.

Figure 1: Organisational boundary of included companies in Reykjavik Energy's (RE's) climate account according to the operational control consolidation approach. The company name Reykjavik Energy, RE, is used when referring to all the companies within the organisation and organisational boundary.

Reporting boundaries

The base year for climate account is 2016 and the emission sources are defined according to the GHG Protocol, with scope 1 (direct emissions), scope 2 (indirect emissions from energy use), and scope 3 (other indirect emissions) along with a scope for carbon insetting and a specific scope for carbon dioxide (CO_2) emissions of biological origin. The emissions sources included in each of the four scopes are shown in Figure 2. All emissions sources from scope 1 and 2 are included, while emissions sources in scope 3 are selected based on the significance criteria shown in table 6. Some examples of excluded emission sources and operations are Nature-based activities, Andakílsárvirkjun hydroelectric powerplant, Low temperature geothermal fields, wholesale electricity trading and taxi-trips. Exclusions are listed and explained on page 21.

The reporting boundaries for RE's climate account are shown in figure 2. There the coloured lines present the value streams operated by Veitur, ON Power and Ljósleidarinn. namely district heating, water utility, sewage utility and electricity distribution.

Because of the scope of RE's operations, RE is responsible for expanding and maintaining its utility systems, this results for example in significant amount of procured goods, which is included in the reporting boundary as well as the rest of the value chain (see figure 2).

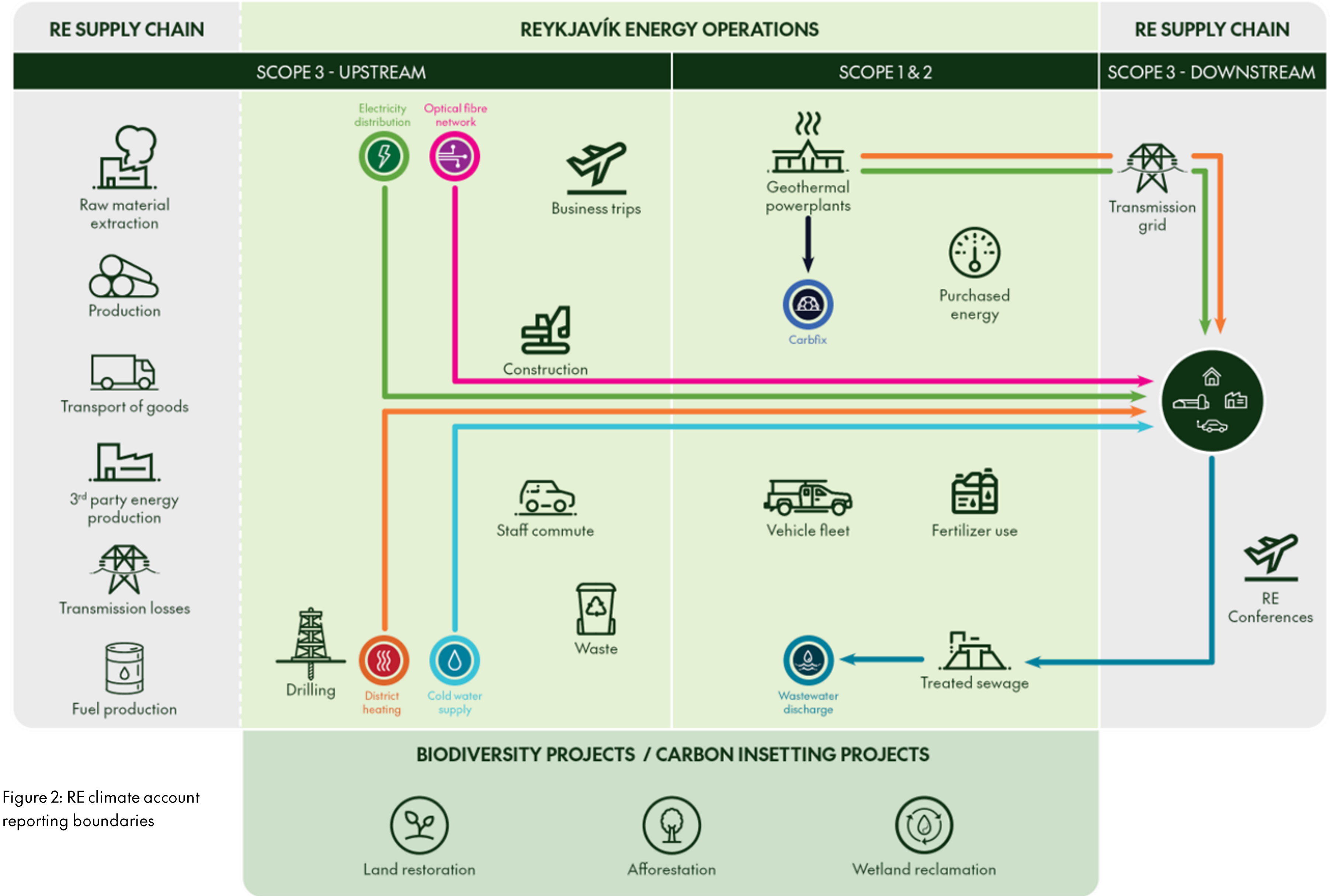

Figure 2: RE climate account reporting boundaries

Sustainability policy and climate goals of Reykjavik Energy

Reykjavik Energy group (RE) has committed to showing respect for the environment, resources, and the community in accordance with the company's ownership policy. RE's sustainability policy forms the basis for successful decision-making and good collaboration, built on information transparency. RE seeks feedback from stakeholders on the sustainability of the group's activities and responds to suggestions responsibly. The sustainability policy is based on RE's values - efficiency, foresight, and integrity - and is present ed in alignment with the guiding principles of the company's ownership.

Within RE groups' operations, the most evident tasks involve combating and adapting to the climate crisis, with final steps towards net-zero and an increased emphasis on actions supporting the circular economy. By serving up to 70% of households in Iceland and being crucial for the development and urbanization of the capital region, the leadership of RE is undisputed and will play a significant role in determining how the Icelandic nation succeeds in these tasks.

In RE's greenhouse gas (GHG) accounts, 2016 was selected as the baseline year due to its representation of RE's typical GHG profile. Since then, RE has tracked its progress in reducing emissions and aligning with the climate goals set for 2030. These goals are in accordance with- and have been validated by the Science Based Target initiative (SBTi), see Table 1. Thus, RE has joined the "Business Ambition for 1.5°C" campaign, a growing group of companies aiming to meet the goal of keeping the temperature rise under 1.5°C. Consequently, RE has become part of the "Race to Zero" campaign supported by the United Nations.

To achieve its climate targets RE has outlined significant steps in its emissions reduction strategy. These include the complete implementation of the Carbfix injection method at the Hellisheidi geothermal power plant by 2025, and achieving full-scale injection at the Nesjavellir geothermal power plant by 2030. Additionally, RE plans to lower emissions from its vehicle fleet. The strategy also encompasses encouraging the use of sustainable materials in procurement and fostering an energy transition in construction processes, Table 1. RE has additionally plans to achieve net-zero emissions by 2040 where the focus will be put on scope 3 with sustainable procurement of goods and services.

Table 1: RE's 2030 climate targets approved by SBTi

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SBTi approved climate targets

Scope	2030 target from 2016 baseline	Related initiatives
Scope 1+2	90% reduction	• Emission free geothermal powerplants in 2025 and 2030 • Emission free vehicle fleet
Scope 3	40% reduction	• Low-emission materials in procurement • Energy transition in construction

Simultaneously actions: Strengthening the community's resilience by adapting RE Group's power plants, utility systems, etc. to climate change. Care is taken to ensure that the climate adaptation does not cause significant harm to other environmental objectives. The goal is that no climate-related risk is classified as being unacceptable in RE's risk assessment base.

SCIENCE BASED TARGETS
DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

Key numbers in 2023

Scope 1: **51,870** tonnes CO_2-eq

Scope 2: **410** tonnes CO_2-eq

Scope 3: **19,940** tonnes CO_2-eq

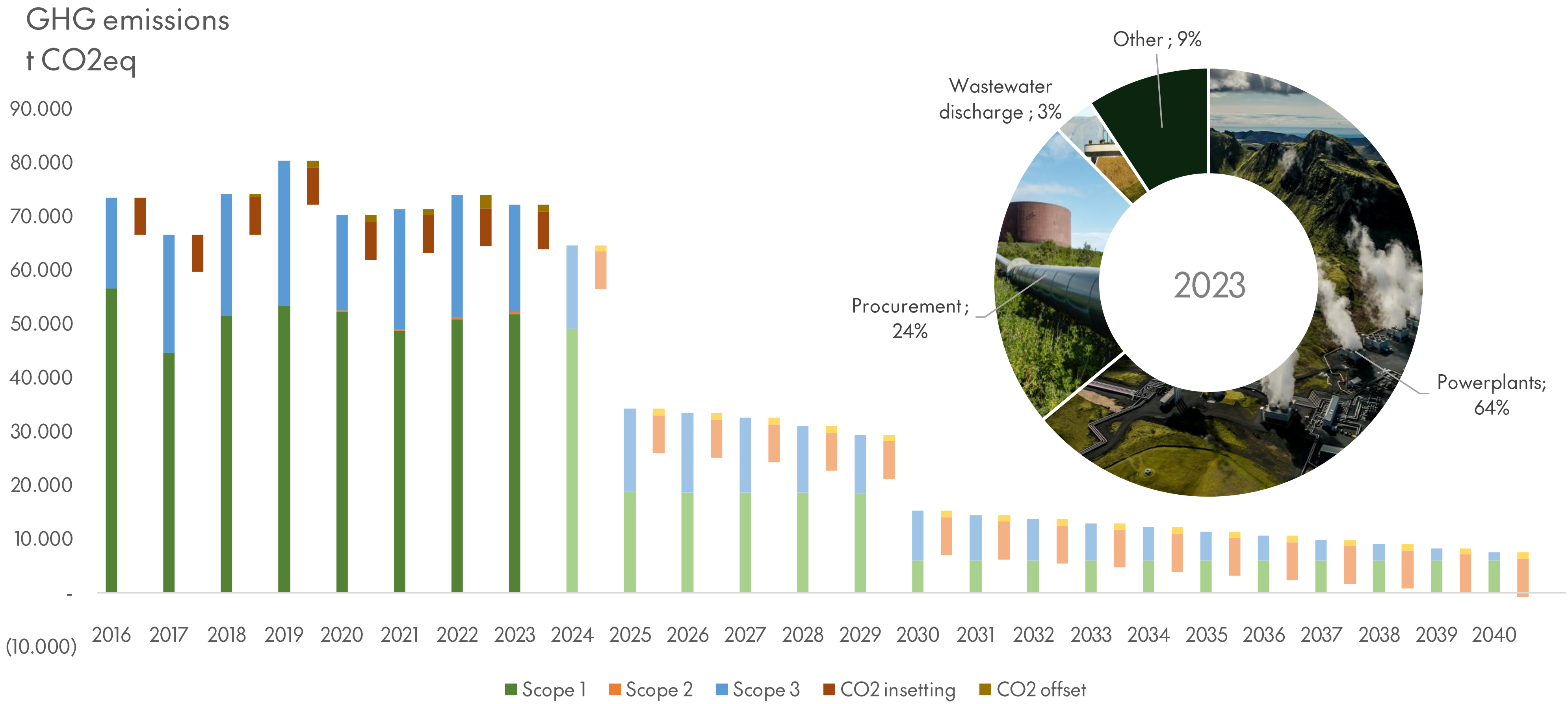
Emission Intensity

Electricity: **7.3** gCO_2-eq/kWh

Heating: **205.2** gCO_2-eq/m^3

21% CO_2 injected

in RE's geothermal power plants using the Carbfix method



Greenhouse gas emissions overview

In 2023 the Reykjavik Energy's (RE) total direct and indirect greenhouse gas (GHG) emissions amounted to 72.220 tonnes CO_2 equivalent, and net emissions amounted to 63,990 tonnes CO_2 equivalent. The primary sources of these emissions were, direct emissions from our geothermal power plants, nitrous oxide (N_2O) emissions from treated sewage discharge and indirect emissions from procurement. Our emissions are categorized into three scopes: Scope 1 (directed emissions) which accounted for approximately 72% of total emissions, scope 2 (indirect emissions from purchased energy) which accounted for less than 1%, and scope 3 (all other indirect emissions) comprised 28%. Breakdown of emissions is presented in Table 2. A table of the applied emissions factors are presented in tables 8-10.

Table 1: GHG emissions in tonne CO_2 equivalents by scope 1, 2 and 3, out of scope emissions, carbon insetting and offsetting projects. As well as the uncertainty in each emissions source.

	Emissions tonne CO_2-eq								Uncertainty
	2016	2017	2018	2019	2020	2021	2022	2023	2023
Scope 1									
Geothermal power plants	54,200	42,380	48,820	50,820	49,700	46,420	48,100	48,780	12.5%
Ratio of injected CO_2	*15%*	*23%*	*21%*	*18%*	*20%*	*24%*	*22%*	*21%*	
Steam utility in Hveragerdi Town	55	55	70	70	70	85	120	125	100%
Wastewater discharge	1,820	1,870	2,300	2,120	2,030	1,860	2,250	2,390	2,495%
Fuel use (TTW)	515	440	455	440	440	360	410	545	10%
HFCs and SF_6	10	2	2	2	1	50	15	25	10%
Fertilizer for land reclamation and afforestation	2	<1	<1	<1	<1	<1	1	<1	233%
Total Scope 1	**56,600**	**44,750**	**51,650**	**55,450**	**52,240**	**48,750**	**50,900**	**51,870**	
Scope 2									
Location based									
Electricity	0	0	0	0	345	365	400	410	1%
Heating	0	0	0	0	0	0	0	0	-
Market based									
Electricity	0	0	0	0	0	0	0	31,620	1%
Heating	0	0	0	0	0	0	0	0	-
Total Scope 2 (Location based)[1]	**0**	**0**	**0**	**0**	**345**	**365**	**400**	**410**	**1%**
Scope 3									
Purchased capital goods	9,020	10,250	11,300	14,880	7,750	11,810	12,140	9,460	60%
Purchased goods	3,720	5,970	5,130	5,840	4,510	4,940	3,770	4,310	60%
Purchased services	2,765	4,185	4,415	4,770	3,965	4,410	5,520	4,605	20%
Trench digging by contractors	*2,690*	*3,210*	*4,380*	*3,950*	*4,410*	*4,420*	*5,260*	*3,520*	50%
Drilling by contractors	*75*	*975*	*35*	*320*	*15*	*0*	*260*	*1,085*	
Transportation of goods	115	140	185	155	60	75	70	65	70%

[1] RE calculates its carbon footprint with the location-based approach, as most its energy use is internal and included in Scope 1.

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Table 2: GHG emissions in tonne CO_2 equivalents by scope 1, 2 and 3, out of scope emissions, carbon insetting projects and offsetting projects. As well as the uncertainty in each emissions source. Continued.

	Emissions tonne CO_2-eq								Uncertainty
	2016	2017	2018	2019	2020	2021	2022	2023	2023
Fuel & energy related activities not incl. in scope 1 & 2	130	120	110	110	150	130	140	170	
Upstream emissions of purchased electricity	*0*	*0*	*0*	*0*	*30*	*30*	*30*	*30*	0%
Transmission losses	*0*	*0*	*0*	*0*	*5*	*10*	*10*	*10*	1%
Fuel use (WTT)	*125*	*110*	*110*	*110*	*105*	*90*	*100*	*135*	10%
Transmission grid, SF_6	415	400	545	360	590	485	345	270	5%
Sewage waste	315	405	365	325	445	310	400	240	35%
Screening waste	130	95	135	90	180	60	85	75	-
Fat and grease	*185*	*310*	*235*	*230*	*265*	*210*	*205*	*165*	-
Sludge from biological treatment	*0*	*0*	*0*	*0*	*0*	*40*	*100*	*0*	-
Sand	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	-
Waste	95	115	100	110	110	95	115	45	35%
Landfill	*95*	*110*	*95*	*105*	*110*	*85*	*90*	*40*	-
Compost	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*<1*	-
Combustion	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	-
Reused/Recycled	*<1*	*1*	*1*	*1*	*2*	*3*	*2*	*1*	-
Hazardous	*<1*	*4*	*<1*	*1*	*1*	*5*	*20*	*2*	-
Employee commuting	110	110	120	110	40	70	90	80	5%
Employee business travel	220	235	255	340	65	20	240	425	
Air travel	*195*	*210*	*225*	*300*	*60*	*15*	*210*	*375*	45%
Hotel stays	*25*	*25*	*30*	*40*	*5*	*5*	*30*	*55*	5%
Downstream event related travel	0	0	0	0	0	0	0	260	45%
Total Scope 3	**16,900**	**21,920**	**22,525**	**27,000**	**17,675**	**22,345**	**22,830**	**19,940**	
Out of scope									
CO_2 from biological origin	40	40	40	55	60	50	50	45	
Total out of scope	**40**	**40**	**40**	**55**	**60**	**50**	**50**	**45**	
Biodiversity and carbon insetting projects									
Afforestation	-5,740	-5,740	-5,740	-5,740	-5,740	-5,740	-5,740	-5,740	
Land reclamation	-1,205	-1,210	-1,215	-1,220	-1,225	-1,235	-1,250	-1,250	
Rewetting of peatland	0	-40	-40	-40	-40	-40	-40	-40	
Total biodiversity and carbon insetting projects	**-6,945**	**-6,990**	**-6,995**	**-7,000**	**-7,005**	**-7,015**	**-7,040**	**-7,040**	
Carbon offsetting projects									
Carbon credits from UNU CDM Malawi project	0	0	0	0	-645	-625	-2,610	-1,200	
Votlendissjódur	0	0	-500	-1,250	-605	-625			
Total carbon offsetting projects	**0**	**0**	**-500**	**-1,250**	**-1,250**	**-1,250**	**-2,610**	**-1,200**	
Total GHG emissions	**73,500**	**66,670**	**74,175**	**80,450**	**70,260**	**71,490**	**74,130**	**72,220**	
Reduced and avoided emissions	**-6,945**	**-6,990**	**-7,495**	**-8,250**	**-8,255**	**-8.265**	**-9.640**	**-8.230**	
Net emissions	**66,555**	**59,680**	**66,680**	**72,200**	**62,005**	**63,225**	**64,490**	**63,990**	x

Scope 1 emissions and initiatives

Geothermal Powerplants and Carbfix CCS Method:

Geothermal steam is utilized for power- and heat production. It consists partially of two greenhouse gasses (GHG), namely carbon dioxide (CO_2) and methane (CH_4). Typically, these GHGs are released from the steam and emitted into the atmosphere. However, Reykjavik Energy (RE) has developed the Carbfix method, a Carbon Capture and Storage (CCS) technology which permanently mineralizes CO_2. A cornerstone of RE's emission reduction strategy is the implementation of the Carbfix method at the geothermal facilities. Carbfix started out in 2006, and was formalized by four founding partners in 2007; Reykjavík Energy, the University of Iceland, CNRS in Toulouse, and the Earth Institute at Columbia University. Since 2007, several universities and research institutes have participated in the project under the scope of EU funded sub-projects.

RE's geothermal power plants emitted 48,780 tonnes CO_2-eq, which was almost an 10% decrease from 2016. This decrease is mainly due to increase of CCS at the power plant in 2023 compared to 2016 and less overall CO_2 concentration in the geothermal steam.

Since 2016, the geothermal powerplants have accounted for 60-70% of RE's total GHG emissions. The implementation of Carbfix on an industrial scale began at Hellisheidi in 2014, capturing 15-24% of CO_2 emissions, with plans to fully implement it, capturing and injecting 95% of CO_2 emissions, by 2025. Pilot injections started at the Nesjavellir powerplant in early 2023 and RE aims for full scale injection at the powerplant by 2030.

In the baseline year, 2016, the geothermal powerplants' CCS rate was around 15%. In 2017, these rates increased to roughly 23%, attributed to enhanced CCS at the Hellisheidi powerplant. Since 2017, the injection rates are ranging from 18% to 24% of CO_2 emissions, with the highest rates recorded in 2017 and 2021. This variability is mainly due to three factors:

Figure 3: Carbfix reinjection well, used for carbon capture and storage. Photo: Gunnar Freyr

1) Variability in the uptime of the CO_2 capture unit at the Hellisheidi powerplant, due to temporary shutdowns related to either construction RE unexpected failures.

2) Variability in energy production at geothermal powerplants.

3) Variability of CO_2 concentration in new boreholes connected to the powerplant.

Steam-Utility in Hveragerdi Town:

In Hveragerdi Town, a municipality east of Hellisheidi powerplant, RE operates a "steam utility", RE a district heating system which draws its energy from geothermal steam. This steam consists partially of GHG, including CO_2 and CH_4, which are emitted once the steam has been used

8% decrease in scope 1 emissions from base year, 2016.

for heating. The GHG emission have been roughly estimated as 55 to 125 tonnes CO_2-eq since 2016. However, the emissions lack precise measurements. RE is currently working on developing more concise measurement methods for this emission category.

Wastewater discharge:

RE manages the infrastructure and operation of wastewater systems in Reykjavík Capital Area, as well as Akranes Town and Borgarbyggð municipality in West Iceland. Wastewater from the Capital Area, that is Reykjavik City, Kópavogur, Mosfellsbær and Seltjarnarnes, in addition to parts of Garðabær, is treated in wastewater treatment plants at Ánanaust and Klettagarðar in Reykjavik. The infrastructure serves approximately

Figure 4: Sewage treatment plant at Eidisgrandi in Reykjavik City. Photo: Einar Örn Jónsson

60% of the population in Iceland. From the treatment plants, the treated wastewater is discharged to the ocean.

This consists of organic nitrogen and carbon. Therefore, RE is responsible for N_2O emissions from the resulting decomposition. The amount of GHG released in 2023 amounted to 2,390 tonnes CO_2-eq, which is a 30% increase form 2016.

Fuel use (TTW):

OR purchases and uses fuel for its vehicle fleet and other machinery. Tank-To-Wheel (TTW) denotes the tailpipe emissions which occur when fuel is burned. RE is also evaluating Well-To-Tank (WTT) emissions which are discussed under the scope 3 section. TTW Emissions in 2023 amounted to 545 tonnes CO_2-eq, which is an increase of 6% from 2016. Although the total number of vehicles in RE's vehicle fleet has increased from 177 in 2016 to 216 in 2023, the relative amount of clean energy vehicles rose from 24% to 46%. RE is actively working on phasing out fossil fuel vehicles for more sustainable alternatives.

HFCs and SF_6:

OR uses two GHGs in its operations that fall under either HFCs RE SF_6.

SF_6, which has a GWP of 23,500, is used as insulation material in various electricity equipment in both the electric distribution system as well as in power plants. Additionally, SF_6 is used in tracers during tracer flow tests (TFT) to measure steam uptake from high temperature geothermal boreholes. SF_6 emissions amounted to 25 tonnes CO_2-eq in 2023, a 190% increase from 2016. This is mainly due to leakages that occurred in both Hellisheidi and Nesjavellir power plants. RE is actively replacing equipment which uses SF_6 such as switches, for more sustainable alternatives.

In RE's freshwater utility, Hydrofluorocarbons (HFCs) are utilized in air conditioning systems to maintain dry air conditions in pumping stations. RE previously used HFC-134a, a GHG with a GWP of 1,300, in its cooling equipment. However, since 2021, RE has begun purchasing equipment that uses R454c, which is a mixture between HFC-32 and HFC-1234yf, and has a GWP of 148. Emissions in 2023 was 25 tonnes CO_2-eq, which is an increase of 15 tCO_2-eq from 2016. RE's goal is to phase out HFC & SF6 use.

Fertilizer Usage:

Fertilizer is used on RE's lands in afforestation and land reclamation projects. The fertilizer consists partially of nitrogen which is converted to N_2O after application. Total emissions resulting from fertilizer application amounts to less than 1 tonne CO_2-eq in 2023. This presents a 60% decrease from 2016 due to less fertilizer usage in the reporting year. RE is evaluating potential solutions to minimize fertilizer emissions, such as buying fertilizer with less nitrogen content.

Scope 2 emissions and initiatives

Scope 2 emissions refer to indirect greenhouse gas (GHG) emissions associated with the Reykjavik Energy's (RE) purchase of electricity, steam, heating, and cooling.

Location Based Approach:

Using the location-based approach, these emissions amounted to 490 tonnes CO_2-eq in 2023, which is relatively low in comparison to RE's energy consumption. This marks a considerable increase from 2016, when no electricity was procured from external sources, and all location-based emissions were zero, as the emissions were already included in scope 1. Similarly, emissions from heating are zero as RE generates all the geothermal water used for heating, with these emissions also included in scope 1.

↑ **37%** increase in CO_2 injection at geothermal power plants from base year, 2016.

The location-based approach is applied in RE's total carbon footprint. This is primarily since RE predominantly purchases energy produced internally, with associated emissions already accounted for under scope 1.

Marked Based Approach:

Under the market-based method, the emissions amount to 7,220 tonnes CO_2-eq. Market-based emissions from electricity have risen by 260%, due to an increase in the emission intensity of the residual mix, a 20% increase in electricity usage, and 225% increase in electricity usage without guarantees of origin since 2016. In this approach, electricity accompanied by a Guarantee of Origin (GO) is assigned an emission factor of zero.

Conversely, purchased electricity without GOs is assigned an emission factor based on the residual mix, as published annually by the National Energy Agency (NEA, Orkustofnun). This aligns with the recommendations of the Association of Issuing Bodies (AIB), which developed and oversees the European Energy Certificate System (EECS).

Scope 3 emissions and initiatives

Purchased Goods and Capital Goods:

Procured goods have a carbon footprint due to direct and indirect emissions by suppliers which produce those goods. Reykjavik Energy (RE) evaluates indirect emissions from procurement by using data based on Life Cycle Assessments (LCA) for products purchased by RE. In cases where such data does not exist, spend based emission factors published by the United Kingdom's Department for Environment, Food & Rural Affairs (DEFRA) are used. These factors describe emissions per currency spent on product categories such as "iron and steel products" etc. LCA data are used to evaluate the emissions from 13% of the total value of procurement in 2023.

Total emissions related to procurement of capital goods amounted to 9,460 tonnes CO_2-eq in 2023, which presents an increase of 5% from 2016. The product category contributing to most of the impacts from total procurement was "Basic iron and steel" with "50% of the impacts". RE is actively evaluating ways to procure more sustainable goods, focusing on sustainably produced steel, as steel pipes are a substantial part of RE's purchases. Emissions from procurement of goods other than capital goods were 4,310 tonnes CO_2-eq in 2023, an increase of 16% from 2016. RE is proactively communicating with its main suppliers to find ways to reduce and outline procurement related emissions.

Purchased services:

OR focuses on services related to construction (mainly trench work) and drilling. Construction emissions are based on the length and volume of trenches, the emissions factor per m of trench was sampled from a project in which a contractor supplied RE with information on emissions. Drilling emissions are based on estimations from drilling contractors.

Construction emissions were 2,820 tonnes CO_2-eq in 2023, an increase of 28% from 2016 due to increased expansion of utility systems in the Reykjavik Capital area.

Emissions from drilling increased considerably from 75 tonnes CO_2-eq in 2016 to 1,085 tonnes CO_2-eq in 2023. Although high-temperature geothermal drilling, now almost exclusively relies on electricity, the avoided emissions are not enough to outweigh the increase in the number of drilling projects, such as Carbfix. RE is working with its suppliers to evaluate the potential of using electricity for smaller drilling projects as well.

Figure 5: Retractable pipe laid in Ljósleiðari trench in Stokkseyri. Photo: Arna Rut Hjartadóttir

RE is proactively encouraging its contractors to shift towards energy transition. This initiative is part of RE's broader strategy to promote sustainable practices and reduce carbon footprint across its operations and supply chain.

Transportation of Goods (in progress):

Goods are transported to and from Iceland by air through commercial airlines and cargo planes. Furthermore, Iceland relies on sea transportation via cargo ships. Goods are transported by land using trucks and other vehicles which is crucial for the last-mile delivery of goods to their final destinations, serving both RE's urban and rural service areas. Emissions from transportation of goods were 60 tonnes CO_2-eq in 2023, a decrease of 28% from 2016. This is due to a decrease in the amount of goods transported. Note that this category only includes transportation of goods directly paid by OR, transportation of goods in the supply chain is included in the category purchased goods and capital goods.

Fuel use (WTT):

Upstream emissions from fuel use, also referred to as well to tank (WTT), are associated with emissions that occur during production of RE's purchased fuels. WTT emissions were 135 tonnes CO_2-eq in 2023 which was an 8% increase from 2016. The emissions in this category are related to TTW emissions and will be reduced in line with RE's journey to complete energy transition.

Figure 6: Street charging at Sundlaugarvegur in Reykjavik City. Photo: Atli Már Hefsteinsson

27% decrease in employee commute emissions from base year, 2016.

Transmission Losses:

This emission category falls under Scope 3 and pertains to the indirect emissions resulting from transmission losses in Iceland's national grid operated by Landsnet, the national electricity grid operator. Specifically, it concerns the electricity RE purchases from external sources. It's important to note that emissions stemming from transmission losses of electricity produced internally by RE are already accounted for in scope 1.

In 2023, the total scope 3 emissions attributed to transmission losses amounted to 10 tonnes of CO_2-eq. This accounting helps in providing a more comprehensive understanding of RE's indirect emissions footprint, particularly those emissions that are not directly produced by its operations but are a consequence of the energy it procures from outside sources.

Transmission Grid:

RE calculates its indirect emissions attributable to SF_6 leakages from the equipment of Landsnet, the national electricity grid operator. SF_6 is a potent greenhouse gas used as an insulating material in electrical equipment. RE's approach to estimating these emissions involves assessing its proportion of electricity production relative to Iceland's total production. This method allows RE to determine its share of the environmental impact caused by Landsnet's SF6 leakages.

Between 2016 and 2022, Landsnet reported SF_6 leakages varying from 85 to 142 tonnes of SF_6. In 2023, the SF_6 leakages from Landsnet that were

18% increase in scope 3 emissions from base year, 2016.

In RE's wastewater treatment operations, filtered sewage waste is systematically gathered and then transferred to designated waste collectors. In 2023, the indirect emissions resulting from the handling and processing of this sewage waste were calculated to be approximately 60 tonnes of CO_2-equivalent. Notably, this figure represents a significant 40% reduction in emissions compared to the levels recorded in 2016.

RE's initiatives include working on innovative projects to prepare for the reuse of sewage waste such as sand, sludge and fat which is of value in the circular economy.

Waste:

In 2023, the emissions resulting from waste generated in RE's operations totalled 45 tonnes of CO_2-eq, marking a decrease of almost 50% compared to 2016. This decline in waste emissions is primarily attributed to changes in waste treatment practices in Iceland. The most significant change contributing to this reduction is the shift from landfilling to combustion for disposing of general waste. This transition has a considerable impact on emissions due to the differing emission factors associated with these disposal methods.

The emission factors used for calculating waste emissions are sourced from the United Kingdom's Department for Environment, Food & Rural Affairs (DEFRA). According to these factors, emissions from combustion are substantially lower than from landfilling. This difference arises because the decomposition process in combustion is utilized for energy generation, and a portion of the emissions is allocated to the energy produced.

Considering these changes in waste treatment and disposal practices, the emission factors applied to each waste category have been updated for 2023. This update ensures that the emission calculations more accurately reflect the actual pathways and impacts of RE's waste management, thereby providing a more precise measure of the organization's environmental footprint in terms of waste-related emissions.

Employee Commuting:

OR accounts for emissions associated with employees' commuting to and from work. Every year RE conducts a survey among its employees to gather information about their commuting habits. This survey inquiries about the modes of transportation used by the employees, frequency, and the distance between their homes and the workplace.

In 2023, the emissions resulting from employees' commutes to work amounted to 80 tonnes of CO_2-equivalent. This represents a 33% decrease compared to 2016. This significant reduction can be attributed to RE's proactive measures to promote sustainable commuting practices among its workforces.

To encourage eco-friendly commuting RE offers a comprehensive travel plan package to its employees. This package includes initiatives such as a green travel grant, which is a monetary incentive granted to employees that opt for climate friendly modes of transport, RE also provides free charging for electric vehicles at the workplace and access to electric bicycles. Additionally, following the experience during covid pandemic, RE supports flexible working arrangements, including the option to work from home, which can significantly reduce the need for daily commuting.

Employee Business Travel:

RE employees regularly travel to attend conferences RE business meetings. In 2023 emissions from work related flights were 375 tonne CO_2-eq. This is a 210% increase from 2016. Likewise, emissions from hotel stays that accompany travel have increased by 140% since 2016, totalling 60 tonne CO_2-eq in 2023. Low emissions especially in 2020 and 2021 are explained by limited travel due to the covid pandemic.

OR Conferences:

RE accounts for all air travel and hotel stays by foreign guests for conferences hosted by RE. In 2023, for the first time, Carbfix hosted a Mineralization Summit, inviting participants from all over the world. Total emissions from participants traveling to the Mineralization Summit was 85 tonnes CO_2-eq.

The summit was held both on-site in Reykjavik and via streaming. This hybrid approach not only promoted message but also had a positive impact on the environment. RE will continue to provide the chance for remote participation in its events.

Out of scope emissions

Reykjavik Energy (RE) reports its biogenic CO_2 emissions separately, adhering to the guidelines of the ISO 14064-1 standard. These emissions originate from the biofuel blend included in the fossil fuels RE purchases, as well as from methane fuel. In 2023, RE's total biogenic CO_2 emissions amounted to 45 tonnes of CO_2-equivalent.

Wastewater discharge releases biogenic CO_2 emissions, these have not been quantified and are not included in RE's total biogenic CO_2 emissions.

GHG breakdown in scope 1

The greenhouse gases (GHGs) that are released directly into the atmosphere because of Reykjavik Energy's (RE) operations are carbon dioxide (CO_2), methane (CH_4), sulfur hexafluoride (SF_6), nitrous oxide (N_2O), tetrafluoroethane (HFC-134a) and R454c, a mixture between HFC-32 and HFC-1234yf. Table 3 describes RE's GHG emissions in Scope 1.

Carbon dioxide (CO_2) is released from the operation of geothermal powerplants and due to research and maintenance drilling in the high-temperature geothermal fields. Furthermore, CO_2 is in the steam utility and due to the operation of fixed and mobile back-up power stations in the supply and distribution system. CO_2 is also released due to the burning of fuel in RE's car fleet.

Methane (CH_4) is released from the operation of geothermal powerplants and due to research and maintenance drilling in the high-temperature geothermal fields. Furthermore, CH_4 is released due to the decomposition of organic substances in wastewater discharge in the ocean, landfilling of waste and the burning of fossil fuels in RE's car fleet.

Nitrous oxide (N_2O) is released due to the decomposition of organic substances as wastewater is discharged in the ocean, due to the burning of fossil fuels in RE's car fleet and as fertilizers are used in land reclamation and afforestation projects.

Hydrofluorocarbons (HFCs) such as tetrafluoroethane (HFC-134a) and R454c are used in the water utility system for cooling air and to prevent moisture forming on pipes, e.g. in airtight pumping stations.

Sulfur hexafluoride (SF_6) is used in electrical equipment in geothermal power plants, in supply and distribution systems, and it can be released when it leaks from the equipment. SF_6 can also be released during tracer flow tests (TFT) in high temperature boreholes.

Table 3: Reykjavik Energy's greenhouse gas (GHG) emissions (tonne) in Scope 1, by various source in 2023

	Scope 1, tonnes GHG						
Source:	**Geothermal power plants**	**Steam utility**	**Wastewater discharge**	**Fuel use (TTW)**	**HFCs and SF_6**	**Fertilizer**	**Total 2023**
CO_2	45,324	125	0	538	0	0	**45,987**
CH_4	123	0	0	0.01	0	0	**123**
N_2O	0	0	9	0.03	0	0.002	**9.02**
SF_6	0	0	0	0	0.001	0	**0.001**
HFC-134a	0	0	0	0	0	0	
R454c	0	0	0	0	0	0	
Total CO_2-eq	**48,779**	**125**	**5,827**	**545**	**25**	**0.63**	**51,863**

CO_2
45,987 tonnes

CH_4
123 tonnes

N_2O
9 tonnes

SF_6
1 kg

HFCs
0 kg

R454c
0 kg

Emissions intensity of energy

Reykjavik Energy's (RE) emissions intensity of its energy production, electricity, and heating, refers to the amount of GHG emitted per unit of energy generated. It is one of the measures that quantifies the environmental impact of producing energy. RE expresses its emissions intensity for electricity in grams of CO_2 equivalent per kilowatt-hour(gCO_2-eq/kWh) and for heating grams of CO_2 equivalent per cubic meter (gCO_2-eq /m^3). The emission factors (hot water and electricity) for power plants are calculated as total power plant emissions, divided by total energy (heat and electricity). The hot water emission factor is further calculated by applying the fraction of hot water in relation to total hot water production.

In 2023, the emissions intensity for electricity is 7.3 gCO_2-eq/kWh which represents a 10% decrease compared to 2016. The emissions intensity for heating is 205.2 gCO_2-eq /m^3 which represents a 2% increase compared to 2016. This is due to increased hot water production from power plants in relation to total hot water production. See Table 4.

Table 4: Emissions intensity for electricity in gCO_2-eq/kWh) and for heating gCO_2/m^3.

	Unit	User scope	2016	2017	2018	2019	2020	2021	2022	2023
Electricity	gCO_2-eq/ kWh	Scope 2	9.9	6.9	8.4	8.9	7.9	7.3	7.5	7.3
Hot water	gCO_2-eq/m^3	Scope 2	245.0	190.5	207.9	214.7	213.0	216.2	231.3	205.2
Electricity-distribution	gCO_2-eq/ kWh	Scope 3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Hot water-distribution	gCO_2-eq/m^3	Scope 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity-upstream	gCO_2-eq/ kWh	Scope 3	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Hot water-upstream	gCO_2-eq/m^3	Scope 3	44.7	49.4	44.5	43.3	48.6	53.5	55.5	50.3

Energy production

Reykjavik Energy (RE) produces renewable energy, electricity, and heating, from sources such as geothermal energy and hydropower. RE utilises about 12% of produced electricity and a 1% of its heating for its own operations.

Table 5: RE energy production from 2016-2023

	Unit	2016	2017	2018	2019	2020	2021	2022	2023
Electricity	GWh	3,400	3,500	3,500	3,500	3,600	3,550	3,450	3,500
Hot water*	GWh	5,000	5,000	5,700	5,400	5,300	5,400	5,400	6,400
High temperature fields	-	*2,200*	*2,100*	*2,600*	*2,300*	*2,200*	*2,700*	*2,800*	*3,100*
Low temperature fields	-	*2,800*	*2,900*	*3,100*	*3,100*	*3,100*	*2,700*	*2,600*	*3,300*

3,500
GWh
7.3
g CO_2-eq/kWh

6,400
GWh
205.2
g CO_2-eq/m^3

Greenhouse gas sequestration and offsetting

Biodiversity and land-based carbon insetting projects

Reykjavik Energy (RE) has undertaken land reclamation and afforestation on the company's own land for more than 70 years, RE since 1950. These nature-based projects aim to restore soil and vegetation cover, improve soil, rejuvenate natural birch forests, and enhance biodiversity. In the past decade, an additional goal has been to sequester greenhouse gases GHG) in vegetation and soil, and thereby aligning RE's land management strategies with climate change mitigation efforts. The synergy between these objectives is beneficial. Land restoration in Iceland is a work of patience due toweather conditions and lack of essential nutrients in the soil which are limiting factors for vegetation and soil biota growth.

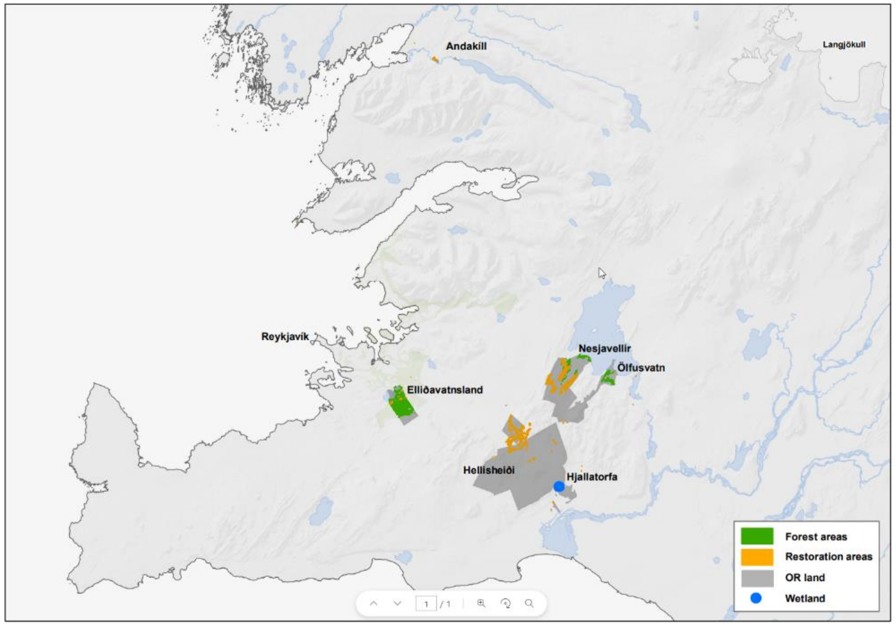

Figure 7: Overview of RE's own land in SV-Iceland and delineation of the afforestation projects, land reclamation projects and rewetting of peatland.

Rewetting of peatland on RE's land took place in the fall of 2016 with the aim of reducing carbon emissions from the land and restoring wetland ecosystems.

The locations of the land-based carbon insetting projects are presented in Figure 7 and 8.

Strengthening of biodiversity in vegetation and soil on RE's own land is and will continue to be a part of the goals of nature-based solutions at OR.

Afforestation Projects:

RE's afforestation projects are all practiced within the companies own land, that is Ölfusvatn and Nesjavellir (starting in the year 1990) in Grímsnes- and Grafningshreppur municipality and at Ellidavatn in the Reykjavík City municipality (starting in the year 1950).

In the beginning, the reclamation areas where unvegetated RE sparsely vegetated areas with less than 20% vegetation cover and are mostly binding areas (carbon sinks).

Afforestation takes place on land that is fenced off so that grazing livestock are kept out of the area. These fenced areas demarcate potential planting areas and are roughly 965 ha. There are more areas on RE's land that could be fenced off and afforested in the future. Expanding afforestation sites by 4 hectares annually remains a key goal. Iceland's large areas of sparsely vegetated ecosystems have a relatively high potential to act as carbon sinks. The soil sequestration is added to the aboveground sequestration.

4% increase in sequestration from land reclamation projects from base year, 2016.

Sequestration in 2023 amounts to 5,740 tonnes CO_2-eq and is the same compared to baseline year, 2016. The explanation for this is that at within 10-year intervals an assessment is done on the sequestration and is thus the same for one decade. See Table 2.

Land Reclamation Projects:

Land reclamation projects are mostly carried out on land owned by RE at Hellisheidi, (Kolviðarhól) and Hjallatorfa in Ölfus Municipality, at Nesjavellir in Grímsnes and Grafningshreppur Municipality and in Andakíl in Borgarbyggd and Skorradalshreppur municipalities. These areas account for about 87% of all RE's land reclamation sites. Around 8% of the land reclamation areas is carried out on lands owned by the state in Hellisheidi, where RE has a license for operations, as well as on private land leased from ÍR by RE 5%. These areas are around 595 ha.

Initially, all land reclamation areas where unvegetated RE sparsely vegetated areas, with less than 20% vegetation cover and are mostly binding areas (carbon sinks). The oldest reclamation area is in Heidmörk (starting in 1950), but other areas from 1990 to 2022.

The restoration method (grass seeding, fertilization, moss spreading etc.) suitable for each area is assessed and documented in RE's GIS database in Arc map and revised every year. Expanding land reclamation sites by 4 hectares annually remains a key goal. The soil sequestration is added to the vegetation sequestration.

Sequestration in 2023 amount to 1,250 tonnes CO_2-eq and has increased by 4% compared to baseline year 2016, see Table 2.

Rewetting of Peatland Projects:

In the fall 2016 rewetting of peatland took place on a 3.2 ha of land, Ytri Thurá, owned by OR, in Ölfus Municipality, see Figure 7 and 8. Prior to the wetland excavation the land was peat and the vegetation included peat moss.

To rise the water level in the land to as natural level as possible, trenches were filled. The results of the rewetting seem to be in accordance with other similar studies, both in Iceland and in other countries within the coniferous forest belt. During a visual inspection in the fall of 2023, it was evident the recovery had been successful.

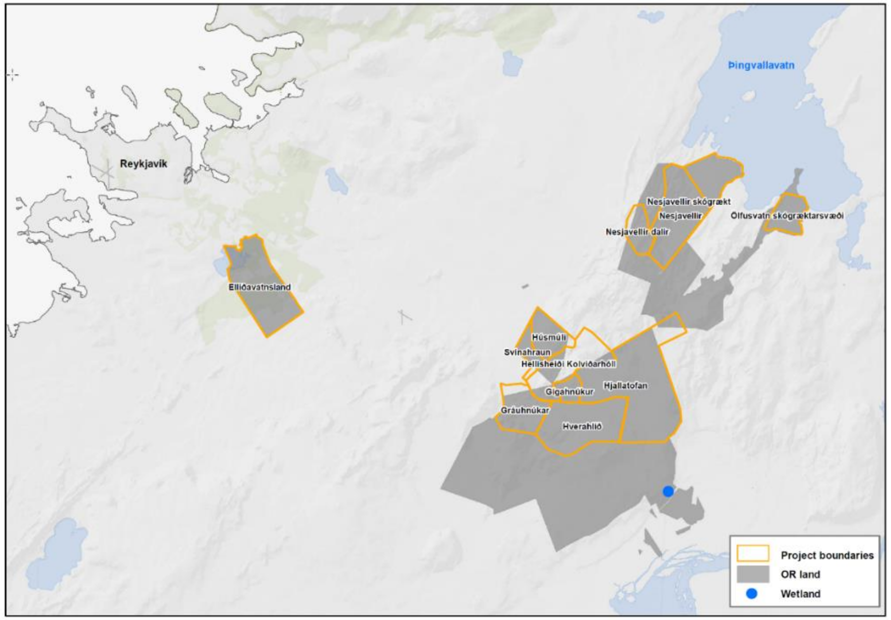

Figure 8: Project boundaries (close up) of afforestation, land reclamation and rewetting of peatland on RE's land.Figure 7: Project boundaries (close up) of afforestation, land reclamation and rewetting of peatland on RE's land.

Avoided emissions from the rewetted land is 40 tonnes CO_2-eq and is estimated the same since 2017, a year after the rewetting took place in the fall 2016. See Table 2.

A specialized study is scheduled to be conducted in the area during the summer of 2024 to verify the effectiveness of the initiative. Continuous monitoring and evaluation of these rewetted lands are essential for guiding future decisions regarding renewable energy strategies in peatland management.

Carbon offsetting projects

OR has actively engaged in carbon offsetting projects since 2018. These projects focus on both reducing GHG emissions and fostering sustainable development and socio-economic benefits.

RIPPLE Africa's Improved Cookstove Project in Malawi: Supported since 2020, this United Nations Carbon Offset Platform project. In 2023 RE has offsett 1,200 tonnes CO_2-eq which has increased by 86% compared to 2020, see Table 2. By supporting the Malawi project, it not only reduces GHG emissions but also combats deforestation and respiratory diseases, especially among women and children. RE's aim is to continue the support for this program.

Votlendissjóður:

From 2018 to 2021, RE supported this initiative, focusing on reducing GHG emissions through wetland restoration in Iceland. This collaboration with various stakeholders helped offset between 500 to 1,250 tonnes CO_2-eq of RE's carbon emissions these years, see Table 2.

Figure 8. Birch planted in sparsely vegetated areas near Ölfusvatn Photo by Magnea Magnúsdóttir.

Methodology

Significance criteria

All scope 1 and scope 2 emissions are estimated as significant. To evaluate significant emissions in scope 3 significance categories with significance criteria are used. Emissions sources only needs to fulfil one of these to be considered significant. These criteria are defined in Table 6.

Table 6: Definition of significance categories and significance criteria

	Significance category	Significance criteria
1	Magnitude	**Significant if** emissions are more than 5% of RE's total emissions
2	Outsourcing	**Significant if** emission is due to activities that RE outsources. This applies to borehole drilling projects which are a key activity in the operations of Veitur's utility systems, geothermal power plants, and carbon sequestration. This also applies to trench digging which is an important part of Veitur's and Ljósleidarinn operations.
3	Employee commuting	**Significant if** emission is due to employee commute to and from work as well as business-related travel.
4	OR sector-specific guidance	**Significant if** sector-specific guidance for RE emphasises specific emission categories, for example from the GHG Protocol RE SBTi
5	Availability of data	**Significant if** activity data is readily available

Included greenhouse gases

Table 7 displays the greenhouse gases released directly in RE's operations, with the main ones being carbon dioxide (CO_2), methane (CH_4), sulfur hexafluoride (SF_6), hydrofluorocarbon (HFC-134a), and nitrous oxide (N_2O). There are other GHGs that may be released indirectly in RE's value chain.

In RE's climate account AR5 and GWP 100 is used for converting GHG's into CO_2-eq, following guidelines from the UNFCCC[2]. This is also consistent with the Environmental Association of Iceland (EAI)[3] as well as the UK Department for Energy Security and Net Zero (DEFRA)[4] that use AR5 for their emissions factors.

Table 7: GHGs released in RE's operations

Greenhouse gas	GWP (100) AR5	Explanation
Carbon dioxide (CO_2)	1	CO_2 is released from the operations of ON's geothermal powerplants as well as due to research and maintenance drilling in the power plant areas, in the operations of Veitur's low-temperature areas and due to the operation of fixed and mobile power stations in Veitur's utility systems. Furthermore, CO_2 is released from the combustion of fuels in the RE's car fleet and rental cars as well as other places in the supply chain.
Methane (CH_4)	28	CH_4 is released from the operations of geothermal powerplants and due to research and maintenance drilling in the powerplant areas. Furthermore, CH_4 is released due to the decomposition of sewage sludge in the sea, landfilling of waist and fuel combustion.
Nitrous oxide (N_2O)	265	N_2O is released to the use of fertilizers, decomposition of sewage waste in the ocean and fuel combustion.
Hydrofluorocarbons (HFCs) HFC-134a	1.300	HFCs can be released in Veitur's freshwater utility where it is used in air conditioning in pumping stations. This gas is being phased out by R454c.
R454c	148	R454c can be released in Veitur's freshwater utility where it is used in air conditioning in pumping stations.
Sulfur hexafluoride (SF_6)	23.500	SF_6 is used in transformers at the geothermal powerplants, it can also be released during trace flow test (TFT).It can also be released in Veitur's utility where it is used as a insulator for transformers.

[2] Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention: https://unfccc.int/sites/default/files/resource/cp2022_10a01_adv.pdf#page=23

[3]EAI:https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.ust.is%2Flibrary%2Fsida%2FLoft%2FLosunarstu%25c3%25b0lar_UST_6.0.1.xlsx&wdOrigin=BROWSELINK

[4] DEFRA: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fassets.publishing.service.gov.uk%2Fmedia%2F649c5340bb13dc0012b2e2b6%2Fghg-conversion-factors-2023-condensed-set-update.xlsx&wdOrigin=BROWSELINK

Exclusions

RE's climate account includes all scope 1 and 2 emissions, as well as scope 3 emissions that fall within the significance criteria. Scope 1 activities that have negligible emissions, and as a result are not included in the climate account are listed below. Identifies scope 3 activities that are excluded are also listed and explained below.

Andakílsárvirkjun hydroelectric power plant (scope 1):

Andakílsárvirkjun is an 8MWe plant that was commissioned in 1947 RE almost 80 years ago. Since 2001, the power plant has been owned by RE Group. The power plant generates power from the fall of Andakílsár running from the power plant's intake reservoir, Andakílsárlón, with the water source being from Skorradalsvatn. The release of GHGs from the intake reservoir and Skorradalsvatn after 80 years of operation is considered insignificant and therefore excluded from RE's GHG accounting.

Low temperature geothermal fields (scope 1):

Veitur Utilities operates low temperature geothermal fields for hot water in the capital region. Direct emissions from these fields are negligible and therefore not included. Emissions from procurement and fuel use associated with the operation of low temperature fields are included.

Hydrogen usage (scope 1):

Emissions due to hydrogen usage in the vehicle fleet are not included as the hydrogen used is produced at the geothermal power plant at Hellisheidi and therefore already included in scope 1. No GHGs are released from the use phase of hydrogen.

Server hosting (scope 3):

Ljósleiðarinn is responsible for building and managing the fibre-optic cables for homes and businesses, which are used by telecommunications companies. Ljósleiðarinn does not sell internet subscriptions to consumers. As Ljósleiðarinn does not sell the telecommunication services themselves, emissions form data transmission (server hosting) is not included.

Wholesale electricity trading (scope 3):

RE buys and sells electricity from 3rd parties. Emissions from the production of this electricity can be included in scope 3, and in the GHG protocol is described as purchased electricity sold to end users. This emissions category falls within the significance criteria but is excluded due to confidentiality issues.

Other emissions (scope 3):

Other scope 3 activities and emissions sources have been identified but are excluded as they fall outside of the significance criteria. This is the use of taxis, electricity use during remote work and purchases made outside of the procurement system. Emissions from taxis as well as homeworking do not fulfil the criteria of magnitude, sector specific guidance or activity data. Emissions from purchases made outside of the procurement system are estimated at x% of the total value of procurement. RE is actively working towards gaining a better understanding and overview of these emissions.

Wastewater discharge (out of scope):

Biogenic CO_2 emissions are not included in RE's out of scope emissions. Biogenic CO_2 emissions have not been quantified in the IPCC standard used to estimate wastewater GHG emissions.

Changes in methodology and corrections

Considerable changes have been made to RE's climate account from previous publications. The scope as well as the methodology of the climate account has been expanded and evaluated in all scopes to better reflect the impact of RE's operations. Emissions categories have been added, and some existing categories have been corrected from previous publications. Key changes made in each of the scopes are listed below.

Scope 1

In scope 1 the largest emissions source that was added is the wastewater discharge, which has previously not been accounted for. Other added emissions sources in scope one includes the steam utility and the fertilizer used in afforestation and land reclamation projects. Emissions from the geothermal powerplants were adjusted to be rounded to the nearest ten where previous publications have rounded to the nearest hundred.

Scope 2

In scope 2 the market-based approach was added. Scope 2 also corrected previous years location-based approach where emissions purchased from 3rd parties, including transmission losses purchased by RE had not been accounted for in scope 2.

Scope 3

In scope 3 all emission categories are new except for waste, employee commute, business air travel, and trench digging by contractors. Previously published emissions from businesses air travel were corrected to include the effect of emissions at higher altitudes, applying a radiative forcing factor of 3. For contractor emissions the methodology was changed, and emissions were estimated based on data directly from contractors.

Emission factors

Emissions factors are selected to give the best and most accurate reflection of the GHG emissions from Reykjavik Energy (RE). Emission factors RE similar information that is received directly from the producer RE supplier have priority. This applies to direct emissions from RE's geothermal power plants, which are measured and published by RE staff. It also applies to, for example, specific 3rd party verified emission factors provided by suppliers.

When specific emission factors from suppliers are not available, then emission factors applicable specifically to Iceland, and RE emission factors provided by the Icelandic environmental agency (EAI)[5] are used. This applies for example to employees commuting to and from work. Emission factors designed specifically for Iceland are not always available, not specific enough RE sufficiently disaggregated by GHG. Then emission factors from DEFRA are used. This applies for example to waste, where the Icelandic emission factors do not have enough waste categories. RE for fuel use where the Icelandic emission factors are not disaggregated by GHG nor does the Icelandic dataset contain WTT emissions. This also applies to procurement where supplier information is not available and there are no emission factors formulated specifically for Iceland. Should it not be possible to use any of the above emissions factors then RE uses information from lifecycle assessments (LCA) for example form the Ecoinvent database[6].

Emission factors for scope 1are given in table 8, scope 2 in table 9 and scope 3 in table 10.

Table 8: Scope 1 emission factors.

Emission source	Activity data unit	Emission factor (EMF)[1] - kg GHG							Uncertainty	Data source
		CO_2	CH_4	N_2O	HFC	R454c	SF_6	CO_2-eq		
Geothermal power plants		X	X					N/A	12.5%	Direct measurement at emission source
Steam utility in Hveragerdi town		X	X					N/A	100%	Direct measurement at emission source
Wastewater discharge – BOD[2]	kg BOD		0					0	233%	EMF: G. A. Auðunsson
Wastewater discharge - N	Kg N			0,008				2,08	2,495%	EMF: IPCC table 6.8A
Fuel use TTW[3] Petrol	Litres	2,08	0,00029	0,00002				2,1	10%	EMF: DEFRA
Fuel use TTW[3] Disel	Litres	2,48	0,00001	0,00012				2,51	10%	EMF: DEFRA
Fuel use TTW[3] Methane (CH_4 and N_2O)	Nm^3							0,002	10%	EMF: EAI
SF_6	Kg SF_6						1	23.500	10%	EMF: IPCC page. 16
HCF-134a	Kg HCF-134a				1			1.300	10%	EMF: IPCC page. 17
R454c	Kg R454c					1		148	10%	EMF: Gas supplier
Fertilizer for land reclamation and afforestation	Kg N			0,016				4,16	10%	EMF: EAI

[1]The EMF can be variable between years. Table shows EMF for 2023, EMF for previous years may differ. The most recent EMF, from the "Data source" column is used.

[5] EAI Umhverfisstofnun | Losunarstuðlar (ust.is)

[6] Ecoinvent: https://ecoinvent.org/

Table 9: Scope 2 emission factors.

[2]CH_4 does not form due to high oxygen saturation, high ocean currents, and little to no sediment formation from discharge.
[3]Tank to wheel (TTW)

Emission source	Activity data unit	Emission factor (EMF)[1] – kg GHG							Uncertainty	Data source
		CO_2	CH_4	N_2O	HFC	R454c	SF_6	CO_2-eq		
Electricity – Location based OR[2]	kWh							0,0073	1%	EMF_{ON}: OR
Electricity – Location based Iceland[3]	kWh							0,00854	1%	$EMF_{Iceland}$:EAI
Heating – Location based	m^3							0	1%	EMF: OR
Electricity – Market based[4]	kWh							510,71	1%	EMF: Orkustofnun
Heating – Market based	m^3							0	1%	EMF: OR

[1]The EMF can be variable between years. Table shows EMF for 2023, EMF for previous years may differ. The most recent EMF, from the "Data source" column is used.
[2]The EMF from RE is applied to electricity from RE and used to avoid double counting with scope 1.
[3]The EMF form the EAI is applied to electricity purchased from 3[rd] parties.
[4]Residual mix EMF from 2022 is used for 2023, EMF for 2023 was not available at the publishing of this report.

Table 10: Scope 3 emission factors.

Emission source	Activity data unit	Emission factor (EMF)[1] – kg GHG							Uncertainty	Data source
		CO_2	CH_4	N_2O	HFC	R454c	SF_6	CO_2-eq		
Purchased capital goods[2]	Piece/m/kg							Variable	60%	EMF: DEFRA supplier LCA
Purchased goods[2]	Piece/m/kg							Variable	60%	EMF: DEFRA supplier LCA
Trench digging by contractors	m							0,00054	50%	EMF: Suppliers
Drilling by contractors – diesel	Litres	2,48	0,00001	0,00012				2,51	20%	EMF: DEFRA
Transportation of goods[3]	ISK							Variable	70%	EMF: DEFRA
Upstream emissions of purchased electricity[4]	kWh							0,00065	1%	EMF: Supplier LCA
Transmission losses	kWh							0,00854	1%	EMF: EAI
Fuel use WTT[5] Petrol	Litres							0,58	10%	EMF: DEFRA
Fuel use WTT[5] Disel	Litres							0,61	10%	EMF: DEFRA
Fuel use WTT[5] Methane (CH_4 and N_2O)	Nm^3							0	0%	EMF: DEFRA
Transmission grid, SF_6	kg						1	23.500	5%	EMF: IPCC page. 16
Sewage waste - Screening waste (Combustion)	Tonne							684	35%	EMF: EAI
Sewage waste - Fat and grease (Combustion)	Tonne							684	35%	EMF: EAI
Sewage waste - Sludge from biological treatment (Landfill)	Tonne							700,21	35%	EMF: DEFRA
Sewage waste – Sand (Landfill)	Tonne							0	35%	EMF: DEFRA
Waste – General (Combustion)	Tonne							21,3	35%	EMF: DEFRA
Waste – Bulk (Landfill)	Tonne							1,2	35%	EMF: DEFRA
Waste – Asbestos (Landfill)	Tonne							5,9	35%	EMF: DEFRA

Table 10: Scope 3 emission factors. Continued.

Emission source	Activity data unit	Emission factor (EMF)[1] – kg GHG							Uncertainty	Data source
		CO_2	CH_4	N_2O	HFC	R454c	SF_6	CO_2-eq		
Waste – Metal (Closed loop)	Tonne							0,99	35%	EMF: DEFRA
Waste – Timper, unpainted (Composting)	Tonne							8,9	35%	EMF: DEFRA
Waste – Timber, painted (Landfill)	Tonne							925.3	35%	EMF: DEFRA
Waste – Garden waste (Landfill)	Tonne							646,6	35%	EMF: DEFRA
Waste – Glass and minerals (Landfill)	Tonne							8,89	35%	EMF: DEFRA
Waste – Tyres (Closed loop)	Tonne							21,3	35%	EMF: DEFRA

Emission source	Activity data unit	Emission factor (EMF)[1] – kg GHG							Uncertainty	Data source
		CO_2	CH_4	N_2O	HFC	R454c	SF_6	CO_2-eq		
Waste – Plastic (Combustion)	Tonne							21,3	35%	EMF: DEFRA
Waste – Corrugated cardboard (Closed loop)	Tonne							21,3	35%	EMF: DEFRA
Waste – Mixed cardboard (Closed loop)	Tonne							21,3	35%	EMF: DEFRA
Waste – Office paper (Closed loop)	Tonne							21,3	35%	EMF: DEFRA
Waste – Newspapers and magazines (Closed loop)	Tonne							21,3	35%	EMF: DEFRA
Waste – Organic (Composting)	Tonne							8,9	35%	EMF: DEFRA
Hazardous Waste – Unknown material (Landfill)	Tonne							497	35%	EMF: DEFRA
Hazardous Waste – Light bulbs (Landfill)	Tonne							8,89	35%	EMF: DEFRA
Hazardous Waste – Batteries (Open loop)	Tonne							21,3	35%	EMF: DEFRA
Hazardous Waste – Accumulators (Open loop)	Tonne							21,3	35%	EMF: DEFRA
Hazardous Waste – Electrical items (Open loop)	Tonne							21,3	35%	EMF: DEFRA
Hazardous Waste – Paint and printing waste (Landfill)	Tonne							520	35%	EMF: DEFRA
Hazardous Waste – Oil and oil contaminated waste (Landfill)	Tonne							520	35%	EMF: DEFRA
Hazardous Waste – Plaster (Landfill)	Tonne							71,95	35%	EMF: DEFRA
Hazardous Waste – Solvents	Tonne							0	35%	EMF: EAI
Hazardous Waste – Organic hazardous material and cooking oil	Tonne							0	35%	EMF: EAI
Hazardous Waste – Inorganic hazardous material	Tonne							0	35%	EMF: EAI
Employee commute[6] – Petrol/diesel	km travelled							0,2	5%	EMF: EAI
Employee commute – EV[6]	km travelled							0	5%	EMF: EAI
Employee commute – Plug in hybrid[7]	km travelled							0	5%	EMF: EAI
Employee commute – Full hybrid[7]	km travelled							0,137	5%	EMF: EAI

Employee commute – Methane	km travelled	0,0026	5%	EMF: EAI
Employee commute – Motorcycle	km travelled	0,067	5%	EMF: EAI
Employee commute[8] – Carpool	km travelled	0,1	5%	EMF: EAI
Employee commute – Walking/bike/scooter	km travelled	0	5%	EMF: EAI
Employee commute[9] – Bus/Strætó	km travelled	0,051	5%	EMF: EAI
Business travel – Air travel[10]	Passengers per trip	Variable	45%	EMF: ICAO
Business travel – Hotel stays[11]	Nights	38,8	5%	EMF: DEFRA
Downstream event related travel[10]	Passengers per trip	Variable	45%	EMF: ICAO

[1]The EMF can be variable between years. Table shows EMF for 2023, EMF for previous years may differ. The most recent EMF, from the "Data source" column is used.
[2]Includes purchased made in the procurement system and any major purchased made outside the procurement system. All emissions paid for in the reporting year are included as emissions in the same year.
[3]Only freight services directly paid for by RE, indirect freight services included in purchased goods and capital goods. Average EMF of land, sea and air transportation used.
[4]Only purchased and used electricity from suppliers other than ON Power, upstream emissions from heating and electricity from ON power is already included in scope 1.
[5]Well to Tank (WTT)
[6]EMF is adjusted from EAI. Diesel and petrol average.
[7]In-house charging assumed to cover transportation to and from work
[8]EMF is adjusted from EAI. Average of 2 people assumed in diesel/petrol car.
[9]EMF is adjusted from EAI. Diesel bus with average of 15 passengers assumed.
[10]EMF is not used as different emissions are different between destinations. Radiative Forcing Factor of 3 is applied to EMFs from the ICAO. See Radiative Forcing Associated with Emissions from Air Travel and Lee, et.al, 2021
[11]Average of all DEFRA hotel stay EMFs

Methodology for Biodiversity and Land Based Carbon Insetting Projects

This section discusses the methodology for estimating emissions and sequestration related to land reclamation and afforestation, as well as the rewetting of wetlands.

Significance criteria:

All scope 1 emissions in the carbon insetting projects, such as those due to fuel use and fertilizer use are counted for and reported in RE's greenhouse gas accounting. Emissions due to fuel use (TTW) and fertilizer use are specified in RE's carbon accounting under scope 1, for both afforestation and land reclamation, but there is no fertilizer use in rewetting peatland. They are the largest contributors to emissions from land reclamation and afforestation. No electricity RE heating (scope 2) is purchased for these projects. Indirect emissions in scope 3 must meet significance criteria to be included in the greenhouse gas accounting, sources like fuel use (WTT) and commuting of employees to the carbon insetting sites. Missions such as fence maintenance, tools, safety clothing and production of grass seeds are not significant and therefore excluded. The significance criteria are defined in Table 6.

Included greenhouse gases for Biodiversity and Land Based Carbon Insetting Projects:

Table 11 shows the GHG released directly in RE's carbon insetting projects, i.e. carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).

Table 11: GHGs released in RE's carbon insetting projects

Greenhouse gas	GWP (100) AR5	Explanation
Carbon dioxide (CO_2)	1	CO_2 is released form fuel use (TTW) and (WTT).
Methane (CH_4)	28	CH_4 is released from decay of biological material.
Nitrous oxide (N_2O)	265	N_2O is released to the use of fertilizers.

Exclusions for Biodiversity and Land Based Carbon Insetting Projects:

RE's climate account includes all scope 1 and 2 emissions, as well as scope 3 emissions that fall within the significance criteria. Scope 1 activities that have negligible emissions, and as a result are not included in the climate account are listed below. Identifies scope 3 activities that are excluded are also listed and explained below.

<u>Land use activities (scope 1)</u>. Where land that is distributed in RE's operations is restored and reclaimed. Nature-based restoration activities of disrupted land are considered to compensate for the emissions caused by the disruption, making the emissions arising from the disruption negligible. The sequestration from the land reclamation of disrupted areas is therefore not included in the carbon sequestration calculations.

<u>Categories that do not meet significance criteria (scope 3)</u>, are fuel use of contractors, fencing and fencing maintenance, purchases such as tools, safety clothing, production of grass seeds.

Sparsely vegetated RE bare land. Carbon sequestration RE emission from land owned by RE where there has been no land use, land reclamation, RE afforestation are not accounted for, as emissions from sparsely vegetated RE bare land are considered negligible according to the National Inventory Report 2023, section 6.10.1, (CRF 4F1).

Changes in methodology and corrections of Biodiversity and Land Based Carbon Insetting Projects:

Considerable changes have been made to RE's climate account from previous publications. The scope as well as the methodology of the climate account of carbon insetting projects has been reviewed, described, and evaluated to better reflect the impact of RE's sequestration projects. Ownership of land and sites have been better described to increase transparency, background emissions due to organic breakdown have been included, as well as impact of trees from nurseries and production of grass seeds. Furthermore, uncertainties have been assessed as well as risk assessment accomplished.

Sequestration and emission factors:

Table 12: Scope 3 sequestration factors and uncertainty. An overview of the sites and projects where afforestation, land reclamation and rewetting of peatland have taken place 2016-2023

Reykjavik Energy (RE) is involved in various projects that contribute to the land-based carbon sequestration and emissions of carbon dioxide in vegetation and soil, through afforestation, land reclamation, and peatland restoration activities. Sequestration factors and emission factors are selected to give the best and most accurate reflection of RE's GHG sequestration and emissions. Sequestration factors and emission factors are selected to give the best and most accurate reflection of RE's GHG sequestration and emissions, Table 12 below. Please note that emissions factors due to fuel and fertilizer us in land-based carbon offsetting projects is discussed in the section on Emission factors above, page 25-27.

Sequestration factors RE similar information that is received directly from RE have priority. This applies to sequestration in afforestation which are RE-specific, that is which are measured on RE's land and published by the Agricultural University of Iceland[7,8,9] and the Environment Agency of Iceland. When specific RE sequestration factors are not available, then sequestration factors are used which are applicable to Icelandic conditions and published by the Environment Agency of Iceland[10] and a new agency, Land og skógur, e.g. merging of the Soil Conservation Service of Iceland[11], and the Icelandic Forest Service[12]. This applies for example to land reclamation sites and rewetted peatland.

If no Iceland-specific sequestration factors are available, general IPCC factors, which are also used in Iceland's National Inventory Report, are used.

Sequestration source (site)	Project	Sequestration factor unit (tonn CO_2-eq/ha)	Uncertainty (95% confidence interval)	Sequestration factor source
Afforestation - sequestration above ground				
Heiðmörk	Young forest <10 years	0.67	23%	Icelandic[1]
Heiðmörk	Conifer forest <5m	7.8	23%	RE[2]
Heiðmörk	Conifer forest >5m	15.2	23%	RE[2]
Heiðmörk	Mixed forest	3.2	23%	RE[2]
Heiðmörk	Natural birch forest	1.2	23%	RE[2]
Ölfusvatn	Conifer forest	8.0	50%	RE[2]
Ölfusvatn	Planted birch forest	0.4	50%	RE[2]
Nesjavellir	Planted birch forest	0.6	50%	RE[2]
Nesjavellir	Natural birch forest	0.7	50%	RE[2]

[7] Carbon sequestration and growth of different forest types in three forests in South-West Iceland. Heiðmörk, Nesjavellir and Ölfusvatn https://skemman.is/handle/1946/45738
[8] Measurement of carbon sequestration of different forest types (Sigurddson et al, 2008) https://timarit.is/page/7489640?iabr=on#page/n301/mode/2up
[9] Joel Owona (soil carbon slope [a], table 20) https://skemman.is/bitstream/1946/34470/1/Joel%27s%20thesis_%20AUI_final.pdf
[10] National Inventory Report 2023 (pg. 234. Table 6.22): https://ust.is/library/Skrar/loft/NIR/ISL_NIR%202023_15%20april_on_web.pdf
[11] Landgræðsla https://land.is/
[12] Skógraektin https://www.skogur.is/is

Table 12: Scope 3 sequestration factors and uncertainty. An overview of the sites and projects where afforestation, land reclamation and rewetting of peatland have taken place 2016-2023. Continued.

Heiðmörk	Young forest <10 years	0.67	23%	Icelandic[1]
Heiðmörk	Conifer forest <5m	7.8	23%	RE[2]
Heiðmörk	Conifer forest >5m	15.2	23%	RE[2]
Heiðmörk	Mixed forest	3.2	23%	RE[2]
Heiðmörk	Natural birch forest	1.2	23%	RE[2]
Ölfusvatn	Conifer forest	8.0	50%	RE[2]
Ölfusvatn	Planted birch forest	0.4	50%	RE[2]
Nesjavellir	Planted birch forest	0.6	50%	RE[2]
Nesjavellir	Natural birch forest	0.7	50%	RE[2]
Land reclamation - revegetation				
Hellisheiði Kolviðarhóll	Grassland/Mossy Heathland/Heathland	2.1	20%	Icelandic[5]
Hellisheiði Húsmúli	Grassland/Mossy Heathland/Heathland	2.1	20%	Icelandic[5]
Hellisheiði Svínahraun	Grassland/Mossy Heathland/Heathland	2.1	20%	Icelandic[5]
Hellisheiði Gráuhnjúkar	Grassland/Mossy Heathland/Heathland	2.1	20%	Icelandic[5]
Hellisheiði Hverahlíð	Grassland/Mossy Heathland/Heathland	2.1	20%	Icelandic[5]
Hellisheiði Hjallatorfa	Grassland/Mossy Heathland/Heathland	2.1	20%	Icelandic[5]
Nesjavellir dalir	Grassland/Mossy Heathland/Heathland)	2.1	20%	Icelandic[5]
Nesjavellir	Grassland/Mossy Heathland/Heathland	2.1	20%	Icelandic[5]
Andakíll	Grassland/Mossy Heathland/Heathland	2.1	20%	Icelandic[5]
Heiðmörk	Grassland/Mossy Heathland/Heathland	2.1	20%	Icelandic[5]

Sequestration source (site)	Project	Sequestration factor unit (tonn CO_2-eq/ha)	Uncertainty (95% confidence interval)	Sequestration factor source
Soil sequestration in afforestation sites				
Heiðmörk	Afforestation	1.50	85%	RE[2]
Ölfusvatn	Afforestation	1.50	85%	RE[2]
Nesjavellir	Afforestation	1.50	85%	RE[6]
Rewetted peatland				
Hjallatorfa	Peatland	13.5	83%	Icelandic[7]
Emissions deducted from sequestration				
All	All land reclamation projects	0		Icelandic[5]
All	Coniferous and mixed forests	0.3		Icelandic[5]

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Young forest	All afforestation projects	0.2478	LCA[8]

[1] Measurement of carbon sequestration of different forest types (Sigurddson et al, 2008)
[2] Carbon sequestration and growth of different forest types in three forests in South-West Iceland. Heiðmörk, Nesjavellir and Ölfusvatn (Viðarsson, G.J, 2023) (Table 11 pg. 46)
[3] Carbon sequestration and growth of different forest types in three forests in South-West Iceland. Heiðmörk, Nesjavellir and Ölfusvatn (Viðarsson, G.J, 2023) (Table 12 pg. 47)
[4] Carbon sequestration and growth of different forest types in three forests in South-West Iceland. Heiðmörk, Nesjavellir and Ölfusvatn (Viðarsson, G.J, 2023) (Table 13 pg. 48)
[5] National Inventory Report 2023 (pg. 234, Table 6.22)
[6] Changes in carbon-stock and soil properties following afforestation in SW Iceland Owona, J., 2019 (soil carbon slope [a], table 20)
[7] Losun gróðurhúsalofttegunda úr votlendi. Yfirlit umræðu og rannsókna VSÓ, 2020.
[8] Estimated from: Life cycle assessment of a field-grown red maple tree
[9] National Inventory Report 2023 (pg. 200, Table 6.5)